NEW LOOK FOR COMMUNICATIONS SATELLITES

electronics today INTERNATIONAL

DECEMBER 1977

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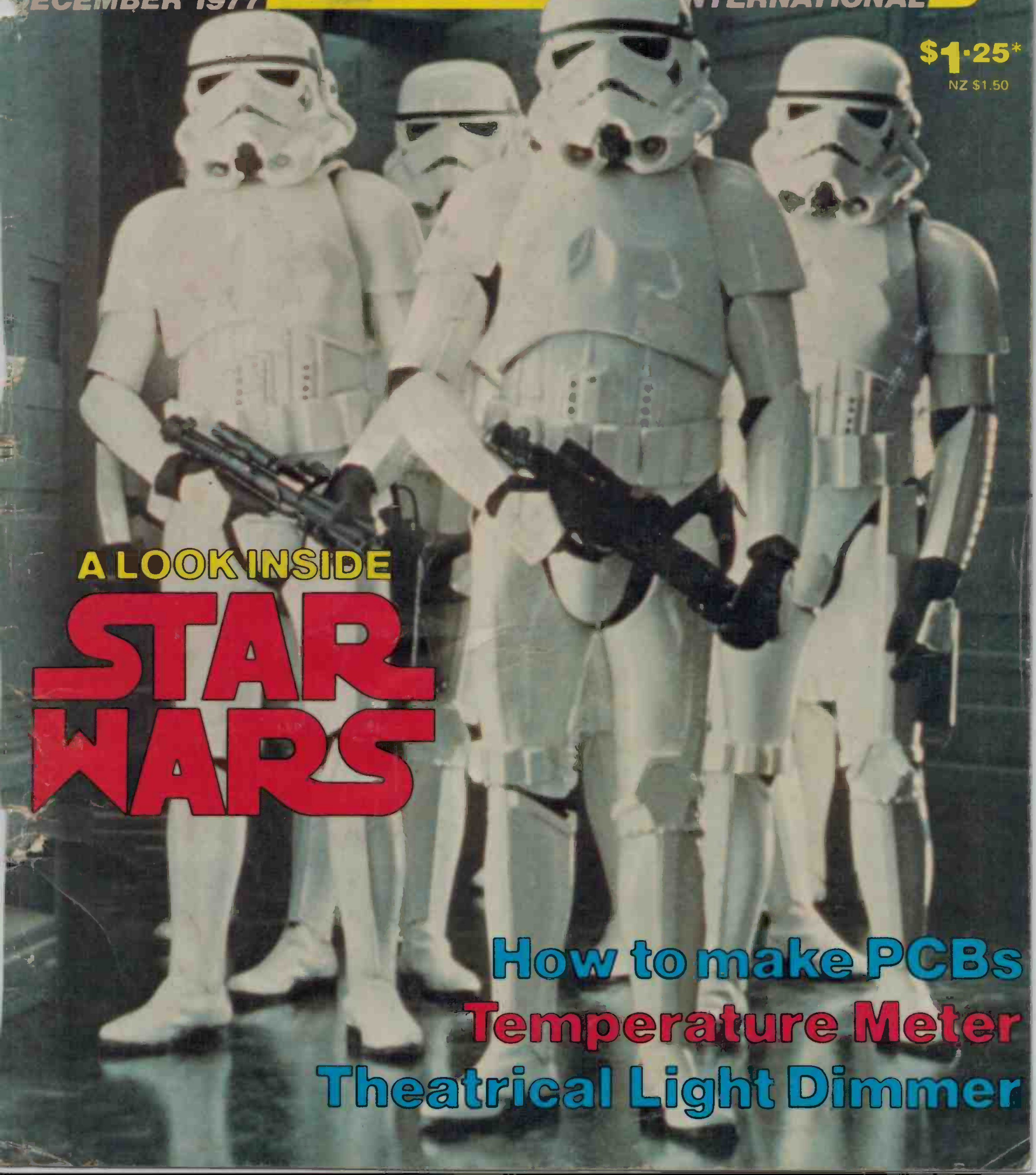

A LOOK INSIDE
STAR WARS

How to make PCBs
Temperature Meter
Theatrical Light Dimmer

AUSTRALIAN OWNED AND PRODUCED

December 1977, Vol. 7 No. 12

electronics today INTERNATIONAL

Editorial: Les Bell

Publisher: Collyn Rivers

716 VHF Power Amp

We regret that, owing to production difficulties, we have had to postpone publication of this project until next month.

Cover: The success story of 1977 for the cinematographic world at least must be Star Wars. With the help of Twentieth Century Fox, we look inside the robots and behind the scenes.

A Modern Magazines Publication
* Recomended retail price only.

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PROJECTS

FEATURES

NEWS & INFORMATION

News Digest

True-RMS (THD) Analyser

A new true-RMS distortion analyser/ac voltmeter/low-distortion oscillator from Hewlett-Packard can make true harmonic distortion measurements as low as 0.0018% from 10 Hz to 110 kHz, including harmonics to 330 kHz. The Model 339A Distortion Measurement Set is designed for use by engineers in audio, broadcast, hi-fi and amplifier design and development.

As a distortion analyser, the 339A measures THD from 0.01% full scale to 100% full scale (-80 dB to 0 dB) in nine ranges. Frequency resolution is two digits over the full range. Automatic set level and nulling is standard in the instrument. Accuracy from 20 Hz to 20 kHz is ±1 dB.

As a true-RMS voltmeter, the 339A measures inputs from 1 millivolt RMS to 300 volts RMS full scale over the range from 10 Hz to 110 kHz, and is calibrated in volts, dBV and dBm into 600 ohms. Accuracy from 20 Hz to 20 kHz is ±2%; from 10 Hz to 110 kHz is ±4%.

As a low-distortion oscillator, the 339A provides a sine wave output from 10 Hz to 110 kHz, with distortion from 20 Hz to 20 kHz specified as low as 0.0018%. Accuracy is ±2% of the selected frequency. The output level is adjustable from less than 1 millivolt RMS to greater than 3 volts RMS into a 600 ohm load with a 10 dB per step attenuator and 10 dB vernier control.

True RMS measurements are more accurate than average readings when testing high distortion levels of non-linear systems or measuring receiver sensitivity performance (SINAD measurements). Rapid and more accurate THD measurements are possible because of the built-in automatic tuning and set level features. A built-in tracking oscillator eliminates the need to find the fundamental frequency and tune the 339A for a null. Front-panel lights indicate when the input range setting is improper.

All FCC-required features for broadcast testing are included in the 339A These are: am detector, 30 kHz low-pass filter and switchable VU meter ballistics. Hum and noise filters, a high level monitor output and floating input are also standard. Duty free price of the Hewlett-Packard Model 339A Distortion Measurement Set is $2090. Duty and Sales Tax are additional, if applicable. Further details are available from your local HP sales office.

VLSI's Progress

That Japanese VLSI programme is ploughing onwards, the latest product being a static 4K RAM with 57 ns access time (that's fast!). It uses a single 5 V supply and is fully TTL compatible.

Illuminated Switch

A Melbourne based electronics company has developed a unique range of 12 volt illuminated toggle switches suitable for automotive and marine applications. The requirement for separate warning lights is eliminated as the toggle section of the switch is illuminated.

Available with conventional or duck bill toggle, the units feature plain or printed bezels for a variety of functions. A range of pre-drilled mounting panels to suit the toggle switches is also available. Further information can be obtained from Swann Electronics Pty. Ltd., P.O. Box 350, Mt. Waverley, Victoria.

4096 – Stage BBD

Matsushita have developed a new bucket-brigade device, the MN3005, with 4096 stages, which can provide up to 205 ms delays.

New Chartwell Monitor

Chartwell have developed a monitor unit which is claimed to have the most faithful sound reproduction so far achieved by a unit up to a maximum rated output of 116 dBA at 1 metre.

The performance of the model PM450 loudspeaker is derived from using a polypropylene plastic to make the cone in the 305 mm diameter bass/mid driver. This plastic does not have to be doped, so no sensitivity is lost. The cone material has a mechanical Q-factor of only 8. It has low density and a high Youngs modulus of elasticity. The voice coil assembly uses high temperature adhesive and an ultra-light high temperature former, permitting a continuous operating temperature of 200°C.

High frequency signals are reproduced by a soft dome, 25 mm unit which employs an aluminium voice-coil former and generates low accoustic colouration.

The loudspeaker is available in two versions. One has a high signal level cross-over fitted with generously rated air-cored chokes and close tolerance polycarbonate capacitors, and requires a normal external power amplifier. The other version, the PM450 Electronic, contains an integrated pre-amplifier, low signal level electronic equaliser and power amplifiers and accepts balanced audio input signals. The filter enables this unit to be equalised to closer tolerances than is possible with the high level cross-over version.

INCOMPARABLE NEW TRANSCEIVER

Powerful Car stereo

A car stereo speaker system more powerful than many home hi-fi units has been introduced to Australia. The Beltek S 5029B speaker system can produce 25 watts music power per channel when driven by a matching power amplifier. The Beltek system will be marketed throughout Australia by the HMV Electronics Division of EMI. It was introduced to meet demand for increasingly sophisticated and powerful car sound systems.

"Many young panel van owners have adapted domestic stereo systems to fit their vans", the managing director of HMV Electronics Division, Mr. N.F. Jones, said this week.

The Beltek system matches a separate power amplifier to two dual-cone 23cm by 15cm speakers. The speakers can be connected directly to a car radio or cassette player but use with the amplifier is recommended for maximum performance. Mr. Jones said the new system was developed to match the range of Beltek car radios, cassette players and AM/FM radio-cassette units introduced to Australia recently. For further information please contact EMI (Australia) Limited, 2-18 Parramatta Road, Homebush NSW 2140.

Portable Noise Monitor

The Model 614 is the only self-contained portable noise monitor with automatic on-site calculation and print-out of airport, community, traffic and industrial noise levels and relevant time of day information. It is a sound level meter that measures, calculates and prints out A-weighted sound pressure levels.

Features include: automatic, unattended on-site calculations with hard copy printout, printout of hourly, daily, L percentiles and Single Event noise levels and 7 day operation with two removable, rechargeable battery packs.

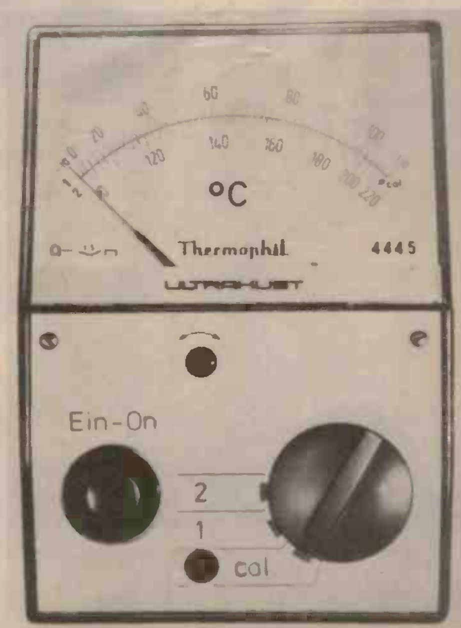
For further information, please contact:–
John Morris Pty. Ltd.,
P.O. Box 80,
Chatswood. NSW, 2067.

AP-C2

No, not out of Star Wars! Auto-Place Inc. of Troy, Michigan, manufactures an industrial robot which uses a General Electric TN-2000 Imager camera at the end of its arm to search for an object in a limited field of view and grasp it whichever way it is oriented. The processing is done by an Imsai 8080 microprocessor.

2464

Production starts early next year at Intel of the 2464 CCD memory chip. The 18 pin 64k memory can be thought of as a rotating drum with 256 tracks of 256 bits per track. Data can be transferred in a serial manner at up to 1 MHz in the first mode of operation but an alternative mode enables data to be transferred from a single page of the memory at 2.5 MHz. In this mode one can visualise the 2464 as a 256 high stack of 256 bit RAMs. Other modes of operation are search and standby.



Temperature Meter

The Ultrakust Thermophil Type 4445 is a relatively inexpensive, handy, small instrument for fast measurements on surfaces, in liquids and gases as well as plastics. A wide range of interchangeable semiconductor sensing elements are available to suit innumerable applications. Temperature range is from -10°C to 220°C, subdivided into two scales. Accuracy is Class 1.5 and the unit operates from 9 volt batteries having approximately 100 working hours operation. Continuous measurements can be made without recalibrating. The unit operates on the Wheatstone bridge principle with the sensing element located on one arm of the circuit. For further information, please contact:–
John Morris Pty. Ltd.,
P.O. Box 80,
Chatswood, NSW, 2067.

18 GHz Frequency Counter

The Hewlett-Packard Model 5342A Microwave Frequency Counter comes in a lightweight, portable package and measures frequency from 10 Hz to 18 GHz with a resolution of 1 Hz on an 11-digit LED display. A new unique rf design is used to accomplish the harmonic heterodyne technique of frequency down-conversion. This provides wide FM tolerance, high input sensitivity, and automatic amplitude discrimination.

From the easy-to-use keyboard, the operator can define his own frequency offsets with a few keystrokes for fast receiver testing. Offsets may be positive or negative, and can be stored in memory for recall and display to the user. Frequency deviations about a given value are equally easy to monitor.

With the new amplitude measurement option (Option 002), the user can now see input level displayed in dBm (with 0.1 dBm resolution and ±1.5 dB accuracy) simultaneously with the input frequency (1 MHz resolution) without switching connectors.

Any three consecutive digits on the display can be converted into an alalog voltage output by adding the Digital-to-Analog Converter Option H01. This feature allows the user to monitor frequency drift with a strip chart recorder. Analog output voltage goes from zero volts with 000 displayed to 9.99 volts with 999 displayed.

Adding IEEE-488 (HP-IB) Option 011 permits remote programming of front and rear panel controls. Measurements can be fed to HP-IB compatible instruments, computing controllers or computers. Up to 80 readings per second can be obtained for frequency measurements; up to 10 measurements per second can be made for simultaneous amplitude/frequency data.

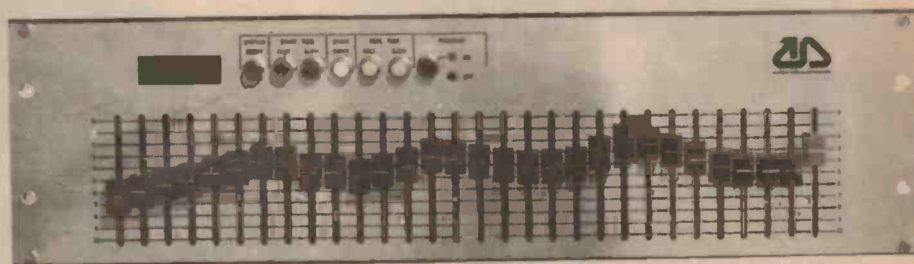
Duty free price of the Hewlett-Packard Model 5342A is $4950. Option 001, High Stability Time Base is $550. Option 002, Amplitude Measurement is $1100 additional. Option 003, Extended Dynamic Range is $415 additional. Option H01, Digital-to-Analog Converter is $275 additional. Option 011, HP-IB is $385 additional. Duty and Sales Tax are additional to all the above prices, if applicable. For further information contact your local HP office.

Getting to Know OSCAR

The Technical Book and Magazine Company Pty. Ltd. of 289-299 Swanston Street, Melbourne 3000, have sent us a copy of the ARRL publication, 'Getting to Know OSCAR', which is a reprint of a series of articles from QST. OSCAR is an acronym for Orbital Satellite Carrying Amateur Radio, and the book explains how to track the OSCAR satellites. OSCAR 6 is now defunct, but OSCAR 7 lives on, and the first Phase III satellite will be launched next year, so OSCAR activity will once again be in the news. This book (which sells for $5.10 approximately) should be in every amateur's library. Who said ham radio was old-fashioned?

Project Electronics Kits

Dick Smith Electronics has released a range of kits based on projects from ETI's volume 'Project Electronics'. The kits, which are packaged in plastic hanger bags, contain all components including wire and solder and require only a soldering iron, wire strippers and cutters to put together. The kits are inexpensive and form a good introduction to electronics. They are available from any Dick Smith store or dealer.



What Is It?

No, it's not a third-octave graphic equalizer! This intriguing device is a programmable attenuator, model PA-30, made by Audio Developments Pty. Ltd., of 42 Sailor's Bay Road, Northbridge. It comprises a 24 hour digital clock which sequentially selects one of 30 slide fades at ½ hour intervals to control the level of an audio signal. This means that the level of background music in a shopping centre, say, can be varied automatically throughout the day to cope with the changing background noise. Cunning, eh? I wonder what else it can be used for?

Errata

In the November issue, in the Techniparts ad on page 72, the price of an MA1003 was incorrectly stated as $32.00 post free. This should have read $27.00 post free.

Way back in September, in Elmeasco's advertisement featuring the Fluke 8020A DMM, a photograph showed a price tag marked '$169'. The correct price, as stated in the text, is $179 plus tax.

On page 83 of the September issue, Figure 1, the circuit diagram of the Drunken Sailor Puzzle has a short circuit across the battery at the left end of the drawing. This should be ignored.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At last: Dick's Australian SSB CB

SCORPION SSB BASE

What have the Hy-gains, the Cobras, the Presidents, the Kracos, the Trams, the Universes, etc etc etc got in common? They're all American rigs, in some cases 'dumped' in this country. What have the Scorpion, Hornet, Wasp & Bumblbee got in common? They're DESIGNED FOR AUSTRALIA, by Australia's No. 1 CBer, Dick Smith!

Here it is — Dick's brilliant new 'Scorpion' SSB/AM base station. 18 channel, designed for Australia — with built-in power supplies for both 12V & 240V. Has LED readout, SWR meter (both meters are huge, easy-to-read types) and the finish is the latest 'black is beautiful' with contrasting chrome trim. An absolutely brilliant apppearance — our drawing just can't do it justice! If you want outstanding value for money in an outstanding set, you can't go past the Scorpion!

$299.50

OUR SPECIAL INTRODUCTORY OFFER: SAVE $50!! Retail price will be $349.50 (as per our press release) but buy now and the price is just $299.50 Cat D-1740

NEW 18 CHANNEL

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OUR OTHER TRUMP CARD: The 18 channel 'HORNET' SSB/AM set. The mobile SSB which will soon have everyone talking — to each other as well as talking about this superb set. LED digital readout: of course! Again, 'black is beautiful'. And look at the knobs. They're those large, specially shaped knobs which everyone wants — but very few have! Ideal for Australians! Up-to-the-minute electronics, full service back up (with spares!),not forgetting the 90 day warranty — a set you'll be proud to own, and one which will keep you happy for years! Cat D-1720

TEACH YOURSELF ELECTRONICS

with 150 in 1 experimenter's kit

A magnificent educational kit for both the inexperienced and advanced experimeter. Beautifully detailed manual describes in step by step instructions, how to make up to 150 different electronic projects. No soldering is required and the complete kit operates off harmless low voltage battery power. An enlarged transparent I.C. (integrated circuit) clearly shows the electronic layout of these most complex space age devices. As no soldering is required (connections are spring terminals) all components can be re-used time and time again. The kit includes the following electronic devices: Cadmium sulphide cell, solar cell, micro-ammeter, radio tuner, poteniometer, relay, I.C., speaker, signal light, microphone, earpiece, morse key, slide switch, transformer, etc. The separate projects are too numerous to list however, it has been said that the only thing that cannot be made is a television! Supplied in a sturdy wooden case. Dimensions 406 x 216 x 89mm. Batteries required: 1 x 9 Volt, 2 x 1.5 Volt.

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NEW LOOK FOR COMMUNICATIONS SATELLITES

The latest Intelsat V series of satellites promises greater capacity through the use of advanced technology. By Brian Dance.

IF ONE PICKS UP a telephone and makes an intercontinental call, the chances are that it will be connected through one of the satellites stationed over the Indian, Pacific or Atlantic oceans. The demand for international telecommunications has increased enormously during the past few years and increasingly sophisticated satellites have been placed in orbit to provide more and more channels. Most of the satellites currently in use are cylindrical in shape with solar cells on the outside of the body, but future trends are stretched arms so that all of the solar cells are directed towards the sun. These new look satellites will provide even more channels of communication than their predecessors.

About 80% of satellite traffic is for telephone use. Although long distance television signals produce quite an impact in millions of homes, television accounts for only about 2% of the use of global satellite communications. About 15% of the traffic is for data and message transmission. Apart from international communications, satellites are now used for communications across a single country such as Canada, Nigeria, Indonesia, etc. Satellites are used for conveying television signals to remote areas and it is rather interesting to note that the earth station which received more occasional television transmissions in 1975 than any other earth station was at Manaus — a Brazilian rubber port about 1400 km up the river Amazon!

History

A regular inter-continental telephone service was first introduced from London to New York in 1927 using a 60 kHz transmitter, but the first trans-Atlantic cable became available in 1956 with 48 speech circuits and provided much better quality and reliability. Reflections from the moon were used to provide a speech link across the U.S.A. in 1956, but our natural satellite is a poor reflector of radio waves and is too far away for low noise wide band signals.

The first artificial communications satellite, Echo 1, was a balloon about 30 m in diameter which was launched in 1960. Its aluminised surface reflected both radio waves and light very well; it formed a very bright object in the sky which has probably been seen by more people than any other man made object. Echo 1 orbited the earth in about two hours and acted as a passive reflector of radio waves so that it could be used to relay signals between Europe and the U.S.A. Echo 2 was rather similar, but the first television transmissions between the U.S.A. and Europe were carried by Telstar 1 in 1962; this satellite had its own transmitter operating on 4170 MHz with a power of 2.25 W, the power being provided by 3600 solar cells.

These and similar satellites had the severe disadvantage that they were visible from any earth station only for a short time — about 20 minutes in the case of Telstar 1 — and had to be followed across the sky by the earth station aerials. Complex systems using as many as 50 satellites were proposed so that continuous communications could be maintained, but each earth station would have required at least two aerials so that one could follow the satellite whilst the other searched for the next satellite coming above the horizon.

A much better system was proposed as long ago as 1929 in which satellites in circular orbits 36,000 km above the equator are used; such satellites have orbital periods of about 24 hours, so they can be made to appear stationary from a point on the earth. The early rockets did not have enough power to place a satellite in one of these geosynchronous orbits. In addition, it took time to develop the technology required to enable the satellites to be manoeuvred in orbit, etc. Satcom 1 was the first geosynchronous satellite launched in 1963, but all modern

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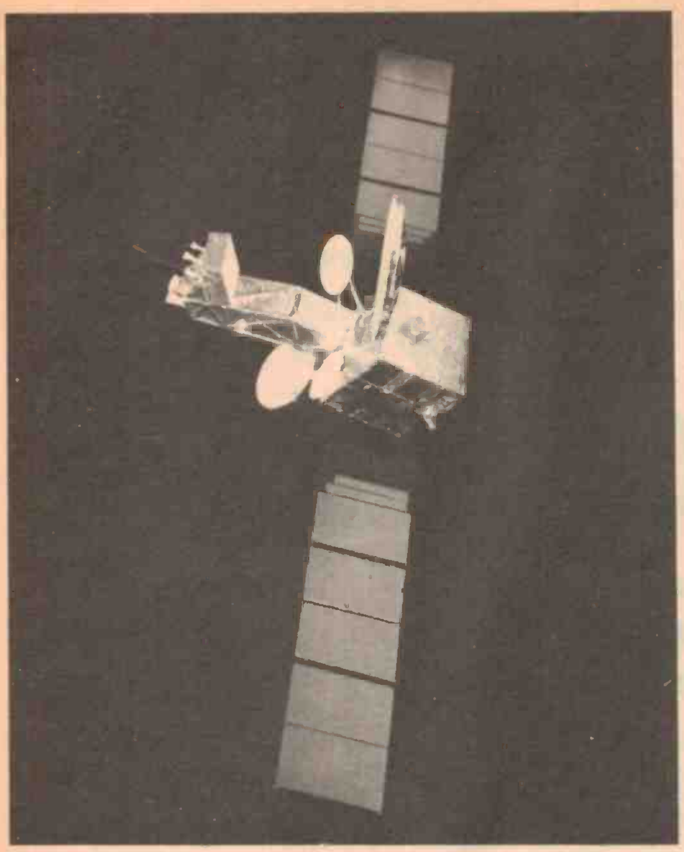

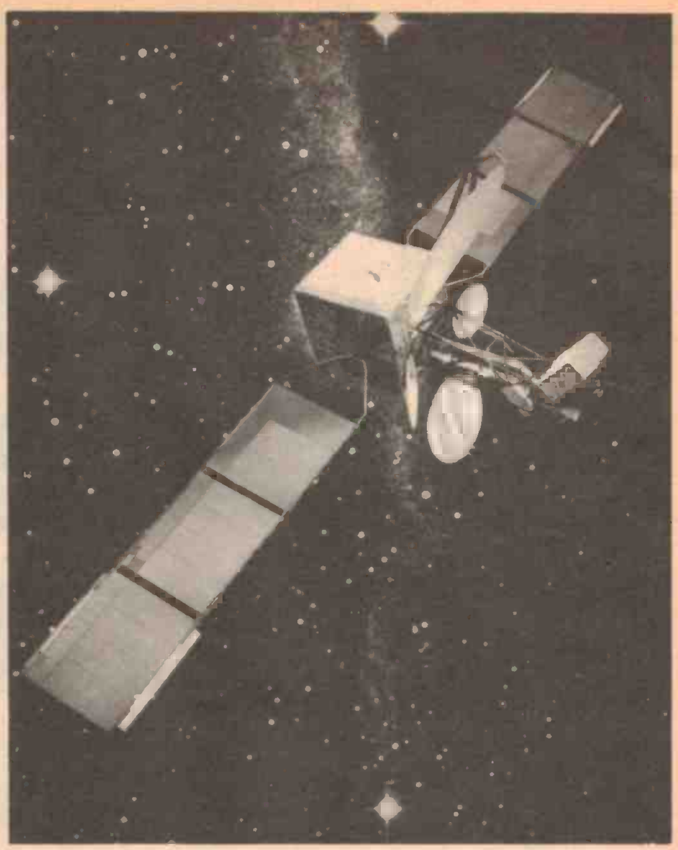

Figs 1 and 2. These two models show the outstretched solar arrays of the Intelsat V satellite.

continued from previous page

communications satellites are geosynchronous.

The International Telecommunications Satellite Organisation (INTELSAT) was founded in Washington in 1964 to provide telephone and television communications to all users on a non-discriminatory commercial basis. INTELSAT owns the satellites and leases circuits to numerous countries, but the earth stations are normally owned by the telecommunications authorities in the countries concerned.

The INTELSAT satellites launched up to the present time are known as the I, II, III, IV and IVA series, whilst a new type V series is planned for 1979. The first INTELSAT I ('Early Bird') could carry only 240 telephone conversations and could communicate with only two earth stations at any time. INTELSAT II ('Blue Bird') had the same capacity, but could operate with several ground stations simultaneously.

The INTELSAT III, IV and IVA vehicles have bodies which are spinning for optimum stability, the rate of spin being of the order of 1 revolution per second. The aerials are placed on a 'de-spun' shelf so that they point in a constant direction. Special lubricants are required for the bearings in the high vacuum of space which can operate over a wide temperature range. Failures occurred in over half of the INTELSAT III spacecraft, but a much greater proportion of the INTELSAT IV and IVA craft have provided the desired performance.

The aerials of the INTELSAT IV satellites include 'global' beams for covering the largest possible area of the earth (including remote islands) and spot beam antennae which provide a 4.5° beam for optimum communication with areas where the traffic density is very high. Each successive type of satellite provides more channels of communication. The main improvement in the IVA series is the use of directional aerials for the east and west beams so that the same frequencies can be used in both of these beams without mutual interference.

INTELSAT V

One of the main disadvantages of the cylindrical spin-stabilised craft is that only a small proportion of the solar cells on the cylindrical body are facing the sun at any one time. Thus the available power is much smaller than that which could be obtained from a satellite with a similar number of cells which all face the sun. The new INTELSAT V vehicles will therefore employ three axis body stabilisation with the solar cells on extendible arms which can be rotated so that all of the cells face the sun at all times. This type of system can provide about three times the power per square meter of solar cells than in a spinning satellite. The new satellites will use the 11GHz and 14 GHz bands for communications as well as the 4GHz and 6GHz bands used by the existing INTELSAT craft.

The contract for the supply of INTELSAT V vehicles was awarded to Aeronutronic Ford (now Ford Aerospace and Communications Corporation) in September 1976 at a cost of US $236 million for seven satellites with options on a further eight. Each INTELSAT V craft will have a capacity of about 12,000 telephone channels and 2 colour television channels. The first will be placed above the Atlantic to cater for the very heavy traffic in that region. The second will be a spare for the first, whilst the third is scheduled for the Indian Ocean (including Australian use). It is hoped to use the NASA space shuttles to launch some of these craft, since this should reduce the cost from about US $25 million to $15 million. All seven craft are due for launching by May 1981.

The INTELSAT V Atlantic satellites will employ space diversity with shaped beams to the east and west so that Europe and Africa are covered by the east beam and North and South America by the west beam. Thus the 500 MHz wide frequency band will be used twice, as in the current IVA craft. In addition, INTELSAT V will re-use the frequency spectrum a second time for the Northern Hemisphere where the traffic demand is heavy. This will be accomplished by polarising these additional beams perpendicularly to the normal beams. The simultaneous use of polarisation and directional isolation is one of the major technical challenges of INTELSAT V.

Frequencies

The current INTELSAT system employs frequencies in the 6 GHz band for transmission from the earth stations, whilst the satellites transmit in the 4 GHz band. These frequencies and other likely to be used are shown in Table 1.

The bandwidth at the lower frequencies is 500 MHz, but there is a 3.5 GHz bandwidth in the 19 and 29 GHz bands for the up and down links respectively. In general the use of the bands is shared with terrestrial services and there is a limit to the power which can be used to avoid interference. However, the frequencies of 19.7–21.2 GHz and 29.5 – 31.0 GHz are to be reserved exclusively for down and up satellite links respectively. The maximum permitted power in the 4 GHz band is -152 dBW/m^2/4 kHz at arrival angles of less than 5° rising to -142 dBW/m^2/4 kHz at arrival angles of 25° or more. These values are 2 dB higher in the 11 GHz band, whilst in the shared part of the 20 GHz band it is increased by a further 11 dB, but the latter is specified for a 1 MHz rather than a 4 kHz bandwidth.

From earth station to satellite (GHz)	From satellite to earth station (GHz)
5.925 – 6.425	3.7 – 4.2
12.5 – 12.75	10.7 – 10.95
14.0 – 14.5	11.2 – 11.45
27.5 – 31.0	17.7 – 21.20

TABLE 1. Frequencies used for satellite communications.

The greater available bandwidth and reduced chances of interference makes the use of the higher frequency bands very attractive, but one of the most fundamental obstacles to the use of frequencies above 10 GHz for satellite communications is the degradation of the signal by heavy rain in the vicinity of the receiving station. Rain and precipitation in the atmosphere not only attenuate the signal from a satellite, but cause depolarisation, increased noise and increased interference between terrestrial and satellite systems. Even when 4 GHz signals were being received from the early Telstar satellite, it was noted that the noise level increased when the receiving station was near heavy rain. The effects of rain can be overcome by the use of diversity techniques with switching between two or more receiving stations, but this is obviously expensive. The use of high transmitter power also helps to reduce the effects of rain.

Telemetry and command signals are transmitted to the satellites within the communications band, but outside the communications channels themselves. The INTELSAT IV spacecraft have 223 command channels.

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Fig 3. The antennas of the Intelsat III and IV satellites are 'de-spun' on a shelf.

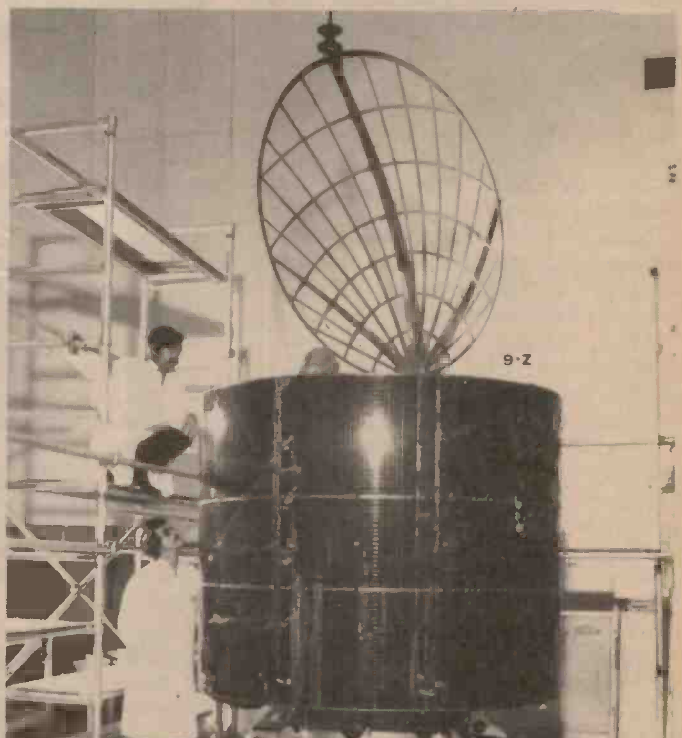


Fig 4. Intelsat satellites are not small, as can be seen here. The use of the Space Shuttle will reduce launch costs tremendously.

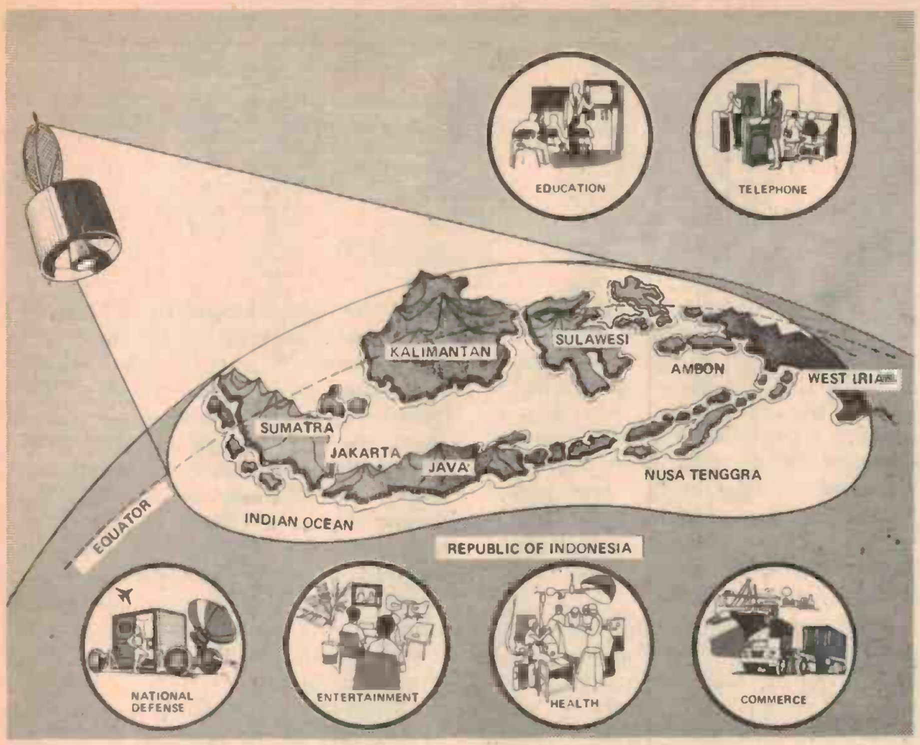


Fig 5. Satellite Communication is ideal for areas such as Indonesia.

Positional control

Gravitational fields due to the sun, moon, etc. and inhomogeneities in the earth's gravitational field cause small movements in the position of a geosynchronous satellite. Solar radiation pressure also produces a small effect which accumulates with time. The drift in the orbit inclination out of the equatorial plane is about 0.8° per year in the case of small inclinations. If uncorrected, the would cause the satellite to move progressively around in a figure of eight. In addition, a satellite is accelerated towards two stable points at 75°E and 105°W due to the non-uniformity of the earth's gravitational field.

When a satellite has moved from its desired position by a certain amount, small thruster jets operated by command signals from the earth cause it to return to the desired position. The gas jets used consist of a mixture of nitrogen and hydrogen obtained by admitting liquid hydrazine into a reaction chamber containing a catalyst which causes the liquid to separate into its two constituent elements. Jets can also be used to keep the aerials on the de-spun shelf of existing satellites pointing towards the earth with an accuracy of 0.1°; the reference direction may be obtained by an infra-red sensor detecting radiation from the earth and from the sun.

Although the use of geosynchronous satellites gives rise to the problems discussed, it brings many advantages, such as no Doppler shift of the signal frequency, few thermal stress cycles, low radiation environment, low magnetic fields, etc. The earth subtends an angle of about 18° at a geosynchronous satellite; a global beam from the satellite will cover about 4/10 of the earth's surface, so ground stations can be linked over great circle distances of up to 17,000 km.

Power levels

The variation of the signal power level at various points is extremely large. Let us trace the levels which are typical for a television signal being relayed from one amplifier in an earth transmitting station to the output of the amplifier of an earth receiving station.

The signal comes into the the transmitter power amplifier at a level of around 1 mW, but is amplified to a level of a few hundred watts before it is fed to the aerial at the centre of one of the giant 30 metre diameter dish aerials. This dish provides an effective gain of about a million by concentrating the power into a narrow beam; a power of a few hundred megawatts would be required to achieve the same signal level at the satellite if this power were radiated equally in all directions. This signal is attenuated by a factor of about 10^{20} its journey to the satellite, so it arrives at a level of a few picowatts. The satellite aerial provides a gain approaching one hundred and the satellite receiver amplifier a gain of about 100,000, so the signal leaves the receiver at a level of about 10 μW.

Power levels in the circuits from the satellite back to earth are of the order of one million times lower than those in the up path in many cases. The 10 μW signal from the satellite receiver is amplified to a level of about 10 W and fed to an aerial with a directional gain of about 50; the effective power radiated by the satellite is thus around 500 W. This suffers a loss of the order of 10^{20} in the down path, so it arrives at the ground station receiving aerial at a level of about 5 attowatts (1 attowatt = 10^{-18}W). However, the enormous receiving dish provides a gain of about a million to bring the signal level up to around 5 pW; without such a dish, the signal would be lost in noise. The signal is then amplified in the ground station receiver system so that its power level is brought up to about the 1mW level (similar to the level at which it arrived at the power amplifier of the ground station transmitter at the start of the cycle).

It is difficult to fully appreciate the enormous range of power levels involved. This range is some 10^{26} times or 260dB between the effective power radiated from the transmitting aerial of the earth station and the effective power level at the aerial of the receiving earth station.

Satellite repeaters

A satellite repeater accepts the incoming signal, amplifiers it, changes its frequency for the new band and amplifies the power level for re-transmission. Frequency modulation is normally employed for simplicity in both the up and down links, the modulation being identical in each case. In the Intelsat IV craft, the band is divided by a filter into 12 channels of 36 MHz each with a 40 MHz spacing of the centre frequencies.

The incoming signal in the 5.932 to 6.418 GHz region is fed to a tunnel diode amplifier operating at the signal frequency. It is then converted into a 2225 MHz signal for broadband amplification before being converted into a 4 GHz signal which is passed to a travelling wave tube for power amplification. These tubes offer efficiencies of about 30% and require a high voltage supply. There is a four fold redundancy in the electronic systems of a satellite to ensure reliability is high.

Tunnel diode amplifiers are simple and light in weight, but other amplifiers can be used in the receiver circuits of satellites. For example, the European Orbital Test Satellite (OTS) uses a parametric amplifier operating in the 11 and 14 GHz bands instead of a tunnel diode. It seems likely that gallium arsenide (GaAs) field effect transistors will

	First launch	Height cm	Mass in orbit (kg)	Power (W)	Effective Band-width (MHz)	Capacity (Voice circuits)	Design life (yr)	Cost per circuit per year (US dollars)
INTELSAT I	1965	59.6	38	42	50	240	1.5	32,000
INTELSAT II	1967	67.3	86	80	130	240	3	11,000
INTELSAT III	1968	104	152	120	500	1200	5	2,000
INTELSAT IV	1971	531	700	420	500	4000	7	1,200
INTELSAT IVA	1975	590	790	500	800	6000	7	1,100
INTELSAT V	1979	1570	1570	1200	2300	12000	7	800

TABLE II. The INTELSAT satellites.

replace tunnel diodes and possibly even travelling wave tubes at frequencies of up to at least 14 GHz.

Earth stations

The design of earth station equipment is very different from that of the circuits in the satellite, since the weight and size of the ground station aerial can be far greater than that of the satellite system. In addition, ample power is readily available at earth stations. The carrier power required from a satellite is approximately inversely proportional to the gain of the earth station aerial in the receiving direction (G_r) and directly proportional to the earth station noise temperature (T_s). Thus the factor G_r/T_s can be used as the figure of merit for an earth station which is conveniently expressed as $10\log_{10}$ (G_r/T_s) dB/°K. This figure of merit is an important parameter of an earth station, since it determines the traffic handling capability. The figure of merit is usually measured by pointing the aerial at a distant radio star so that the noise level may be compared with that of other aerials using the same star. This method is most satisfactory for large aerials, but the moon may be used for smaller 10 meter diameter dishes. For small aerials of up to 8 m diameter, it is more convenient to obtain the figure of merit from the noise temperature and gain.

All standard earth stations in the INTELSAT network must have a high figure of merit, namely 40.7 dB/°K. An aerial of at least 26 m diameter is required to obtain this figure, but a 30 m dish is normally used to give more flexibility in the positioning of low noise receivers by using longer wave guides with higher losses. The total weight of a '5th generation' standard aerial for INTELSAT use is about 300,000kg and the overall height some 28m.

The satellites are not quite stationary. A fixed antenna is unsatisfactory, since the aerial beam angle is narrow (about 0.2° at 6 GHz for a 30 m aerial). A servo system is usually used to control the movement of the aerial, the error signal being obtained by using a beacon signal emitted by the satellite. Most aerials are fully steerable and can be moved to operate with any satellite.

Earth station receivers

Some of the very early earth station receivers employed maser amplifiers in the first stage, but these amplifiers cannot operate over the wide bandwidth used in the INTELSAT system. A very low noise amplifier is essential to handle a low power signal over a 500 MHz bandwidth.

Parametric amplifiers cooled to about 15° K are usually employed. Such an amplifier can provide a gain of some 30dB with an effective noise temperature of about 15°K. It may be followed with a tunnel diode amplifier giving a gain of about 10dB or with a travelling wave tube amplifier. Continuously operating cryogenic cooling devices using gaseous helium have been developed in which the helium is re-circulated in a closed system.

Although the receiver noise temperature is about 15°K, this is increased by about 15°K by losses in the feeders, by 15°K by side lobe pick-up and by 25°K by atmospheric absorption. Thus the total effective noise temperature is about 70°K.

Each earth station receives a carrier from every other earth station with which it wishes to communicate. The number of carriers sent from stations is reduced to a minimum by using a single carrier for conveying signals to various destinations. Thus the number of transmitted carriers is lower than the number of signals received by various stations.

Earth station transmitters

The power required from an earth station transmitter depends on the aerial gain, on the geographical position and on the gain of the satellite system. The latter will depend on whether global or spot antennae are being employed and on the number of channels available. The required power can be obtained at the earth station by using narrow band transmitters (some tens of MHz) using klystrons or a wide band transmitter using travelling wave tubes (500 MHz bandwidth). If klystrons are used, each carrier is amplified to a suitable level in a separate transmitter and the outputs of the transmitters are combined before the signals are fed to the areial. This arrangement is used mainly in stations operating with relatively few carriers. The initial cost and the running costs are fairly small with klystrons, but long breaks are required to change frequencies.

Large stations operating with many carriers favour travelling wave tubes. The carriers are combined at low power and then are amplified by the wide band transmitter before being passed to the aerial. The non-linearity of the travelling wave tube produces some intermodulation products at the output and these must be limited by operating the tube some 10dB below its capability to prevent interference with other signals. Travelling wave tubes are more expensive and less efficient than klystrons in these circuits, but their wide band capability is very convenient.

Domestic satellites

There is a rapidly growing demand for communications via 'domestic' satellites across a single country. Signals from satellites used for this purpose can be concentrated within the boundaries of a nation, so smaller earth station aerials can be employed than for international communications where the beam energy must be more widely dispersed. For example, 10 m diameter antennae give G_r/T_s values of around 31 dB/°K, whilst 10 m antennae of G_r/T_s about 26 dB/°K are being delivered in the USA for receiving only television signals. Antennas of 2 to 3 m in diameter with a figure of merit of 14 to 20 dB/°K can be used in remote areas for providing 12 voice channels for emergency use or on oil drilling rigs, etc.

Telephone companies cannot charge such high rates for inland calls as they do for international calls, so the viability of domestic satellites is more severely limited by costs than that of international communications systems. However, domestic systems are now well established in countries such as Canada whose Telesat system provides television and voice communication

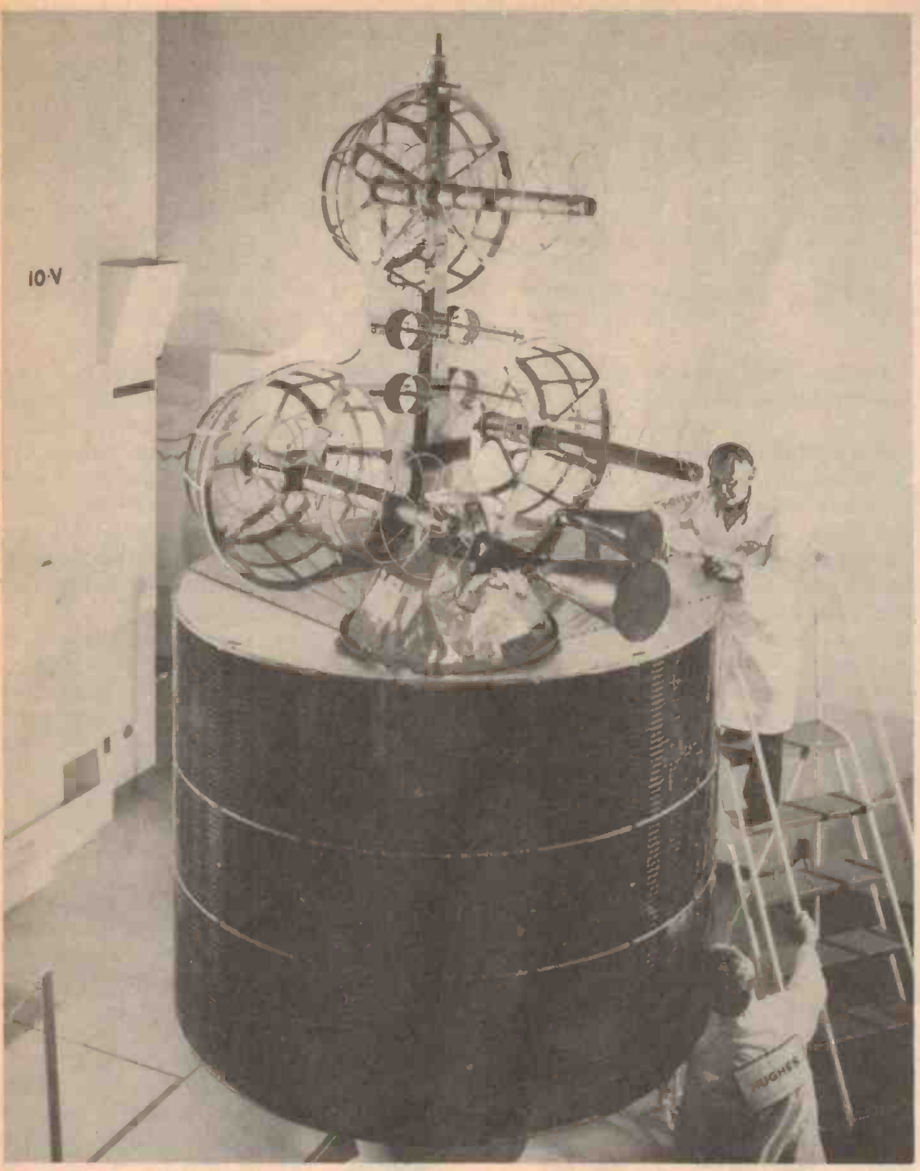


Fig 6. The Marisat satellites utilise an unusual and complex antenna array.

throughout the country, the USSR (mainly television), the USA, which has three systems provided by three different companies and various other countries.

Some countries, such as Spain and Mexico, have leased INTELSAT circuits for their domestic use, but the charges are high enough to make it more economical for most large countries to have their own system. In some cases a group of countries close together can jointly own a system.

Comparison with cables

Satellite communication links are generally cheaper than long distance cables operating under the ocean, but the cables have a minimum expected life of 25 years against 7 years for a satellite. It is uneconomic to connect remote islands by cable, so satellite or radio links are used. Satellites are essential for carrying high bandwidth signals (like television) over intercontinental distances. The new TAT-6 cable laid across the Atlantic can carry 4000 voice channels, but satellites of the IVA series can carry 6000 speech channels and some domestic satellites even more. Cables may be more vulnerable to enemy attack and communications are vital in war.

A peculiarity of a satellite link arises from the fact that the signal must travel rather over 36000 km to the satellite and a similar distance back to the earth. Thus there is a delay of about a quarter of a second before the signal reaches its destination and a delay of at least half a second before any response reaches the sender. If a signal received by a satellite was transmitted to another satellite before being returned to earth, the delay of a second or so before any response could be returned to a person might be unacceptable in ordinary telephone coversations. The longest delay on sub-oceanic cables is about 1/16 second.

Conclusions

Satellite communications are one of the most useful products of the huge investment in space technology. They have radically changed the pattern of world communications and confer outstanding benefits on the lives of ordinary people. It seems likely that satellites able to handle 100,000 telephone circuits will be developed without any great increase in the satellite mass. Improvements in frequency re-use, 3 axis body stabilisation, high efficiency solar cells, on board switching, hybrid modulators, etc. will provide great improvements. The life of satellites is partly limited by the life of the batteries used to provide power when the vehicle is eclipsed by the earth, but new nickel-hydrogen cells are showing great promise for this application.

Wharfedale: Uncompromising dedication to true fidelity.

The discerning listener has long been aware of the absolute purity of 'uncoloured' English sound.

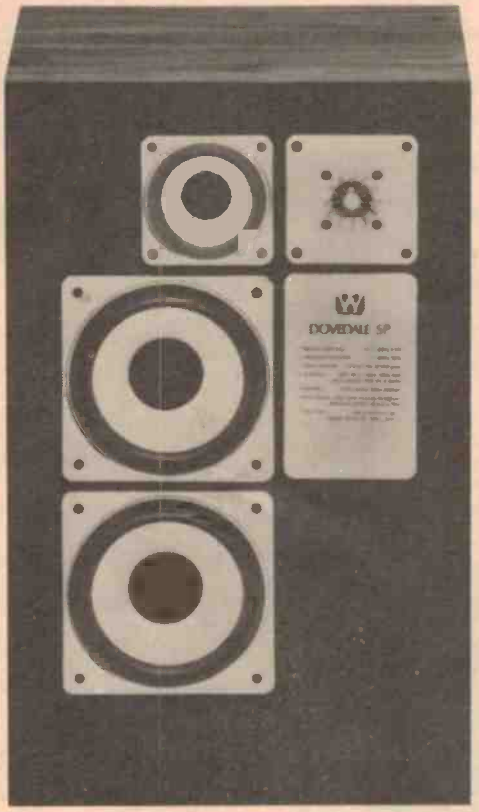
Wharfedale – Britain's largest manufacturers of hi-fi speakers – are dedicated to the design of speaker systems that exemplify this tradition.

Now Wharfedale speakers are fully imported into Australia.

Sold and serviced nationally by Rank Australia. Available at all leading Hi-Fi Specialists.

WHARFEDALE

Glendale 3XP. Larger bass drive than Linton with increased cabinet volume. Power handling 40 watts DIN.



Dovedale SP. 4 drive units including 2 small bass drivers for excellent bass response. Handles power of 60 watts DIN.

Linton 2XP. Separate, specially designed drive unit for bass, midrange and treble. Handles power of 40 watts DIN.

(Not illustrated)

Airdale SP. Top-of-the-range model with 4 specialist drive units in reflex-loaded enclosure. Power handling 100 watts DIN.

We Keep Performing

RANK AUSTRALIA

CU152/77

TV SHOPPING

A revolutionary new TV service gives tens of thousands of housewives up-to-the-minute news of store prices. By James Gold.

FOR 68,000 FAMILIES in the New York area and thousands more in various other American towns, grocery and drug shopping is as close as their television sets.

Subscribers of Cablevision, the pay-television service that comes into the home via cable rather than over the air waves, can sit back with their shopping lists and price 64 different items offered by 14 different supermarkets. At the same time — the service is broadcast from 4.30 pm continuously until 10.15 am the next day — shoppers can price 70 frequently prescribed drugs at 10 major drug stores.

A viewer studies the latest prices.

The televised surveys aren't advertisements, such as those shoppers pore over in the daily newspaper in an effort to save money on their food bills. And this fact makes the televised surveys distinctly advantageous. For the newspaper ads merely feature the prices of items each supermarket or drug store wishes to feature. And that leaves unanswered the question of which store has the best prices *overall*.

Both surveys are provided under contract with Cablevision by Vector Enterprises, a California-based company that was started three years ago by four computer experts.

In the case of the supermarket price survey in the New York area, each Monday four women who live nearby and are employed by Vector, go to the stores, gather the prices and telephone them three thousand miles away to California. An operator there feeds the prices into a computer that tabulates and stores them. In the evening a computer operated by Reuters News Service in Manhattan calls Vector's computer and takes the data which is then transmitted to Cablevision and sent out along the cable to its subscribers.

If it sounds complicated, it really isn't. The whole thing — after the surveys are completed — only takes a few seconds of whirring and blinking.

Each separate supermarket item and its price are shown on the screen for 20 seconds and after all have been shown individually, the totals are given for produce, meat, groceries and sundries. A grand total, computed to include the quantities of each item likely to be consumed by a family of four, is also given. Among the items surveyed are ground beef, stew beef, most kinds of steak, three kinds of roasts, beef, liver, bacon, whole frying chicken, two kinds of fish, apples, bananas, cantaloupe, tomatoes, potatoes, coffee, spaghetti, cereal, bleach, tissues, eggs, kidney beans and the cheapest brand of detergent on hand.

Why is the service being offered?

"It's not so much that we are being crusaders," said Alan Krause, programme director for the company, "although I look at the differences that show up among the various stores for the same item and I'm shocked. We really give our customers the opportunity to get an objective and fair assessment of what's on sale . . . before they have left the house and committed themselves by entering a particular store.

"Money is very tight everywhere," he added. "People are happy to save even a few dollars over the period of a week."

Cumulative

The supermarket survey has been shown on Cablevision since the end of 1975 and a look at the cumulative cost of the

148-item market basket over the period provides an interesting look at the pricing of various chains.

From December 29th 1975 to June 7th, 1976 . . . 24 weeks . . . the most expensive and the cheapest were separated by a difference of 17 percent overall, or $454.55 for all the items.

But some shoppers aren't all that interested in overall savings as the difference between many of the stores over a long period are not that great. They're more interested in saving on an item by item basis. They like to plan a shopping day, leaving a certain amount to be spent at one store with a special price on one product before going to another bargain elsewhere.

Many viewers say that they have made substantial savings, using both the newspaper advertisements and the television lists in conjunction.

A woman in Massapequa, a suburb about 40 miles east of New York City, said that she had shopped at the same supermarket for fifteen years — until she began keeping close tabs on the survey. "Then I realised that they weren't the cheapest by any means," she said. "I didn't switch over to another store completely, though. Because after looking at the surveys for a few weeks, I could see a pattern in pricing begin to emerge and I saw that some of the items it carried were cheaper. Now I shop at three or four stores, all nearby. The extra time travelling is worth it."

There are some who complain. Ernest Barbella, vice president of A & P on Long Island, has disputed the results of the survey that places them 12th out of 14 stores. "I know our price structure and there is no way we are 17 per cent higher than many other stores listed. I could believe one or two per cent because not all stores are the same."

A spokesman for Grand Union said that "it was no use commenting" because the surveys were not "scientifically conducted." The spokesman pointed out that inconsistencies in the survey make for big differences such as stores which might stock large and high quality items which must invariably cost more. "Some goods you wouldn't want to serve your family, no matter how much you could save," he said.

Useful Information

According to Russel Smith, president of Vector, the firm that conducts the surveys, consumers are left to draw their own conclusions from the data they see on their television screens. He also said that his firm never intended the survey as a guide to quality.

But Mr. Smith said he believed the information was useful and that the survey had proved popular. The service is already being offered in Los Angeles and on two stations in San Diego and will soon begin in Honolulu, Hawaii, Dover and Oakland, New Jersey and in Manhattan.

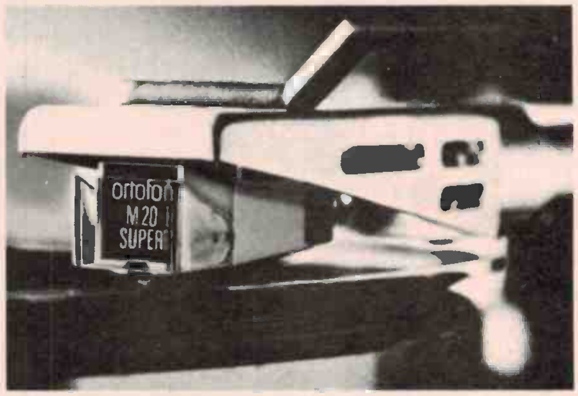
Since many markets already accept orders by phone and deliver them the possibilities for the future are intriguing indeed. Combined with the telephone, shopping may be only as difficult as sitting in an easy chair before the television with an extension nearby.

This is seen as a potential saviour for the elderly, bed-ridden and disabled in particular, and for very busy housewives and professional women who don't have the time to spend in the market but wish to retain some control over how much they spend and what they buy.

"Eventually what we are hoping for, is to show the actual product on the shelf, allowing the customer to shop by television by merely pressing a button when she sees what she wants," said Krause. "That, however, is a bit far off. But not as far as you would think . . ."

WHAT GOES IN MUST COME OUT.

Ortofon professional cutter head type DSS 732 in action.



Latest from Ortofon is the M 20 Super—a unique magnetic stereo cartridge, based on our exclusive world-patented Variable Magnetic Shunt (VMS) principle.

When it comes to perfection in recorded sound the principle is as simple as this:

What goes in must come out.

Which means that the response from the groove of your favourite record should be as close as possible to the sound of the original master tape.

With this in mind, we at Ortofon concentrate our activities in two areas only: the production of sophisticated cutting equipment for making master records—and the manufacture of the finest pick-up cartridges to play the discs which they produce.

Most of the major record companies use Ortofon cutters. And because it is only natural that the manufacturer who knows most about making the records should also know most about playing them, our cartridges for many years have been the choice of professionals and discerning music lovers throughout the world.

Ortofon do not make turntables, amplifiers or loudspeakers. We put all our experience into developing advanced products to cover the two most critical sectors in sound reproduction: the cutting and the playback of records.

For us accuracy in sound is more than just a slogan.

It's our reason for being in business.

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SOUND

DISCTRAKER

The subject of pickup arm damping has come in for a great deal of comment of late, particularly in connection with moving coil cartridges, and Decca Londons. Both moving coil cartridges, and Deccas are effectively undamped at the fundamental arm/cartridge resonance (this resonance being a fairly complex function related to pickup compliance and effective arm mass), and the majority of other cartridges are generally less than optimally damped.

In a well compromised pickup system, the resonance will fall into the 8-12 Hz region, which is below the normal audible frequency range and above the frequency of record surface undulations such as warps and ripples. Even so, the resonance can still be quite easily excited by external vibration (particularly shocks and knocks transmitted through the turntable structure) and the result can sometimes be alarming, the pickup leaving the groove and bouncing merrily about the record surface with accompanying fiendish noises — in themselves potentially dangerous to amplifier and speakers — to say nothing of the stylus and the record itself.

The idea of damping is to reduce the 'Q' of this resonance and in some instances to shift its frequency to some more appropriate point in the spectrum.

Damping can be applied in any of a number of ways, the most common being viscous silicone or oil about the pickup arm bearing. Examples of this kind of damping can be found in the JH Formula 4, the Decca International, Keith Monks' Laboratory arm and the Grace 704 and 714. SME recently introduced a damping system for its model 3009 series arms, consisting of an arctuate trough placed ahead of the pivot in which a quantity of oil is placed. An adjustable paddle, clamped to the arm tube is suspended in the trough, resistance of the oil against the paddle providing the damping. Onlife, in the highly advanced Dynavector arm, has provided electro-

magnetic damping of a novel type, the design featuring a surprisingly flexible and effective damping system applicable to a wide range of cartridges especially, of course, the Dynavector 20A and 20B.

The chief benefit of damping is to provide improved stylus/groove interface, and this improves not only low frequency performance but gives better contact at higher frequencies. Anyone who has heard a Decca London, first in an undamped arm (in which it usually sounds awful) and then in a good damped arm (in which it sounds magnificent) will testify to the improvement damping can create. Damping will also reduce the effects of rumble and other subsonic noise reaching the pickup system since the arm will move more responsively and with less tendency to overshoot by inertia, thus the unwanted motion of stylus relative to the arm will be reduced.

Good news for owners of undamped arms is the DiscTraker, made by the Discwasher people in the U.S. This small and rather improbable looking device attaches to the headshell of the arm and operates in much the same way as the shock absorber of a motor vehicle, where the spring is equivalent to the compliant suspension of the stylus cantilever.

The manufacturers claim the DiscTraker to be more effective, both in theory and in practice, than the more normal sort of pivot damping since the damping effect takes place close to the stylus. Arena Distributors, the local agents, supplied us with a long discourse on why this is so and this can presumably be obtained on application.

Our tests involved two cartridges, both used in our JH Formula 4 arm — Decca's Mk 6E and the superb Garrott P77, this latter representing the more conventional types of cartridge.

The DiscTraker unit consists of a pneumatic plunger which bears upon the record surface, the support shaft being attached using an adjustable screw to a bracket which fits into the majority of headshells, in some instances with the help of assorted accessories supplied with the unit. Precise instructions are supplied concerning the correct installation of the device and in essence the idea is to place the plunger as close to the stylus as possible and precisely upon the radius between the record centre and the stylus. It is also essential that the plunger is exactly vertical.

Using the Decca 6E, we found a marginal improvement in bass quality, but unfortunately midrange and high frequency performance seemed less satisfactory. We attributed this more to the peculiarities of the Decca than anything else, and here it is significant to note that the 6E seems to perform best in the Decca International arm, which is a low-friction damped unipivot of moderately low effective mass.

But it was a different story with the Garrott. Once correctly set up, the DiscTraker gave a substantial improvement to bass quality, providing a tighter, better-defined sound and improved transient performance. Midrange and high frequencies became cleaner and smoother without any apparent sacrifice of the already excellent sound quality. The Garrott sounds magnificent regardless, but with the DiscTraker, our sample P77 contributed to a clarity and definition we could hardly have credited, and this became most apparent in terms of improved stereo imaging and perspective.

But there were drawbacks. The plush pad which bears upon the record surface quickly became soiled with dust and fluff, even from what appeared to be perfectly clean records. Cleaning this rubbish off was something of an awkward chore, the debris having a definite attraction to the plush which required vigorous brushing before playing a record. Failure to remove the rubbish seemed to degrade tracking performance rather seriously, and on some dished records, the DiscTraker-equipped arm showed a distinct tendency to travel inward toward the record centre during cueing until the stylus was finally located in the groove.

We found the recommended bias compensation did not give best performance; a substantial increase of bias compensation force was needed to give the correct (subjective) result.

Despite these drawbacks the DiscTraker really does work, provided it is carefully installed and kept scrupulously clean. We imagine it would be most beneficial with entirely undamped arms, and the most obvious benefit for most users would be reduced sensitivity of the pickup system to external knocks and shocks.

As the opportunity arises, we will use the device with various arm/cartridge combinations and report accordingly.

Rega & Armstrong

WE'VE RECEIVED the very exciting news from Concept Audio, 13 Rickard Road, North Narrabeen, NSW, 2101, that Rega turntables and Armstrong electronics components are to be available in the New Year. Concept Audio, which also handles Onlife (Dynavector) and Sonab products, has recently been established in place of Sonab of Sweden to enable this product diversification to take place.

The Rega turntable has been described as 'the poor man's Linn-Sondek' but this, we feel, is an injustice. Whilst designer Roy Gandy has adhered to the principle of preventing as much vibration as possible from reaching the playing surface of the record during use (this is also the broad principle of the Linn Sondek), construction and setting up has been simplified. The Rega platter is made of glass, and we understand the unit is, like the Linn, a single-speed device fitted simply with an on/off switch. The turntable is offered in the UK either complete with arm or with a blank mounting board enabling you to fit the arm of your choice (which could, we guess, pose problems with some arms using deep mounting pedestals for the Rega is a very low-profile design). Gandy has adopted a straightforward belt-drive system using a synchronous motor, and it seems likely that this turntable will add further fuel to the belt-drive v. direct-drive flames. Well, we're saying nothing until we've seen and heard one in the flesh, although our spies in England are telling us very nice stories indeed.

Armstrong is a very high-regarded British manufacturer of well-designed, high performance amplifiers, tuners and receivers. The current 600 range is based on an integrated amplifier with power yield of forty watts per channel minimum. The basic amplifier model 621 can be teamed with either of a pair of tuners, model 623 offering AM and FM reception and model 624 for FM only. Those who prefer tuner-amplifiers can choose between model 625 with FM only or model 626 with FM and AM. We expect Australian prices of these attractively-designed units will reflect their very competitive U.K. prices and are confident that Armstrong will be well received in this country. Also scheduled for introduction before the end of next year is a separate preamp and power amp, power output anticipated at 150 watts per channel which will make this the first really high power British amplifier to become available, with the possible exception of the Quad 405 which can be bridged for high-output mono operation.

SOUND BRIEFS

● Le Nouvel Entre

Entre is the brand name of a new cartridge – a moving coil (what else) – with tapered cantilever and relatively low overall mass. So far we've seen it but not heard; it looks very interesting indeed.

● Jordan Watts

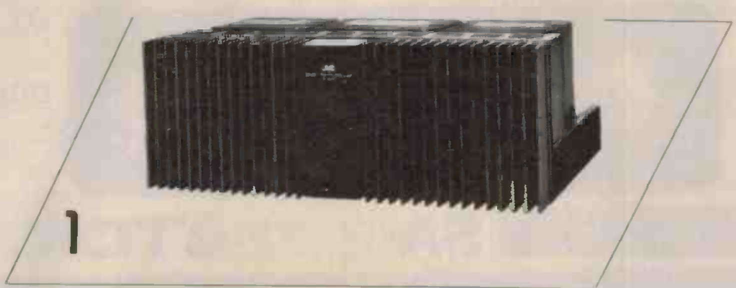
The Jordan Watts module is one of the few full-range drive units made, and forms the basis of a number of loudpeaker systems shortly to be marketed in Australia using locally manufactured enclosures conforming to Jordan Watts specifications.

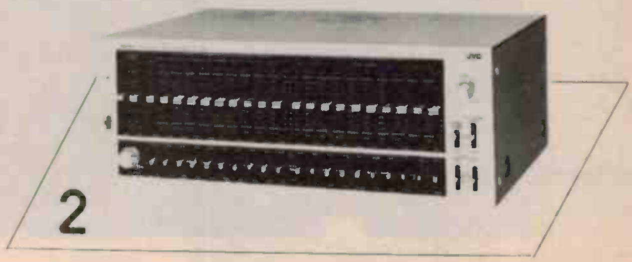
Adjustable Speaker Stands

Associated Metal Products, 88 Gow Street, Padstow, NSW 2211, has introduced a range of fully adjustable **speaker stands**. These range in price from $17.95 to $28.95 per pair, plus 27½% tax, according to size (small or large) and finish (copper, black or chrome).

New High-End Components from JVC

A refined **frequency-synthesizer stereo FM tuner** is but one of an exciting new range of products from JVC which also includes a 100 watt per channel direct-coupled amplifier and matching preamp, a new direct drive turntable and a 10-band graphic equaliser. Samples are to hand and reviews are in preparation.





1 JVC Model M-3030 stereo power amplifier

2 JVC Model SEA-7070 S.A.E. graphic equalizer

3 JVC Model QL-10 quartz-locked direct-drive turntable

New Chartwell Monitor

A new **Chartwell monitor** unit, the PM450, is available in two versions. The first uses a conventional crossover to drive a 305 mm polypropylene midrange/bass driver and 25 mm soft dome tweeter. The PM450 Electronic has a built in active crossover and power amplifiers, requiring only an external preamp.

ETI TLS Loudspeaker

Our mailbag overfloweth with correspondence on the ETI transmission line loudspeaker. A **follow-up article** will be presented in the January issue of ETI and this should answer all those questions. We regret we have been unable to answer individual enquiries; one problem has been that many of the questions asked were in fact answered in the original article!

Litz Wire

We've carried out experiments using 60-strand Litz wire (each strand individually enamel insulated and the bundle wrapped in nylon) for speaker connection. Result: vastly **improved HF performance**.

New Thorens Arm

Worth investigation is the new Thorens low-mass arm, fitted to several Thorens turntables. A low mass, straight-arm design, the new model features a detachable tube with a locking-collar close to the pivot.


AUTOMATIC CrO2 TAPE SELECTOR
A
Compact Cassette
EQ
DOLBY
Printed in Japan
SA-C90 TDK.
PIONEER
REW
FF
STOP
PLAY
REC
PIONEER

"Before the CT-F 1000 you could count the exceptional cassette decks on one finger."

Pioneer's CT-F1000 is a unique new three-head machine which brings together every worthwhile technological advance. In the important areas of facilities, performance and price, it is the possible dream that most sound connoisseurs have been waiting for.

With separate record and playback heads, you naturally have the ability to monitor sound a split-second after recording, as well as the provision to lay additional tracks over those already recorded. And since the CT-F1000 is equipped with separate *Dolby circuitry for both recording and playback, you can actually monitor Dolby in operation. This in itself is a valuable aid to recording quality, but the big plus is the facility to calibrate the degree of Dolby required to eliminate hiss and high frequency noise.

Facilities are one thing. And you can go into raptures over external cosmetics. But the performance of any tape device relies heavily on the heads.

In the CT-F1000, ordinary crystal ferrite has been superseded by unicrystal ferrite, leading to higher linearity gap construction potential, unity, and anti-abrasion characteristics.

In terms of absolute performance, the sophisticated tape transport system in the CT-F1000 plays a critical part. Fast forward/rewind is powered by one motor. While a stable DC servo-motor takes charge of the record/play functions, driving a closed-loop dual capstan. With two separate sets of capstans and pinch rollers, stable head contact combined with reduced dropout and level variation is assured. The result of all of this is a wow and flutter reading of not more than 0.05% WRMS.

The front-loading CT-F1000 is a showcase of Pioneer advances. Memory stop/memory play. Auto chrome sensing/switching. Auto tape slack cancelling. And new integrated IC amplifier circuitry, to name but a few.

Other facilities provided include: pitch control with a ±6% adjustment. 2-position Bias, 3-position EQ curves. Direct logic controls. Switchable MPX filter. Wide-range Vu meters. Full auto-stop and tape-end indicator light. Separate mic input controls line/source. Optional rack mounting adapters.

In turntables and some other component areas, it's fair to say that no longer is exceptional performance of purely academic interest. In the CT-F1000, Pioneer introduces 'the possible dream' for all those vitally interested in truth in sound. It represents a whole new benchmark in accessible cassette deck technology.

A short specification:

Frequency response	20 to 19,000 Hz.
Wow and flutter	No more than 0.05% (WRMS)
Signal-to noise ratio	
Dolby off:	More than 54dB
Dolby on:	More than 68·5dB (over 5kHz)
Harmonic Distortion	No more than 1.3% (0dB)
Reference tape	Chromium Dioxide (CrO_2)

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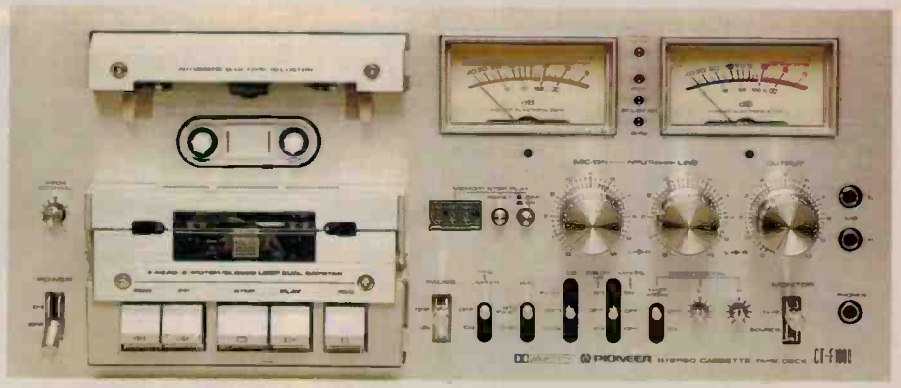

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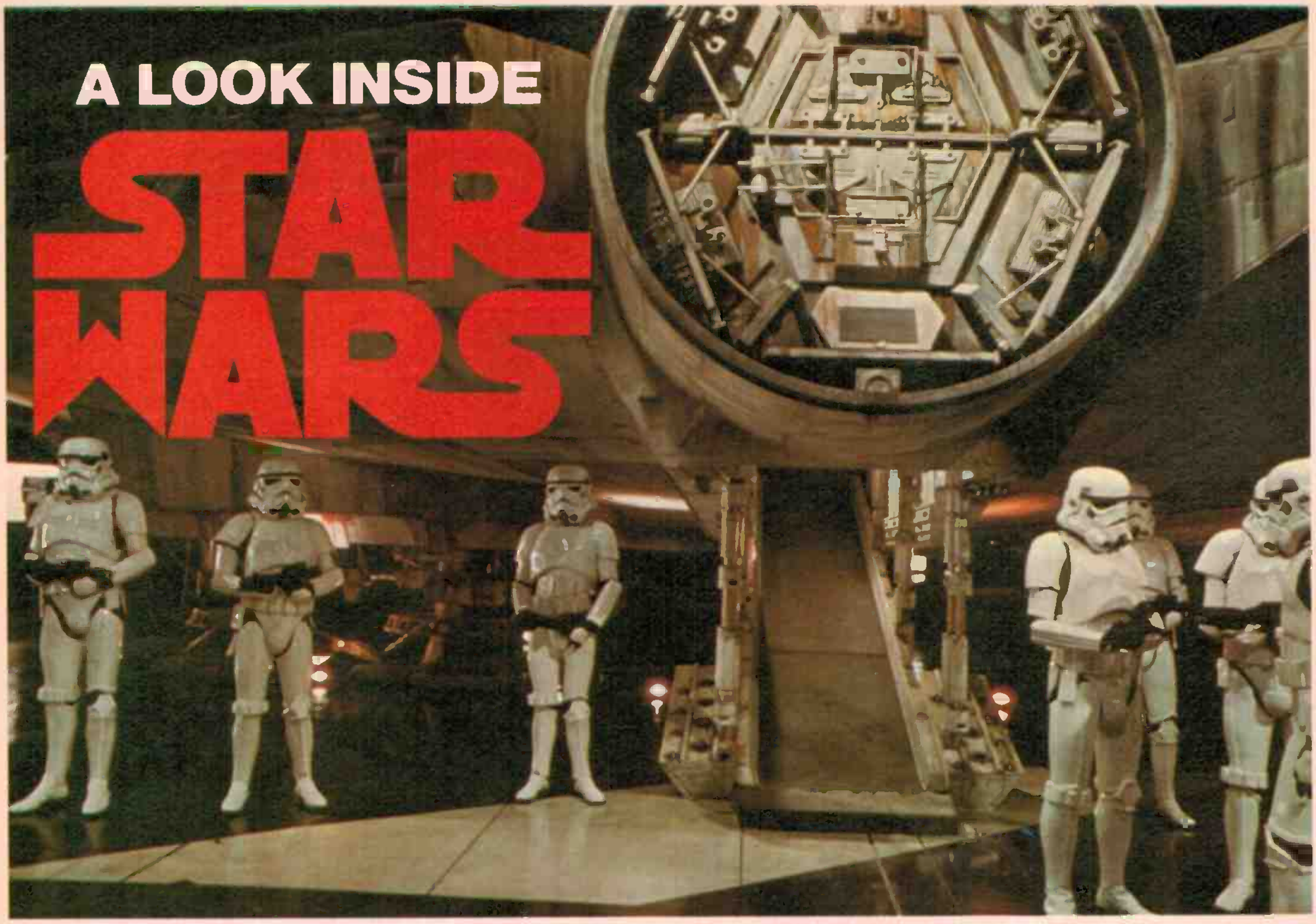
A LOOK INSIDE STAR WARS



Jim Perry looks behind the scenes and inside the robots

BY THE TIME this story is printed STAR WARS will have probably grossed 200,000,000 dollars worldwide. All those zeros are the result of six years work by writer-director George Lucas, and an end product that makes the TV series Star Trek look as spectacular as Number 96!

As early as 1971 George Lucas had the idea of filming a space fantasy. Originally he wanted to make an up-to-date version of Flash Gordon — but couldn't obtain the copyright to the characters created by Alex Raymond. Thwarted by this setback, he started researching the possible sources that inspired Flash Gordon. After a fair bit of digging, he realised that the Flash Gordon concept was probably based on a series of books by Edgar Rice Burroughs (of Tarzan fame) about "John Carter of Mars." In turn it looks as though Burroughs had been inspired by Edwin Arnold's "Gulliver on Mars" published in 1905. Jules Verne had preceded even this but never made his hero battle space creatures or have adventures on distant planets — the basis for a whole new concept (then) in adventure stories.

As soon as he finished American Graffiti George started writing Star Wars — that was in January 1973. He worked on the story virtually full time right up to and even during the actual filming in March 1976. At one point there were four different scripts, each one with a different blend of storyline and characters.

United Artists were the first to be offered the embryo idea, but they turned it down because they couldn't see the potential! Universal were more interested at first, but also gave it the thumbs down. Finally 20th Century Fox were persuaded to back it, but nobody thought it would be a big success — little did they know.

New Worlds

The first step after completing a satisfactory basic script concept was to visualize a whole new world. Collin Cantwell, who had worked on "2001 — A Space Odyssey", was brought in to design the spacecraft models. Starting off with simple sketches, Ralph McQuarrie began visualizing the characters, costumes, robots and scenery — finally producing a series of full colour paintings to give an idea of what George Lucas wanted in various scenes.

Meanwhile producer Gary Kurtz had the headaches of finding a suitable place to film, working out logistics and budgeting. In turn all American, North African and Middle Eastern deserts were visited; the aim was to find a suitable location for Tatooine, the desert planet home of hero Luke Skywalker. Finally the southern part of Tunisia was chosen, near Tozeur in the Sahara desert.

Partly as a result of the decision to film locations in Tunisia, but mainly because of the facilities and people available, the interior work was to be done at EMI Studios in Elstree. It was the only studio complex in England or America that could provide up to nine sound stages simultaneously, and the technical staff are among the best in the world.

Production designer John Barry and his crew began designing and building the huge number of props and sets in August 1975. In order to make things look realistic $40,000 was spent on junk and scrap metal; anything from sewage pipes to jet engines were used to make scenery look realistic. One of the interesting aspects of Star Wars is that everything looks used — just like real life!

The job of making the robots was given to John Stears (alias Special Effects Worldwide), who won an Academy Award for his special effects in Thunderball. John had also worked on six other Bond movies — he fitted out the legendary Aston Martin that did everything except make tea!

John's job was to turn Ralph McQuarrie's illustrations into reality (or as near as possible). He was also responsible for the production effects. The main robot is R2-D2 (Artoo Detoo): the one that looks a bit like a dustbin with three legs. Artoo's partner is C-3PO (See Threepio), an android type. The only robot not made by John was Threepio, as he was just a casing designed by art director Norman Reynolds and sculptress Liz Moore — with Anthony Daniels entombed inside.

Besides Artoo types there were four other basic robot types used in the film, these were the Umbrella-type, Stick-type, Dome-type and Box robots. All of these were radio controlled — internal shots are given later in this article.

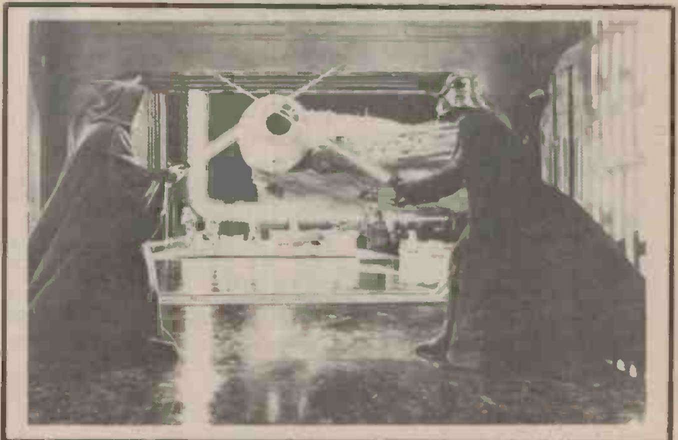
Now You See It . . .

As well as the variety of robots, John designed the Speeders used as transport on Tatooine, the multitude of explosions and the light sabres. The Speeder shells were moulded in fibreglass, and supported on a boom arm; after filming the boom was painted out frame by frame.

The light sabre effect was produced with the aid of reflective and non-reflective facets of the sabres. With a light mounted on the camera, the sabres appeared dark if their non-reflective part was towards the light, and glowed when revolved to expose their reflective section. By spiraling the reflective portion and spinning the sabre the effect of the light moving out was created.

Even though John Sears is an electro-mechanical wizard and special effects veteran, he hadn't made anything quite like Artoo and his (its?) fellow robots — even though his hobby is radio-controlled models. Asking for advice at St. Mary's College (University of London), where he met Professor Thring, the robotics expert, and Queen Mary's Hospital in Roehampton where he met artificial limb specialists, he gained useful information on pneumatics and electronics. The only problem was that when told the time available, everyone said it was impossible! In fact John did the impossible — with one exception: there wasn't enough time to produce a version of Artoo that wobbled on two legs.

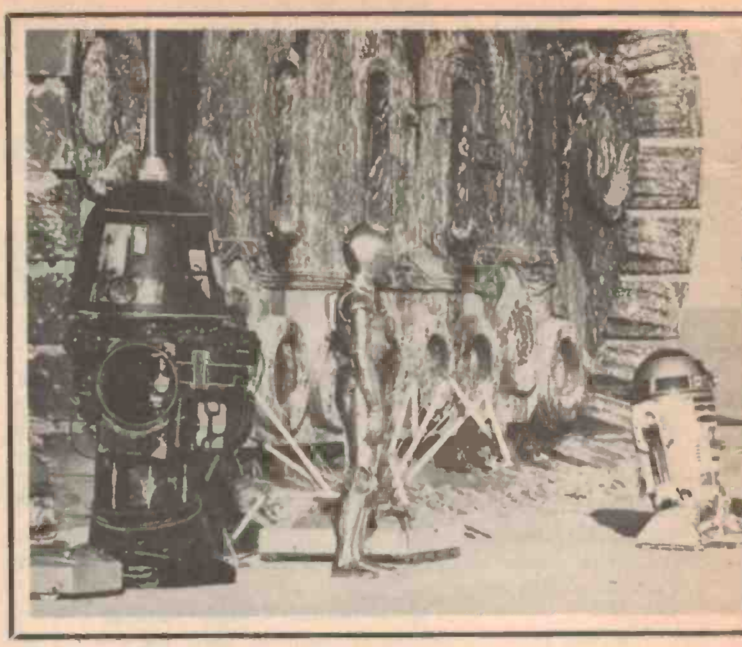
The wobble effect was needed to make Artoo a bit more human and, as a final solution, a special Artoo casing was constructed for 3ft. 8in. Kenny Baker to wobble around in! Simple way of telling which version is in a scene is two legs



▲ *Ben Kenobi (Alec Guinness) battling forcefully with the superevil (boo,hiss) Lord Darth Vader (David Prowse) near the captured Millennium Falcon space freighter.*

STAR WARS

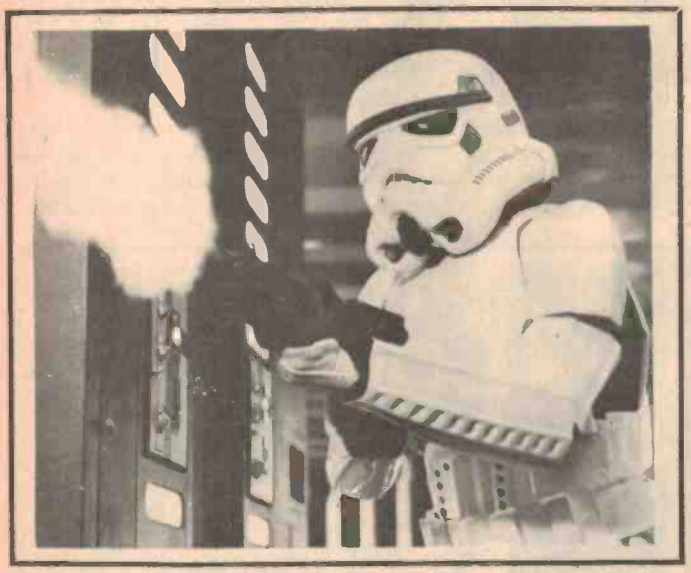
STAR WARS



Kenny, three legs the real Artoo with radio control. In March, 1976, the production unit moved into Tozeur in the South of Tunisia, to begin the transformation of desert into desert (from a different galaxy), and construction of massive Jawa transport vehicles. The Algerian army caught sight of these massive props and thought they were real!

After eight weeks of preparation the filming started. During the first week the entire crew had to wear sand goggles due to a big sandstorm. The filming lasted two-and-a-half weeks on location before moving to Elstree for the next 14½ weeks, where all nine sound stages were filled with John Barry's 30 sets. Planets, starships, caves, control rooms, cantinas and a vast network of corridors from inside the Death Star were at Elstree — but the Alliance's secret hangar full of X-wing and Y-wing fighters had to be built at Shepparton Studios, because it was the only place in Europe big enough!

When on location all the robots had to be cleaned every day — the sand and salt got in everywhere! One problem arose with the radio control systems because of static-charged windborne sand particles present in the Sahara; an extra aerial wire had to be attached to Artoo. Also being miles from nowhere the internal batteries had to be charged from mobile generators, which also had to be maintained. Trying to keep track of up to 30 sets of batteries is guaranteed to give anyone a twitch! Artoo and company were operated by John Stears and his crew, with Dick Hewitt (of Compact Video Systems) supervising the electronics.



▲ *Imperial stormtrooper (hiss) blasting after Princess Leia inside the Alliance ship.*

Built from Scratch

As well as the robots and mechanical effects, Star Wars uses the most advanced optical and miniature effects — the deep space shots, laser guns, etc. In June 1975 John Dykstra was asked to supervise all the photographic special effects. There was a slight problem — no commercial facility had either the time or even equipment to produce what was required — so John built Industrial Light and Magic Corporation, from scratch, in an empty warehouse in the San Fernando Valley.

The ILM complex included a carpentry shop and machine shop, which had to build or modify the special camera, animation equipment, editing and projection equipment needed to produce the effects. Other departments included optical printing (for putting the many different layers of film together), a rotoscope department (for matte work and general backgrounds) and a library section for keeping track of the thousands of pieces of film.

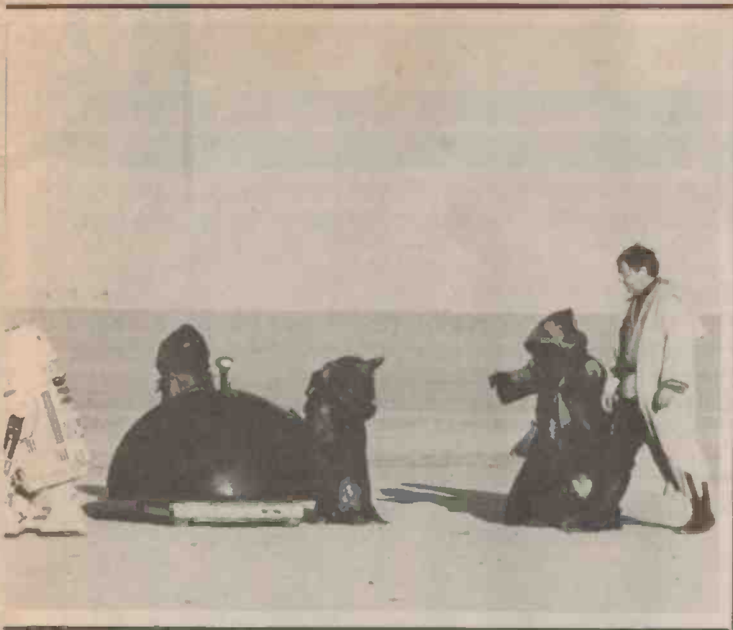
Dykstraflex

The most important part of ILM is the Dykstraflex camera, which is based on an old VistaVision camera, linked into a computer. The VistaVision camera runs 35mm film through sideways, like a 35mm still camera, whereas normal movie cameras run the film vertically — the benefit is increased resolution, which is needed when up to 12 shots are put together on one print. The computer is used to store movement with control of seven separate parameters simultaneously.

Each of the 365 special effects needed between two and 12 separate exposures of film, in all 3 838 exposures were needed. For example, in the battle sequence you see an X-wing fighter swooping and soaring over the Death Star — in fact, the model of the X-wing never moved an inch! The camera moves, creating the illusion that the fighter is moving; the Death Star is filmed separately with different camera movements. The two exposures are then printed together to create the impression of X-wing swooping over revolving Death Star — not to mention more fighters, laser flashers, stars, etc.

This is where the computer comes in. If the angle of the camera changes during a shot, the other shots change as well — hence each separate frame has to be exactly matched for each different component of the composite shot. The computer remembers everything and moves the camera accordingly — simple, but until the Dykstraflex, no camera could do it.

To create realism in the dogfight scenes, thousands of feet of World War II movies were viewed, together with storyboards. By studying the real life movements of the planes,

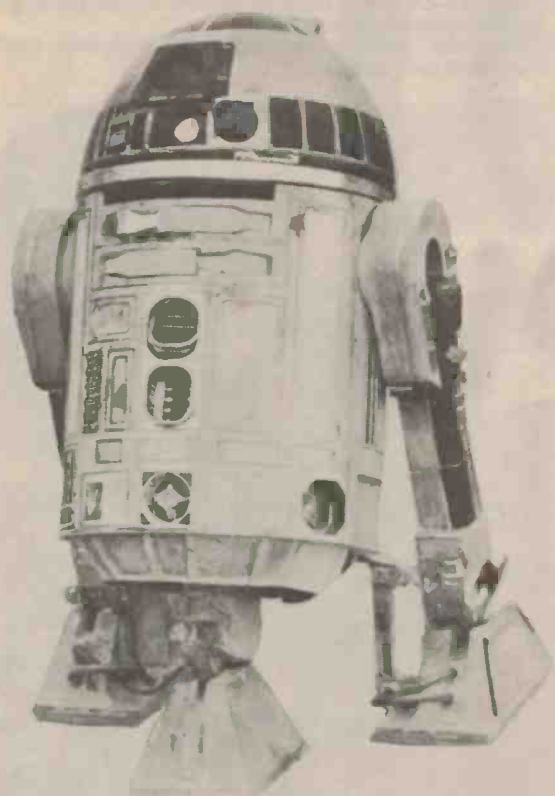


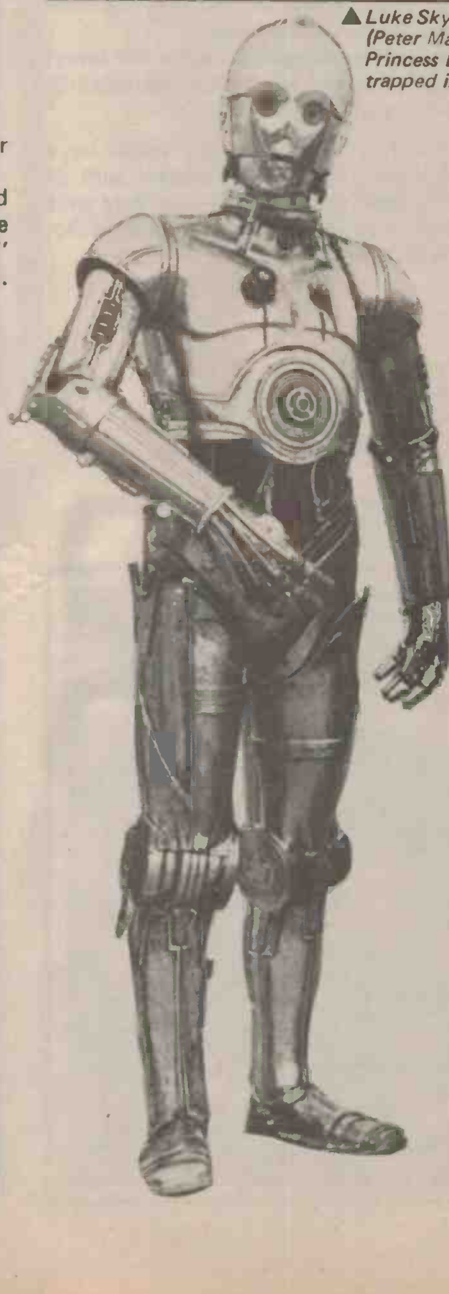
▲ *Owen Lars (Phil Brown), uncle of Luke Skywalker, being shown the Jawa robot collection by the chief Jawa (Jack Purvis). The huge sandcrawler in the background was mistaken for a military vehicle by the Algerian army.*

the model shots were planned to be the most realistic ever made — they succeeded.

Even with the aid of the Dykstraflex the ILM crew had several problems to solve. It was easy for the director to move his hand, and say "I want the starship to move like this . . ." but to actually turn this into a finished shot was a problem. Firstly the movement had to be put down on paper, so that the camera operator could try and emulate the movement — then the operator had to teach the computer the movement, in fact he had to 'fly' the camera over the fixed model. Needless to say at the end of the filming the camera operators were all accomplished pilots!

▲ *Luke Skywalker, Han Solo, Chewbacca (Peter Mayhew) and the lovely Princess Leia Organa (Carrie Fisher) trapped inside the Death Star.*





Thanks are due to John Stears and 20th Century Fox for their help in producing this feature. All photographs are world copyright 20th Century Fox Corporation.

STAR WARS

R2

Contrary to some reports, most of the R2-D2 sequences were with a real robot, built by mechanical wizard John Stears – read all about the real R2-D2 here!

TWO VERSIONS of R2-D2 were made, one for Kenny Baker to fit inside and the three-legged radio controlled version. Our interest centered on the radio controlled version.

R2-D2 has three forward speeds, but no reverse, and is steerable. Provision is made for the change from two legs to three legs by radio control, also when tilted the third leg drops automatically. The reason for this is that R2 would fall over if left on only two legs!

Mechanical

In order to achieve forward motion, the two rear legs have individual traction motors which drive twin inline wheels. Steering is via the front drop leg, with a proportional self centreing servo unit. The twin wheels in the steering foot remain parallel to the other wheels during turns.

The front leg and foot can be retracted inside the body. When the front leg drops it is held at the correct distance by wires, R2-D2 can then move off at full speed.

The casings for all the R2s were specially made by a company called Petric Engineering for the modest sum of almost $30,000, which may seem a trifle high – but they were precision pieces of engineering to the highest standard, in fact John Stears says they were excellent value.

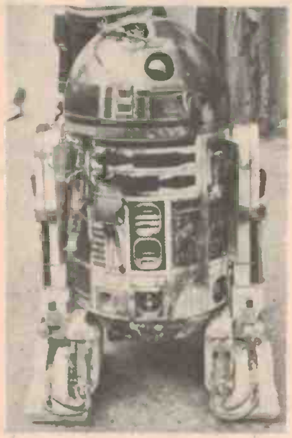
Head Interior

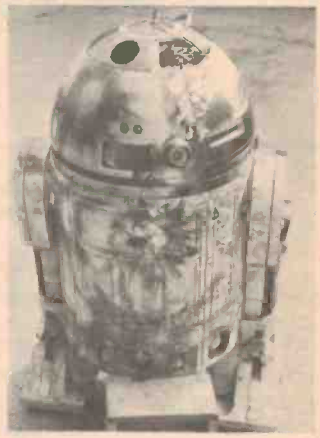
▼

1. QI light source (front)
2. Coloured disc motor (front)
3. Pulsating lights (green/yellow)
4. Fibre optic display (rear)
5. QI light source (rear)
6. Coloured disc motor (rear)
7. Fibre optic display (front)
8. Pulsating lights (red/blue)

Cleaning Up

For several of the scenes R2-D2 was made to appear thoroughly blasted, or covered in grime. The only way was to virtually blast it in real life, and then clean up for the next shot. While in the Tunisian desert John Stears was also continuously cleaning real dirt and sand from R2, it got in everywhere!

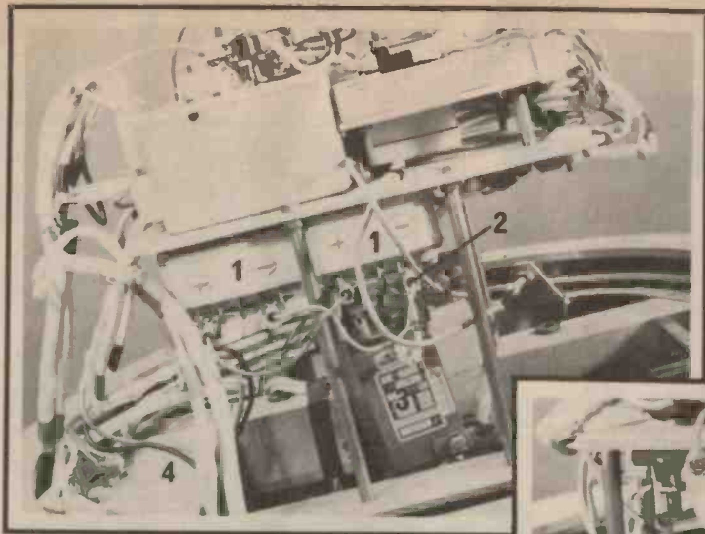




▲ *Above, R2–D2 in two stages of disorder – heart-breaking work, wrecking such a nice machine!*

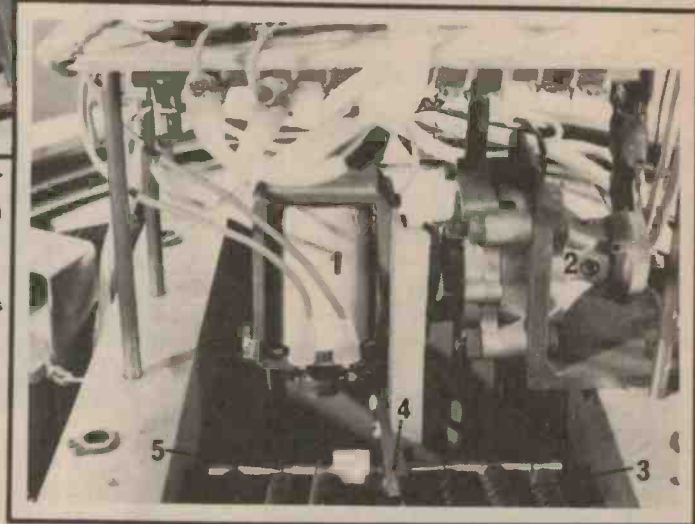
▼ *Below, John Stears gropes under R2–D2 on location, even the best robots need repairs.*

D2



◀ Pulsating Light Drives

1. Pulsating light control box
2. Pulsating light connections
3. Leg drop solenoid
4. Light and steering batteries.



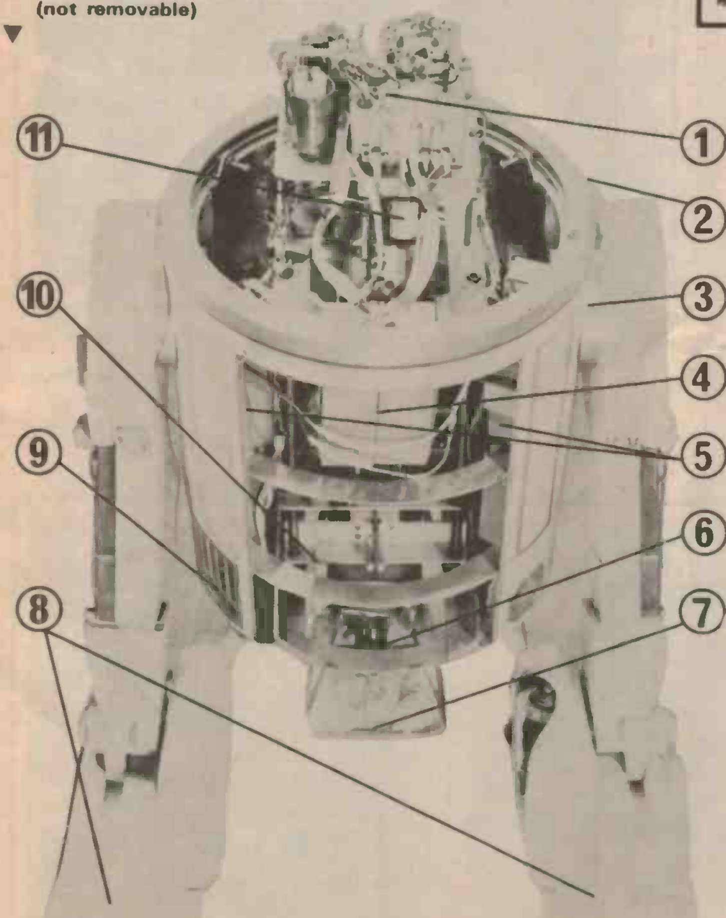
▶ Leg Drop

1. Leg drop solenoid
2. Damper
3. Body tilt tension springs
4. Leg drop locking arm
5. Leg drop locking rod

General

1. Radio control gear
2. Head ring
3. Shoulder bearing
4. Two 6V batteries for lights and steering (removable)
5. Six 6V batteries for traction (not removable)

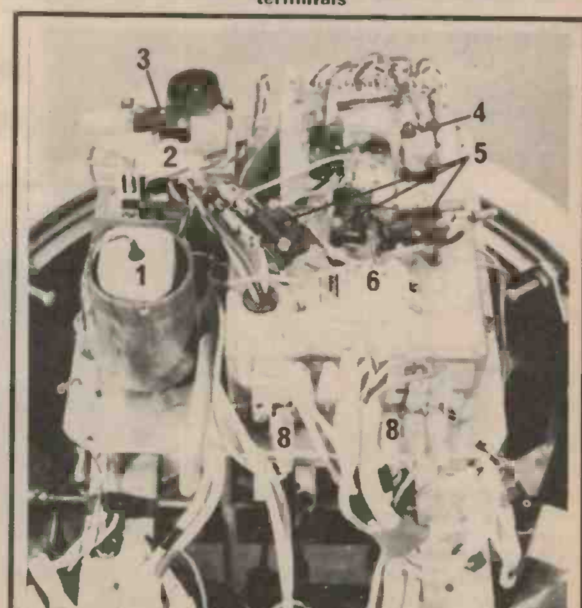
▼



Radio Control Gear

▼

1. Deac
2. Main receiver
3. Leg drop servo and microswitches
4. Steering servo and microswitches
5. Speed control microswitches
6. Speed control servo
7. Traction motor connections
8. Traction batteries charge terminals



STAR WARS

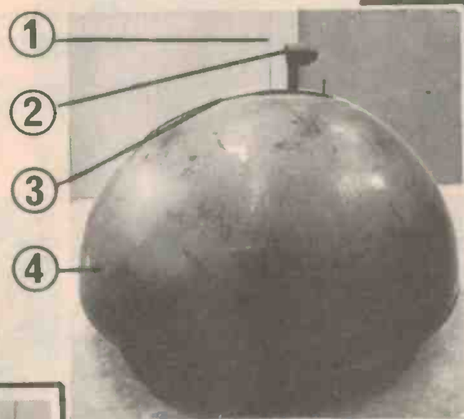
DOME

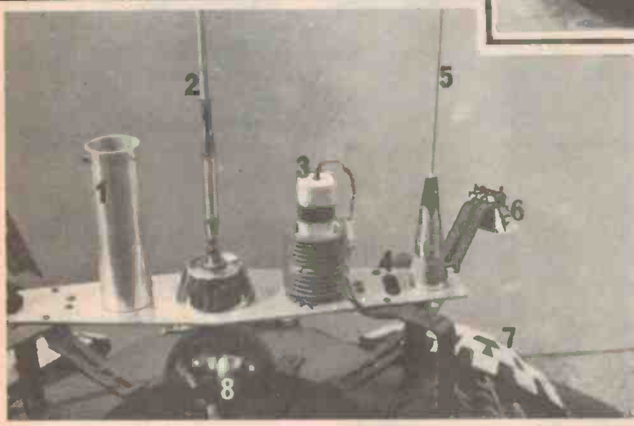
▲ Super Structure

1. Dome locating blocks
2. Mirror domes
3. Electronics compartment

General ▶

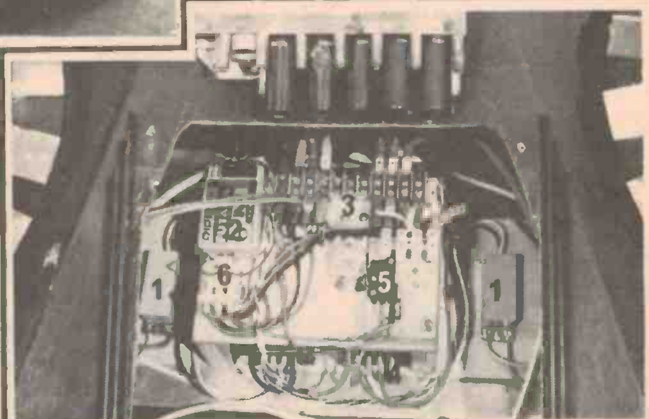
1. Real aerial
2. Eye
3. Slot
4. Perspex dome





▲ Bridge Assembly

1. Eye Socket
2. Dummy aerial
3. Deac
4. Receiver on/off
5. Real aerial
6. Oil light
7. Mirror dome
8. Flashing beacon



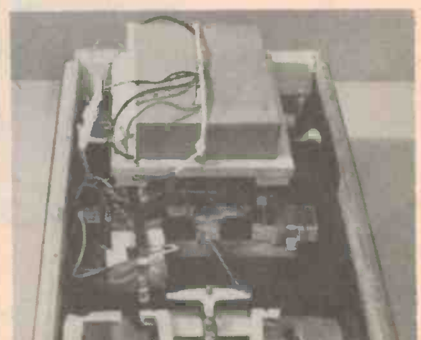
▲ Radio Control Gear

1. Suppressors
2. Receiver
3. Connecting block
4. Speed controls
5. Lighting servo
6. Lighting relay

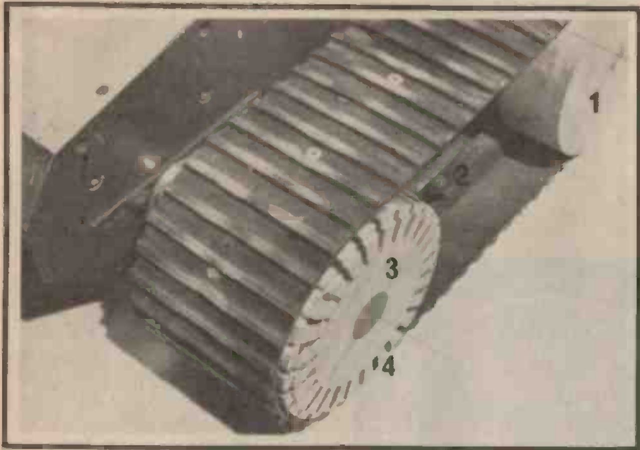
BOX

▶

Most people think the Box robot should have been called the Rat robot, its the one that runs around the Imperial Death Star. A Radio controlled yellow streak, makes Box robots turn and run when confronted with a Wookie!



STICK

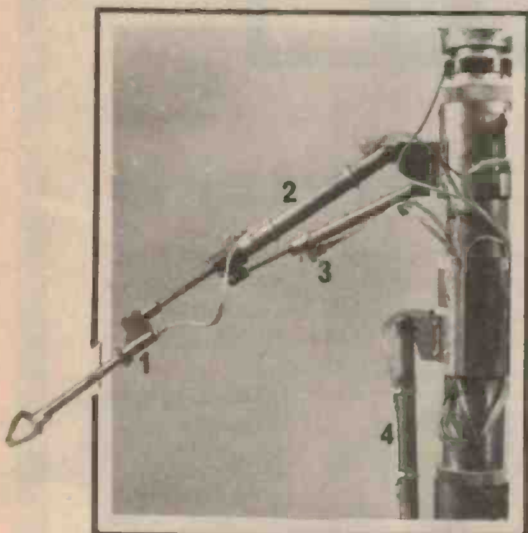


▲Track

1. Idler wheel
2. Track guide
3. Drive wheel
4. Sand escape vents

▲Head

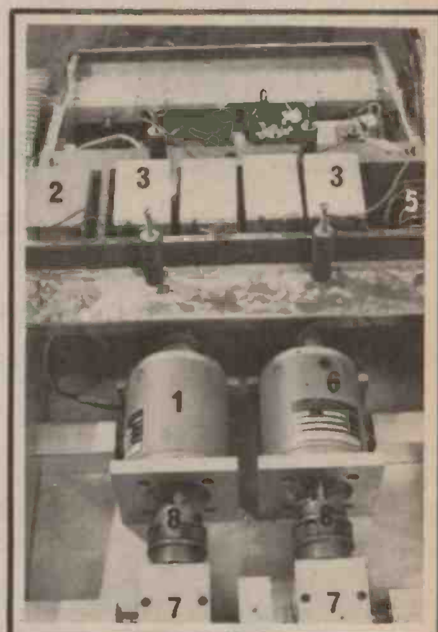
1. Eyes
2. Pivot
3. Slipring
4. Brush
5. Eyes up/down crank
6. Counter balance spring
7. Eyes up/down motor
8. Slip ring feed



▲

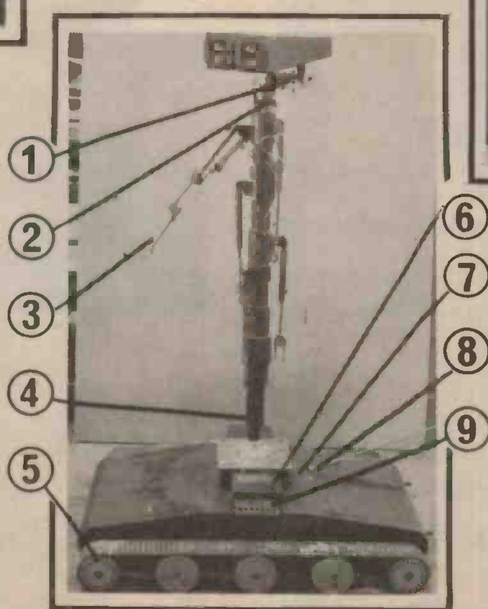
Arm

1. Claw ram
2. In/out ram
3. Up/down ram
4. Dummy ram



▲Base

1. Right traction motor
2. Auxiliary battery
3. Traction batteries
4. Receiver
5. Pneumatic connections
6. Left traction motor
7. Gearboxes
8. Flexible couplings



General ▶

1. Eyes pivot
2. Head swivel
3. Practical arm
4. Stick
5. Drive wheels
6. Battery compartment
7. Receiver on/off
8. Real aerial
9. Pneumatic connections

STAR WARS

Bucket Brigade Audio Delay Line

This audio delay line uses the latest in IC technology, the 'Bucket Brigade' to give a simple unit suitable for various effects. However this is a project for the experimenter as full details of how to use it for any particular use are not given.

ANYONE WHO has been in an anechoic chamber will appreciate the need for some reverberation. In music the use of artifical reverberation or echo can compensate for a 'dead' room or create a new effect. Up until recently reverberation was normally obtained by mechanical means such as a spring or plate which is vibrated or excited by an electrical signal; a pickup elsewhere on the plate or spring receives the delayed signal. Due to the nature of resonances in springs, multiple echos occur giving the effect of reverberation.

A single echo is obtainable by using a tape loop, recording the signal on one head and playing back through a second. The distance between the heads and the tape speed determines the delay. Echo can also be obtained accoustically by a long tunnel with a microphone and speaker.

When the price of digital ICs started to come down a number of digital delay lines were developed. These used an A–D (analogue to digital) converter, a long shift register and finally a D–A converter. To accomodate the wide dynamic range required very good, fast, A–D, D–A converters along with a large shift register. Even with the low price of ICs these units still cost around $500.00 or so (this is the main reason we have not published one as a project).

A number of years ago several IC manufactures started playing with a 'digital' delay line which works by storing an analogue voltage on a capacitor and then transferring this voltage to another and then successive capacitor. This is accomplished by switching FETs on and off under digital control. The circuit became known as a bucket brigade and this name has stuck.

The IC we have chosen is the MN3001 which is a dual 512 step device. This was chosen mainly for its availability through Elcoma. Brief specifications of other devices we know about are given below. All the devices except the SAD 1024 (Reticon) are handled by Elcoma.

Uses of BBD

Variable or fixed delay of analog signals
Reverberation
Echo
Tremolo, vibrato, flanging or chorus effects
Voice control of tape recorders
Time compression of telephone conversations
Voice scrambling

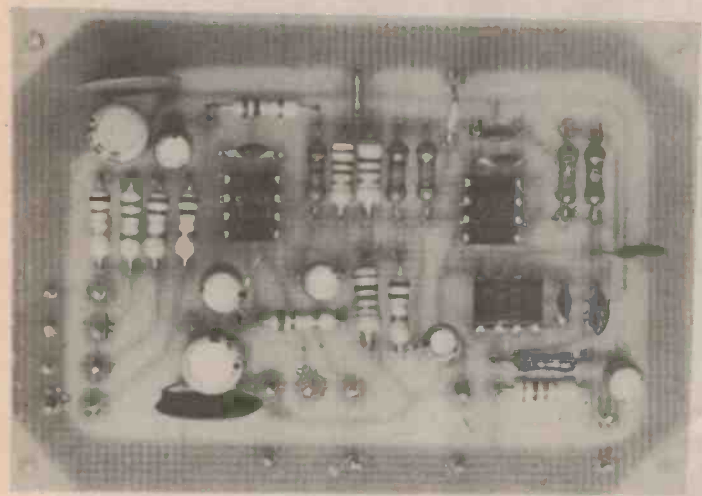
Construction

As we are describing no mechanical arrangement our description of construction is limited to the assembly of the PC board. It is recommended that a socket be used for the BBD IC as it is an expensive MOS device. The inputs are protected but it should be handled with care. The same care should be taken with the CMOS IC but as a socket costs more than the IC it cannot be recommended!

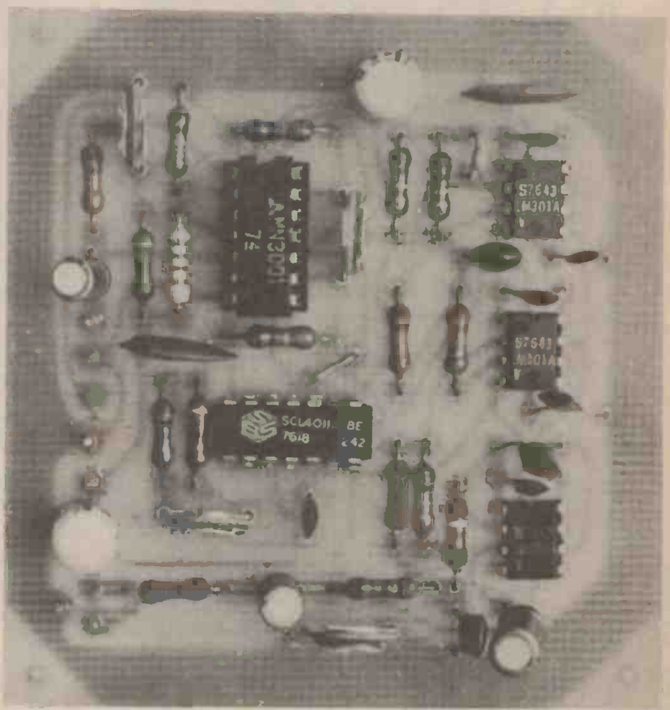
The interconnection between the pc boards depends on the effect needed.

SPECIFICATION – ETI 450

Maximum input < 3% distortion		2.0V RMS
Delay time internal oscillator		6 – 30ms
Frequency response		see graph
Distortion 1V in 1kHz		0.3%
Signal to noise re 2V input		67dB
Supply current (A)	+ 5V	6mA
	– 15V	9mA
(B)	+ 5V	6mA
	–15V	6mA

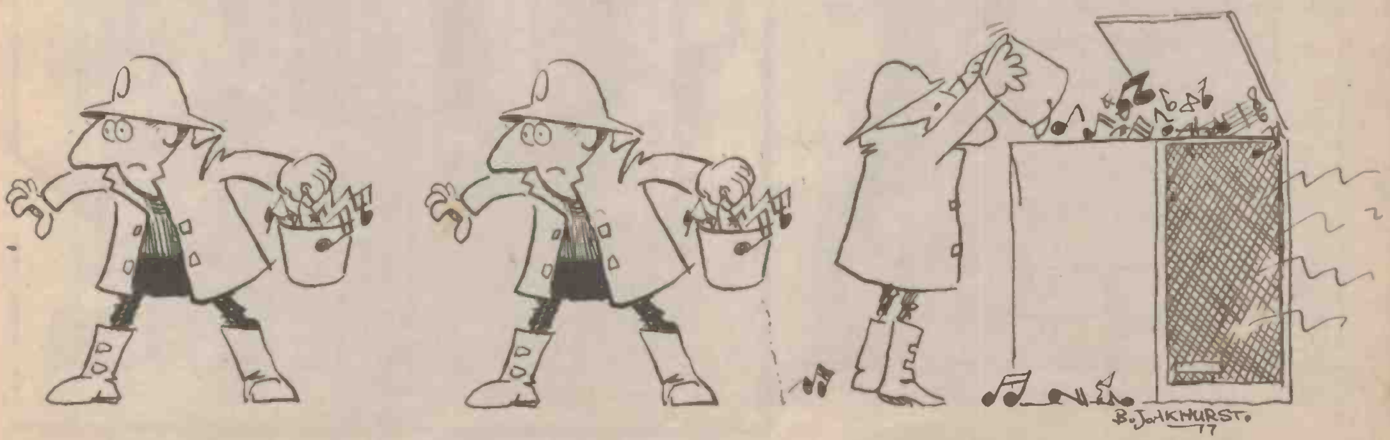


The mixer, filter board ETI 450B.



The bucket brigade board ETI 450A.

The printed circuit boards for this project are on page 97.



Bucket Brigade Audio Delay Line

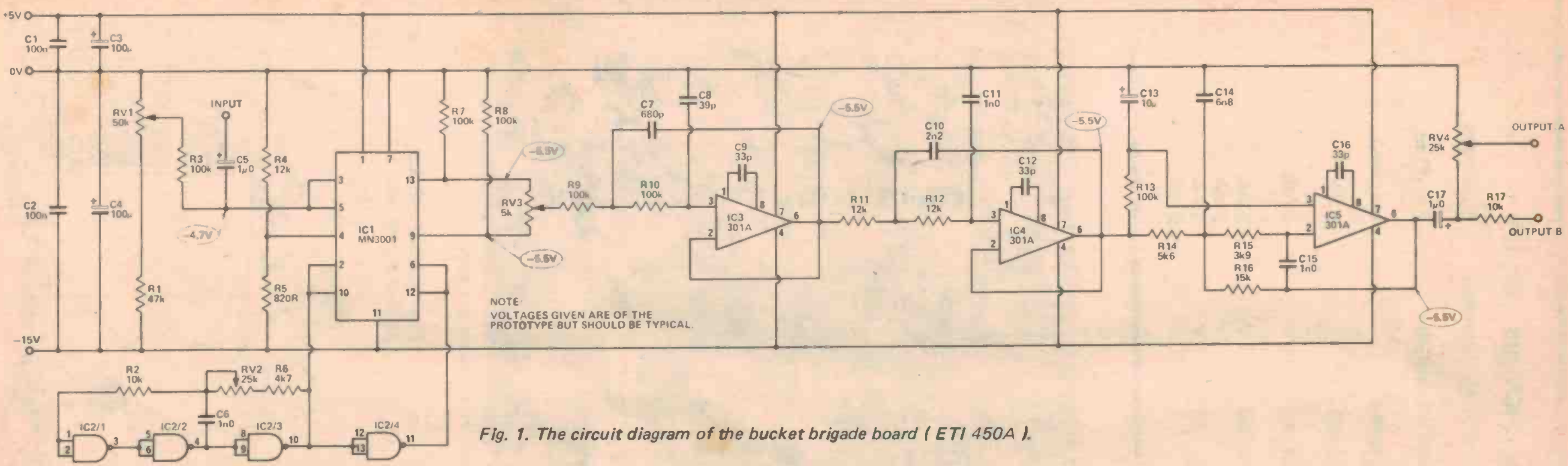


Fig. 1. The circuit diagram of the bucket brigade board (ETI 450A).

HOW IT WORKS – ETI 450

The bucket brigade device is an analogue delay line which samples the input waveform at an instant in time and stores this voltage on a capacitor. As we need more than just one point on the waveform we sample the input at least 3 times faster than the highest frequency required. A single capacitor cannot store more than one voltage at one time and so a series of capacitors is used. Before the second sample is taken the energy in the first capacitor is transferred to the second capacitor thus freeing the first to sample the input again. Then before the third sample the energy in the second capacitor is transferred to the third. The first into the second and the first again samples the input. This process continues on each sample with the energy in each capacitor being transferred to the next. Eventually we run out of capacitors and this then becomes the output. The number of capacitors, or stages, and the sample (clock) frequency determine the time it takes an input sample to appear at the output.

In the device we have used there are 512 stages in each of two identical and independent sections. The internal circuit diagram of the initial part and of the output stage is shown below (there are over 1000 capacitors and 2000 FETs in the IC!)

The transfer of energy is done using FETs which are controlled by the two clock lines CP1 and CP2. These are complementary square wave signals. Using a 40 kHz signal the input is sampled every 25μs then 'remembered' and transfered every 25μs. On the output, from stage 509 on, the signal is divided into two paths, one having an extra stage. This is needed as the signal on the output is only there for half the 25μs period. By adding these two out-of phase outputs a continuous output results.

All of this transferring of energy does however waste energy and the output is of a lower amplitude than the input. In the MN3001 it is about 8.5dB lower. To increase the delay it is normal to connect two sections (or more if needed) in series. However the output has then twice the loss and even with an intermediate amplifier this results in a lower signal to noise ratio.

A second method of obtaining a large delay is to run the two sections in parallel with each sampling on alternate half cycles of the clock waveform giving effectively two sampling periods per clock pulse. This allows the clock frequency to be halved for the same frequency response giving twice the delay with only one attenuation loss. However as you never get anything for nothing the lowering of the clock frequency increases the low frequency energy content of the noise, making the filter do more work.

Getting back to the circuit diagram we see that the input signal is coupled to the input of both halves of the BBD with dc biasing being provided by RV1. IC2 is used as an oscillator with frequency adjustable from about 20 kHz to 90 kHz giving delays of 6-30 ms. The output of IC2/3 is inverted by IC2/4 giving the two complementary clocks required by the BBD. The outputs of the BBD are mixed with RV3 being used to remove the clock frequency before the 6 pole filter IC2 – IC4 removes all the other hash generated by the clocking. The first two sections of this filter have unity gain while the third stage has a gain of 8.5 dB to compensate for the loss in the BBD. These gains are of course below the cut off point!

The second board used is simply a mixer and 4 pole filter which can be used together or in separate parts of the unit. Due to the sampling done by the BBD, the frequency of an input signal must not exceed the clock frequency otherwise it will appear at the output at some other frequency lower than the clock frequency. This is due to the BBD input circuit sampling almost corresponding points on successive cycles of the input waveform. For this reason the 4 pole filter is used before the BBD.

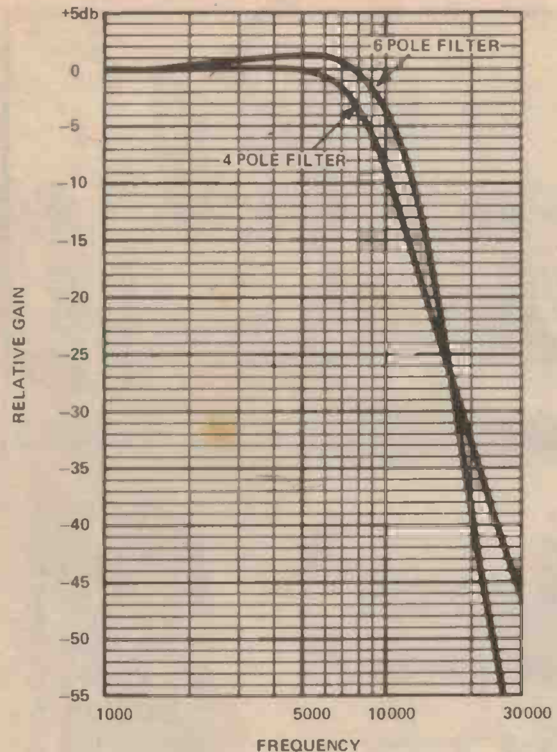


Fig. 3. The frequency response of the two filters. The overall response is approximately the sum of these two filters provided the clock frequency is at least 20 kHz.

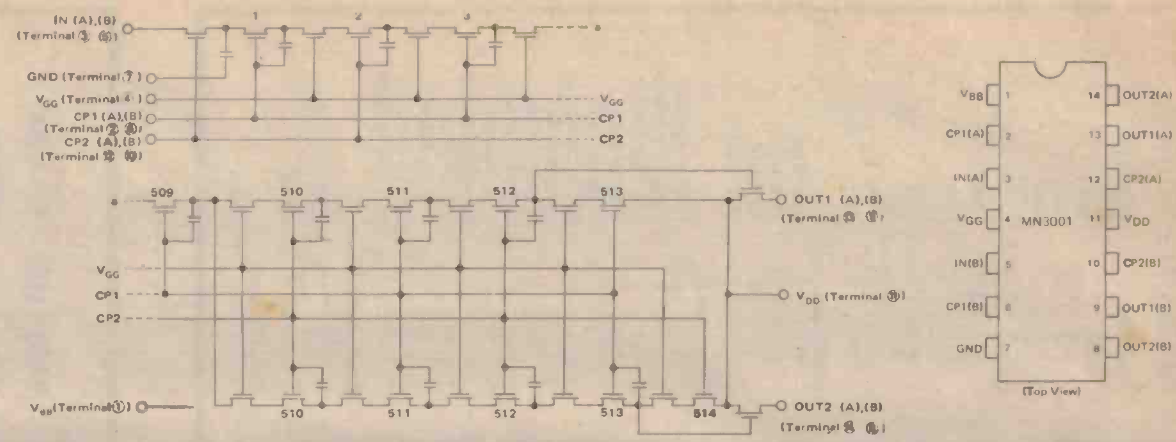
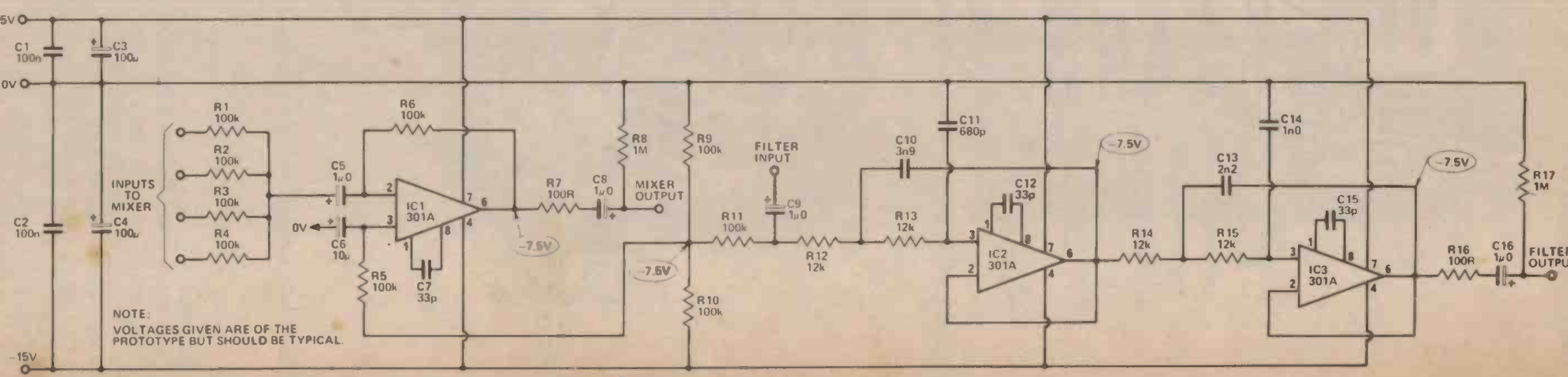


Fig. 2. The internal circuit of the MN3001 showing the first three and last four stages.

TYPE	MN3001	MN3002	MN3003	MN3004	TDA1022	SAD1024
NO OF STAGES	2 X 512	512	2 X 64	512	512	2 X 512
DELAY (ms)	1–25	1–25	0.16–3.2	2.5–3.2	0.5–50	0.2–170
INSERTION LOSS (dB)	8.5	8.5	3.5	1.5	4.0	
DISTORTION (%)	0.4	0.4	0.5	0.4	0.4	1.0
SIGNAL TO NOISE (dB)	70	70	>68	85	74	>70
SUPPLY VOLTAGE (V)	+5, –14, –15	+5, –14, –15	–8, –9	–15	–15	–15

Fig. 4. Summary of the bucket brigade ICs which we know exist.

Fig. 5. The circuit diagram of the mixer, 4 pole filter board (ETI 450B).



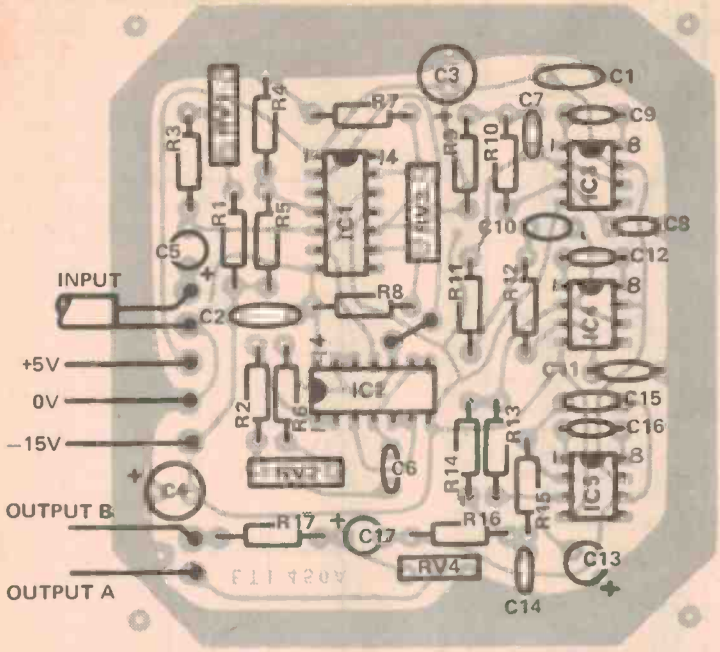


Fig. 6. The component overlay of the bucket brigade board.

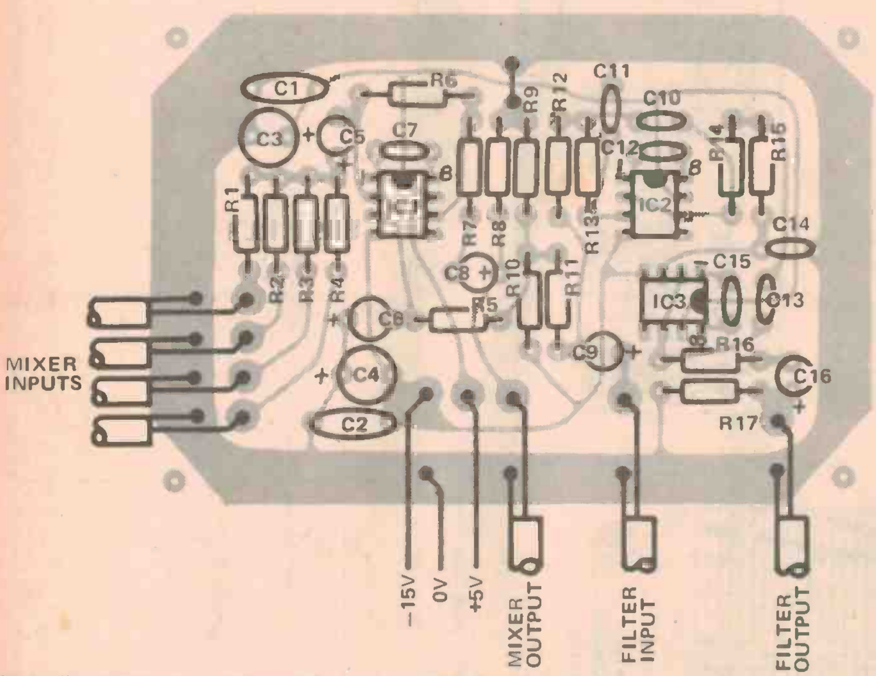


Fig. 7. The component overlay of the mixer — filter board.

Adjustment

RV1 is used to set the bias voltage. If an oscilloscope is available look at the output of the board while feeding in a sine wave signal. Adjust RV1 to allow the maximum input signal without clipping. RV2 adjusts the delay while RV4 sets the output level to compensate for differences in the loss of the BBD sections. RV3 is used to remove the clock frequency from the output. If an oscilloscope is available look at the wiper of RV3 and adjust to give the smoothest output. The switching transients at this point are very high but these are removed by the filter.

PARTS LIST – ETI 450A

Resistors all ½W 5%

R1	47k
R2	10k
R3	100k
R4	12k
R5	820R
R6	4k7
R7–R10	100k
R11,12	12k
R13	100k
R14	5k6
R15	3k9
R16	15k
R17	10k

Potentiometers

RV1	50k trim
RV2	25k trim
RV3	5k trim
RV4	25k trim

Capacitors

C1,2	100n polyester
C3,4	100μ 25V electro
C5	1μ0 25V electro
C6	1n0 polyester
C7	680p ceramic
C8	39p ceramic
C9	33p ceramic
C10	2n2 polyester
C11	1n0 polyester
C12	33p ceramic
C13	10μ 25V electro
C14	6n8 polyester
C15	1n0 polyester
C16	33p ceramic
C17	1μ0 25V electro

Semiconductors

IC1	MN3001
IC2	4011 (CMOS)
IC3–IC5	301A

Miscellaneous

PC board ETI 450A

PARTS LIST – ETI 450B

Resistors all ½W 5%

R1–R6	100k
R7	100R
R8	1M
R9–R11	100k
R12–R15	12k
R16	100R
R17	1M

Capacitors

C1,2	100n polyester
C3,4	100μ 25V electro
C5	1μ0 25V electro
C6	10μ 25V electro
C7	33p ceramic
C8,9	1μ0 25V electro
C10	3n9 polyester
C11	680p ceramic
C12	33p ceramic
C13	2n2 polyester
C14	1n0 polyester
C15	33p ceramic
C16	1μ0 25V electro

Semiconductors

IC1–IC3	301A

Miscellaneous

PC board ETI 450B

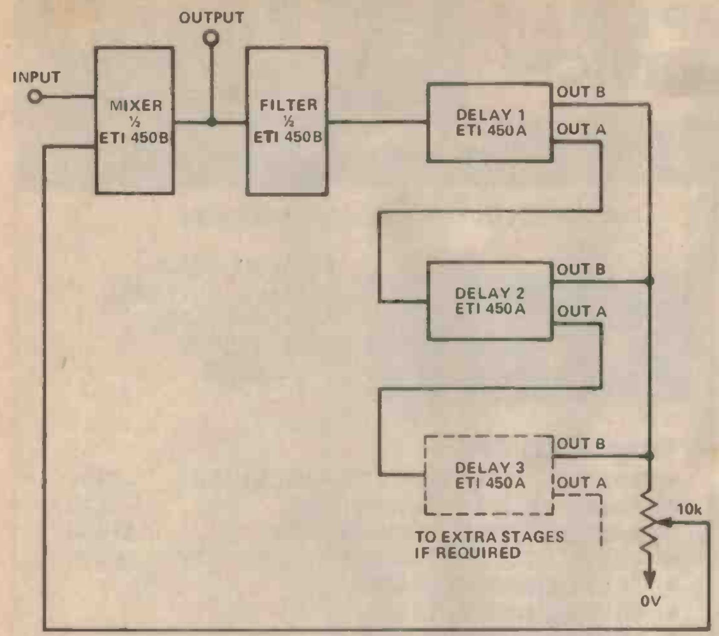


Fig. 8. The interconnection for reverberation.

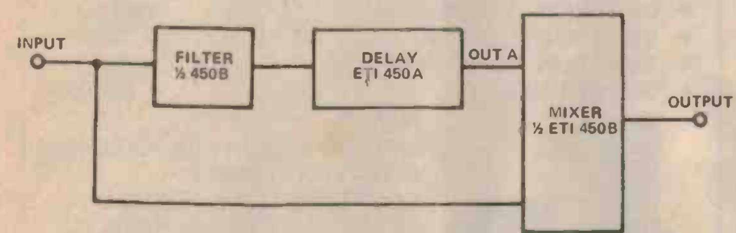


Fig. 9. Connections for a single echo. With a short delay this becomes a phaser.

Reverberation

If the audio signal is fed via a mixer into the delay line and its output fed back into the mixer we have a feedback system which will repeat a single sound many times. This is reverberation. If several different delays are used the effect will seem more natural. With all feedback systems if the sum of all the delayed outputs exceeds the original sound uncontrolled oscillations will result. This is similar to howl-round in PA work and careful adjustment is needed if long reverberation times are required.

Echo

This is similar to reverberation except the delayed signal is not fed back to its own input. A single echo only results (from a single delay) and it can be of any amplitude in relation to the original signal.

Phasing (Flanging)

By varying the delay times and by mixing in the right proportions total cancellation of some frequencies can occur. Now if the clock frequency is made variable a phasing or flanging effect occurs. A variable clock can be made by replacing potentiometer RV2 by an LDR and illuminating it with a globe the brilliance of which is controlled (try a 555 timer). We must leave details of this to the individual constructor.

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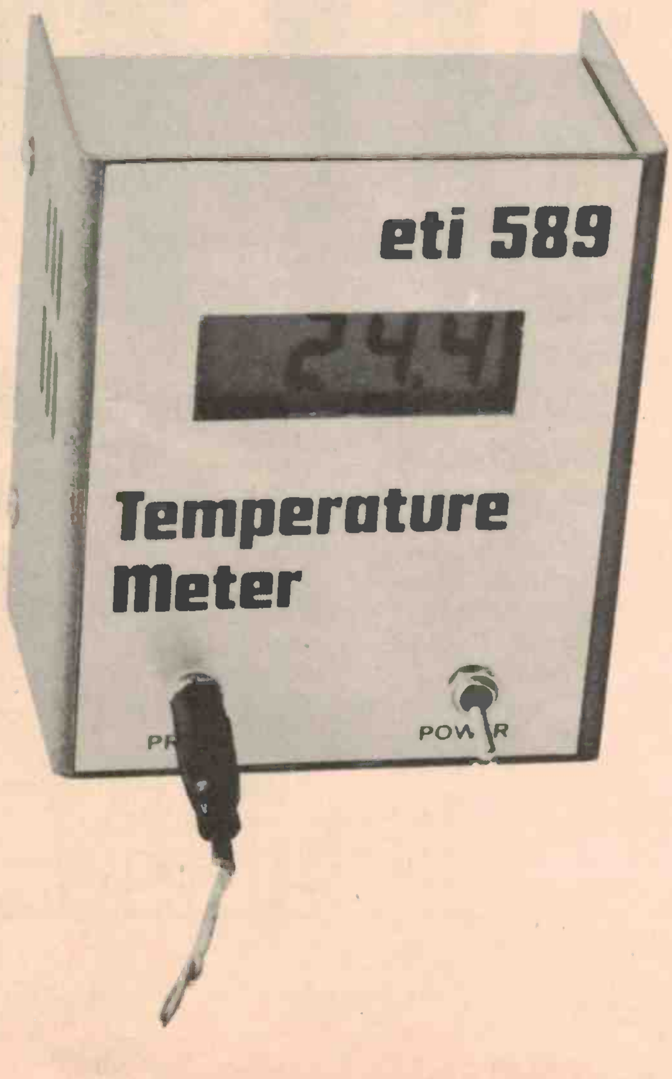
Digital Temperature Meter

This simple yet accurate temperature meter will find many uses in the laboratory or home. It utilizes the digital panel described in the October issue.

THE RELIABILITY OF electronic circuits in the days of valves was, to say the least, poor by today's standards. The introduction of transistors and integrated circuits increased reliability dramatically. One of the main reasons for this is the reduction of power dissipation and the resultant lowering of temperature. Devices and circuits are now designed to minimise power dissipation as this allows a higher component density while increasing reliabjlity. However some circuits by their nature must dissipate high power and the semiconductor devices used must be kept within their temperature limits.

This temperature meter will allow transistor temperatures to be measured and the appropriate heatsink chosen. It is just as useful outside the electronic scene measuring liquid or gas temperature especially where the readout needs to be physically separate from the sensor.



Use and Accuracy

The accuracy of the unit depends on the calibration; provided it has been calibrated around the temperature at which it will be used, accuracy of 0.1 degree should be possible. We could not accurately check linearity but it appeared to be within 1° from 0° to 100°C.

However other errors will affect this reading. If measuring the surface temperature i.e. a heatsink temperature, there will be a temperature gradient between the surface and the junction of the diode. Silicon grease should be used to minimise the surface-to-surface temperature difference. Also when measuring small objects, e.g. a TO-18 transistor, the probe will actually cool the device slightly. At high temperatures these effects could give an error of up to 5% (the reading is always less than the true value). If the probe is in a fluid, e.g. water or air this problem does not occur.

Construction

Assemble the panel meter as previously described but omitting the zener diodes and R6 and R7. The value of R1 has also been changed. The decimal point drive should be connected to the right-hand decimal point. The additional components can be assembled on a tag strip as shown.

We mounted our unit on a tag strip as shown in the photo. While we have not given any details, knocking up a case should be no problem. For a power supply we used eight penlight Nicad cells giving a 10 V supply. If dry batteries are used six penlight cells are recommended although a 216-type 9 V transistor battery will give about 300 hours of operation.

The sensor should be mounted in a probe as shown in Fig. 1 if other than air temperature will be measured. This provides the electrical insulation needed for working in liquids etc. It should be noted however that the quick dry epoxies are not normally good near or above 100°C and if higher temperatures than this are expected one of the slow dry epoxies should be used.

Calibration

To calibrate this unit two accurately known temperatures are required, one of which is preferably zero degrees and the second in the area where the meter will normally be used and highest accuracy is required. For a general-purpose unit 100°C is suitable. The easiest way of obtaining these references is by heating or cooling a container of distilled water. However temperature gradients can cause problems, especially at zero degrees.

One method of obtaining water at exactly zero degrees is to use a test tube of distilled water in a flask of iced water and allowing it to cool to near zero. Now by adding salt to the iced water its temperature can be lowered to below zero. If you are very careful, the test tube water will also drop below zero without freezing (you should be able to get to about -2°C). However the slightest disturbance at this temperature will instantly cause some of the water to freeze and the remaining water to rise to exactly zero, providing an ideal reference.

For a hot reference the boiling point of distilled water is very close to 100°C especially if the container has a solid base and is evenly heated e.g. on an electric hotplate.

The actual calibration is done as follows:

1. In the 0°C reference adjust RV2 and RV3 until the unit reads zero.
2. In the hot reference adjust RV1 to give the correct reading.

This should be all the adjustment required.

If zero degrees is not available, e.g. if setting up for °F, the following method can be used:

1. In the cold reference use RV2 and RV3 to adjust reading to zero.
2. In the hot reference use RV1 to adjust the reading to indicate the temperature difference between the two standards. If freezing and boiling points are used, this will be 180°F.
3. Now, back in the cold bath, adjust RV2 and RV3 to give the correct reading.

No further adjustment should be required.

SPECIFICATION – ETI 589

Temperature range	– 50°C to +150°C – 60°F to +199.9°F
Resolution	0.1°C or F
Sensor	silicon diode
Power consumption	1.5mA @ 9 V dc

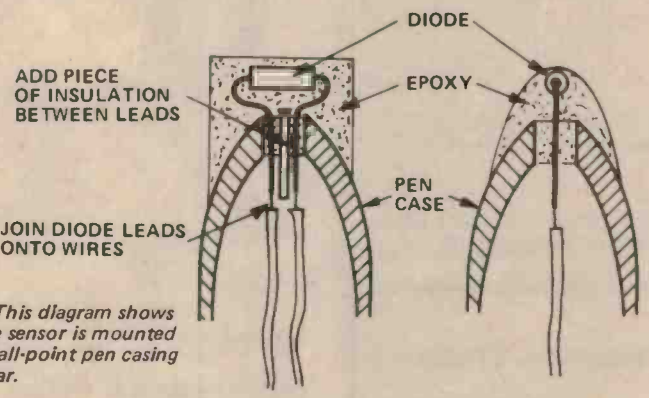


Fig. 1. This diagram shows how the sensor is mounted into a ball-point pen casing or similar.

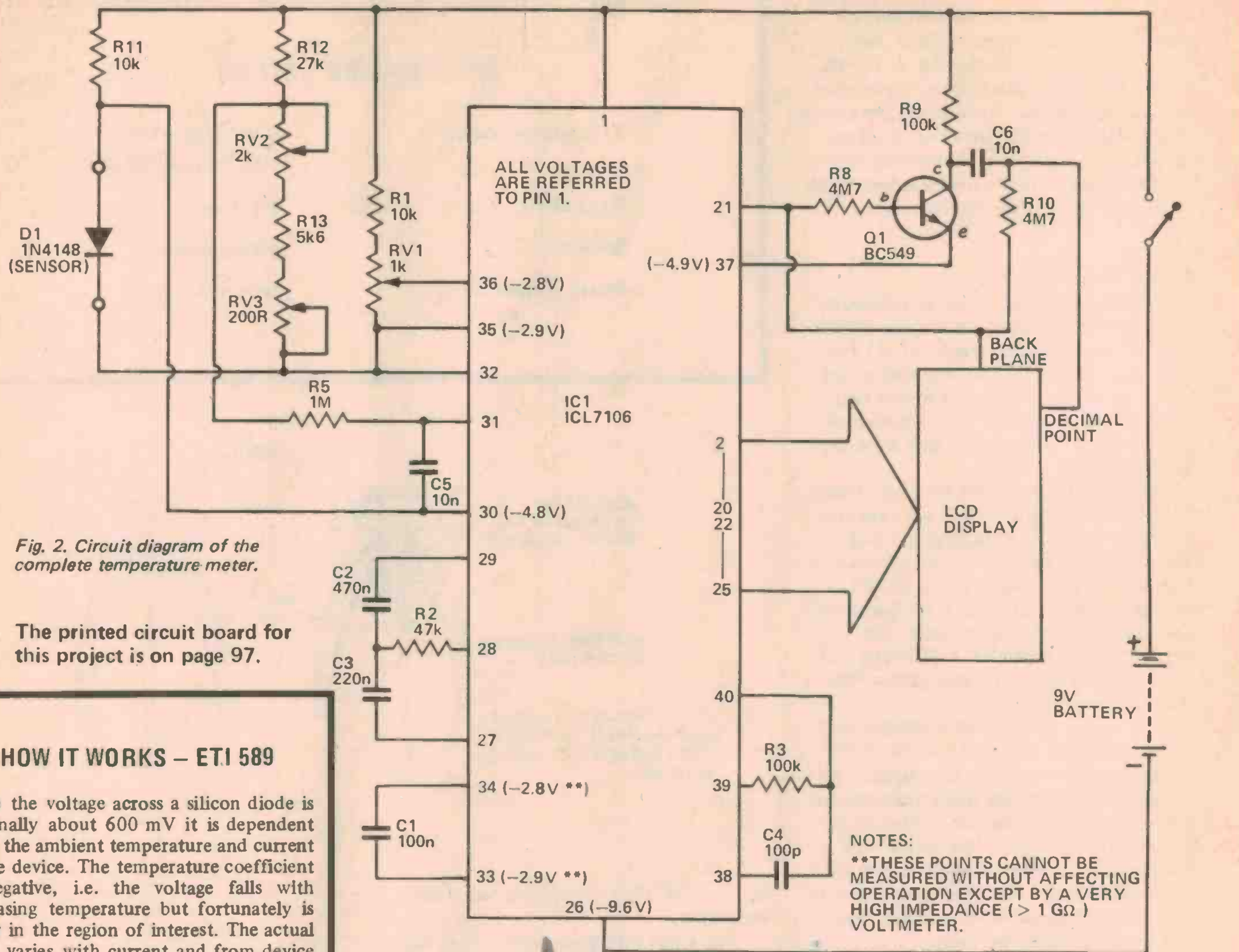


Fig. 2. Circuit diagram of the complete temperature meter.

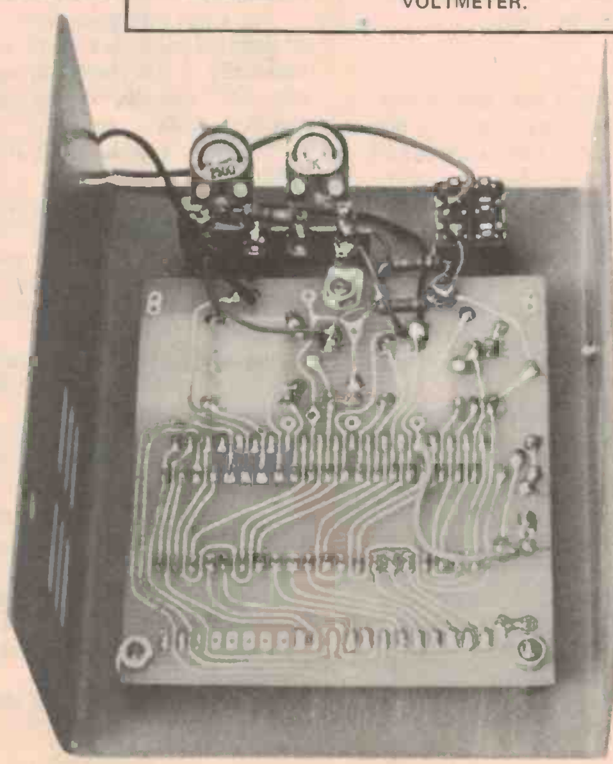
The printed circuit board for this project is on page 97.

HOW IT WORKS – ETI 589

While the voltage across a silicon diode is nominally about 600 mV it is dependent upon the ambient temperature and current in the device. The temperature coefficient is negative, i.e. the voltage falls with increasing temperature but fortunately is linear in the region of interest. The actual value varies with current and from device to device, but is typically –2.2 mV/°C at 250 μA.

By measuring the voltage across the diode with a suitable offset voltage to balance the voltage at zero degrees an accurate temperature meter results. The digital panel meter described in October has a stable reference voltage available (between pins 1 and 32) of about 2.9 V; with the 10k resistor R11 this provides a constant current for D1 (the sensor). The offset voltage is also derived from this reference voltage by R12, RV2 and RV3. The panel meter is used as a differential voltmeter and measures the potential difference between the offset voltage and the diode. We have used two trimpots in series in the offset adjustment to give better resolution. If desired a 10-turn trimpot can be used (2k2). Adjustment of the three potentiometers allows the meter to be calibrated in either °C or °F with the upper limit of 199.9°F due to the panel meter over-ranging.

The power supply is simply a 9 V battery, and so the zener diodes and dropping resistors described in the panel meter article should be omitted.



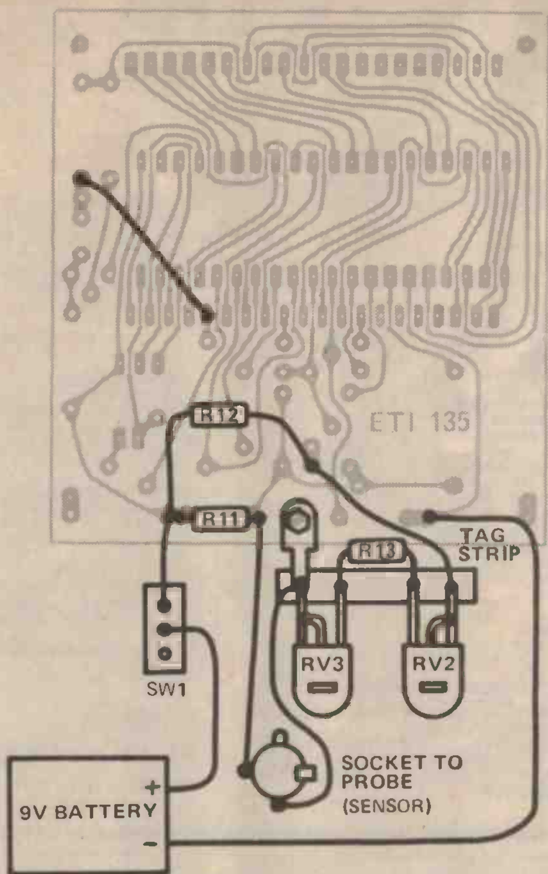


Fig. 3. The external components associated with the panel meter. For details of the panel meter see October 77 ETI.

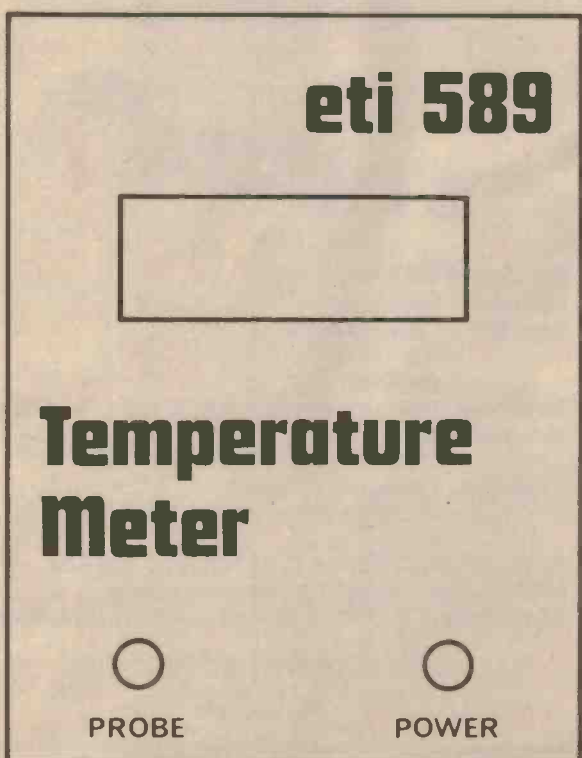
PARTS LIST – ETI 589

Resistors	all ½ W, 5%
† R1	10k
* R2	47k
* R3	100k
R4	not used
* R5	1M
R6	not used
R7	not used
R8	4M7
R9	100k
R10.	4M7
R11.	10k
R12.	27k
R13.	5k6
Potentiometer	
* RV1	1k 10 turn trim
RV2	2k trim
RV3	200 trim
Capacitors	
* C1.	100n polyester
* C2.	470n "
* C3.	220n "
* C4.	100p ceramic
C5.	10n polyester
C6.	10n "
Semiconductors	
* IC1	ICL7106
Q1	BC549
D1	1N4148

Miscellaneous
PC board ETI 135
Tag strip
* LCD Display
* Socket for LCD display
Box
Switch
9V battery

* These components are supplied with the Intersil ICL7106 EV evaluation kit.

† This value has been changed from the original panel meter.



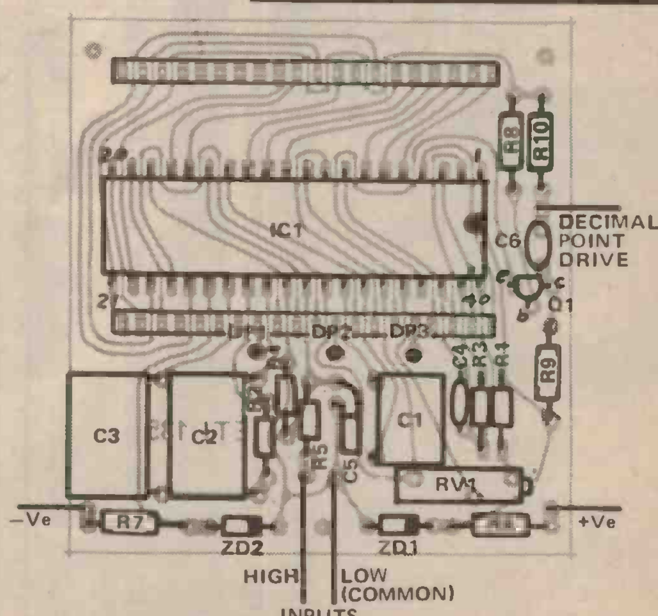


Fig. 4. The component overlay of the panel meter with the display removed. Note that for this project R4, 6, 7, ZD1, 2 and the external leads are not used.

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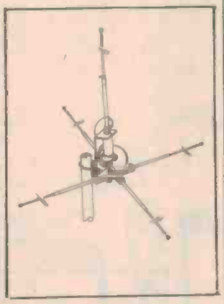

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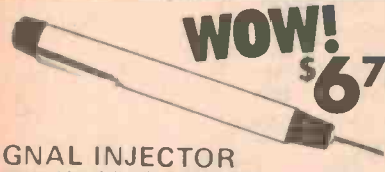

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Cat. Q-1310 . . . . $95.00

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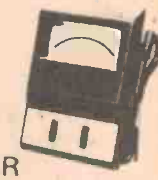

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Printed Circuit Boards Design & Production

At last! The inside story on making PCBs from artwork in ETI (or your own).

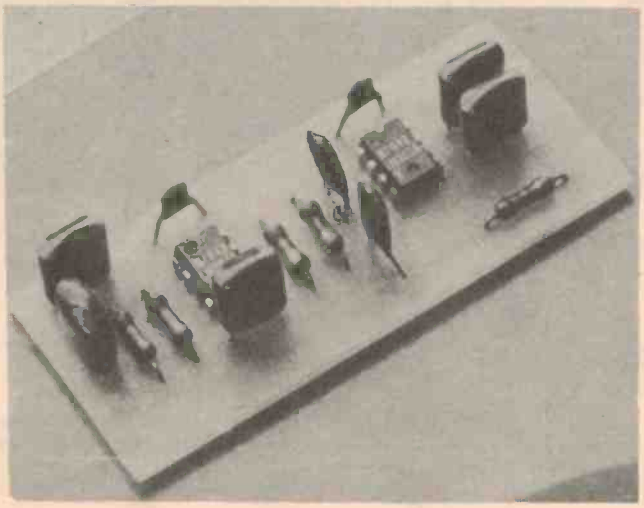
WITH TODAY'S ELECTRONICS becoming more and more complex, the use of a printed circuit board is more than a luxury, it is virtually a necessity. For prototypes a hand wired system may be the ideal, but where more than one is required or high reliability is needed the PCB is without peer. In a purely digital circuit wire wrap can be used but it is limited to digital work.

As circuits become more complex, the copper tracks have to become thinner with tracks down to 0.25 mm being used sometimes, even in projects. The old method of copying the pattern with bituminous paint is no longer a practical proposition, if at all possible!

The use of a photographic method of placing an image on the copper is therefore much better; this article will first explain how to make the pc board using the 'negative photoresist' method, and then how to design the artwork itself allowing your own designs to be built on PCBs.

Before continuing, a very brief explanation of the basic method of producing circuit boards may be of help to those who have not tried it before.

1. The pc board material when purchased is normally 1.6mm thick in either fibreglass or phenolic with a sheet of copper about 0.03mm thick bonded onto one or both sides. This copper weighs 1oz/sq. ft. and is simply called 1oz copper. Two ozs. copper is also available.
2. An image is then painted or photographically placed on the copper in the pattern required, i.e., the pads and tracks. This is called the resist.



3. The board is placed in a solution which dissolves copper and any areas of copper not protected by the resist are removed leaving copper only where required.
4. Finally, the resist is cleaned off, leaving bright copper ready to be drilled and suitable for soldering.

As we have said, we will start this article half-way through the normal sequence of pcb manufacture by assuming that you have the artwork finished. This is the case if you are building an ETI project as normally the full size artwork is published. We will explain more on pcb design later.

To copy artwork out of a magazine it is usually necessary to photograph it one-to-one using a process camera. As we realized that this equipment is not generally available to the home constructor, we have changed our presentation to allow a negative to be made without elaborate or expensive equipment. You may have noticed that as of the October issue the pcb designs have been published on a separate glossy page and that the copy on the reverse side of this page is in blue only. This allows a contact print to be made using Scotchcal 8007 emulsion film and a UV light source. As the blue is transparent to UV (as is the white page) it will not come out in the negative.

We have chosen to describe the negative photo resist method (i.e., the resist is hardened by exposure to light meaning a negative is required) as it is much easier to use (less fussy about baking temperature, exposure, etc.). If the magazine artwork is copied by the method described a negative will be made anyway.

Production

Equipment Needed

1. Source of UV light – Sylvania F20T12–BL or Philips TLA20W/05 Actinic Blue Fluorescent tubes or a sun lamp or the sun.
2. A method of holding the negative on to the pc board material during exposure. This could be as simple as a sheet of glass on a piece of foam plastic held down by a couple of weights or as complex as a vacuum frame. The setup we use is shown in Fig. 4.
3. A metal or glass tray for developing the pc board.
4. Photo resist – see table 1.
5. Photo resist developer – see table 1.
6. A soft, new, paintbrush.
7. Negative film (Scotchcal 8007 emulsion film).
8. Negative film developer (Scotchcal 8500).
9. Glass or plastic container for etching.
10. Etchant. See table 2.

Making the Negative

This method can only be used to copy ETI artwork from October 1977 on. Attempts to copy artwork from prior issues or other magazines' artwork by this method are unlikely to be successful.

Scotchcal 8007 film is UV sensitive and can be handled under normal room light. As normal fluorescent lights have some UV content, do not leave the film exposed to them any longer than necessary.

Cut a piece of Scotchcal 8007 emulsion film a little larger than the pc board and expose it to UV light through the page of the magazine. The non emulsion side should be in contact with the pc board pattern side of the page. The emulsion surface can be detected by its lack of gloss or by the fact that, if it is picked up by one corner, it will curl towards the emulsion surface. Exposure to the emulsion side will not result in a bad image – it will result in no image at all!

The film can now be developed by placing it emulsion side up on a table and pouring some developer (Scotchcal 8500) on the surface, spreading it to give a liberal coating over the entire surface using a piece of cotton wool, tissue or soft paper. Allow it to settle for 5–10 seconds then, with a light rubbing action, remove the unexposed material leaving the desired image. Wipe off excess developer and allow the film to dry.

If excessive rubbing is necessary to remove the unwanted material the exposure was too long while if the wanted material also tends to come off, the film was under exposed.

Using Photo-resist

The KPR and CCNR204 resists are liquids and are used to coat blank pc board material while Riston is a plastic material which is supplied prebonded to fibreglass pc board material. It is easier to use but more expensive. For Riston, skip the next instructions and go direct to 'exposure'.

Laminate Preparation

Cut the blank pc board material, preferably about 10mm larger than the finished size. This simplifies handling and coating of the board.

The laminate should now be scrubbed thoroughly using a powdered abrasive cleaner such as Ajax, using a new Scotchbrite pad or clean paper towelling and water. Wash the surface well and ensure that there is no trace of grease on the board and it "wets" evenly. Dry the surface then wipe it with a paper towel dampened with the appropriate developer, then dry again. Be careful not to touch the surface as skin oils will nullify the preparation.

Coating the Laminate

Like Scotchcal film, these resists are UV sensitive and can be handled under room lighting but exposure to fluorescent lights should be avoided or minimised.

Pour a small pool of resist in the centre of the prepared laminate and smooth it over the entire surface with a soft clean paintbrush to give an even *thin* coating. If too much resist has been used pour some off the edge, then smooth it out again. A second method, and the one we use with KPR resist, is to place the board on the palm of the hand and pour some resist onto the centre of the surface as before. Then by tilting the board slightly the resist can be made to move around and finally cover the entire surface. Now the excess is drained off (back into the bottle if desired) and the board is left resting on edge (on a paper towel preferably) for about five minutes. Wipe off any excess on the edge, as with all negative acting resists the coating must be thin. Your paintbrush should be cleaned after use in the appropriate developer. This will soften and rinse out the resist.

Bake the laminate at about 80°C for 10-15 minutes to ensure the coating drys. KPR will dry at room temperature in about four to five hours if an oven is not available.

Exposure

All three resists are exposed in the same way using the same setup as for the Scotchcal film. That is, the negative is clamped onto the precoated surface and exposed to UV light. With the Riston there is a protective plastic coating on the surface and this should be left *on* during exposure.

Exposure times will of course vary with different light source/distance but we found that six minutes for KPR, three minutes for CCNR204 and one and a half minutes for Riston suited our setup, so experimenting around these times should yield reasonable results.

Development

All three resists have their own developer but the procedure is similar. With the Riston remove the protective plastic sheet before development.

Place the board face up in a tray of developer. With the Riston brush gently with a paint brush until the unwanted material is removed. With the CCNR204 gentle rocking is recommended for about two minutes until the unwanted resist dissolves, while with the KPR simply leave the board for three minutes or so.

Wash the board under running water, particularly the KPR which should be sprayed with a strong jet of water as the unwanted resist is simply softened and must be removed.

If the required image comes off it either means under exposure or bad surface preparation. If the unwanted area will not come off or if the tracks widen and holes fill in it is over exposed.

Post Baking

The CCNR204 requires a post bake of about 30 minutes at 110°C.

Etching

Place the laminate in the etchant and gently agitate until the unwanted copper is dissolved. Alternatively if the container is deep enough, support the board by its edge, but off the bottom, until etched.

While there are many etchants available the two most common (and least dangerous) are ferric chloride and ammonium persulphate. The method of mixing and ideal concentrations are as follows-

Ferric chloride

(a) Hydrated (yellow lumps). Mix 1kg. with each litre of water. Heating to 75-80°C will help it dissolve.

(b) Anhydrous. Slowly mix 500 gm. with 1½ litres of cold water, stirring continuously as extreme heat is generated.

Ammonium Persulphate

Mix 400 gm in one litre of water.

Pro's and Cons of Etchants

Ferric Chloride — It is cheap and will work cold. However, it is dirty and will stain clothes, etc.

Ammonium Persulphate — It is clean, will not stain clothes, is transparent allowing etching to be seen. However, it must be used hot, i.e., 40-50°C. New solution etches in about five minutes.

Lower concentrations of both etchants will result in longer times. As both etchants will attack most metals, use plastic or glass containers. For ammonium persulphate a shallow fish tank (less the fish!) and heater (suitably wound up to 45°C) is ideal.

Storing

Ferric chloride can be stored in a bottle (not a drink bottle please) when not in use. Ammonium persulphate must not be stored in a closed container due to a gas given off. It also decomposes with time so don't be surprised if a six month old solution doesn't work.

After Etching

The resist normally has to be removed as it makes soldering more difficult. For KPR rubbing with steel wool is the easiest method while with CCNR204 a couple of minutes in the developer softens the film allowing it to be rubbed off with a paper towel. The Riston can be removed with acetone or lacquer thinners.

A light rub with steel wool to clean the surface followed by a thin coating of liquid flux helps.

Drilling

If a drill press is available with a reasonably high speed the use of tungsten tipped drills, provided you are doing a reasonable quantity of boards, is economical. These cost about $3.00 each compared to 75c for normal drills (No. 60 or 1mm), but they don't go blunt! They are not recommended for handheld drills as they are brittle and break easily.

APPROXIMATE TIMES IN BOARD PRODUCTION

JOB	APPROX. TIME
Expose negative	20 min.
Develop negative	5 min.
Cut and prepare board	10 min.*
Coat and pre bake board	20 min.*
Expose board	5 min.
Develop board	5 min.
Etch board	15 min.
	1.20 min.

*These can be done while negative is being exposed.

TABLE 1

Resist	KPR Photo resist	CCNR204	Riston
Developer	KPR Photo resist developer	CCNR206	Riston developer
Pre bake time	20 min. @ 80°C	15 min. @ 80°C	NIL
Post bake time	NIL	30 min. @ 110°C	NIL
Exposure time (relative)	6 min.	3 min.	1½ min.
Supplier	Kodak	Circuit Components	

Design

Equipment Needed

Light box*

Transparent 2.54 or 1.27 mm (0.1 or 0.05 inch) grid*

Matte one side drafting film (Accufilm)*

Crepe tape of appropiate widths

Crepe pads of suitable diameters

Stick on patterns for special components (ICs etc)

*A 2.54 mm (0.1 inch) graph pad and tracing paper will suffice if you are not going to do many boards.

The Circuit Diagram

This obviously is the starting point. Use a component numbering scheme, i.e. R1, R2, C1, C2 etc, as it will aid the layout. The circuit should have been proven in a breadboard setup unless it is very simple and foolproof (remember Murphy!)

Working out the Pattern

This takes time, patience and experience to do well. Some of the complex computer type boards may have taken more than a week just to layout! However simpler boards can be done a lot quicker especially if size is not important.

Cut a piece of the drafting film and stick it matte side up on the grid on the light box. The matte surface will take pencil well. Before starting the layout check all components to be used to obtain their physical size and note if their leads must be positioned accurately as with ICs. Also check from the circuit diagram if any conductors are carrying high currents or are at high voltages as this will affect track width and spacing. Tables 2 and 3 give the current capability of tracks and clearances required. Also note if there is any special requirements to prevent feedback or similar problems. With

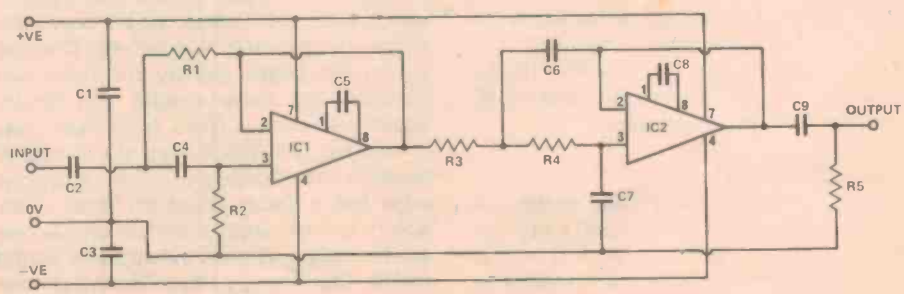


Fig. 1. The circuit diagram of a filter which we are using as an example.

TTL circuiting for example the 0V line should be as solid as possible with decoupling capacitors on the 5V line every 2 or 3 packages. For general, low voltage/current work we recommend pads of 3 mm (0.125 inch) tape of 1 mm (0.04 inch) wide using at least 0.75 mm (0.03 inch) clearances. Where space is at a premium lines of 0.65 mm (0.025 inch) and spaces of 0.5 mm (0.02 inch) can be used; however to maintain these clearances double - size artwork is needed.

The layout is initially done in pencil with the components represented by either their physical size or their circuit symbol. This drawing should be done from the component or non copper side. In our example we have initially given a layout which is done virtually as the circuit diagram is drawn. While this is easy and will work it uses a lot of board space, especially on a large circuit. By rearranging the components the layout in Fig 3 results. This is much neater and requires less board space.

Normally several different arrangements will be necessary before the final one is chosen. With a larger more complex board it is often easier to lay out sections of the board separately on different parts of the sheet of film and finally combine them into a single main drawing. This is especially so if the layout has to fit into a specific size board.

With a single sided board it is often impossible to join all pads even with careful positioning of components. In this case jumpers or links can be used. If a larger number of these are required it may be easier to use double sided board.

Taping

Before taping the circuit, double check to ensure there is enough room between the pads for the conductors to pass through with adequate clearance. Lift off the drafting film and turn it over repositioning it accurately on the grid. Commence taping with the IC sockets and any other special pads which have a backing material larger than the pattern itself. Then add the circular pads and finally the lines. The crepe line can be bent to go round corners, even sharp ones if you are careful. It should not be stretched more than necessary as it may creep and move off the pad creating an open circuit.

When running a tape between pads the maximum clearance is obtained when the tape is at right angles to the line between the pads. Fig. 5 gives an example of this.

Once the taping has been finished add a number or code onto the board using 'letraset' or similar so that you

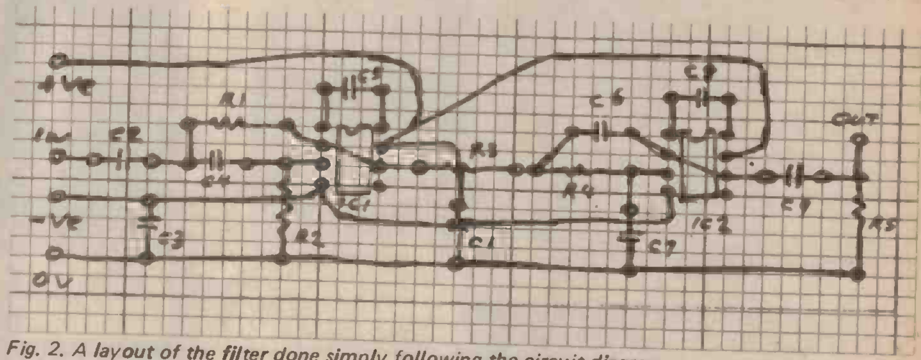


Fig. 2. A layout of the filter done simply following the circuit diagram.

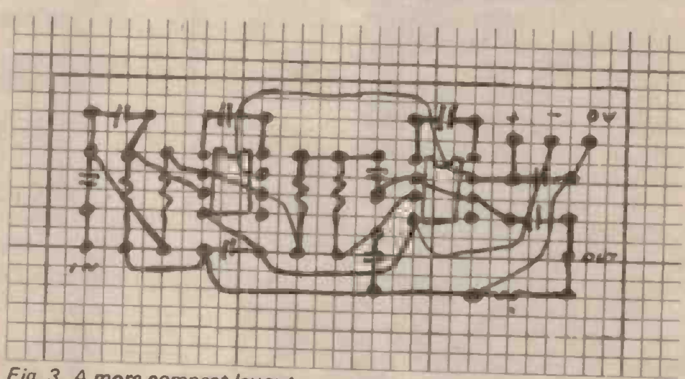
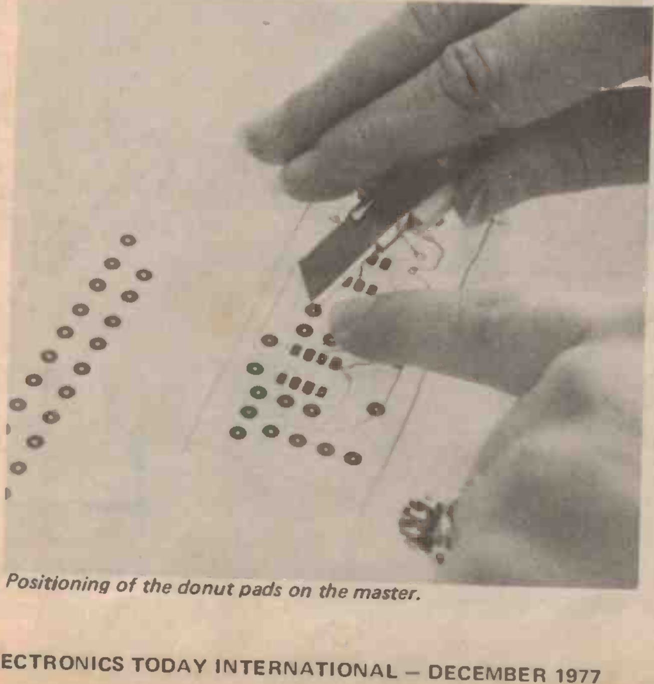
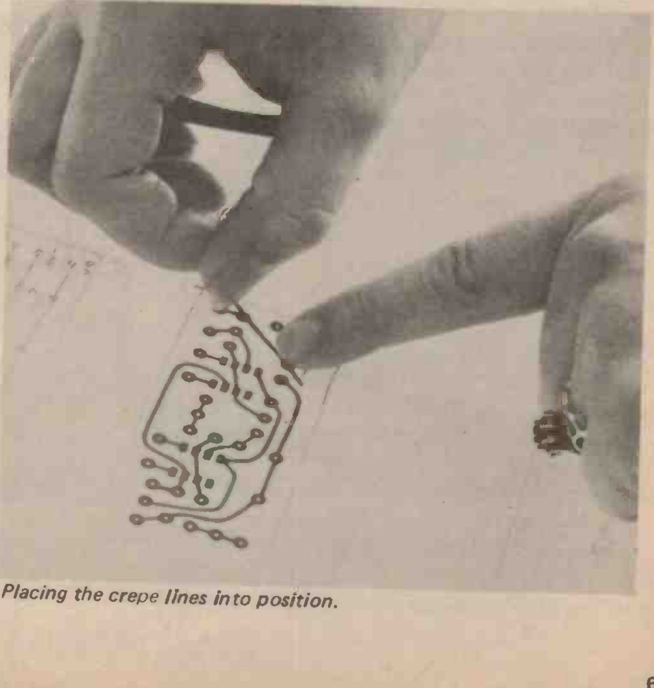


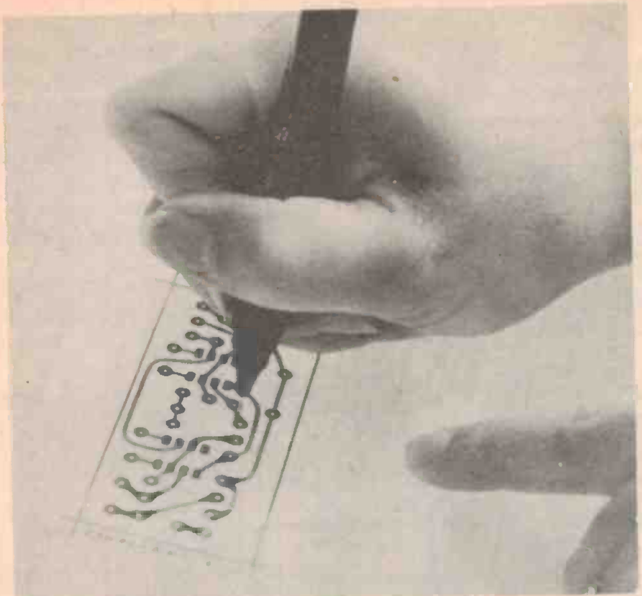
Fig. 3. A more compact layout.



Positioning of the donut pads on the master.



Placing the crepe lines into position.



Filleting the tape-pad junctions.

Dissolving the resist (Riston) in the developer.

will know which is the right way round once a negative is made. Lift off the film and reverse it again. All the pencil can now be rubbed off and the layout checked for accuracy. A photo copy is good for this if available.

When soldering a pad the glue holding it to the pc board base material always softens. If the line joining the pad is too thin it may not conduct heat itself and if any pressure is applied to the joint a break may occur at the edge of the pad. To avoid this the line to pad junction should be filleted. This can be done with a normal drawing pen and ink on the matte side of the master. This film however does not absorb ink and drying time is long. A hair dryer or similar is useful for speeding up this process.

The Negative

This is similar to copying the artwork out of the magazine except only about 1½ min. exposure is needed and the non taped side should be against the negative film (non emulsion side).

TABLE 2
MINIMUM CONDUCTOR SPACING
(uncoated boards to be used below 10,000 ft altitude)

Voltage dc or peak ac	mm	Spacing (inch)
0 - 50	0.4	0.015
50 - 150	0.6	0.025
150 - 300	1.25	0.050
300 - 500	2.54	0.100
500 +	0.005/volt	0.0002/volt

60% of the above clearances may be used where the board is to be coated with a suitable spray.

TABLE 3
CURRENT CAPABILITY OF 1 OZ COPPER TRACKS

Line width mm	Line width inch	Current (45°C rise)
0.5	0.020	3A
0.8	0.031	3.5A
1.0	0.040	4.5A
1.25	0.050	5A
1.6	0.062	6A
2.5	0.10	9A
3.2	0.125	10A
3.8	0.150	12A
5.0	0.20	15A
6.4	0.25	17A

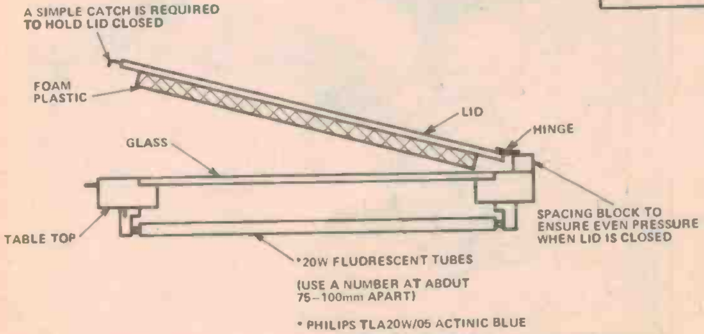


Fig. 4. The setup we use for exposing the PC boards.

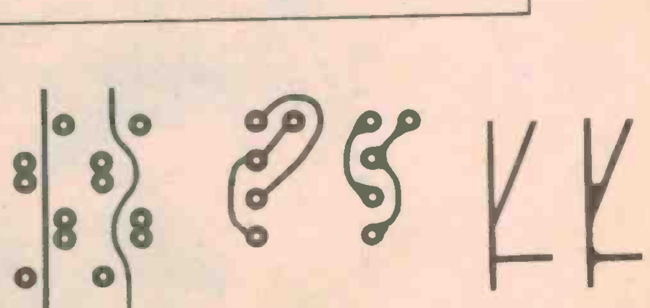


Fig. 5. The correct way and the wrong way to run tapes for maximum clearance and minimum line length.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1 uF	5c	6c	8c
2.2 uF	5c	6c	8c
3.3 uF	6c	6c	8c
4.7 uF	6c	7c	8c
10 uF	6c	7c	8c
22 uF	7c	8c	9c
33 uF	8c	9c	10c
47 uF	9c	10c	11c
100 uF	10c	12c	14c
220 uF	11c	13c	—
470 uF	16c	22c	—
1000 uF	22c	35c	—

2200 uF/50 axial — 95c
Axials price list SAE

T03 KITS MOUNTING
10 for $1 or $4 box of 50
Generous kit includes mica, screws, nuts, washers, tag, nylon bushes.
LEDs: 28c ea. big red & clip. Clip alone 3c
Zeners: 15c ea. 400mW 5% E24. 3V to 33V

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		
.068	10c		
.082	10c		

All values in uF

Specials: Economy LEDS — big red with clip — 20c ea. $1.80/10, $15/100.
Electrospecial: Axial 1000uF/16V — 20c ea. plus 2c ea. extra postage.

Resistors: 2c ea. ¼W carb film 5% E12 values 1 Ohm to 1M $1.80/100 same. Also ½W: 3c ea. metal glaze 5% E12 2.2 Ohm to 470K only. $2.50/100 same.

SCRs:

0.8A	30V	C103Y	35c
0.8A	200V	C103B	60c
4A	30V	C106Y1	40c
4A	400V	C106D1	75c
8A	400V	C122D	$1.05
8A	500V	C122E	$1.20
25A	400V	C37D	$2.50

TRIACS:

2A	400V	ESP240	65c
2A	400V	SC141D	$1.30
10A	400V	SC146D	$1.50
25A	400V	SC260D	$2.50

DIAC ST2 — 35c
Chart to identify leads plus trigger info. — 15c

DIODES:

1N4001	7c (1A 50V)
1N4002	8c (1A 100V)
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1N4007	12c (1A 1000V)
1N4148	6c. $4.50/100 $38/1000

Potentiometers: 50c ea. rotary carbon sing. gang — log or lin: 1K, 5K, 10K, 25K, 50K, 100K, 250K, 500K, 1M, 2M (metal shafts).
Trim Pots: 17c ea. — 10 mm .1W horiz. or vert: 100 Ohm, 250 ohm, 500 Ohm, 1K, 2K, 5K, 10K, 25K, 50K, 100K, 250K, 500K, 1M, 2M

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Unitrex Calculator Contest

Well, we all had a lot of fun with the October contest, you thinking up those root two mnemonics and us reading them! We also had a tough time deciding on a winner; we got it down to a short list of six all of which were excellent and one of which was unprintable!

We'll show you what we mean. First off is Ivan Martin of Lindfield, NSW who got two entries into the big six. His first entry starts 'A girl I know is a bit loose,' and the rest is unfortunately unprintable! But we thought it was rather funny, having the same curious sense of humour as Mr. Martin!

Ivan Martin also contributed a second entry, which runs like this: 'I have a disc by a new group coming to our country, the incredible 'Cosmology'. whose relativity song, 'Crawling Neutrino', engendered a simply gigantic overseas acclaim.' This entry uses three 10-letter words to represent the zeros in the value of root two – other entries used all kinds of tricks to get round this problem.

A.I. Godfrey of Ardross, WA, submitted: 'A girl I know is a new woman thanks to her rushing out, acquiring rifle, then shooting paramour; a female approach becoming popular'. in which the punctuation marks count as zeros.

Also from Ardross, WA – from Mrs. H. Godfrey, in fact – comes this piece of genuine old-fashioned chauvinism: 'I hate a chap in a bed being ardent in the British way! Australia awake! More chivalry required! A maiden deserves Southern passion' which makes ! = 0.

The celluloid-inspired Mr. P. Jarvis of Mt. Kuring-gai, NSW tackled the zeros head-on in this piece:

'I, whom I know as a cad,
Think fondly of the wistful sad O,
Miserable weepy O,
Ever drearily mournful O,
A subtly poignant creature tragedy'.

If the poetic Story of O doesn't move you, here's an attempt that would have moved the great McGonigall himself to tears:

'A poem I trim as I sit
Scant regard to any synonym fit,
Cyphering roots,
Such bulldust pollutes,
I hereby bequeath immortal iambics'

using commas to represent zeros.

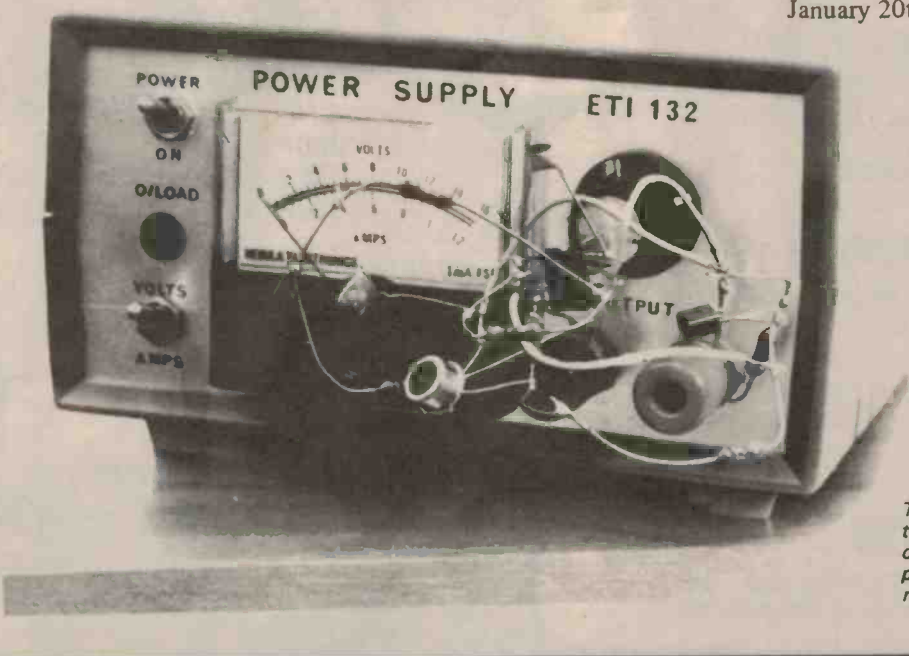
After the great wailing and gnashing of teeth had died down in the office, we decided the only fair and equitable thing to do was to award a calculator to each of our winners.

If you really want to read Ivan Martin's rather bawdy first entry, then send us a stamped addressed envelope and we'll send you a photocopy. But be warned – if you are offended, it's your own fault for being so curious. Also, if we suspect from your handwriting that you are in what we shall call the 'junior age group' and too young for such provocative reading, you'll just get an empty envelope back.

On the subject of puzzles, please, please, no more solutions to the Puzzle of the Drunken Sailor unless they take less than thirty moves which is the current minimum. Since that puzzle went down so well, here's a similar one as the December ETI/Unitrex Calculator Contest, which was contributed by a gentleman with an unintelligible signature from Dandenong, Vic. (no kidding, we hope he knows we mean him!).

Two 'mobs' of sheep (English 'mobs', only four sheep per 'mob') are proceeding along a narrow path, the width of one sheep, in opposite directions. When they meet, there is one sheep's length between the leaders, and they now have to pass each other. Each sheep is only agile enough to jump over one other sheep or move forward a space, but can make as many moves as it likes without getting exhausted. Numbering the initial positions of the sheep 1 through 9, position 5 being a space, in what order should the sheep move to minimise the number of moves required?

Seal an empty envelope, write your answer on the back of it with your name and address, and send it to: *Unitrex Calculator Contest (December), ETI Magazine, 15 Boundary Street, Rushcutters Bay, NSW 2011.* Closing date is January 20th, 1978.



This rather unusual project prototype turned up in our labs the other day. We hope the final project will be slightly more refined!

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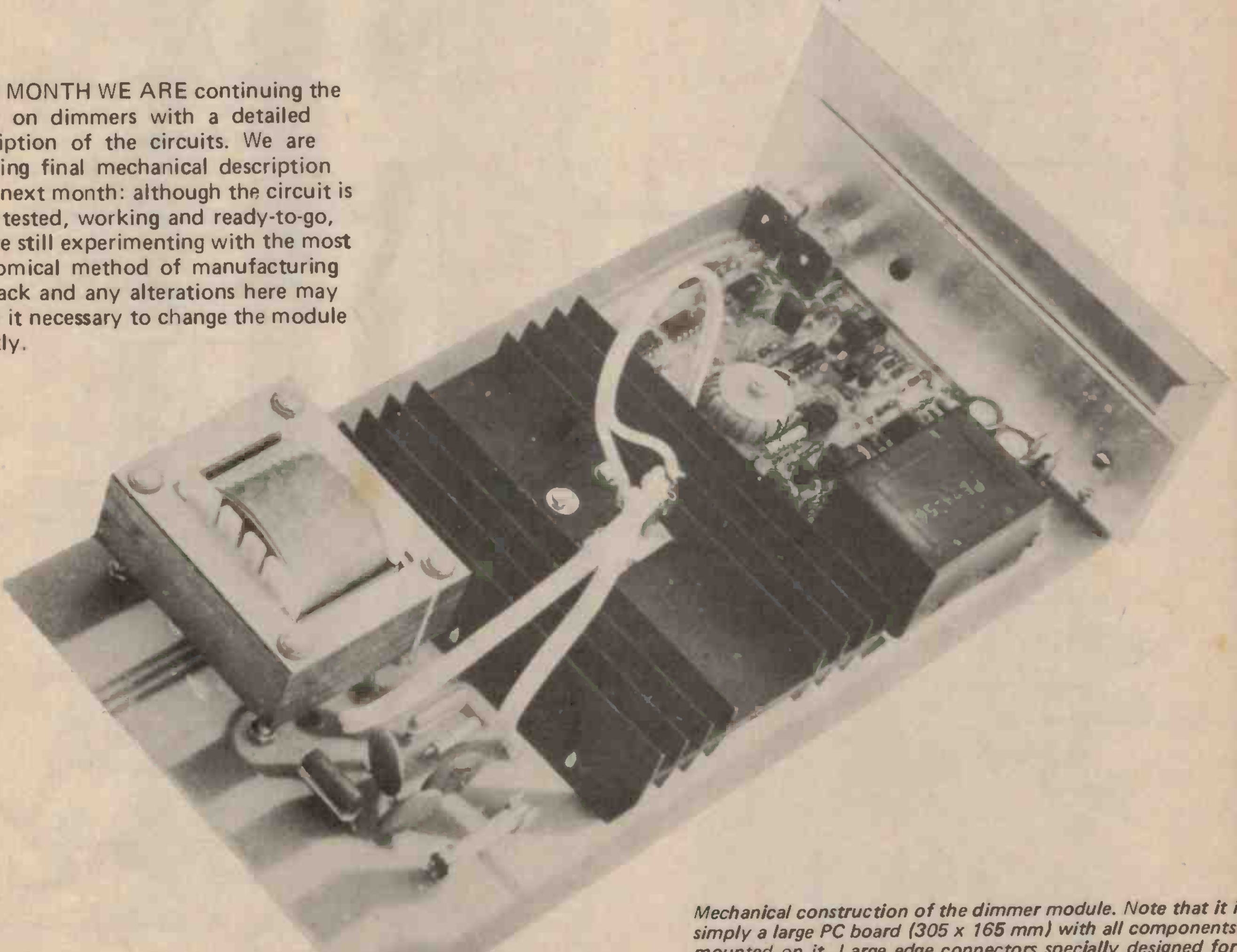
THEATRICAL LIGHTING CONTROLLER

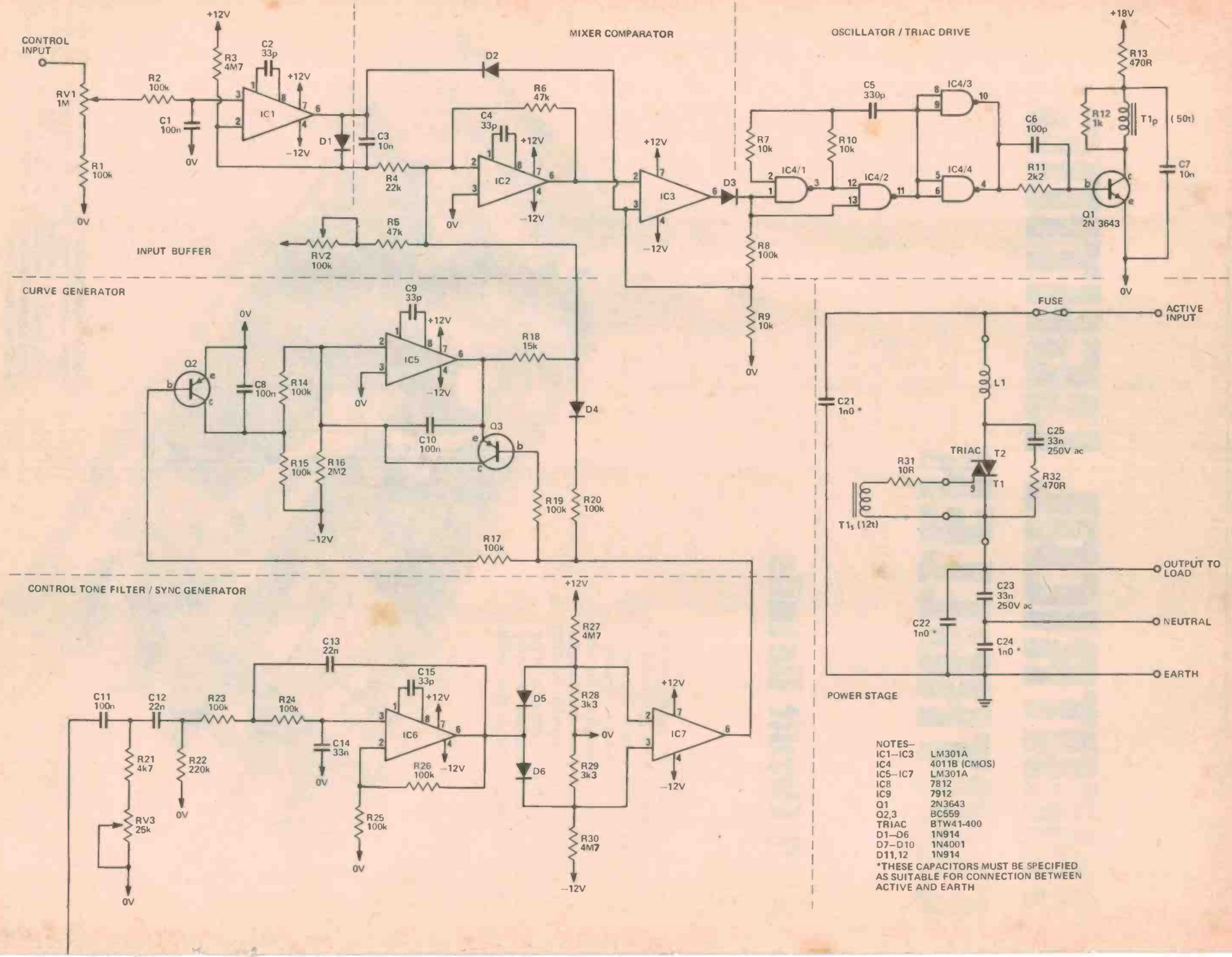
Pt.2 Circuit Details

THIS MONTH WE ARE continuing the series on dimmers with a detailed description of the circuits. We are delaying final mechanical description until next month: although the circuit is fully tested, working and ready-to-go, we are still experimenting with the most economical method of manufacturing the rack and any alterations here may make it necessary to change the module slightly.



Mechanical construction of the dimmer module. Note that it is simply a large PC board (305 x 165 mm) with all components mounted on it. Large edge connectors specially designed for the purpose are used for high current terminals. For the 20 A unit a double sided board is used for twice the contact area and a different fuse is used.

THEATRICAL LIGHTING CONTROLLER



NOTES—

IC1—IC3	LM301A
IC4	4011B (CMOS)
IC5—IC7	LM301A
IC8	7812
IC9	7912
Q1	2N3643
Q2,3	BC559
TRIAC	BTW41-400
D1—D6	1N914
D7—D10	1N4001
D11,12	1N914

*THESE CAPACITORS MUST BE SPECIFIED AS SUITABLE FOR CONNECTION BETWEEN ACTIVE AND EARTH

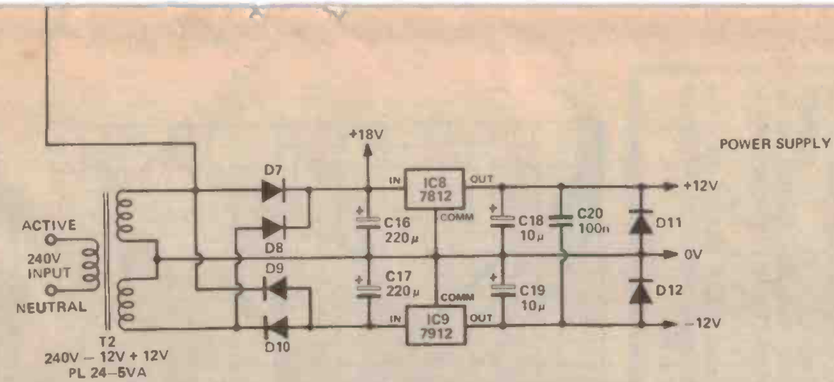


Fig. 1. The circuit diagram of the complete dimmer module.

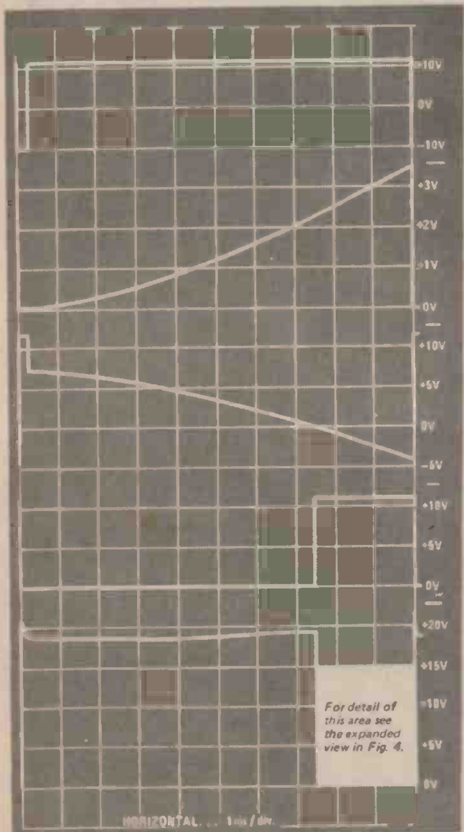


Fig. 2. Waveform taken on our 5 beam oscilloscope? No we cheated to show the phase relationships between various waveforms.
Waveforms from the top are:
sync pulse (output of IC7)
curve generator (output of IC5)
mixer output (output of IC2)
oscillator control (pin 1, 13 of IC4)
transformer drive (collector of Q1)

Fig. 3. Waveform showing relationship between the end of the half cycle and the sync pulse.

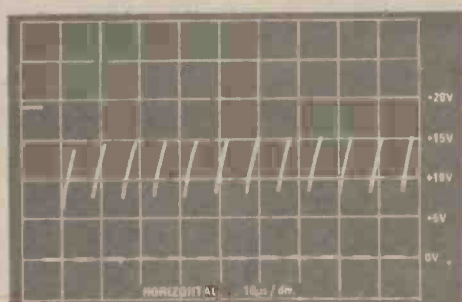


Fig. 4. An expanded view of the transformer drive waveform showing the collector voltage of Q1.

HOW IT WORKS – ETI 588

To help explain the operation the circuit can be broken into seven sections.

1. Power supply

This is a simple full wave rectifier which gives about ± 18V after being filtered by C16 and C17. Using 3 terminal regulators this is reduced to ± 12 volts which is needed for the circuitry.

2. Control tone filter and sync generator

As the name implies this removes the control tones that the supply authority superimposeson the mains voltage. These are normally about 1050Hz and can cause problems by upsetting synchronization of dimmers. The filter is a low pass type comprising IC6 and associated components. As filters always alter the phase relationship this is corrected using phase shift networks. C11/R21 and C12/ R22. Potentiometer RV3 is used to ensure the phase shift is zero (at 50 Hz) with normal component variations. If the output of IC6 is between +0.6 volts and –0.6 volts, neither D5 nor D6 will be forward biased sufficiently to change the input voltages to IC7 so its output will be –10 volts. As the output voltage of IC6 is a 'clean' 50 Hz sine wave of about 6 volts amplitude this will only occur at a small region about the zero crossing point. At all other times the output of IC7 will be +10 volts. The result is a negative pulse, about 250µ s wide, at the zero crossing point of the 50Hz.

3. Curve generator

This produces the output shown in Fig. 6. When the sync pulse occurs, transistors Q2 and Q3 discharge capacitors C8 and C10. Immediately on release of the sync pulse the output of IC5 begins to ramp up slowly due to R16 charging C10. However, while initially the voltage across R14 is zero and therefore does not affect the charging of C10, as C8 begins to charge due to R15 its effect becomes more and more dramatic. A curve is necessary as it gives a better input/output voltage relationship but the curve must be reproduceable hence the circuit used.

4. Input buffer

This serves two purposes; firstly, it allows a megohm input impedance and secondly it detects when the input voltage falls below 0.1 volt and turns the dimmer output completely off. This allows the minimum light control to be turned up to give a better control range, ie with the filaments just glowing, yet have them off if the control voltage is reduced to zero.

If the voltage is above 0.1 volt the diode D1 will lift the voltage on pin 2 of IC1 to equal that of the input on pin 3. However if the voltage falls below this level, the voltage on pin 2 will remain at about 0.1 volt due to R3 and the output of IC1 will go to about –10 volts.

5. Mixer-comparator

IC2 mixes the input voltage, the output of the curve generator the sync pulse and the minimum adjustment potentiometers. This gives the waveform shown in Fig. 2 with the input voltage and the minimum adjustment only moving the curve up and down without altering the shape. When the output of IC2 falls below zero volts the output of IC3 goes from –10V to +10 volt with D3 and R8/9 providing about 1 volt of positive feedback. The voltage has to rise to above 1 V to force the output back to –10 volts. The diode is necessary to ensure that the voltage at the input of the oscillator IC4 remains within the supply voltage of the IC. (+12V, 0V)

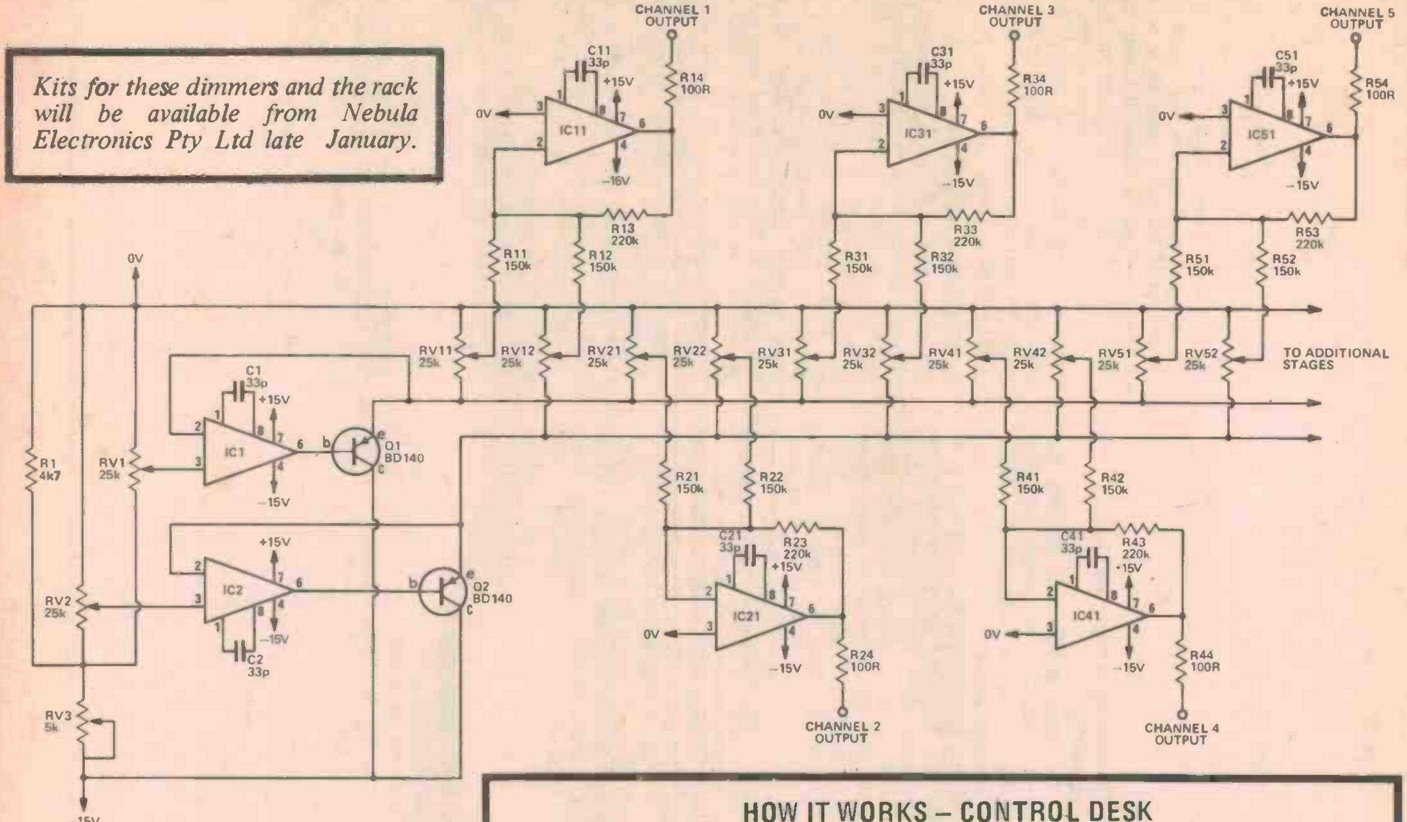
6. Oscillator/triac drive

A CMOS oscillator IC4 is used to drive Q1 which supplies the energy for the pulse transformer T1. The oscillator will only operate when the control inputs (pins 1 and 13) are at +10 V. The frequency is controlled by C5 and is set at about 150 kHz. Resistor R13 provides current limiting for the pulse transformer while R12 prevents the reverse voltage damaging Q1 if the load on the secondary load (the triac) becomes disconnected.

7. Power stage

This is simply a triac with a choke in series to prevent both RFI and 'filament rattle' and a fuse to protect against short circuits. Capacitors are also used as bypasses to help prevent RFI.

Kits for these dimmers and the rack will be available from Nebula Electronics Pty Ltd late January.



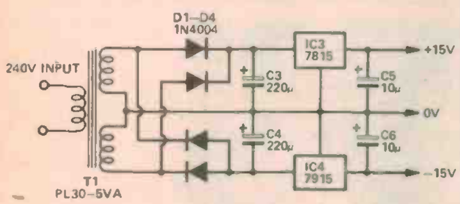


Fig. 5. The circuit diagram of the control desk.

HOW IT WORKS – CONTROL DESK

There are two controls for each dimmer along with two master controls. The master controls vary the voltage on the individual level control potentiometers from 0V (no light) to −8 volts (full light). Normally one master will be at maximum and the second at zero. The outputs of the two controls for each dimmer are added by an operational amplifier, referred to 0V. As one set of potentiometers has 0V on both of its ends it can be varied without changing the output allowing it to be set for the next scene. By varying the master controls together, but in opposite directions, the complete lighting set up can be smoothly varied from one scene to the next.

As we need +12V out to drive the dimmers the supply voltage of the control desk is ±15 volts.

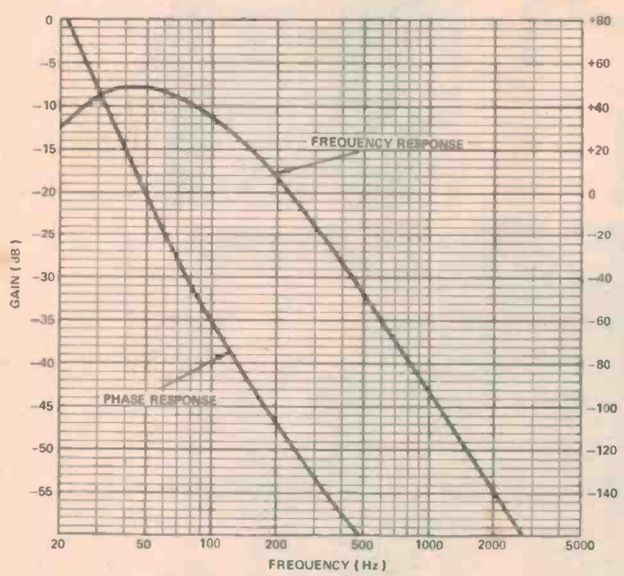


Fig. 6. The frequency and phase response of the control tone filter.

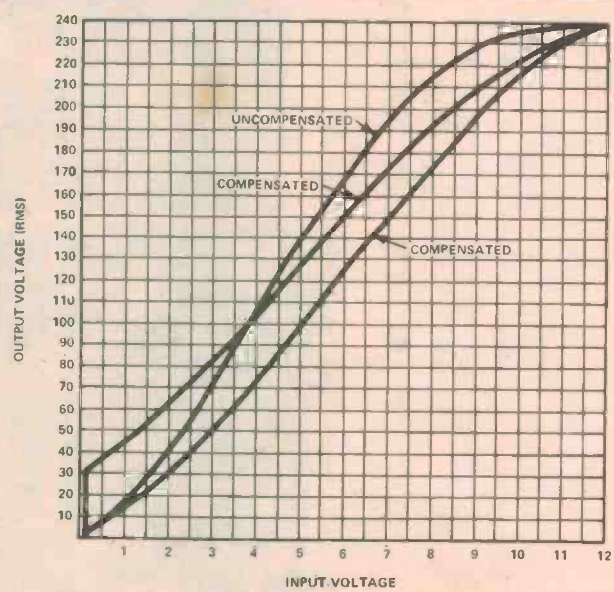


Fig. 7. The input-output relationship with the minimum adjustment at two different levels compared with a non compensated control curve (linear phase angle control).

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.068—.15. . . . 15c

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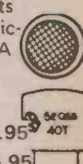

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Don't buy one of the OLD, SUPERCEDED HELICALS: Insist on the slug-tuned!

$29.00 Cat D-4076

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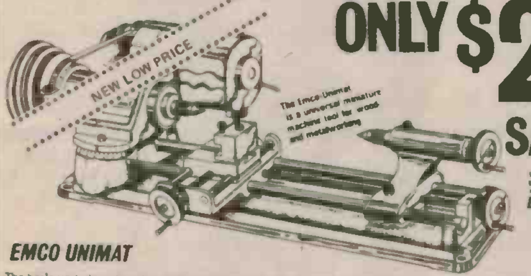

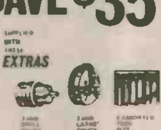

EMCO UNIMAT

The basic unit alone together with the motor and attachments (a 3 jaw lathe chuck, a 3 jaw drill chuck and 6 assorted tool bits which are supplied) permits a large number of operations irrespective of whether the component is made of balsa wood, tool steel or one of the modern plastics. The Unimat will give you the professional finish and accuracy you want — at a fraction of the cost of a 'normal' lathe. And you don't have to have a spare room for it — the Unimat is small enough to fit in anywhere!
Cat. T — 6010 .. ..Including Lathe Chuck, Drill Chuck, Basic Lathe and Six Assorted Tool Bits $280

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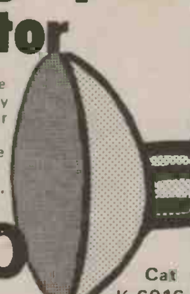
OOPS! We boo-booed! Someone bought too many reflectors for our strobe kits. So you benefit! Use them for almost any photo work, store displays, etc etc etc etc



4.50 Cat K-6016

See eti top projects book for original strobe project

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Cat T — 6011 .. .. $99.00 **$99**

SAVE $15 ~~$125~~ NOW ONLY $110

The hobby centre kit is everything the hobbyist or model-maker needs. Double insulated for safety. Speed control for versatility. No hobbyist should be without this machine.

COMPLETE KIT INCLUDES: — Bench Grinder and Disc Sander — 5" x 6½" x 9" compact base unit with built in storage area 3" 60 Grit High Speed Grinding Wheel — Tool Rest — Eye Shield — Spark Arrestor — Small Parts Tray — 2" Sanding Disc Plate — 3 assorted 2" Sanding Discs — Calibrated Adjustable Tool Rest — Allen Wrench High Speed Hand Grinder With 36" of Flexible Shaft — 2 Double Ended Wrenches 39 Piece Accessory Kit — 9 Mounted Emery Wheels — 1 Dressing Stone — 2 Hi - Speed Rotary Files — 2 Mounting Arbors — 2 Felt Pol. Wheels — 1 Drum Sander — 3 Sanding Drums — 1 Polishing Wheel — 10 Sanding Discs — 1 Drill Bit — 2 Nylon Brushes — Plastic Carry Box 40 Page "HOW TO DO IT" Book.
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95¢ Small Cat H-3742

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ETI data sheet

MN3001 Bucket Brigade Panasonic

THE MN3001 is the heart of our BBD experimenter's boards featured on page 40 of this issue. Each device contains two 512-stage BBDs with independent input, output and clock terminals. A pair of output terminals is provided in each BBD for cancellation of the clock component superimposed on the output signals.

P-channel silicon gate technology is used to fabricate the BBDs from chains of tetrode type MOS transistors and storage capacitors. The MN3001 is packaged in the standard 14-lead DIL plastic package.

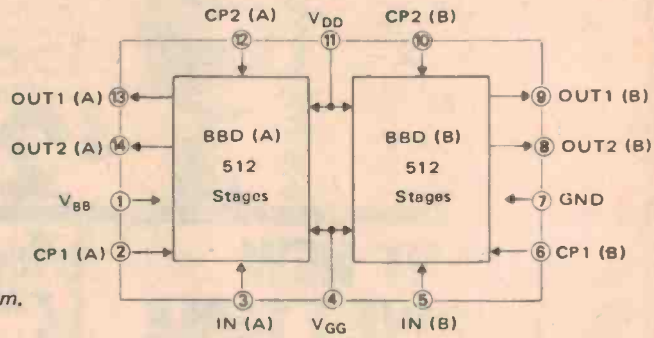


Fig. 1. Block diagram.

ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)

Item	Symbol	Ratings	Unit
Terminal Voltage	V_{DD} V_{GG} V_{CP} V_{IN}	- 20 ~ + 0.3	V
Back-gate Bias Voltage	V_{BB}	- 0.3 ~ + 10	V
Total Power Dissipation	P_T	50	mW
Operating Temperature	T_{opr}	- 20 ~ + 60	°C
Storage Temperature	T_{stg}	- 55 ~ + 125	°C

TERMINAL ASSIGNMENT

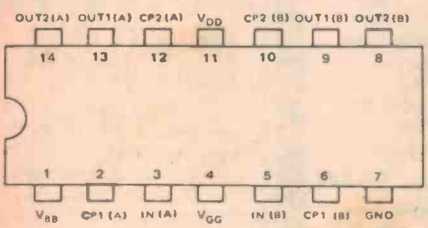


Fig. 2. Voltage transfer characteristics.

OPERATING CONDITIONS (Ta = 25°C)

Item	Symbol	Conditions	Typ.	Unit
Drain Supply Voltage	V_{DD}		- 15	V
Gate Supply Voltage	V_{GG}		- 14	V
Back-gate Bias Voltage	V_{BB}	V_{CPH} = 0 ~ -1V	+ 5 •1	V
Clock Voltage "H"	V_{CPH}	V_{BB} = +4 ~ 6V	0 •1	V
Clock Voltage "L"	V_{CPL}		- 15	V

•1 The MN3001 can be used at V_{BB} = 0V, if V_{CPH} is fixed at -3V.

ELECTRICAL CHARACTERISTICS (Ta = 25°C, V_{DD}=V_{CPL}=-15V, V_{GG}=-14V, V_{BB}= +5V, R_L=100 kΩ)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Clock Input Capacitance	C_{CP}				350	pF
Clock Frequency	f_{CP}		10		800	kHz
Signal Delay Time	t_D		0.32		25.6	msec
Clock Pulse Width •2	t_{CPW}				0.5T •3	
Clock Rise Time •2	t_{CPr}			0.05T		
Clock Fall Time •2	t_{CPf}			0.05T		
Input Signal Frequency	f_{in}	f_{CP} = 40 kHz,3dB down	0		$0.3f_{CP}$	kHz
Input Signal Swing	V_{in}	2.5% Distortion			2	Vrms
Output Signal Attenuation		f_{CP} = 40 kHz, f_{in} = 1 kHz		8.5	11	dB
Output Distortion	D_{tot}	f_{CP} = 40 kHz, f_{in} = 1 kHz V_{in} = 2 Vrms			2.5	%
Noise Level	V_N	f_{CP} = 100 kHz Weighted by "A" curve		0.25		mVrms
Signal to Noise Ratio	S/N	Max. Output Voltage vs. Noise Voltage		70		dB

TYPICAL CHARACTERISTICS (Ta = 25°C)

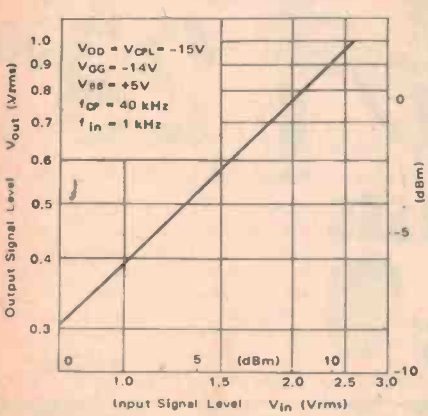
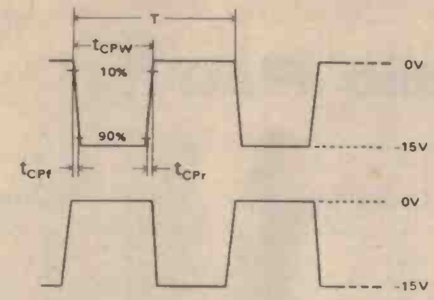


Fig. 3. Distortion characteristics.

• 2 Clock Waveforms



• 3 $T = 1/f_{CP}$ (Clock period)

Fig. 4. Cut-off frequency.

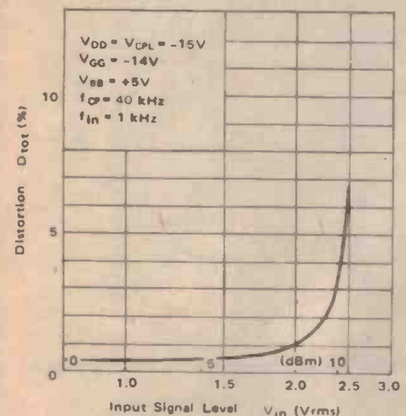


Fig. 5. Output voltage swing.

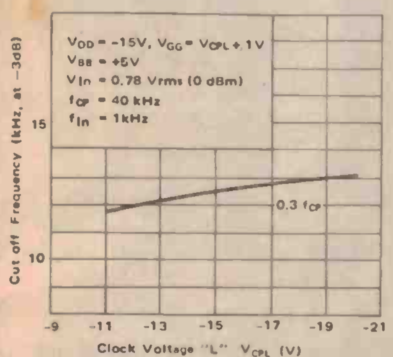


Fig. 6. Frequency response.

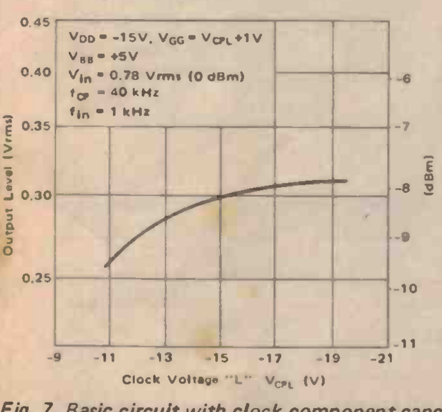


Fig. 7. Basic circuit with clock component cancellation (single channel).

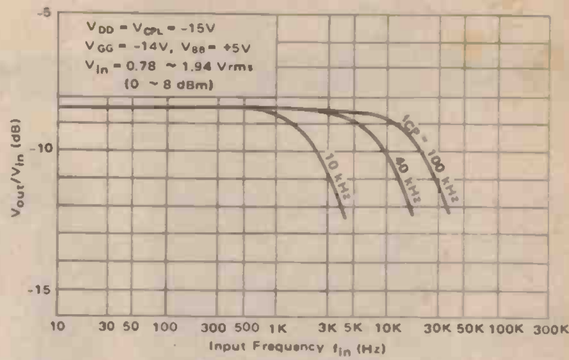
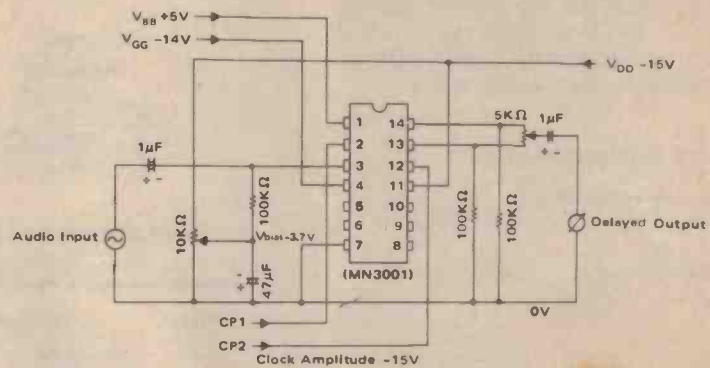
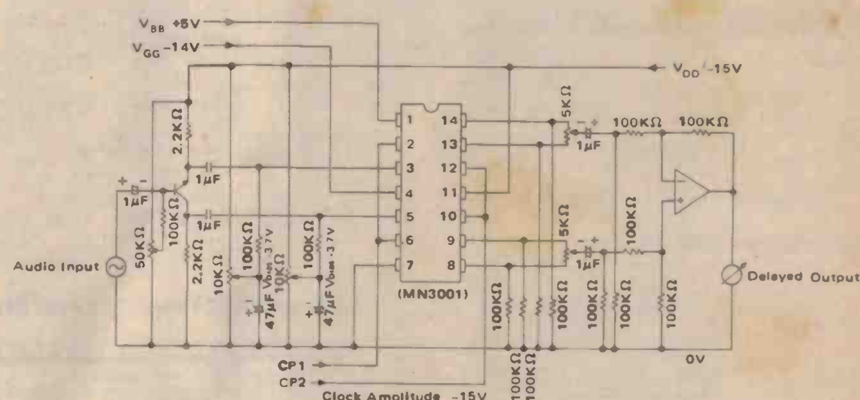


Fig. 3 — FREQUENCY RESPONSE

Fig. 8. Compensation of DC level shift due to clock frequency change using two BBDs.





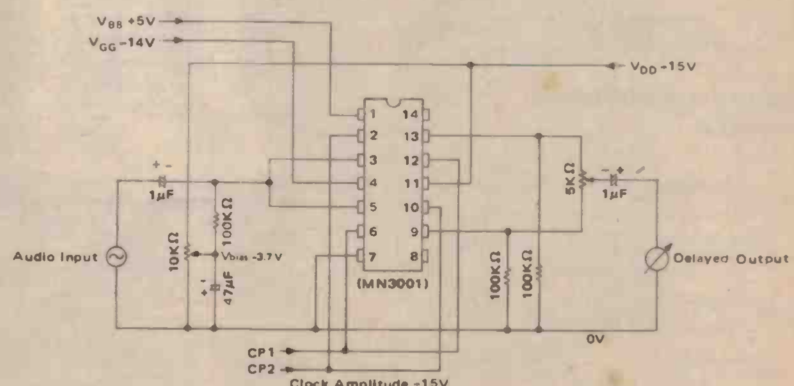


Fig. 9. Extension of bandwidth nearly twice using two BBDs. Effective sampling rate becomes twice clock frequency.

ETI data sheet

2112 256x4 Bit Static RAM — Intel

LACK OF SPACE last month prevented the inclusion of the 2112 in the Data Sheet Special on Memories, but we've made up for it this month. The 2112 is a 256 x 4 bit TTL-compatible static RAM which is very popular in small systems where two 2112s will provide 256 bytes of memory. Memory expansion in 256 byte increments is easy until you reach 1 K, where 8 2102s could have done the job slightly more easily. The 2112 is made by Intel, National Semiconductor and many other semiconductor manufacturers.

ABSOLUTE MAXIMUM RATINGS

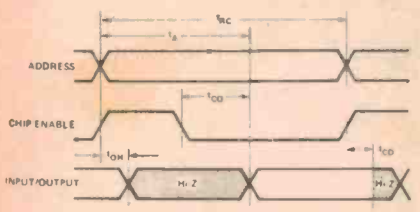
Ambient Temperature Under Bias . . . . . -10°C to 80°C
Storage Temperature . . . . -65°C to +150°C
Voltage On Any Pin
With Respect to Ground . . . . -0.5V to +7V
Power Dissipation . . . . 1 Watt

CAPACITANCE [2] $T_A = 25°C$, f = 1 MHz

Symbol	Test	Limits (pF) Typ.[1]	Max.
C_{IN}	Input Capacitance (All Input Pins) $V_{IN} = 0V$	4	8
$C_{I/O}$	I/O Capacitance $V_{I/O} = 0V$	10	15

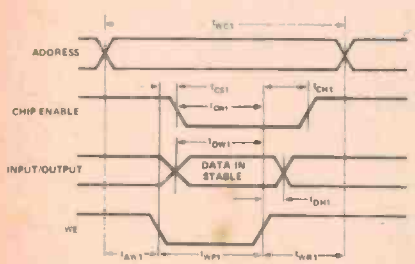
NOTES:
1. Typical values are for $T_A = 25°C$ and nominal supply voltage.

READ CYCLE WAVEFORMS



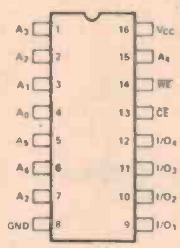
WRITE CYCLE WAVEFORMS

WRITE CYCLE #1

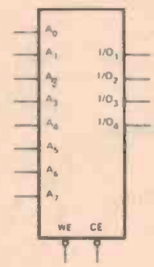


NOTE: 1. Typical values are for $T_A = 25°C$ and nominal supply voltage.

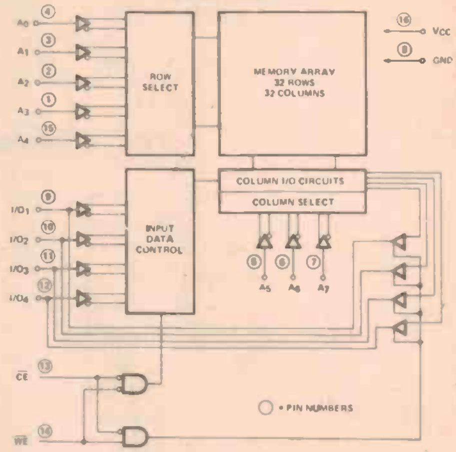
PIN CONFIGURATION



LOGIC SYMBOL



BLOCK DIAGRAM



PIN NAMES

A_0-A_7	ADDRESS INPUTS
$\overline{WE}$	WRITE ENABLE
$\overline{CE}$	CHIP ENABLE INPUT
I/O_1-I/O_4	DATA INPUT/OUTPUT
V_{CC}	POWER (+5V)

D.C. AND OPERATING CHARACTERISTICS

$T_A = 0°C$ to $70°C$, $V_{CC} = 5V \pm 5\%$ unless otherwise specified.

Symbol	Parameter		Min.	Typ.[1]	Max.	Unit	Test Conditions
I_{LI}	Input Current			1	10	µA	$V_{IN} = 0$ to 5.25V
I_{LOH}	I/O Leakage Current			1	10	µA	Output Disabled, $V_{I/O} = 4.0V$
I_{LOL}	I/O Leakage Current			-1	-10	µA	Output Disabled, $V_{I/O} = 0.45V$
I_{CC1}	Power Supply Current	2112A, 2112A-4		35	55	mA	$V_{IN} = 5.25V$, $I_{I/O} = 0mA$
		2112A-2		45	65		$T_A = 25°C$
I_{CC2}	Power Supply Current	2112A, 2112A-4			60	mA	$V_{IN} = 5.25V$, $I_{I/O} = 0mA$
		2112A-2			70		$T_A = 0°C$
V_{IL}	Input "Low" Voltage		-0.5		0.8	V	
V_{IH}	Input "High" Voltage		2.0		V_{CC}	V	
V_{OL}	Output "Low" Voltage				+0.45	V	$I_{OL} = 2.0$ mA
V_{OH}	Output "High" Voltage	2112A, 2112A-2	2.4			V	$I_{OH} = -200µA$
		2112A-4	2.4			V	$I_{OH} = -150µA$

A.C. CHARACTERISTICS FOR 2112A

READ CYCLE $T_A = 0°C$ to $70°C$, $V_{CC} = 5V \pm 5\%$ unless otherwise specified.

Symbol	Parameter	Min.	Typ.[1]	Max.	Unit	Test Conditions
t_{RC}	Read Cycle	350			ns	t_r, t_f = 20ns
t_A	Access Time			350	ns	Input Levels = 0.8V or 2.0V
t_{CO}	Chip Enable To Output Time			240	ns	Timing Reference = 1.5V
t_{CD}	Chip Enable To Output Disable Time	0		200	ns	Load = 1 TTL Gate
t_{OH}	Previous Read Data Valid After Change of Address	40			ns	and C_L = 100pF.

WRITE CYCLE #1 $T_A = 0°C$ to $70°C$, $V_{CC} = 5V \pm 5\%$

Symbol	Parameter	Min.	Typ.[1]	Max.	Unit	Test Conditions
t_{WC1}	Write Cycle	270			ns	t_r, t_f = 20ns
t_{AW1}	Address To Write Setup Time	20			ns	Input Levels = 0.8V or 2.0V
t_{DW1}	Write Setup Time	250			ns	Timing Reference = 1.5V
t_{WP1}	Write Pulse Width	250			ns	Load = 1 TTL Gate
t_{CS1}	Chip Enable Setup Time	0			ns	and C_L = 100pF.
t_{CH1}	Chip Enable Hold Time	0			ns	
t_{WR1}	Write Recovery Time	0			ns	
t_{DH1}	Data Hold Time	0			ns	
t_{CW1}	Chip Enable to Write Setup Time	250			ns	

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4011	.29	4068	.32
4012	.32	4069	.32
4013	.68	4070	.32
4014	1.96	4071	.32
4015	1.64	4081	.32
4016	.72	4082	.32
4017	1.62	4416	1.32
4018	1.84	4426	3.56
4019	.60	4449	.29
4020	2.56	4511	2.32
4021	2.24	4510	2.76
4022	1.56	4518	2.00
4023	.32	4520	2.00
4024	1.12	4528	1.52
4025	.32	4556	2.20
4026	3.64	74C00	.44
4027	.92	74C04	.44
4028	1.48	74C08	.44
4029	1.84	74C10	.44
4030	.40	74C14	2.16
4035	3.76	74C75	1.12
4040	2.48	74C192	2.96
		74C193	2.96

LINEAR IC'S

301	.64	556	1.96
307	.88	565	1.96
308	1.24	566	1.96
311	1.24	567	2.24
324	1.40	709	.64
339	1.40	741	.58
349	2.25	3900	1.22
379	6.96	3089	2.80
380	2.04	1310	2.44
381	2.04	TCA220	2.00
382	1.66	SAK140	1.86
386	1.92	UAA170	2.82
555	.58	UAA180	2.82
		50242	12.48

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7400	.32	7470	.48
7401	.32	7472	.48
7402	.32	7473	.68
7403	.32	7474	.60
7004	.32	7475	.88
7405	.32	7476	.60
7406	.36	7480	.88
7407	.48	7482	1.48
7408	.32	7483	1.32
7409	.32	7485	1.64
7410	.32	7486	.60
7411	.48	7489	3.64
7413	.32	7490	.68
7414	1.44	7491	1.12
7416	.64	7492	.60
7417	.64	7493	.60
7420	.32	7494	1.48
7426	.56	7495	1.04
7427	.44	74100	1.84
7430	.32	74107	.56
7432	.44	74121	.56
7437	.48	74123	.76
7438	.48	74150	1.84
7440	.32	74151	1.36
7441	1.10	74153	1.24
7442	1.56	74154	1.62
7447	1.24	74157	1.36
7448	1.24	74160	1.36
7450	.32	74164	1.48
7451	.32	74165	1.84
7453	.32	74173	2.64
7454	.32	74192	1.52
7460	.32	74193	1.52
		74221	2.86

VOLTAGE REGULARS

309	2.00	7824	1.95
317	3.50	78L05	.72
323	6.95	78L12	.72
325	3.75	78L15	.72
7805	1.95	79L05	.88
7806	1.95	79L12	.88
7808	1.95	79L15	.88
7812	1.95	723	.85
7815	1.95	7905	2.56
7818	1.95	7912	2.56
		7915	2.56

TTL-LOW SCHOTTKY

74LS00	.39	74LS78	.56
74LS02	.39	74LS86	.62
74LS03	.39	74LS90	1.48
74LS04	.39	74LS92	1.48
74LS05	.42	74LS93	1.48
74LS08	.42	74LS109	.66
74LS09	.42	74LS113	.70
74LS10	.42	74LS114	.70
74LS11	.42	74LS154	2.48
74LS12	.42	74LS157	2.20
74LS14	2.15	74LS163	2.54
74LS20	.42	74LS164	2.15
74LS21	.42	74LS174	2.15
74LS27	.46	74LS175	2.15
74LS28	.46	74LS191	2.55
74LS30	.42	74LS192	2.55
74LS32	.46	74LS193	2.55
74LS37	.46	74LS194	2.14
74LS38	.46	74LS195	2.14
74LS40	.46	74LS196	2.14
74LS42	1.64	74LS221	2.00
74LS73	.53	74LS253	2.00
74LS74	.56	74LS367	1.56
74LS75	.92	74LS368	1.56

OPTO

Red Led (6 mm)	.18	NSN71	1.86
Green Led (6 mm)	.20	NSN73	1.86
Orange Led (6 mm)	.35	NSN61	2.04
4N26 isolator	1.72	FND500	1.92
		MEL12	1.58

DIODES

OA91	Germanium	.12
IN914	Silicon	.09
IN4004	1A/400V	.10
A7579	5A/100V	.76
MD3502	35A/200V bridge	3.80
MD3504	35A/400V bridge	4.80
400mW zenr diodes (all values to 20V)		.22

TRANSISTORS

BC547	.18	2N6577	2.18
BC548	.18	2N3442	2.68
BC549	.18	40411	3.20
BC557	.18	2N3638	.38
BC558	.18	PN3643	.38
BC559	.18	2N3644	.38
BD137	.62	μPF102	.62
BD138	.62	2N5457	.62
BO139	.84	2N5459	.64
BD140	.84	2N5461	.74
MJ2955	1.96	2N5485	.78
2M3055	.98	2N6027	1.32
μJE340	1.30	2N4626	1.54
		μPF131	1.08

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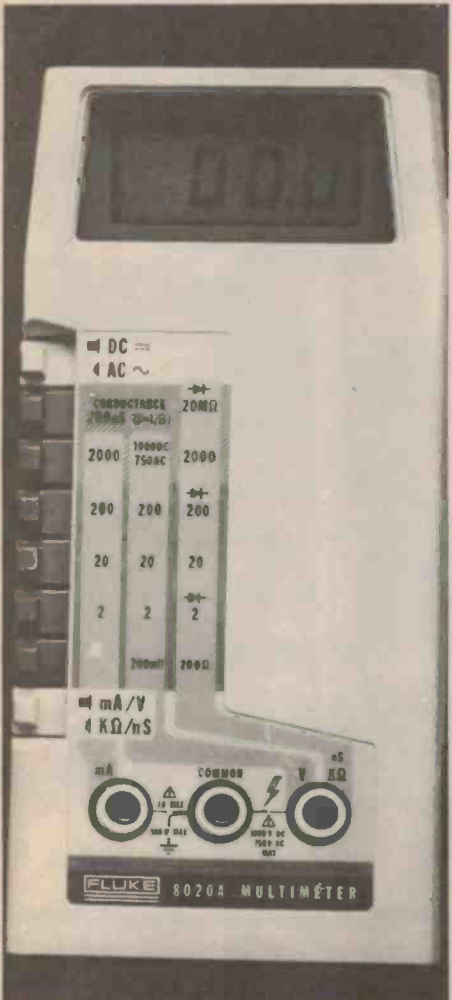
Product Review: FLUKE 8020A DIGITAL MULTIMETER



The traditional moving coil analogue scale multimeter which has served as prime tool of the trade for just about everyone involved with electricity is losing ground rapidly to comparatively new digital instruments. A widely held, and generally valid, belief is that the eradication of moving parts from equipment and their replacement with electronics will result in improvement in performance and a quantum jump in reliability. Multimeters such as the 'industry standard' Avo 8 must naturally succumb to this almost-law, relying as they do on fragile, precision jewelled movements.

Early digital voltmeters were rather large, to say the least, but of course we have all seen the effects of Large Scale Integration over the last few years. The latest product from the John Fluke Manufacturing Co. of Mountlake Terrace, Washington, takes advantage of the benefits of LSI to produce a good quality and very functional multimeter which will fit in a pocket.

The 8020A is designed to meet the demands placed on a portable digital multimeter used in the field: it must be reliable, unaffected by rough handling, easy to use, must be small and light, run from batteries, must stay calibrated over long periods, and must be cheap. To fit this bill, the 8020A's designers chose to use CMOS LSI for the circuitry, coupled with a liquid crystal display in a tough plastic moulded case. In fact, the single chip in the meter is made by Intersil and is very similar to the 7107 described in ETI Data Sheet for October; this approach means a low component count, hence reduced costs.

The Chip

Fluke collaborated closely with Intersil in the design of the CMOS A-D chip, which has a number of interesting features. It uses the now well-established dual slope integration method of conversion. At the start of the measurement cycle, all counters are reset to zero and the unknown voltage is applied to an integrator circuit, which begins to ramp up. After 10,000 counts, the unknown voltage is disconnected and a reference voltage of opposite polarity is applied which causes the integrator to ramp down while the counter stages count down. When the integrator output reaches its starting point of zero, a comparator detects this and latches the counter output into the display.

Since the unknown voltage and the reference voltage are applied to the same circuitry, inaccuracies due to component tolerances tend to cancel out and accuracy is now dependent on the long term stability of the reference voltage and any range-selection circuitry to which the reference is not applied.

Of course, in the Fluke, it's not that simple: the A/D converter also has some logic for polarity indication and also for auto-zero, which complicates the basic measurement cycle just described.

Range switching is provided by a potential divider scheme on voltage inputs and shunts on current ranges in a similar manner to a conventional multimeter, except that the input current of the A-D chip is of the order of a few pA.

A cunning trick has been used to simplify the range switching using the characteristics of dual slope A-D. One of the pins on the chip is a range input which allows selection of either 200mV or 2V f.s.d. (full scale deflection? Well, you know what I mean!). This is done by changing the integration period from 1,000 counts on the 2V range (used for three resistance ranges) to 10,000 counts for the 200mV range (used on other ranges for greater resolution). This pin can also be used to swap the reference voltage with the unknown to allow conductance (inverse of resistance) measurements — yet another scheming trick.

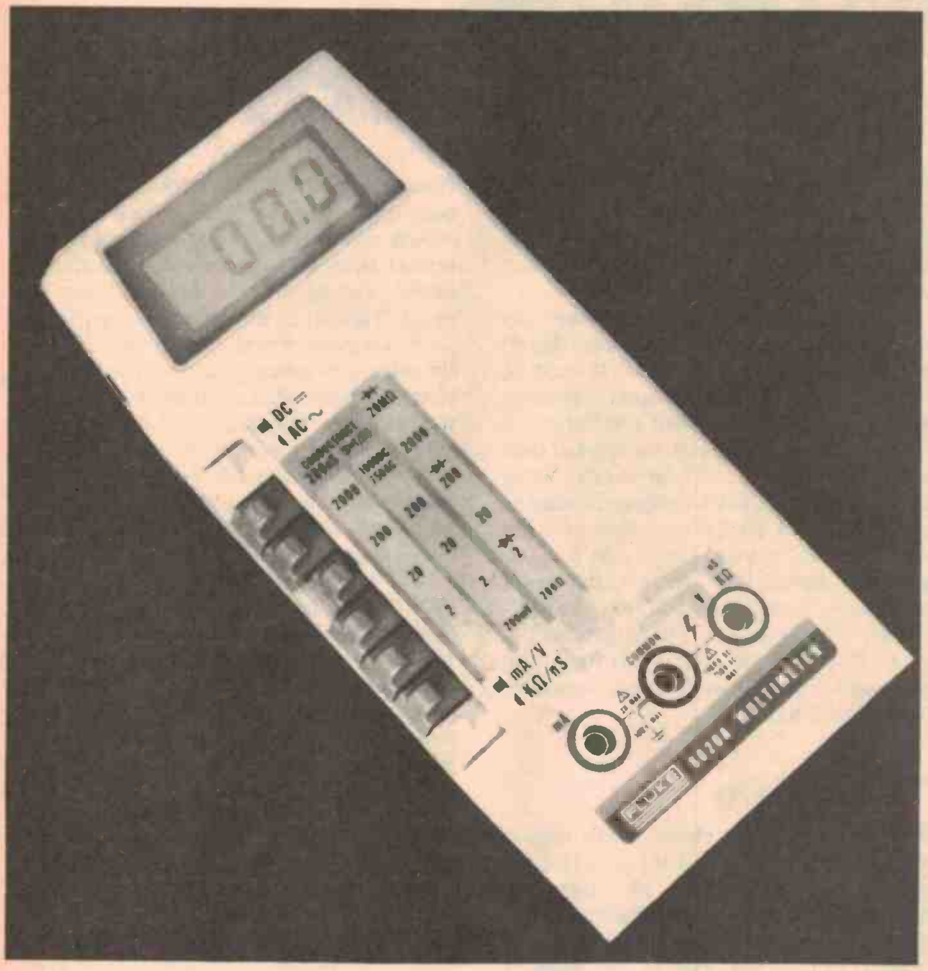
Cunning design trick number three: by making the clock frequency harmonically related to the mains frequency, the A-D converter will automatically average out and reject any mains ripple signals. Unfortunately the clock is generated by a 3.84MHz crystal, which divides neatly to 60kHz, which is fine for the US 60Hz mains but doesn't work so well for our 50Hz mains. Mind you, when we tried to figure out what difference this made, we couldn't find any effect.

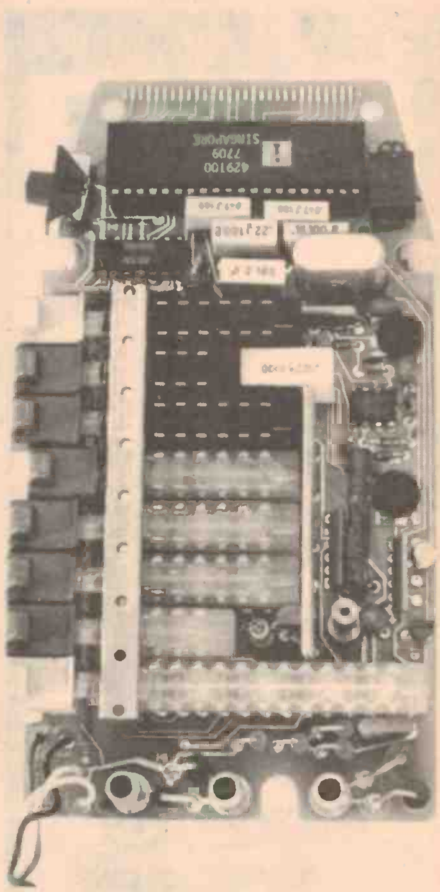
In addition to performing the A-D function and the associated control logic, the CMOS chip also contains the display decoding and driving circuitry — fortunately this isn't too difficult with an LCD display, except for the problem of finding pins to get all the data out! The choice of an LCD display is obvious and we can expect to see a lot more equipment going to this type of display. In areas such as labs or test benches where there is a fairly high ambient light level, LEDs just don't give as much contrast.

In Use

We found the 8020A to be very easy to use, and very convenient on the work-bench. Selection of voltage and

Product Review: FLUKE 8020A DIGITAL MULTIMETER





resistance or current measurements is made by selecting the correct socket for the test probe and voltage or resistance/conductance measurements are selected on one of the side pushbuttons (if that sounds complex, look at the photo!). AC/DC selection is the top of the push-button bank. The remaining push-buttons are the range switches, which correspond to the colour coding on the front panel. It took us a little while to remember which combination of letters to press for conductance measurements, but then the scheme clicked and we'd got it all figured out. A small operator's guide card helped us while we were becoming familiar with the machine.

The tilt stand/hanger/handle on the back meant that the meter can be propped at an angle: this, combined with the LCD display, gives good visibility. The meter could easily be hung on the wall at the back of your workbench where it is completely out of the way. For portability, the 8020A is excellent, it measures only 180 x 90 x 40 mm and runs off a single 9V cell – battery drain is less than 1.5 mA and the chip will operate down to 6V!

Accuracy on our review model is well within specs, and agreed with the 0.1% accuracy instruments we have in the lab. We checked resistance against some 0.1% resistors and found close agreement (within one digit). Try doing that with an Avo 8!

At the Australian price of $179, + tax, the 8020A is pitched mainly at servicemen, small labs, technical colleges, etc. and also at the hobbyist – once you've got a DMM you don't know how you got along without it, even for fairly simple projects.

Our thanks for Elmeasco, of 15 Macdonald Street, Mortlake, NSW 2100, who supplied our review model. Perhaps the highest recommendation we can give the Fluke 8020A is that Elmeasco just made another sale – the review model is now indispensable in our lab!

ACCURACY SPECIFICATIONS

(1 year, 18° to 28°C (64° to 82°F), up to 90% R.H.)

VOLTS DC (all ranges) .... ±(0.25% of reading +1 digit)
VOLTS AC

<table>
<tr><th>RANGE</th><th>45 Hz to 1 kHz</th><th>1 kHz to 2 kHz</th><th>2 kHz to 5 kHz</th></tr>
<tr><td>200 mV</td><td rowspan="4">±(0.75% of reading +2 digits)</td><td rowspan="4">±(1.5% of reading +3 digits)</td><td rowspan="3">±(5% of reading +5 digits)</td></tr>
<tr><td>2V</td></tr>
<tr><td>20V</td></tr>
<tr><td>200V</td><td rowspan="2"></td></tr>
<tr><td>750V</td><td>±(1% of reading +2 digits)</td><td></td></tr>
</table>

RESISTANCE

2 kΩ thru 2000 kΩ Ranges ...... ±(0.2% of reading +1 digit)
200Ω Range .... ±(0.3% of reading +3 digits)
20 MΩ Range .... ±(2% of reading +1 digit)
CURRENT DC (all ranges) .... ±(0.75% of reading +1 digit)
CURRENT AC (all ranges) .... ±(1.5% of reading +2 digits) 45 Hz to 1 kHz except on 2mA range: 45 Hz to 450 Hz

CONDUCTANCE*

2 mS Range .... ±(0.3% of reading +1 digit)
200 nS Range .... ±(2% of reading +10 digits)

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We get many enquiries from readers wanting to know where they can get kits for the projects we publish. The list below indicates the suppliers we know about and the kits they do.

Any companies who want to be included in this list should phone LES BELL on 33-4282.

Key to companies:

- A Applied Technology Pty. Ltd. 109 - 111 Hunter St, Hornsby. 2077. NSW.
- C Amateur Communications Advancements, PO Box 57, Rozelle, NSW.
- D Dick Smith Pty. Ltd. of Crows Nest, NSW. (see Ads. for address).
- E E.D. & E. Sales, Victoria.
- J Jaycar Pty. Ltd. 405 Sussex St., Sydney 2000.
- L Delsound Pty. 1 Wickham Terrace. Queensland.
- M Mode Electronics. PO Box 365, Mascot 2020.
- N Nebula Electronics Pty. Ltd. 15 – 19 Boundary St., Rushcutters Bay 2011. NSW.
- O Appollo Video Games of Hornsby, NSW.
- P Pre-Pac Electronics. 718 Parramatta Rd., Croydon NSW 2132.
- S BKX Electronics Supply Service. 179 Victoria St., Kings Cross. NSW 2011.
- T Townsville Electronics Centre. 281E Charters Towers Rd, Rising Sun Arcade, Hermit Park. 4812

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ETI 064	Intercom	AT
ETI 065	Electronic Siren	D
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ETI 113	7-Input Thermocouple Meter	P,E
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ETI 121	Logic Pulser	L,E
ETI 122	Logic Tester	E
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ETI 408	Spring Reverb. Unit	E
ETI 410	Super Stereo	E
ETI 413	100 Watt Guitar Amp	P,L,E,J,DT
ETI 413	x 200 Watt Bridge Amp	SE
ETI 414	Master Mixer	E,J
ETI 414	Stage Mixer	E
ETI 416	25 Watt Amplifier	E
ETI 417	Amp Overload Indicator	E
ETI 419	Guitar Amp Pre-Amp	P.E.DT
ETI 420	Four-channel Amplifier	L,E
ETI 420E	SQ Decoder	E
ETI 422	International Stereo Amp	S L,E,D
ETI 422B	Booster Amp	E
ETI 422	50 Watt Power Module	E
ETI 423	Add-on Decoder Amp	E
ETI 424	Spring Reverberation Unit	S L,E
ETI 425	Integrated Audio System	E
ETI 426	Rumble Filter	E
ETI 427	Graphic Equaliser	S L,E,J
ETI 430	Microphone Line Amp	E
ETI 433	Active Crossover	E,J
ETI 435	Crossover Amp	E,J
ETI 438	Audio Level Meter	L,E
ETI 440	Simple 25 Watt Amp	L,E
ETI 441	Audio Noise Generator	L,E
ETI 443	Compressor-Expander	E,J
ETI 444	Five Watt Stereo	E
ETI 445	Preamp	J,E,D
ETI 446	Audio Limiter	J,E
ETI 447	Phaser	E,J
ETI 449	Balanced Mic Preamp	J
ETI 480	50 W. 100 W Power Amp	A
ETI 480P	Power Supply	DAT
ETI 482A	Preamp Module	A
ETI 482B	Tone Controller	A
ETI 485	Graphic Equalizer	J
ETI 480	50W. 100W Power Amp	A,D,B

MISCELLANEOUS

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ETI 503	Burglar Alarm	ET
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ETI 506	Infra-Red Alarm	E
ETI 509	50-Day Timer	E
ETI 512	Photographic Timer	E
ETI 513	Tape Slide/Synchroniser	E
ETI 514	Flash Unit — Sound Operated	E
ETI 515	Flash Unit — Light operated	E
ETI 518	Light Beam Alarm	ET
ETI 525	Drill Speed Controller	E
ETI 526	Printimer	E
ETI 527	Touch Control Light Dimmer	E
ETI 528	Home Burglar Alarm	P,ET
ETI 529	Electronic Poker Machine	E
ETI 533	Digital Display	L,E,A
ETI 534	Calculator Stopwatch	A,D
ETI 539	Touch Switch	E
ETI 540	Universal Timer	E
ETI 541	Train Controller	ET
ETI 543	Double Dice	A
ETI 544	Heartrate Monitor	A
ETI 528	Home Burglar Alarm	P,E
ETI 583	Gas Alarm	M

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ETI 706	Marker Generator	E
ETI 707	Modern Solid State Converters	C,E
ETI 708	Active Antenna	E
ETI 710	2 metre Booster	C,E
ETI 711B	Single Relay Remote Control	A
ETI 711C	Double Relay Remote Control	A
ETI 711R	Receiver	A
ETI 711AR	Remote Control Transmitter	A
ETI 711DR	Remote Control Decoder	A
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ETI 780	Novice Transmitter	E

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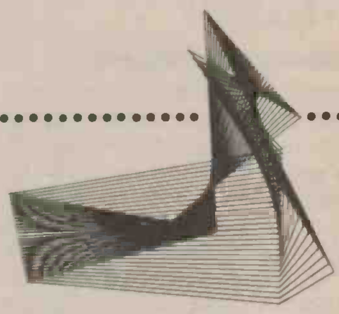
PRINTOUT

ETI's COMPUTER SECTION



NEWS

Brisbane Micro Course

Norman Wilson of the Brisbane Microcomputer Interest Group writes to tell us he has arranged with the Technical and Further Education Dept. for the inclusion of a course on microcomputer fundamentals in the 1978 programme. The course starts on Tuesday 14th February 1978 at 7.30 pm in the Adult Education City Centre, William Street, Brisbane. The course lasts for 10 weeks, 2 hours each week, and costs \$10, payable on enrollment. The prerequisite for the course are some electronics background and a basic knowledge of digital electronics. To enrol, write enclosing a cheque or money order for \$10.00 to: The Superintendent, Technical and Further Education Dept., P.O. Box 29, Mater Hill, Qld. 4101. For telephone enquiries, ring 224-7848.

Depending upon the response and need it is proposed to follow this course with a more advanced one on software. Incidentally, the Brisbane group seems to be thriving and now boasts 120 members.

Canberra Group

A letter from Peter Harris in Canberra advises us of the formation of a computer group in that area. MICSIG (MICroprocessor Special Interest Group) is affiliated to the Canberra Branch of the ACS but membership is not restricted to members of that august body as the club caters for both professionals and hobbyists. Membership is \$5 or \$2 for under 18's, over 60's, registered unemployed, etc. The club meets on the second Tuesday of the month at 7.30pm in Building 9 of the CCAE, and a monthly newsletter is produced which has all the news that's fit to print. Further details in the Directory.

Book Reviews

You can't run a computer without software, and the whole idea of hobby computing is that you write your own software. This collection of 'how-to' manuals and guides is available from Nerff, P.O. Box 32, Drummoyne, NSW 2047, who supplied our review copies.

Paperbytes Tiny Assembler 6800.

Jack Emmerichs' 'Tiny Assembler for the M6800' was first published in the April and May 1977 issues of Byte; this volume consists of reprints of both articles plus a User's Guide and both source and object code listings. The first section explains the design philosophy of the assembler, in particular demonstrating (by means of pseudocode) the structured programming techniques used in the writing of the assembler. If one intends to modify or patch a program of this complexity, it is important to have an overview of the program structure – besides, if you ever want to write an assembler yourself, it is useful to analyse one of the animals.

The second section of the book deals with the implementation of the assembler, specifically the translation from pseudocode into 6800 machine code which could actually be run. This section also contains notes on modification, a hex object code listing and a bar code representation of the assembler which can be input to a computer using a light-sensitive bar code scanner, as previously described in Byte. Using this method of input avoids the tedious job of hand entry – provided you've got the bar code scanner and software.

The third section provides a concise user's guide, while the fourth is an assembly listing of the assembler assembled by itself. It is a single pass assembler which runs in 4k of memory

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. 262 1351.
New England: New England Computer Club, c/- Union, University of New England, Armidale, NSW 2351. (New club; not restricted to students)

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.

and has a number of interesting features which we cannot discuss here.

A must for the 4k 6800 owner at $8.50 + $1 p. & p.

Understanding Microcomputers

A good book for the complete beginner, this volume starts small but ends up discussing quite complex devices and system considerations. It is obviously difficult to discuss microcomputer programming without giving examples, and to do this Scelbi have chosen to use a hypothetical computer which bears a remarkable similarity to the 8080. The different instructions used by common micros are introduced and this leads to a discussion of machine code programming and then higher level languages. On the hardware side, various peripherals and I/O devices are described and different microcomputer system configurations are discussed.

The treatment is entirely non-technical, and people who are already playing with a micro will have covered much of the material before, but they will still find a lot of interesting reading here. Excellent for beginners – $10.95 + $1 p. & p. well spent.

Scelbi 8080 Software Gourmet Guide and Cook Book

This book really carries on where 'Understanding Microcomputers' leaves off. Many readers of that book, being familiar with an 8080-like processor, will naturally gravitate towards an 8080-based (or Z-80 based) system. If they don't immediately jump to BASIC, but instead dabble in the delightful art of machine code programming, this is the book for them. The chapters cover: the 8080 instruction set; using the 8080 stack; general purpose routines; conversion routines; decimal arithmetic routines; floating point routines; I/O processing; and search and sort routines. Scelbi don't use the standard Intel instruction mnemonics, which is a bit baffling at first, but one soon becomes familiar with 'LAB' in place of 'MOV A, B', for example. The routines are all useful and are well explained. This book should be a textbook in many Computer Science courses. Highly recommended. There is a companion volume on 6800, by the way. Both are priced at $10.95 + $1 p. & p.

The '8080' Programmer's Pocket Guide.

A great crutch for stumbling beginner programmers who can't remember which flags are affected by what instructions and similar information. Each 8080 instruction is analysed as to what it does, what registers and flags it affects, what it is used for, and the machine code is given in both octal and hexadecimal. An added bonus is the inclusion of an Intel-format paper tape loader. The Pocket Guide is $3.50 + p. & p.

Tychon Code Cards

Tychon, Inc., are the very talented people who produced the 'Bugbook' series on digital electronics and microcomputers. Their slide-rule-like '8080 Hex Code Card' and '8080 Octal Code Card' are cunning devices that let you find the machine code corresponding to a particular mnemonic. This makes hand assemblies a lot easier. The cards also indicate which flags are affected by an instruction and has ASCII-octal, octal-binary conversions and other information on the back. Both cards are $43.50 + p. & p.

LSI-II Rides Again!

The Digital Equipment Corporation (DEC) LSI-II microcomputer has apparently undergone a major redesign and now son of LSI-II takes to the range. The new design will be around 40% cheaper through the use of new LSI components such as 16k dynamic RAMs.

R2-D2 Nuthin'!

A report in the New York Times tells of a 2 metre self-propelled robot security guard which makes Star Wars seem like Snow White and the Seven Dwarves! The Century I security robot, manufactured by Quasar Industries Inc. of Rutherford, New Jersey, weighs 300 kg and is bullet-proof. Century uses various sensors to detect bodyheat, movement and noise, and after locating an intruder, can pursue him at 20 mph. Says Quasar's robot expert, A.J. Reichelt, 'he can keep at that speed a lot longer than you can'. When the robot gets within 3 metres of the intruder, it orally instructs him to stop. If that doesn't work, Century can use a strobe light to blind him, an electronic gun to shock him, a high frequency sonic transducer to deafen him, or can simply squirt laughing gas at him. Personally, I'd stop!

If Century I doesn't impress you, Century II, which is under development for the US Army certainly will. A.J. Reichelt's comment is, 'Once he's put on program, nobody can stop him.'

CCD 2nd Sourced

National Semiconductor and Intel have signed a second-source agreement for the 65536 bit CCD memory type 2464.

Owners of Altair, Imsai, Vector Graphic, Parasitic Engineering, Cromemco Z-2, TDL and other S-100 bus computers take heart!

Subsystem B offers a choice of three memory modules — 4KRA, 8KRA or 16KRA — with four, eight or sixteen thousand bytes of memory for programs and data. The VDM-1 module interfaces the computer with a tv monitor. The CUTS (the Computer Users Tape System) module interfaces with a cassette recorder for program loading and mass storage of up to 200,000 characters per C-60 cassette. For all other communication to the outside world — keyboard, teletype, printers and so forth — 3P + S provides three ports for data input or output.

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PYRAL OFFER

The unanticipated response to the Pyral offer (August ETI) far exceeded the available stock for C90LN cassettes, whilst the demand for the Cobalt cassette was unprecedented.

Replenishment stock has been arranged so that all orders can be fulfilled at these very special prices.

It is confidently expected that this shipment will be received in Australia in 8-10 weeks from 15 November, 1977.

In the meantime, credit vouchers are being issued by Magna-techtronics for the quantity of cassettes which to date remain outstanding on orders placed through ETI and/or Hi-Fi Review magazines.

Any inconvenience caused by inability to meet the extroadinary demand for Cobalt and C90LN cassettes is regretted. Every effort is being made to meet such demand.

8080 octal monitor program

Even if you never use it (maybe you don't even have an 8080) this monitor program is interesting as a good programming example. By Thomas E. Doyle.

THIS MONITOR PROGRAM will enable you to control your 8080 system from an ASCII keyboard and a TTY or CRT readout. All standard front panel control functions (examine, examine next, deposit, load and run) are provided in octal format. Audio cassette input and output functions as well as a loader for MITS software are also included. Once you have this monitor in ROM, the drudgery of entering and reading data from the front panel switches and lights is all but eliminated.

Port Assignments

The monitor is designed to operate in an 8080 system with keyboard date input on port 1 and keyboard data available checked on port 0, LSB (active low). Data output is also available on port 1 with terminal ready to receive data checked on port 0, MSB (active low). The audio cassette interface data are on port 7 with status checked on port 6. These standards correspond with MITS port assignments used for the ACR and serial I/O boards used in Basic and Package II software.

Memory Requirements

Required are 512 bytes of memory which may be ROM or RAM. The program may be located anywhere in memory. A source object listing assembled to start at 376 000 is included at end of text. The best configuration is to put the monitor in EROM and locate it in a high memory location so it may reside concurrently with programs in the low RAM address. The program is organized as a series of general purpose subroutines which may be called from user programs.

Monitor Functions

The monitor functions are:

EXAMINE (E): User types in octal address of memory location he wishes to examine and the computer prints out the address and data in octal format. HHH LLL: DDD:

EXAMINE NEXT SPACE: When in the examine mode the user may type the space bar and the computer will print the address and data for the next location in memory in octal format. HHH LLL: DDD:

DEPOSIT (D): After examining a location the user may deposit new data in that location by typing the letter D followed by the new data in octal format. The computer checks for proper storage by typing out the octal equivalent of the data actually stored at that address. HHH: LLL: DDD: D XXX where XXX is the new octal data the user wishes to deposit at the address.

Note: You must examine a location before you can deposit data in that location.

RUN (R): After examining a location the user may elect to start program execution at that address by typing the letter R.

Note: You must examine a location before you can begin program execution at that location.

LOAD (L): After examining a location the user may elect to load octal data in sequential addresses by typing in L followed by the octal data. After the third digit in each octal number the computer will deposit the data in that address and check it as in the deposit mode, increment the address and automatically accept the next octal number. This mode is useful when you have a large amount of data to enter in sequential locations.

Note: You must examine the starting address before you can begin loading.

TAPE OUTPUT (O): Typing an O will select the tape output mode. The Computer will ask for the starting and ending addresses for the block of data you wish to put on cassette tape. After typing in the start and finish addresses, type space to begin output. The computer will record two STX characters (002) followed by the data. When it is finished the terminal will print: indicating it is through outputting data to the tape and is ready for a new command.

TAPE INPUT (I): Typing an I will select the tape input mode. The computer will ask for the starting address where you wish to begin depositing the data from the cassette tape. Type a space following the address. When you are through entering the tape, type in a carriage return and the computer will print a: indicating it is ready for a new command.

Note: The system will not automatically return to command mode at the end of the tape. You must type carriage return.

BOOT STRAP (B): Typing a B will copy a modified MITS cassette boot strap loader for 8K Basic down into RAM starting at location 000 000. After typing B, type a space and start your basic tape. No need to wait the 15 seconds. This feature will be greatly appreciated by those who have grown weary of toggle switching the boot strap in. Since the boot strap is copied into RAM you may make any necessary changes before starting execution.

Note: Typing a carriage return will return the monitor to the command mode.

Subroutines Available for User Applications.

Several of the subroutines used in the monitor may be used to handle I/O in user programs. These subroutines save all used registers so it is only necessary to call the subroutines.

PNT: Prints the contents of the accumulator on the terminal connected to port 1.

INP: Inputs data from the keyboard and returns with the data in the accumulator. The routine INP (page 2 000) is not used in the program. It is a general purpose routine for input from a keyboard and returning with the keyboard data in the accumulator. It was included as a general purpose routine for use in other programs.

CRL: Outputs an ASCII carriage return and linefeed.

SPC: Outputs an ASCII space.

POC: Prints the octal equivalent of the accumulator contents.

IOC: Inputs a 3 digit octal number from the keyboard and returns with data in accumulator.

TOT: Outputs the contents of the accumulator to the audio cassette interface.

TIN: Inputs from the audio cassette interface and returns with the data in the accumulator.

Program Expansion

Provision for simple expansion of the program is made by including a

8080 octal monitor program

group of 3 NO-OPS in two critical locations. The end of the print (PNT) subroutine contains 3 NOP's which may be used for a call to a special I/O handler program (i.e. ASCII to BAUDOT converter). The input control (INC) subroutine inputs from the keyboard and runs through a series of comparisons to determine which command is present. If the program reaches the bottom of the list of comparisons without finding a match it enters a default routine which prints a ? indicating that an invalid command was present. Three NO-OPS are included just ahead of the default routine to allow calling another set of comparisons and associated jumps for additional commands.

This monitor is by no means the ultimate but it does provide all basic control of the microcomputer and I/O. The length was arbitrarily limited to 512 bytes so it could be held on two 1702 type PROMS. Possible areas for expansion are:

- Tape verify routine; after a block of memory has been recorded on audio cassette it could be read in and verified.
- HEX format, basic monitor functions handled in HEX format.
- Cassette I/O improvements, inclusion of file names and checksum on input and output routines.

Notes on Modified MITS Bootstrap Loader

This routine copies the modified bootstrap loader, which is stored in the monitor program starting at (page 1 016) down to RAM starting at (000 000). After the routine has been copied down the routine waits for a key to be pressed on the keyboard. If any key other than a carriage return is pressed program execution will begin at the start of the bootstrap (000 024). The loader that is copied down is for MITS 8K BASIC version 3.2.

If you wish to load software other than 8K BASIC, after typing B type a carriage return. You will now be back in the command mode and you can change whatever you need to by changing memory location (000 002) to 017 for 4-K Basic and Programming System II or to 057 for EXTENDED BASIC in the bootstrap. After making the changes, begin execution at (000 024).

The routine waits for the correct character marking the beginning of MITS tapes (Memory page 2 Address 044). For most current software this is 256. If you have an old version change location (000 027) to whatever character starts your tape. (Some older tapes use 175).

Notes on Listing

The Program is contained on two 256 word pages. The first page contains the instructions for the commands. the second page contains the general purpose subroutines. The two pages do not have to be adjacent in memory. The listing includes object code for page 1 with a high address of 376 and page 2 with a high address of 377. These page references are underlined in the listing. Changing these page references in the jump and call commands will allow the program to run in any two blocks of memory.

The first instruction (376 000) sets the stack pointer. Location of the stack pointer is dependent upon user's RAM configuration and may be changed depending on your available memory.

Port assignments may be changed by changing—

(Page 2 346)	**For Keyboard Status**
(Page 2 354)	**For Keyboard Data**
(Page 2 364)	**For Display Status**
(Page 2 373)	**For Display Data**

(Page 2 116) and (Page 2 136) for ACR board status

(Page 2 125) and (Page 2 146) for ACR board data

Program execution begins at (Page 1 000)

COMMAND PROCESSING

```
MEMORY PAGE 1
000-061 377 037   INC: LXI SP      ;LOAD STACK POINTER
003-315 302 377   STA: CALL CLC    ;PRINT CR/LF AND :
006-315 345 377        CALL RCV    ;INPUT KEYBOARD DATA
011-376 105            CPI "E"     ;COMPARE FOR ASCII "E"
013-312 050 376        JZ EXA      ;JUMP TO EXAMINE ROUTINE IF "E"
016-376 111            CPI "I"     ;COMPARE ASCII "I"
020-312 202 376        JZ TIP      ;JUMP TO TAPE INPUT IF "I"
023-376 117            CPI "O"     ;COMPARE FOR ASCII "O"
025-312 246 376        JZ TOD      ;JUMP TO TAPE OUTPUT IF "O"
030-376 102            CPI"B"      ;COMPARE FOR ASCII "B"
032-312 345 376        JZ BSL      ;JUMP TO BOOT LOADER IF "B"
035-000                NOP         ;GROUP OF THREE NO OPS TO
036-000                NOP         ;ALLOW EXPANSION OF
037-000                NOP         ;COMMAND TABLE
040-076 077       DEF: MVI A, "?"  ;MOVE ASCII"?" TO A
042-315 362 377        CALL PNT    ;CALL PRINT SUBROUTINE
045-303 003 376        JMP STA     ;JUMP BACK TO START
```

EXAMINE

```
050-315 315 377   EXA: CALL CL>    ;PRINT CR/LF AND>
053-315 150 377        CALL LHK    ;LOAD H AND L FROM OCTAL INPUT
                                    FROM KEYBOARD
056-315 330 377   PXA: CALL CRL    ;PRINT CR/LF
061-315 166 377        CALL POH    ;PRINT OCTAL ADDRESS AND DATA
064-076 072            MVI A, ":"  ;MOVE ASCII ":" TO A
066-315 362 377        CALL PNT    ;CALL PRINT SUBROUTINE
071-315 345 377        CALL RCV    ;INPUT DATA FROM KEYBOARD
074-376 040            CPI " "     ;COMPARE ASCII "SPACE"
076-312 123 376        JZ EXN      ;JUMP TO EXAMINE NEXT IF
                                    "SPACE"
101-376 122            CPI "R"     ;COMPARE ASCII "R"
103-312 127 376        JZ RUN      ;JUMP TO RUN IF "R"
106-376 104            CPI "D"     ;COMPARE ASCII "D"
110-312 130 376        JZ DEP      ;JUMP TO DEPOSIT IF "D"
113-376 114            CPI "L"     ;COMPARE ASCII "L"
115-312 152 376        JZ LDE      ;JUMP TO LOAD IF "L"
120-303 040 376        JMP DEF     ;JUMP TO DEFAULT ROUTINE
```

EXAMINE NEXT

```
123-043           EXN: INX H       ;INCREMENT H AND L
124-303 056 376        JMP PXA     ;JUMP TO PRINT OCTAL ADDRESS
                                    AND DATA
```

RUN

```
127-351           RUN: PCHL        ;START EXECUTION AT ADDRESS
                                    REFERENCED BY H AND L
```

DEPOSIT

```
130-315 272 377   DEP: CALL SPC    ;CALL PRINT SPACE SUBROUTINE
133-315 054 377        CALL OCI    ;CALL OCTAL DATA IN FROM
                                    KEYBOARD
136-167                MOV M,A     ;STORE DATA IN MEMORY
137-315 272 377        CALL SPC    ;PRINT SPACE
142-176                MOV A,M     ;MOVE DATA FROM MEMORY TO A
143-315 231 377        CALL POC    ;PRINT OCTAL EQUIVALENT OF
                                    DATA
146-043                INX H       ;INCREMENT H AND L
147-303 056 376        JMP PXA     ;JUMP TO PRINT OCTAL ADDRESS
                                    AND DATA
```

LOAD

```
152-315 330 377   LDE: CALL CRL    ;PRINT CARRIAGE RETURN/LINE
                                    FEED
155-315 166 377        CALL POH    ;PRINT OCTAL EQUIVALENT OF
                                    ADDRESS AND DATA
160-315 272 377        CALL SPC    ;PRINT ASCII "SPACE"
163-315 054 377        CALL OCI    ;LOAD OCTAL DATA FROM
                                    KEYBOARD
166-167                MOV M, A    ;MOVE DATA TO MEMORY
167-315 272 377        CALL SPC    ;PRINT ASCII "SPACE"
172-176                MOV A, M    ;MOVE DATA FROM MEMORY
173-315 231 377        CALL POC    ;PRINT OCTAL EQUIVALENT OF
                                    DATA
176-043                INX H       ;INCREMENT H AND L
177-303 152 376        JMP LDE     ;JUMP FOR NEXT BYTE
```

TAPE IN

```
202-315 315 377   TIP: CALL CL>    ;PRINT CR/LF AND>
205-315 150 377        CALL LHK    ;LOAD H AND L FROM KEYBOARD
210-315 302 377        CALL CLC    ;PRINT CR/LF AND :
213-315 345 377        CALL RCV    ;WAIT FOR A KEY ON KEYBOARD TO
                                    BE DEPRESSED
216-315 127 377   TSC: CALL TIN    ;INPUT DATA FROM ACR BOARD
221-376 002            CPI "2"     ;CHECK FOR STX (002)
223-302 216 376        JNZ TSC     ;JUMP IF DATA IS NOT STX
226-315 127 377   TSD: CALL TIN    ;INPUT DATA FROM ACR BOARD
231-376 002            CPI "2"     ;CHECK FOR STX (002)
```

```
233-302 226 376        JNZ TSD          :JUMP IF DATA IS NOT STX
236-315 127 377   TSN: CALL TIN         :INPUT DATA FROM ACR BOARD
241-167                MOV M, A         :STORE DATA
242-043                INX H, L         :INCREMENT H AND L
243-303 236 376        JMP TSN          :JUMP FOR NEXT BYTE
```

TAPE OUT

```
246-315 315 377   TOD:CALL CL>          :PRINT CR/LF AND>
251-315 150 377       CALL LHK          :LOAD H AND L FROM KEYBOARD
254-315 272 377       CALL SPC          :PRINT SPACE
257-076 124           MVI A, "T"        :MOVE ASCII T TO ACCUMULATOR
261-315 362 377       CALL PNT          :PRINT T
264-076 117           MVI A, "O"        :MOVE ASCII O TO ACCUMULATOR
266-315 362 377       CALL PNT          :PRINT O
271-315 272 377       CALL SPC          :PRINT A SPACE
274-345               PUSH H            :PUSH H AND L
275-315 150 377       CALL LHK          :LOAD H AND L FROM KEYBOARD
300-124               MOV D, H          :MOVE H TO D
301-135               MOV E, L          :MOVE L TO E
302-341               POP H             :POP H AND L
303-315 330 377       CALL CRL          :PRINT CR/LF
306-076 002           MVI A, "2"        :MOVE STX "002" TO
                                         ACCUMULATOR
310-315113 377        CALL TOT          :RECORD STX ON TAPE
313-076 002           MVI A, "2"        :MOVE STX "002" TO
                                         ACCUMULATOR
315-315 113 377       CALL TOT          :RECORD STX ON TAPE
320-176           TOE: MOV A, M         :MOVE DATA FROM MEMORY TO
                                         ACCUMULATOR
321-315 113 377       CALL TOT          :RECORD DATA ON TAPE
324-174               MOV A, H          :MOVE H TO A
325-272               CMP D             :COMPARE D WITH H
326-302 341 376       JNZ TON           :JUMP IF D NOT = H
331-175               MOV A, L          :MOVE L TO A
332-273               CMP E             :COMPARE E WITH L
333-302 341 376       JNZ TON           :JUMP IF E NOT = L
336-303 003 376       JMP STA           :JUMP BACK TO MONITOR SINCE
                                         ENTIRE BLOCK HAS BEEN
                                         RECORDED
341-043           TON:INX H             :INCREMENT H AND L
342-303 320 376       JMP TOE           :JUMP FOR NEXT BYTE
```

MITS BOOTSTRAP

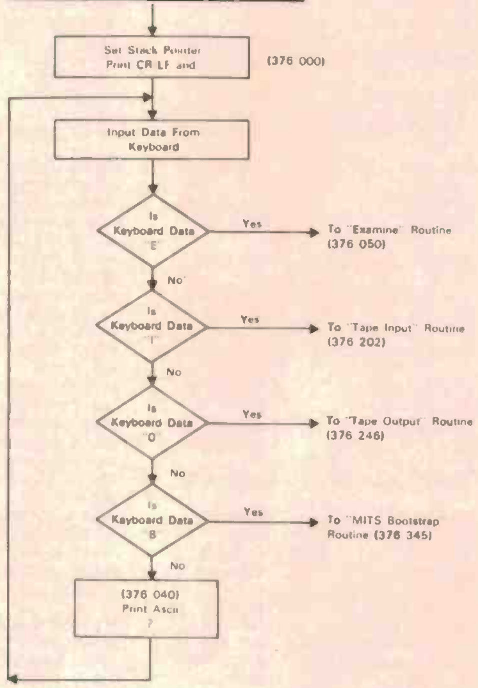
```
345-021 000 000   BSL: LXI D, "0, 0"    :LOAD D AND E WITH 000 000
350-041 016 377        LXI H, "377 016":LOAD H AND L WITH 376 016
353-176                MOV A, M         :MOVE M TO A
354-363           BSN:XCHG              :EXCHANGE H AND L WITH D AND E
355-167                MOV M, A         :STORE DATA
356-353                XCHG             :EXCHANGE H AND L WITH D AND E
357-175                MOV A, L         :MOVE L TO A
360-376 055            CPI "055"        :CHECK FOR END
362-312 372 376        JZ END           :JUMP IF END
365-043                INX H            :INCREMENT H AND L
366-023                INX D            :INCREMENT D AND E
367-303 353 376        JMP BSN          :JUMP FOR NEXT BYTE
372-315 345 377   END:CALL RCV          :WAIT FOR KEY ON KEYBOARD TO
                                         BE DEPRESSED
375-303 024 000        JMP "000 024"    :JUMP TO 000 024 WHICH IS START
                                         OF BOOTSTRAP LOADER
                                         PROGRAM
000-333 000       INP: INO              :INPUT KEYBOARD STATUS
002-017                RRC              :ROTATE RIGHT
003-332 000 377        JC INP           :JUMP BACK IF NO DATA
                                         AVAILABLE
006-333 001            IN 1             :INPUT KEYBOARD DATA
010-000                NOP              :NO OPERATION
011-000                NOP              :NO OPERATION
012-000                NOP              :NO OPERATION
013-303 362 377        JMP PNT          :JUMP TO PRINT SUBROUTINE
016-041 256 037   BSP LXI H             :LOAD H AND L WITH (037 256)
021-061 022 000        LXI SP           :LOAD STACK POINTER WITH (000
                                         022)
024-333 006            IN 6             :INPUT ACR STATUS
026-017                RRC              :ROTATE RIGHT
027-330                RC               :RETURN IF CARRY
030-333 007            IN 7             :INPUT ACR DATA
032-275                CMP L            :COMPARE L
033-310                RZ               :RETURN IF ZERO
034-055                DCR L            :DECREMENT L
035-167                MOV M, A         :MOVE DATA TO MEMORY
036-300                RNZ              :RETURN IF NOT ZERO
037-351                PCH L            :EXCHANGE PC WITH H AND L
040-003                INX B            :INCREMENT B AND C
041-000                NOP              :NO OPERATION
042-333 007            IN 7             :INPUT ACR DATA
044-376 256            CPI 256          :COMPARE FOR CHARACTER
                                         MARKING 256
046-302 024 000        JNZ (000 024)    :JUMP BACK IF DATA IS NOT 256
051-303 000 000        JMP (000 000)    :JUMP TO START OF BOOTSTRAP
054-305           OCI: PUSH B           :PUSH B
055-006 000            MVI B            :MOVE 000 TO B
057-315 345 377        CALL RCV         :CALL KEYBOARD DATA INPUT
062-346 003            ANI "3"          :AND IMMEDIATE (MASK 2 LSB'S)
064-037                RAR              :ROTATE RIGHT
065-037                RAR              :THREE TIMES
066-037                RAR              :
067-200                ADD B            :ADD B
070-107                MOV B,A          :MOVE A TO B
071-315 345 377        CALL RCV         :CALL KEYBOARD DATA INPUT
074-346 007            ANI "7"          :AND IMMEDIATE (MASK 3 LSB'S)
076-007                RLC              :ROTATE LEFT THROUGH
077-007                RLC              :CARRY THREE
100-007                RLC              :TIMES
101-200                ADD B            :ADD B
102-107                MOV B,A          :MOVE A TO B
103-315 345 377        CALL RCV         :CALL KEYBOARD DATA INPUT
106-346 007            ANI "7"          :AND IMMEDIATE (MASK 3 LSB'S)
110-200                ADD B            :ADD B
111-301                POP B            :POP B AND C REGISTERS
112-311                RET              :UNCONDITIONAL RETURN
113-365           TOT: PUSH PSW         :PUSH ACCUMULATOR
114-067                STC              :SET CARRY
115-333 006       TOI: IN 6             :INPUT ACR BOARD STATUS
117-007                RLC              :ROTATE LEFT THROUGH CARRY
120-332 115 377        JC TOI           :JUMP IF VART BUFFER FULL
123-361                POP PSW          :POP ACCUMULATOR
124-323 007            OUT 7            :OUTPUT DATA TO ACR BOARD
126-311                RET              :UNCONDITIONAL RETURN
127-333 001       TIN: IN 1             :INPUT KEYBOARD DATA
131-376 015            CPI "CR"         :COMPARE FOR ASCII CARRIAGE
                                         RETURN
133-312 003 376        JZ STA           :JUMP IF ASCII CARRIAGE RETURN
136-067                STC              :SET CARRY BIT
137-333 006            IN 6             :INPUT ACR BOARD STATUS
141-017                RRC              :ROTATE RIGHT THROUGH CARRY
142-332 127 377        JC TIN           :JUMP IF NO DATA AVAILABLE
145-333 007            IN 7             :INPUT ACR BOARD DATA
147-311                RET              :UNCONDITIONAL RETURN
150-365           LHK: PUSH PSW         :PUSH ACCUMULATOR
151-315 054 377        CALL OCI         :CALL OCTAL IN
154-147                MOV H,A          :MOVE ACCUMULATOR TO H
155-315 272 377        CALL SPC         :PRINT A SPACE
160-315 054 377        CALL OCI         :CALL OCTAL INPUT
163-157                MOV L,A          :MOVE ACCUMULATOR TO L
164-361                POP PSW          :POP ACCUMULATOR
165-311                RET              :UNCONDITIONAL RETURN
166-365           POH:PUSH PSW          :PUSH ACCUMULATOR
167-315 204 377        CALL POA         :PRINT OCTAL EQUIVALENT OF
                                         ADDRESS
172-076 072            MVI A, " "       :MOVE ASCII : TO ACCUMULATOR
174-315 362 377        CALL PNT         :PRINT :
177-315 222 377        CALL POD         :PRINT OCTAL EQUIVALENT OF
                                         DATA
202-361                POP PSW          :POP ACCUMULATOR
203-311                RET              :UNCONDITIONAL RETURN
204-365           POA:PUSH PSW          :PUSH ACCUMULATOR
205-174                MOV A,H          :MOVE H REGISTER TO
                                         ACCUMULATOR
206-315 231 377        CALL POC         :PRINT OCTAL EQUIVALENT OF H
                                         REGISTER
211-315 272 377        CALL SPC         :PRINT A SPACE
214-175                MOV A, L         :MOVE L REGISTER TO
                                         ACCUMULATOR
215-315 231 377        CALL POC         :PRINT OCTAL EQUIVALENT OF L
                                         REGISTER
220-361                POP PSW          :POP ACCUMULATOR
221-311                RET              :UNCONDITIONAL RETURN
222-365           POD:PUSH PSW          :PUSH ACCUMULATOR
223-176                MOV A,M          :MOVE MEMORY DATA TO
                                         ACCUMULATOR
224-315 231 377        CALL POC         :PRINT ACCUMULATOR OCTAL
                                         EQUIVALENT
227-361                POP PSW          :POP ACCUMULATOR
230-311                RET              :UNCONDITIONAL RETURN
231-345           POC: PUSH H           :PUSH H AND L REGISTERS
232-157                MOV L,A          :MOVE ACCUMULATOR TO L
233-007                RLC              :ROTATE LEFT TWICE
234-007                RLC              :
250-346 007            ANI "7"          :MASK OFF ALL BUT 3 BITS
252-366 260            ORI 260          :FORM ASCII DIGIT
254-315 362 377        CALL PNT         :PRINT SECOND OCTAL DIGIT
257-175                MOV A, L         :MOVE L TO ACCUMULATOR
260-346 007            ANI "7"          :MASK OFF ALL BUT 3 BITS
262-366 260            ORI 260          :FORM ASCII DIGIT
264-315 362 377        CALL PNT         :PRINT THIRD OCTAL DIGIT
267-175                MOV A,L          :MOVE L TO ACCUMULATOR
270-341                POP H            :POP H AND L REGISTERS
271-311                RET              :UNCONDITIONAL RETURN
272-365           SPC: PUSH PSW         :PUSH ACCUMULATOR
273-076 040            MVI A " "        :MOVE ASCII SPACE TO
                                         ACCUMULATOR
275-315 362 377        CALL PNT         :PRINT SPACE
300-361                POP PSW          :POP PSW
301-311                RET              :UNCONDITIONAL RETURN
302-365           CLC: PUSH PSW         :PUSH ACCUMULATOR
303-315 330 377        CALL CRL         :PRINT CARRIAGE RETURN AND
                                         LINE FEED
306-076 072            MVI A, ":"       :MOVE ASCII : TO ACCUMULATOR
310-315 362 377        CALL PNT         :PRINT :
313-361                POP PSW          :POP ACCUMULATOR
314-311                RET              :UNCONDITIONAL RETURN
315-365           CL>:PUSH PSW          :PUSH ACCUMULATOR
316-315 330 377        CALL CRL         :PRINT CARRIAGE RETURN AND
                                         LINE FEED
321-076 076            MVI A, ">"       :MOVE ASCII> TO ACCUMULATOR
323-315 362 377        CALL PNT         :PRINT
326-361                POP PSW          :POP ACCUMULATOR
327-311                RET              :UNCONDITIONAL RETURN
330-365           CRL: PUSH PSW         :PUSH ACCUMULATOR
331-076 015            MVI A, "CR"      :MOVE ASCII CARRIAGE RETURN
```

8080 octal monitor program

```
                                       TO ACCUMULATOR
333-315 362 377        CALL PNT       ;PRINT CARRIAGE RETURN
336-076 012            MVI A, "LF"    ;MOVE ASCII LINE FEED TO ACCUM
340-315 362 377        CALL PNT       ;PRINT LINE FEED
343-361                POP PSW        ;POP ACCUMULATOR
344-311                RET            ;UNCONDITIONAL RETURN
345-333 000        RCV:IN 0           ;INPUT STATUS CHANNEL
347-017                RRC            ;CHECK LSB
350-332 345 377        JC RCV         ;JUMP BACK IF NO KEYBOARD
                                       DATA
353-333 001            IN 1           ;INPUT KEYBOARD DATA
355-376 015            CPI "CR"       ;COMPARE FOR ASCII CARRIAGE
                                       RETURN
357-312 003 376        JZ "STA"       ;JUMP TO START IF CARRIAGE
                                       RETURN
362-365           PNT: PUSH PSW       ;PUSH ACCUMULATOR
363-333 000       PNA:IN 0            ;INPUT STATUS CHANNEL
365-007                RLC            ;CHECK MSB
366-332 363 377        JC PNA         ;JUMP BACK IF TERMINAL NOT
                                       READY
371-361                POP PSW        ;POP ACCUMULATOR
372-323 001            OUT 1          ;PRINT ACCUMULATOR CONTENTS
374-000                NOP            ;NO-OP'S TO ALLOW CALL TO
375-000                NOP            ;SPECIAL I/O HANDLER
376-000                NOP            ;ROUTINE
377-311                RET            ;UNCONDITIONAL RETURN
```

COMMAND PROCESSING

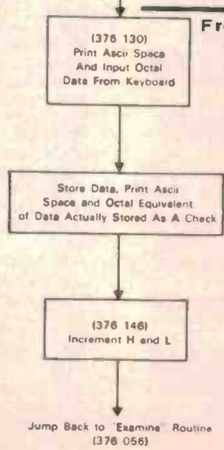
Fig. 1.



DEPOSIT ROUTINE

Fig. 3.

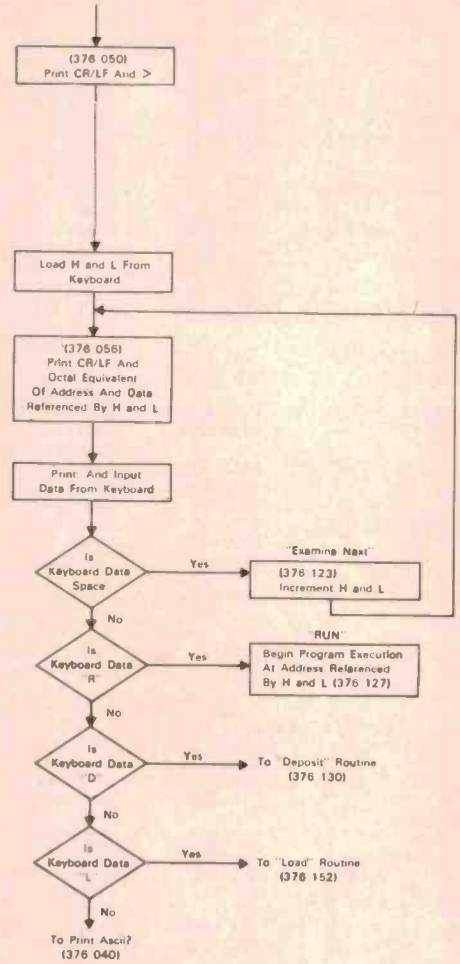
From Examine Routine



EXAMINE ROUTINE

From Command Processing

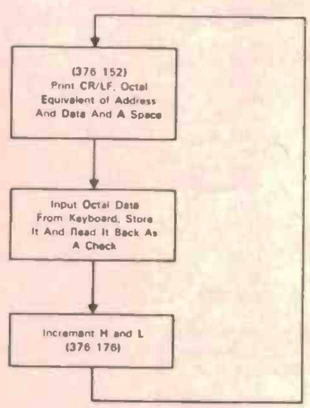
Fig. 2.



LOAD ROUTINE

Fig. 4.

From Examine Routine



NOTE: Typing a carriage return instead of octal data will cause a return to the command process routine.

TAPE INPUT ROUTINE

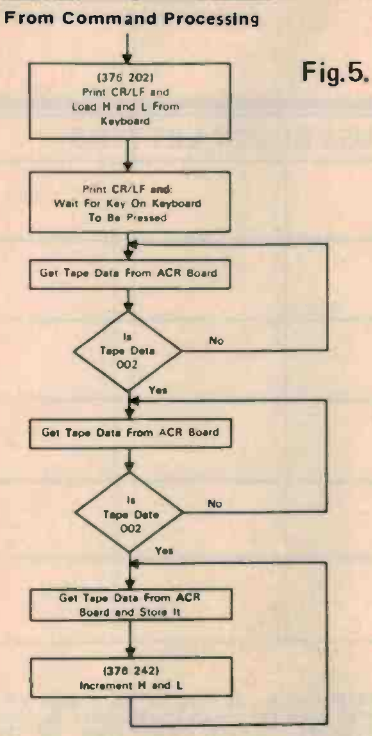


Fig.5.

NOTE: After the tape has been read in type a carriage return to return to the command process routine.

TAPE OUTPUT ROUTINE

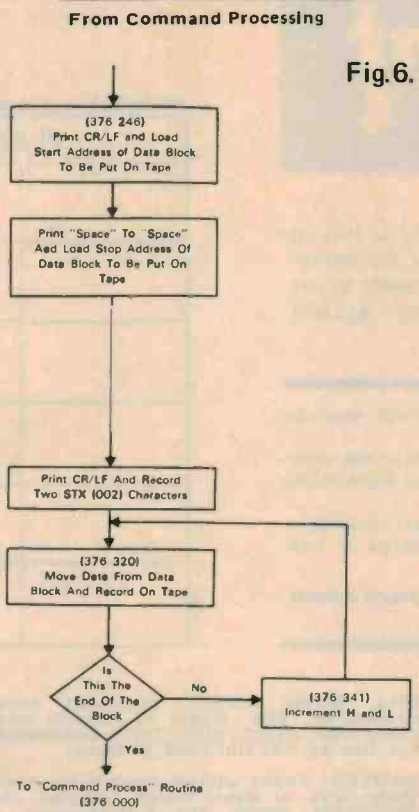


Fig.6.

MODIFIED MITS BOOTSTRAP

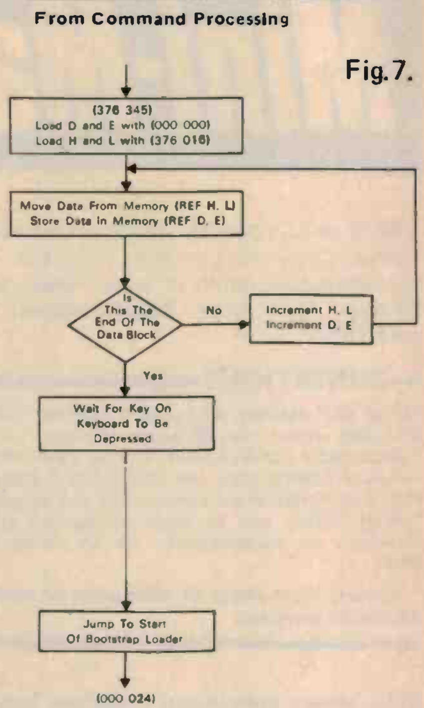


Fig.7.

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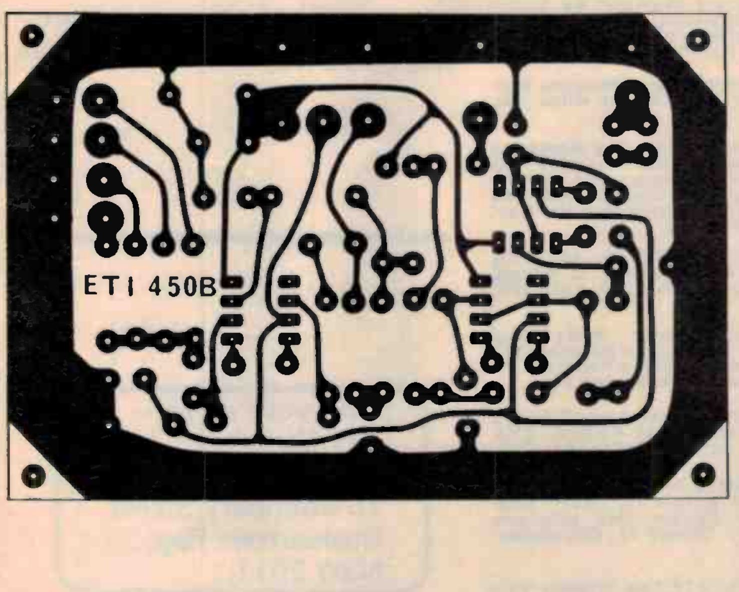
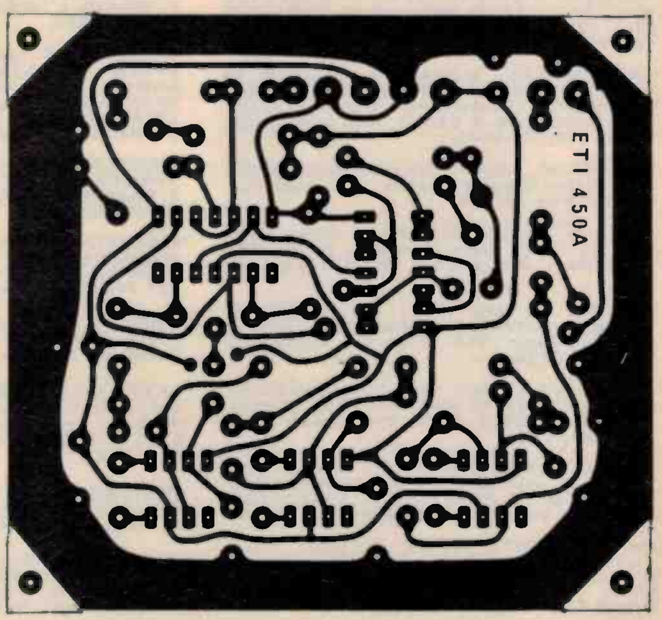
PCB's





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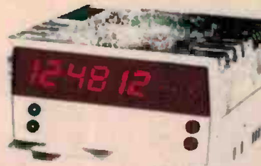

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	3 POLE 4 POSITION	

PC BOARD

BOARDS FOR ALL PROJECTS ARE AVAILABLE, PRICES AS FOLLOWS FOR EACH BOARD :
SINGLE LAMINATE : 90c + 6c PER SQUARE INCH
SINGLE FIBREGLASS : $1.20 + 8c PER SQUARE INCH
DOUBLE FIBREGLASS : $1.80 + 12c PER SQUARE INCH

BOARDS TO YOUR OWN POSITIVE OR NEGATIVE ARTWORK AVAILABLE AT THE SAME COST PROVIDED ARTWORK IS SUITABLE FOR PHOTOGRAPHY.

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PLUGPACK POWER SUPPLY. 9 VOLTS AC AT 500mA NO PROBLEMS WIRING TO 240 VOLTS. VERSATILE SINCE NOT RECTIFIED, MANY DIFFERENT USES, ELIMINATE MAINS WIRING FROM SMALL TEST EQUIPMENT.

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REED RELAYS

THESE REED RELAYS WORK FROM SIX VOLTS TO 20 V. EACH RELAY HAS TWO SPST NORMALLY OPEN CONTACTS PC BOARD MOUNTING, 6.5 cm. x 2 cm. x 1.25 cm. LIMITED QUANTITY ONLY, BUY EARLY. 1.95

VALVES

GR110	Small nixie tube, long leads	45c
GR111	Large nixie tube, long leads	45c
ZM1000	Nixie tube, PC board mount	50c
12AU7		40c

SPECIAL IC's

LOOK AT THIS SELECTION OF DIGITAL AND LINEAR INTEGRATED CIRCUITS. EXOTIC DEVICES AND SOME OF THE COMMON BUT HARD TO GET..............

MK50395 SIX DECADE COUNTER, LATCH, DECODER, PRESETTABLE, UP-DOWN, INTERNAL SET REGISTER AND COMPARATOR, LEADING ZERO BLANKING. DATA SUPPLIED. 19.60

MM5330 FOUR AND HALF DIGIT DIGITAL VOLT METER INTEGRATED CIRCUIT.DUAL RAMP AUTOMATIC ZERO, AUTOMATIC POLARITY DATA SUPPLIED. 12.60

MM5369 SEVENTEEN STAGE OSCILLATOR DIVIDER WHEN USED WITH 3.579MHz CRYSTAL IT GIVES 60Hz OUTPUT. CRYSTAL ~~$4.95~~ 3.90

CA3130T RCA FET OP AMP
CA3140T RCA FET OP AMP 1.90

AY3-8550 NEW GAMES CHIP REPLACES 3-8500 IN CIRCUIT WITH NO CHANGES. ADDITION OF A FEW EXTRA COMPONENTS AND PAN POTS ALLOWS VERTICAL & HORIZONTAL MOVEMENT OF BATS. PRICE INCLUDES TWO PAN POTS. 23.40

PROJECTS

PROJECT ELECTRONICS FROM ETI. (With P&P) $ 5.0

ETI 041	CONTINUITY TESTER	$ 4.95
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ETI 044	TWO TONE DOORBELL	$ 6.
ETI 045	500 SECOND TIMER	$ 5.9
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ETI 511	BATTERY SAVER	$ 3.9
ETI 048	BUZZ BOARD	$ 5.9
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ETI 085	OVER - REV ALARM	$ 5.95
ETI 528	INTRUDER ALARM	$ 9.95
ETI 084	CAR ALARM	$ 8.95
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ETI 086	FM ANTENNA	$
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MAIL ORDER MINIMUM.......$8.00
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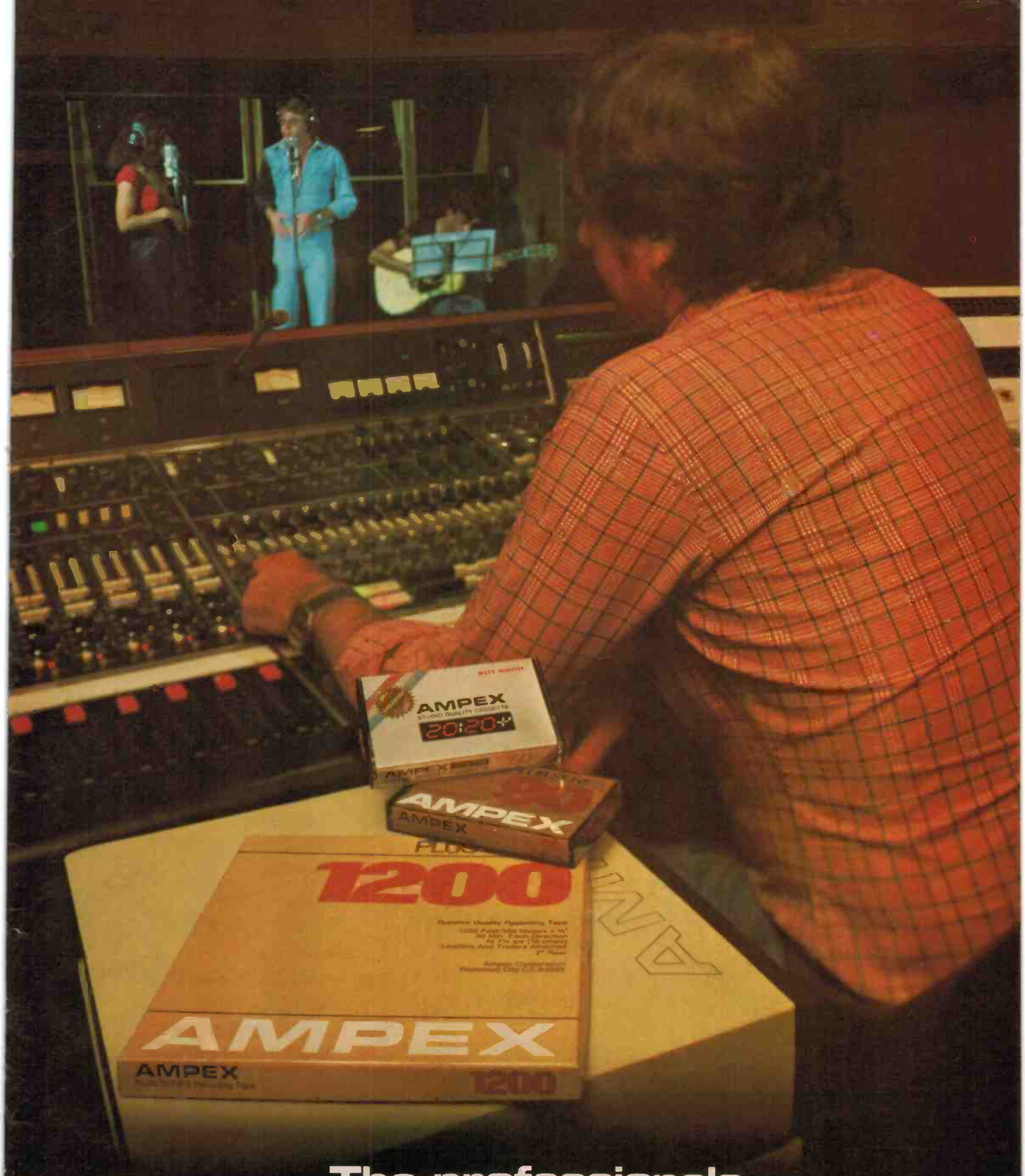

The professionals

Rehearsals have ended. This is the real thing. In the new year, Ampex professional quality cassettes and tapes will be available from selected retailers. Ampex — well worth waiting for.

Photographed at Alberts Studios — Sydney
Recording Engineer — Bruce Brown
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ELECTRONIC (DISTRIBUTORS)
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13KV, 18KV, 20KV 75c ea.
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S.C.R. BT100A 300V 2AMP 60c ea.
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2N3055, 90c ea. AD149, $1.00 ea. AY8110, 80c ea. OC912, $1.00 ea. AY8139 and 9139, 45c ea. IN914 diodes 10c ea. 5 amp AC panel meters $3.50 ea. 2500 uF 35V P/T electrolytics, 60c ea. 2200 uF 25V P/T electrolytics, 40c ea. Aluminium and plastic instrument boxes and ARLEC multimeters NOW IN STOCK.
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A&R 240V ac primary, 115V secondary at 95Vamps, $7.50 ea.

Phone enquiries and personal shopping only.
Also in stock – large range of electrolytic capacitors – wire wound resistors – switches – panel meters – transistors – diodes – plugs – sockets – edge connectors – vero board – transformers – chokes. We could go on and on, so call in and browse around and check our low, low prices.

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CB NEWS

Va, Va, Va – VICOM!

Vicom have just released their power microphone designed for CB base station operation.

It is designed for direct replacement of any low impedance push to talk microphone, used for CB transceivers, with impedance values in the range 250 to 600 ohms.

A push-to-talk switch bar with finger-tip control is mounted on the front of the base and for continuous keying of the transmitter, a lock switch is provided.

A new type dynamic element provides crisp communication quality audio and the output lead will accommodate 3, 4, 5 or 6 pin plugs as fitted to the majority of CB transceivers.

Construction is of heavy plastic material giving a solid feel to the mic, and ensuring stability on the operating table.

The VICOM VM2 is available from the Australian distributors, Vicom International Pty. Limited, 139 Auburn Road, Auburn, Vic, 3123 and their authorised dealers.▼

That's life!

Along with your TV, fridge, blender, toaster oven, deep cooker, microwave oven, hi-fi system, etc. – you can now equip your lifestyle with Sanyo CB's!

Sanyo have released a range of 18 channel AM rigs having very attractive styling with sloping, wood grain front panels.

The range includes an economy (TA2100) model, a mid-range (TA4100) model and a top-line (TA6100) rig all featuring digital LED readout and large front panel meters.

Each rig features the usual complement of controls and should be available through the usual Sanyo outlets.

Jaguar growls!

The Hatadi Electronics Division of Esquire products will be bringing a 40-channel UHF transceiver on to the Australian market early in the new year, possibly ahead of Philips.

Made by a large Japanese communications equipment manufacturer, under the Pearce-Simpson brand name, for Hatadi, the rig will be called the Jaguar in line with the jungle-cat names given the range of Pearce-Simpson 27MHz transceivers.

Rumored to be a fully-featured 'prestige' unit, as befits the name, the rig will sell for a very competitive price through Hatadi dealers throughout Australia.

Here's a plug!

A new range of high quality co-ax connectors from Japan is being marketed in Australia by Soanar Electronics P/L.

This, the latest addition to their comprehensive range of electronic hardware, enables Soanar to cater specifically for the growing CB fraternity.

All the connectors are of particularly robust construction with low loss characteristics.

The range includes UHF plugs, sockets, elbows, T-junctions, adaptors, cable joiners and dummy loads.

There are also microphone plugs and sockets, mic holders, lightning arrestors, high performance antennas and a range of CB noise and inteference suppressors.

Enquiries to Soanar Electronics P/L, 30 Lexton Road, Box Hill, Vic, 3128.

SSB-AM mains supply

A new mains power supply from Expo will hit their dealer network in time for the Christmas rush.

Manufactured in Australia for Expo by Ferguson transformers, the attractive little supply will give 13.8 volts at 2 amps continuous output, 4 amps peak.

All the controls etc, are on the front panel, which include a LED 'on' indicator, the power on/off switch and the output terminals.

Attractively finished in matt black, everything is clearly marked in brilliant white and approved by all electricity authorities.

Further enquiries should be directed to your nearest Expo Fanon/Courier dealer – a list appears in the back of CB Australia this month.▼

CB NEWS

Turner mobile mic

Communications Power Inc. have released a new Turner mic – the M3 mobile microphone.

The M3 incorporates a high output compression amplifier with the capability of fully modulating any transmitter or transceiver.

With the slide actuated gain control properly set you are assured of full modulation at all times without overmodulation.

The M3 has a tailored frequency response of 300 to 3500 Hertz with a rising characteristic.

This provides maximum speech intelligibility on transmission with a reduction in local noise interference.

This combination of full modulation capability provided by the compressor amplifier and the tailored frequency response of the generating element assures you of maximum voice power to increase range and cut through local QRM.

Enquiries to Communications Power Inc., Box 246, Double Bay, 2028 NSW (357-2022).

Meters galore

Dale International of Sydney and Danben from Melbourne are distributing a whole range of meters, matchers and filxdr accessories made by the Japanese JD company.

The range includes SWR meters, combination field strength and SWR meters, matchers, TVI filters and combination SWR/power/s/signal-strength meters and matchers!

Trade enquiries to Dale International P/L, 139 Harbord Road, Harbord, NSW, 2096 (939-7874, 939-6261) or Danben Imports, 729 High St., Armadale, Vic, 3143.

Watt meter

This accessory from CPI, the WM-1000 wattmeter, provides a separate meter for power, VSWR and modulation.

Readings are fast, accurate and not confused.

The WM-1000 reads both average and true peak power. Both readings are essential for proper transmitter performance evaluation.

The ultra-precise VSWR meter has a full 30db directivity for accurate measurement down to 1.1:1 VSWR.

Many other meters are inaccurate below 2:1 VSWR.

Modulation is indicated through a full-wave circuit which sums the entire modulation waveform.

Both VSWR and modulation meters allow on-the-spot calibration. Both work for 1 to 1000 watts of forward power.

The total measurement range of all WM-1000 functions covers 2-30MHz. ▶

A battery check circuit is built-in, as well as an automatic shutback circuit which prolongs battery life should the unit be inadvertently left on after use.

Trade and customer enquiries to Communications Power Inc., Box 246, Double Bay, 2028, NSW (357-2022).

Biblio 1

In Orange, California, the Public Library has installed a base station with the handle 'Biblio 1' to answer questions over the air on local travel and other reference topics. The scheme is still under development, but already they are planning expansions to include phone patches so that CB'ers can be put through to reference librarians, as well as rigs in the mobile libraries.

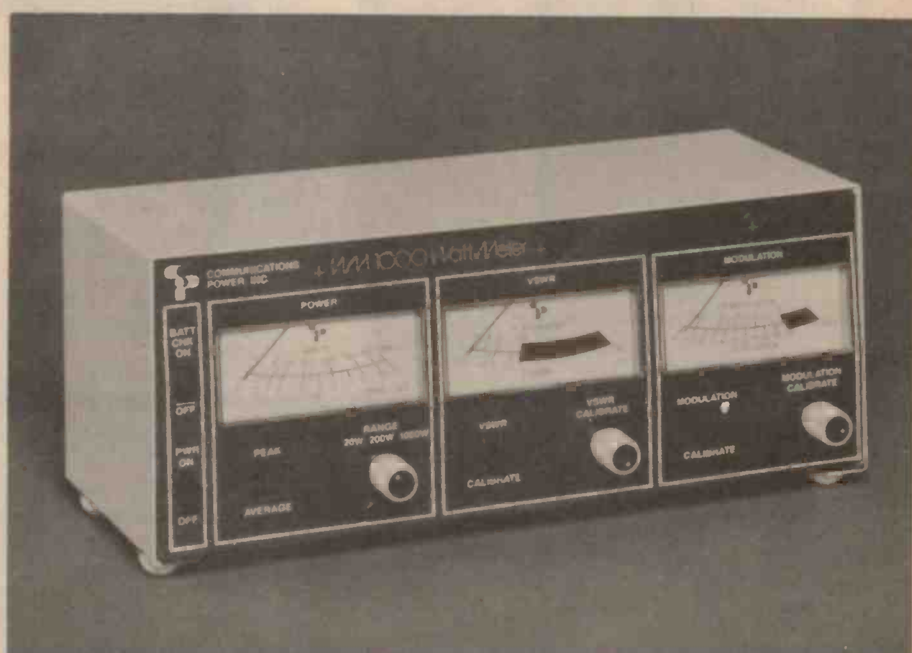
The CPI equipment at the Sydney CREST HQ.

CREST's Sydney HQ

CREST, the emergency service organisation arm of the NCRA, opened their Sydney Region headquarters and 24-hour monitoring station on December 5.

Located at Northpoint Towers, 100 Miller St, North Sydney, CREST will man a 24-hour monitoring station transmitting from the top of the building.

The site will enable coverage from Gosford to Wollongong and west to the Blue Mountains.



ACE RADIO

Season's Greetings one and all

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MAGICAL MUSICOLOUR ORGAN $75.00

Make your Xmas Party — New Year's Eve Party — Any party — a SUCCESS with a Musicolour. Easy to connect to your Hi-Fi or PA system — instructions included. Plug in coloured globes to three power points located on back of Musicolour. Switch on your sound system — and be amazed at the Musicolour effects. N.S.W. P and P $3.50, Interstate $5.50.

***From the Australian Speaker Factory of:* MAGNAVOX**

You get the best value for your $$$$. DECEMBER ONLY SPEAKER SALE!!!

MODEL 10—40	MODEL 8—30	MODEL 6—25	MODEL XJ—3
10" 8 OHMS	8" 8 OHMS	6" 8 OHMS	1" Dome Tweeter
Watts. RMS. 40	30	25	18-15 OHMS
Freq Response			
30—8000Hz	30—8000Hz	45—6000Hz	2.20 KHZ
V-C Dia. 1½"	1½"	1½"	1"
$24.50	$17.95	$15.95	$8.95
PandP NSW $1.50	$1.50	$1.10	$0.75
PandP Interstate $2.50	$2.50	$1.70	$1.20

MAGNAVOX MV—50 CABINET KIT

$69.95

ADD: 3-41L 3 way cabinet kit as above Baffle Board Pre-cut for 8" plus 3" and vent

$55 PAIR plus freight

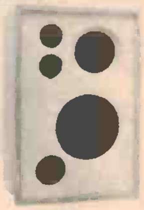
SCOOP! BEAUTIFUL SPEAKER SYSTEMS

8 OHMS 15"H. 9⅞" W 6¾" D. 10 Watts

● They look good ● Sound great ● Teak Veneer ● Wide range 6JX speaker ● Freq. 35-14000 HZ ● Black 1" thick foam ● Plastic speaker grille ● 6½" Twin Cone

PandP $3.50

$39.00 Pair



MAGNAVOX MV-50 CABINET KIT

$69.00 per pair + freight

The top and bottom, both sides and back, are factory assembled — there is little else left to do other than staining or oiling. The inner-bond, speaker grille cloth material and vent tube is included. Cabinet wt. 30 lbs.

PACK of 20 MIXED NEW GUARANTEED ... TRANSISTORS

BC 549, BC 327, BC 639, BC 547, BC 558, BC 640, BC 337, 2N4250, 2N3638, 2N4248, BC 177 **$2.50**

PandP 50c

GARRARD Model 82 **$57.00**

pandp NSW $2.50 Interstate $3.50

A superb 3-speed transcription changer/player auto/manual operation. 4-pole magnetically shielded syn. motor. Resiliently mounted. Counterbalanced. Elegant tone arm with slide-in cartridge carrier calibrated. Anti-skate, 265 mm (10½"). Aluminium platter. Cue and pause control. Cartridge tilting lever. Magnetic cartridge diamond stylus. Size 375 x 335 x 170 mm (14¾" x 13¼" x 6¼") 4.5kg (10lbs).

LM — 75 ELECTRET CONDENSER FM WIRELESS CARDIOID MICROPHONE

SPECIFICATIONS

● Transmitting Frequency Range : 88.1MHz—106MHz ● Modulation System : FM (F3) ● Maximum Frequency Deviation : 75 KHz ● Field Strength : Less than 50 V/m at 50 feet ● Microphone : Electret Condenser type ● Directionality : Unidirectional ● Semi-conductors : 2 Transistors ● Power Supply : DC 1.5V (UM-3) x 1 ● Current Drain : Less than 2.5 mA ● Dimensions : 580 x 200mm ● Weight : 140 gr with battery ● Accessories : Screw Driver, Lavalier, Battery UM-3

$27.95 pandp 80c **FM WIRELESS MICROPHONE**

Cardioid Electret condenser type. Transmitting freq. range 88-106MHz freq. dew 75 KHz. Field S 50uV/MAT 50ft

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Essential Accoutrements

TEXAS INST Lo Profile Sockets

Pin	1	10	100*
8	.30	2.50	20.00
14	.25	2.00	18.00
16	.27	2.20	20.00
18	.40	3.20	27.00
20	80	6.00	40.00
22	50	4.00	30.00
24	50	4.00	30.00
28	50	4.00	30.00
40	50	4.00	30.00

*Write for 1K μp pricing

Common DB Series Connector

	1	10	100*
DB 9P	1.10	1.00	.80
DB 9S	1.50	1.40	1.15
DB15P	1.50	1.40	1.15
DB15S	2.25	2.00	1.75
DB25P	2.25	2.00	1.80
DB25S	3.25	3.10	2.75
DC37P	2.95	2.75	2.50
DC37S	4.90	4.50	4.00
DD50P	3.90	3.50	3.25
DD50S	6.50	6.00	5.40

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IMSAI	699.
SOL20	1095.
Cromenco Z2	595.
Apply II (16K)	1698.
Compucolor	2750.
Poly 88	735.
Xitan I	769.
Vector Graphics	619.
Alpha Micro System	1495.

Memory Modules We Stock

SSM MB7 200ns 16K	525
Industrial μ Systems 8K	229
SPACEBYTE 16K Static	599
SSM MB7 450ns 8K	199
Vector Graphics 250ns 8K	269

DIP Switches

	1	10	100
4	1.85	1.65	1.45
5	1.85	1.65	1.45
6	1.85	1.65	1.45
7	2.00	1.80	1.60
8	2.20	1.90	1.70
9	2.30	2.10	1.75
10	2.40	2.20	1.80

The Precision Decision. We made it. Now it's your turn.

QL-7

JL-F50

We believe that precision is the most important factor in turntable design and performance. Which is why we've built such a high degree of precision into our advanced new line of JVC turntables.
So you'll need a whole new set of reasons to choose the one that's right for you. And when it comes to value, all will play second to none.

Take our new QL-7 Quartz-Locked and JL-F50 Fully Automatic direct drive, shown above. They're both unusually close when it comes to some important specs, but what will surprise you most is that they're also both in the same price range.

For instance, the JL-F50 checks in with less than 0.03% wow and flutter (WRMS); 70dB signal-to-noise ratio (DIN B). And it offers a host of convenience features as well, with most controls up front so you can operate them without lifting the dust cover. Its fully automatic operation gentles your favourite records, and lets you repeat them from one to six times, or infinitely. A built-in strobe makes speed adjustments easy and accurate. And the JL-F50's looks are in keeping with its precision design.

The QL-7's looks are equally great. And in its electronic heart, it's a tiger. All business, with the incredible accuracy only a Quartz-Locked machine can boast. Truly for a perfectionist, the QL-7's wow and flutter measures only 0.025% (WRMS); S/N is more than 74dB (DIN B). Figures that most other QL turntables we've seen in its category cannot match. It's totally manual, with strobe speed indicator.

The way we see it, you're left with a superb decision: our JL-F50 at less than \$350* . . . with all the convenience and performance most people could ever want, or our QL-7, the finest under \$450* turntable available today for the discriminating audiophile.

Whatever JVC you choose, you'll know you've made the right choice.

For details on JVC Hi Fi Equipment, write to: JVC Advisory Service, P.O. Box 49, Kensington, N.S.W. 2033
*Approximate retail value.

JVC
the right choice

ACCESSORIES for the CBer....

Purchasers of ham equipment may be asked to produce evidence that he/she is a holder of an Amateur Certificate of Proficiency.

IMPROVE "TALK POWER" AUDIO MIC COMPRESSOR

MIC COMPRESSOR

The model MC330 is a high quality audio compressor inserted in the microphone line. FEATURES ac/dc operation, front panel compression level meter, two tone for ssb checking, built-in pre-amp and superb construction. Price $71

IMPROVE √ "TALK POWER" **$71**

POWER MIC

QUALITY

1 The new VM-2 power mic for base station use. Includes a built-in pre-amp with volume control, lock down ptt switch, adjustable neck. Good quality. Price $29.80

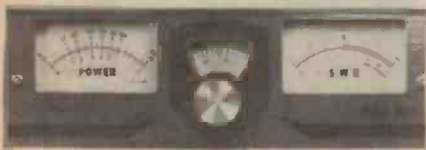
$29.80

2 The VM-1 noise-cancelling ptt hand mic ideal for Amateur or CB mobile operation. Noise-cancelling is achieved by using twin inserts which are out of phase. Fitted with high quality ptt switch and coiled lead. Low Impedance, frequency response 300-5000Hz. Price $9.80

NEW

$8.90
NOISE-CANCELLING

QUALITY SWR BRIDGES
✱OSKERBLOCK
✱VC2 √



FOR THE PROFESSIONAL
The popular Oskerblock SWR200 handles power measurement 2/20/200/2000 watts with dual impedance and good accuracy. Price $75

The popular VC2 swr/pwr meter for ham and CB use covers 3-150MHz. Each unit is individually calibrated for the Australian ham bands plus CB, high accuracy with power measurements 12/120 watts with total capability 1000 watts. Comes complete with informative instructions. Price $38

RECEIVER BOOSTER $39

This preselector improves the selectivity and sensitivity of your short wave communications receiver. It covers four bands from 2-30MHz with a gain of 15dB!

COMBINATION

TELESCOPIC ANT. – Toploaded	
CB/AM/FM Manual	$35
CB/AM/FM Automatic	$57

QUALITY COAX SWITCH

The model CS201 is a high quality professional 2 position coaxial switch suitable for up to 500MHz. Low insertion loss and instrinsic VSWR, the non-used terminals are earthed. Price $24

√ **$338**

FRG-7 Receivers YAESU

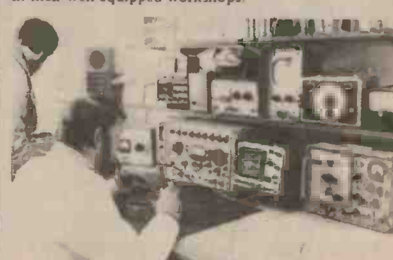
The Yaesu FRG-7 general coverage communications receiver covers 500KHz thru 30MHz.

HIGH POWER LOW PASS FILTER √

FD30M High power (1Kw), 32MHz cut-off	$35
FD30LS 32MHz cut-off, 200w max. 3 stages	$20

SERVICE by EXPERTS

VICOM are experienced communications engineers and are able to service the most complex of equipment in their well-equipped workshops.



MARINE ANTENNAS 27.910 MHz $69

NO GROUND-PLANE REQUIRED
6ft marine whip tuned 27.910MHz, may be mounted on fibre-glass, wood or on the mast. Quality USA manufacture. Price $69

TRANSISTORS SPARES

DRIVER & FINALS

2SC1306	$5.00	2SC1018	$5.00
2SC1307	$6.50	2SC1818	$6.50
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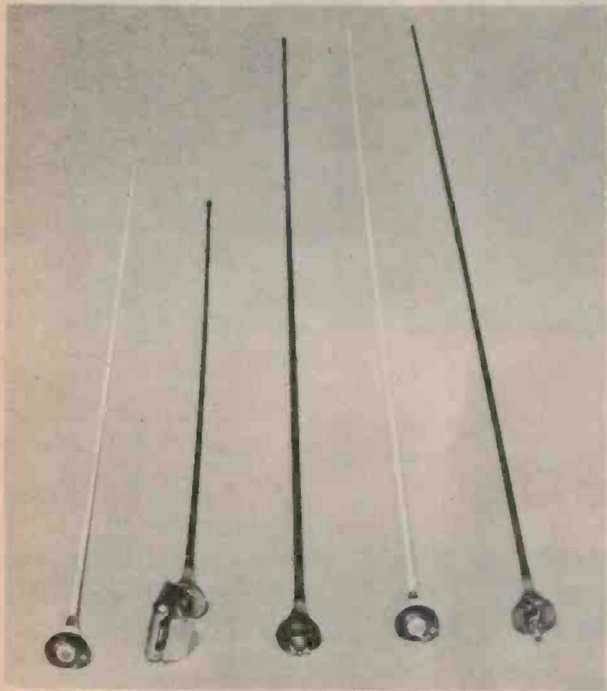

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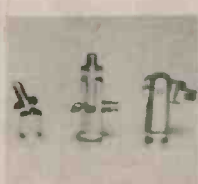

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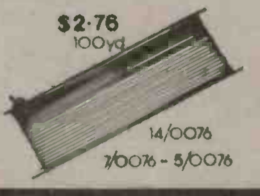

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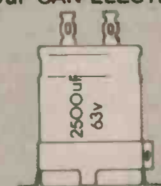

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Senator Cotton opens the new CREST HQ at North Point Towers in North Sydney. CREST is the emergency service arm of the NCRA.

NCRA SEEKS REGS CHANGES

THE NCRA SEEKS major alterations to the Citizens Radio Service regulations, as set out in the P & T Department's document RB14.

In a submission to the P & T Department and the Government, the NCRA demanded changes in eight major areas.

1. The NCRA want the definition of a station extended so that the operator and not the transceiver are licensed.
2. A reduction in the license fee is sought.
3. The tenure of the license should be able to be increased, at the licensee's option, to five years with an associated fee discount.
4. The NCRA claims that the users want a dual HF/UHF service and demand that the 27 MHz HF allocation be extended beyond 1982.
5. The 18 channel 27 MHz CB band be extended to 40 channels.
6. An immediate increase of UHF band channels is recommended, from 40 to 100 (at 25 kHz spacing), and further channels set aside.
7. The NCRA wants CBRS Advisory Committees similar to those operating with the Amateur Radio Service.
8. The NCRA wants the Department's list of approved transceivers published.

In their submission, the NCRA criticizes the Department's policy that CRS stations be issued with 'Land Mobile Service' licenses.

They argue against this saying:-

> Australia has a well defined Land Mobile Service, generally such licences have been issued to applicants who can prove a need for such a service. The general style of approach is to licence a master base station with subsidary mobile stations, all on a discrete frequency. This group (or family) of stations are usually constrained to restricting radio contacts within their group. The Taxi company provides a well known example. Usually the contact is limited Base to Mobile, or Mobile to Base (as apposed to Mobile to Mobile contacts).
>
> The defacto CB service is shared frequencies with base or mobiles in contact with base or mobiles with or without existing relationships (in simpler terms — anyone contacts anybody).
>
> Already, the trend of RB14 is to let mobile stations contact any mobile station without regard to the distance between them, but in the case of base stations — a radial distance of 32 km is suggested.
>
> The Citizens Radio Service is not a Land Mobile Service within the ITU context, nor should it be in the Australian context and previous practice. The LMS is basically a discrete relationship service as exemplified by the business model.

The NCRA submission also contains a lengthy criticism of the implied definition of a station contained in RB14, pointing out anomilies they see in the existing Wireless Telegraphy Act.

They say:-

> The Wireless and Telegraphy Act and its Regulations fail to explicitly define the contents of a station. There are some regulations that provide hints to aid interpretation (e.g. WTR R66(2)). It appears that the Departmental interpretations have run the gambit from one or more sets per station (for the Amateur Service), one or two sets (for business services where a standby or replacement set is sometimes permitted) to one set per station (for handphone service and CRS).
>
> As the WTR provides for recognition of the International Accords, an examination of the International Radio Regulations of the International Telecommunications Union provides us with the following definition of the term STATION (Definition 21):
>
> "Station — One or more transmitters or receivers or a combination of transmitters and receivers, including the accessory equipment, necessary at one location for carrying on a radiocommunication service. Each station shall be classified by the service in which it operates permanently or temporarily."

For your interest, the proposed FCC definition of station is:

"Station means all of the equipment used by a CB licensee or authorized user, regardless of the ownership of the equipment" and additionally,

"Station address means the place where the station licence is kept or posted, where the station records are kept and where the primary fixed transmitter (if any) is operated".

The clear inference in these two precedents is that the Australian practice of only licencing sets is open to challenge.

In regard to the license fee, the NCRA claims that the CBer is being ripped off.

What NCRA believes to be the case is that the revenue from the CRS licences are not being used to administer the Citizens Radio Service, but are being used to defray the costs of the Department in administrating its other services — and in an inefficient manner at that.

The NCRA further believes that the licence fee is not related to the cost of providing or maintaining the CBRS, but in fact is a tax levy on a specific user group. As such the NCRA questions the constitutional right of the Government to use the licence fee to tax the user and asks that the Attorney General provide a legal opinion.

The current Wireless Telegraphy Act provides for a maximum license period of only one year. The NCRA would like to see this period raised to five years maximum at the option of the user with a 12 month license period being the basic tenure.

They say that a number of economies would flow from this measure and that the benefits of this could be passed on to the licensee.

Dual HF/UHF Service

The UHF band appears to have a place in the minds of most CBers. But not as an 'only child' allocation says the NCRA.

It is the Government's expressed intention that the HF CB service on 27 MHz will not continue beyond 1 July 1982. Those people wishing to continue operating on 27MHz after that date will be required to obtain an amateur license — a fourth class of amateur licence, with fewer requirements than the present Novice Amateur license, has been foreshadowed by the Government.

The Government does not want to transfer a 'pirate' situation of 1977 to 1982. They hope to do this by providing a fourth class amateur license.

This is naive according to the NCRA, who says:-

The Government will in fact be inviting legal operators to become illegal operators in 1982.

The Government attitude that HF CBers needs will be satisfied by entering the Amateur Radio Service is not shared by the majority of current users because:

(a) The user regulations of ARS are not keeping with the CRS operators,

(b) The morse code and technical requirements of the ARS are not capable of being met by CRS users (e.g. wives, businessmen, farmers and the like)

(c) The non-technical/appliance aptitude status of CRS operators and the aims and motivations of the ARS are simply not commensurate with the aims, aptitudes, inclinations, motivations and desires of both current and future Citizen Band operators.

More Channels

In addition to retaining the 27 MHz allocation, the NCRA want the present 18 channel system expanded to the 40 channel US system.

The Department's argument that 18 channels on 27 MHz is sufficient on a per capita basis is severely criticized in the NCRA submission. They say this:-

It is in error of understanding for the Department to claim that Australian CRS users are solely interested in purchasing 40 channel sets just to talk USA Skip — the 40 channel sets represent a low technical cost to the user.

NCRA maintains that the population densities of Sydney and Melbourne are quite compatible with the urban areas in the USA — seeing these places are where the majority of Australian CRS operators try to operate, then the 18 channel per capita argument does not hold.

In other words — there is a strong justification now to expand the spectrum space for the HF CBer.

It could be true to say that the eventual UHF CB population might rise to 100,000, 250,000 or even 1,100,000 — even if this were true (and only time will tell) there is little doubt that UHF will not satisfy the needs of all CRS operators.

For example, the CRS operators in the country areas — farmers and the like — just how well they take to a UHF system that is not only line of sight, but also suffers from additional signal absorption due to the abundant vegetation?

What about the CBer who takes no delight in having UHF conversations with his neighbours in the next suburb?

The Department and the Government should recognise that as far as the ordinary citizen is concerned (not the Amateur, not the taxi companies) he wants the ability to communicate cheaply and at no technical cost to him in terms of training.

The Government should cater for the two basic groups of CBers — both short haul CBers and the recreation/hobbyist who lack the necessary technical skills to go Amateur.

The users want a dual HF/UHF service — they want both services to be viable in terms of spectrum space and cost — and if the Government considers that there will be no pirate problem in 1982, then they have only to consider the events of the last two years and the prospect of an increased and unified CB community in 1982 with other thoughts in mind.

With regard to the channels on UHF, the NCRA would like to see more on this band too! Like up to 900!

NCRA recommends the increase of the number of UHF channels to 100 at 25kHz spacing with further provision for an additional 900 channel allocated and set aside now.

The NCRA claim that the 476 MHz allocation is out of kilter with the thinking of the FCC in America which is presently considering a number of VHF and UHF bands for their CB service.

Further, they believe that the 40 channels allocated for the UHF band here are insufficient to cope with traffic densities that already exist and will only increase in the future.

The NCRA argues that:-

The 40 channel UHF allocation is grossly inadequate and bears no relationship to the normal and peak density needs of the service in metropolitan areas as predicted by the Department and such large manufacturers as Philips-TMC.

Consideration should be given to Mr. Wilkinson's response to the question asked at the 1st Annual CB Convention — 'Would your Department's attitude to UHF be to align with major potential users such as the USA?' to which Mr. Wilkinson replied 'We would fall in line with any major user of UHF CBRS.'

The USA have no intention of starting a UHF CBRS in the 470 MHz area. Given that one of the objectives of going UHF was the potential revitalisation of Australian manufacturing and its potential export markets — now our Postal and Telecommunications Department yet again blundered in determining the frequency band and number of channels and shown its incompetence in Spectrum Management to the detriment of the user, the manufacturer and thus the public of this country as well.

They maintain that the interests of all CB users would be accomodated with a dual HF/UHF allocation.

Apart from the other points mentioned at the start of this article, the NCRA are seeking a clear definition of the manner in which a base station can be set up and licensed.

There is much contention surrounding the '32km limit' mentioned in the CB regulations, RB14, regarding the permissable range of base stations. There is no distance limit, other than the geographical limits of Australia, mobile — mobile contacts.

As it is virtually impossible to prevent long distance contacts that occur via the ionosphere, RB14 sensibly put no restriction on this — except for base stations, although ambiguous interpretations of this section of the regulations are possible. The NCRA would like to see the ambiguities cleared up and base stations allowed to participate in skip QSO's as mobiles are.

Base antenna heights are presently limited to 6 metres above the structure on which they are mounted (excluding towers). The NCRA seek to have this extended to 10 metres. They maintain that this would allow operators to get their base antennas above the height of most suburban TV antenna installations, reducing TVI.

NCRA would like to see beams allowed for CREST stations and country stations or any other situation where antenna gain would allow communications where the existing provisions make operation difficult.

The Department admits difficulties in policing the CB channels adquately — the NCRA has recommended that CBRS Advisory Committes be set up, similar to the Amateur A.C.'s that have existed for some years, to aid in self-regulation and policing within the CB service.

In their submission, the NCRA were critical of the attitudes of some District Radio Inspectors whom the NCRA thought were hindering cooperation between the CB clubs and the Department on this issue.

Entering the 'consumer protection' field, the NCRA say in their submission that the Department's list of approved equipment should be published to protect the interests of purchasers of CB equipment and to ensure that operators only bought licensable equipment.

CB AUSTRALIA

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DECEMBER Vol.2. No.3. 80c*

Fretilin radio base exposed!

A GROUP calling themselves the Campaign for an Independent East Timor (CIET) has been using Australian radio equipment to operate a secret communication service between East Timor and Australia for two years.

CIET have been operating a transceiver, passing messages to and from Fretilin forces in overun East Timor since December 1975 when East Timorese forces were forced to flee into the mountains ahead of invading Indonesian troops.

Operating 50 watt single sideband Australian made transceivers on frequencies in the 4 to 6 MHz landmobile band, CIET have passed thousands of messages to and from Timorese refugees and Fretilin officials in Australia and Fretilin forces trapped in East Timor.

This unlicensed operation has been providing what has been called "an invaluable service" under extremely harsh conditions from secret locations in the bush near Darwin in the Northern Territory.

Despite three 'busts', harrassment and considerable Government searching using sophisticated direction-finding equipment, the group has persisted quite successfully in maintaining the only communications link that Fretilin has with the outs[illegible] world.

One 'bust' in Se[illegible] 1976, occurred on the e[illegible] Prime Mini[illegible]ser's [illegible] to Djaka[illegible] Indone[illegible] Pre[illegible] and F[illegible] Mi[illegible]k.

Ag[illegible] the e[illegible]ne Minis[illegible]er's [illegible] ASE[illegible]it co[illegible] in Kua[illegible] — e[illegible]s year, a r[illegible]ion-[illegible]g unit was [illegible] the transceiver s[illegible].

CB Australia has it on good authority that Mr Fraser ordered the clandestine transceiver put off the air.

Apparently the Army has been cooperating with the P & T Department in Darwin to assist in monitoring and direction-finding activities in a so far vain attempt to find the clandestine transceiver site and keep them off the[illegible]

Sufficient equi[illegible]s been obtained [illegible] to [illegible] pand oper[illegible] areas if neces[illegible]

[illegible] 'bust' occur at a[illegible] anothe[illegible] transceiver [illegible] placed [illegible] operation [illegible]ys.

[illegible]ast Tim[illegible] was inva[illegible] by [illegible]onesian [illegible]roops on December 7. 19[illegible]

[illegible] that [illegible]onth, the CIET [illegible]nsceiver and at-[illegible]ommunications with Fretilin forces in East Timor.

On the day of the invasion, Alarico Fernandes, Fretilin Minister for Information and National Security, broadcast from the hospital in Dili on the Australian Outpost Radio Network frequency.

He was picked up by the Overseas Telecommunications Commission [illegible] in Darw[illegible] pro[illegible]

Their [illegible] on deaf ears.

OTC ac[illegible]pted [illegible] on radio te[illegible]rams fr[illegible] Timor until [illegible] 1976.

However, c[illegible]mmunications was only one-[illegible]

Initially, a [illegible]mber of the CIET living in Darwin, Mr Tony Bellows, established two-way communications [illegible]ith Fretilin by putting a transceiver in his Mini Moke and driving out into the bush south of Darwin and setting up a temporary station.

He used a Traegar transceiver manufactured in South Australia, which are made for use on the outpost radio network.

Returning from one of these jaunts early in January 1976, tony was 'busted' and the transceiver confiscated.

The department has never proceeded with the case.

A campaign then swung into action in Sydney with the CIET raising funds to buy a transceiver to be used to restore communications with East Timor.

The Australian made Wagner transceiver first used for regular contact [illegible] Fretilin. This equipment was siezed in September '76 by P&T off[illegible]

February 1976 and contact with East Timor was restored later that month.

A Timorese refugee became the radio operator at this stage.

The crew for this operation lived in Darwin and commuted to the site not far south of Darwin where the radio [illegible] set up.

Not long after e[illegible]ishing this operation [illegible] made, pres[illegible] ernmen[illegible] the rad[illegible]

T[illegible] to [illegible] site [illegible] of D[illegible] [illegible]ommu[illegible]on with East [illegible] wa[illegible]ried on from [illegible] a daily basis for [illegible]our months.

The transceiver site was

Ken Fry, Labor MHR for Frazer has spo[illegible]directly to East Timor via th[illegible]

moved [illegible] 1976 to the west coast of C[illegible] Peninsula, a long way south [illegible] of Darwin and right on the [illegible]st.

The orig[illegible] Timorese [illegible]perator th[illegible]urned to [illegible]elbourne a[illegible]nother re[illegible]gee, Estanislau Da Silva, [illegible]k over.

[illegible]stanislau operated every [illegible] from this site from July [illegible]hrough September '76.

On September 27 the crew packed up to move camp.

Just as they were about to pull out, some Government officers literally 'stumbled' across them.

Continued on P.4

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7411	.25	7476	.30	74165	.99
7413	.43	7483	.68	74166	1.25
7414	.65	7485	.88	74170	2.10
7416	.35	7486	.40	74173	1.49
7417	.35	7489	2.25	74174	1.23
7420	.16	7490	.43	74175	.97
7422	.30	7491	.75	74176	.89
7423	.29	7492	.48	74171	.84
7425	.27	7493	.48	74180	.90
7426	.26	7494	.78	74181	2.45
7427	.29	7495	.79	74182	.79
7430	.20	7496	.79	74184	1.90
7432	.23	74100	.98	74185	2.20
7437	.25	74105	.44	74187	5.75
7438	.25	74107	.37	74190	1.15
7440	.15	74121	.38	74191	1.25
7441	.89	74122	.38	74192	.95
7442	.59	74123	.65	74193	.85
7443	.73	74125	.54	74194	1.25
7444	.73	74126	.58	74195	.74
7445	.73	74132	.89	74916	1.25
7446	.81	74141	1.04	74197	.73
7447	.79	74145	1.04	74198	1.73
7448	.79	74150	.97	74199	1.69
7450	.17	74151	.79	74200	5.45

LOW POWER

74L00	.29	74L51	.29	74L90	1.40
74L02	.29	74L55	.29	74L91	1.20
74L03	.23	74L71	.29	74L93	1.50
74L04	.29	74L72	.45	74L95	1.50
74L06	.29	74L73	.56	74L98	2.25
74L10	.29	74L74	.56	74L164	2.25
74L20	.29	74L78	.75	74L165	2.30
74L30	.29	74L85	1.09		
74L42	1.39	74L86	.65		

LOW POWER SCHOTTKY

74LS00	.36	74LS32	.38	74LS95	2.09
74LS02	.36	74LS40	.45	74LS107	.59
74LS04	.36	74LS42	1.40	74LS164	2.20
74LS08	.38	74LS74	.59	74LS193	2.20
74LS10	.36	74LS90	1.30	74LS197	2.20
74LS20	.36	74LS93	1.30		

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74H00	.25	74H22	.25	74H61	.25
74H01	.25	74H30	.25	74H62	.25
74H04	.25	74H40	.25	74H74	.39
74H08	.25	74H50	.25	74H101	.58
74H10	.25	74H52	.25	74H102	.58
74H11	.25	74H53	.25	74H103	.60
74H20	.25	74H55	.25	74H106	.72
74H21	.25	74H60	.25	74H108	.72

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4001A	.25	4020A	1.72	4068A	.44
4002A	.25	4021A	1.18	4069A	.44
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4007A	.26	4023A	.25	4072A	.35
4008A	1.52	4024A	.89	4073A	.39
4009A	.57	4025A	.25	4075A	.39
4010A	.54	4027A	.59	4078A	.39
4011A	.29	4028A	.98	4082A	.35
4012A	.25	4030A	.44	4516A	1.56
4013A	.45	4035A	1.27	4528A	1.56
4014A	1.27	4040A	1.39	4585A	2.10
4015A	1.27	4042A	1.47		
4016A	.48	4049A	.59		
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74C00	.19	74C74	1.04	74C162	2.49
74C02	.26	74C76	1.34	74C163	2.66
74C04	.44	74C107	1.13	74C164	2.66
74C08	.68	74C151	2.62	74C173	2.22
74C10	.35	74C154	3.15	74C195	2.26
74C20	.35	74C157	1.76	80C95	1.15
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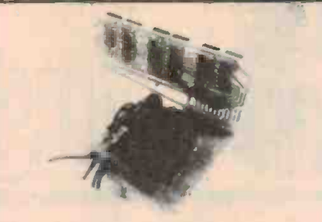

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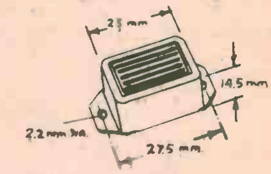

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2.2 mfd	35V	.30	22 mfd	16V	.45
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Ideas for experimenters

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.
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SIMPLE CROWBAR CIRCUIT

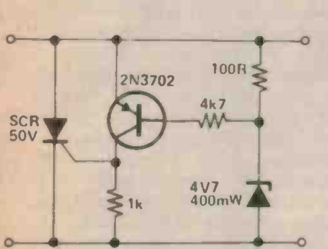

Fig. 1

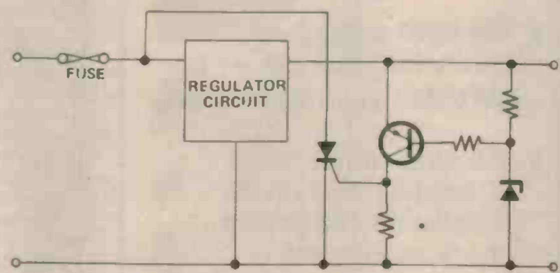

Fig. 2

This circuit provides overvoltage protection in case of voltage regulator failure or application of an external voltage. It is intended to be used with a supply offering some form of short circuit protection, either foldback, current limiting or simple fuse. The circuit is less effective in the latter case however, as a good deal of damage can be done in the time taken to blow a fuse.

The most likely application is a 5V logic supply, since TTL is easily damaged by excess voltage. The values chosen in Fig. 1 are for a 5V supply, although any supply up to about 25V can be protected by simply choosing the appropriate zener diode. When the supply voltage exceeds the zener voltage +0.7V, the transistor turns on and fires the thyristor. This shorts out the supply, and prevents the voltage rising any further. In the case of a supply with only fuse protection, it is better to connect the thyristor across the unregulated supply as shown in Fig. 2 to prevent damage to the regulator circuit when the crowbar operates.

The thyristor should have a current rating about twice the expected short circuit current and a maximum voltage greater than the supply voltage. The circuit can be reset by either switching off the supply, or by breaking the thyristor circuit with a switch.

DRIFT FREE CURRENT SOURCE

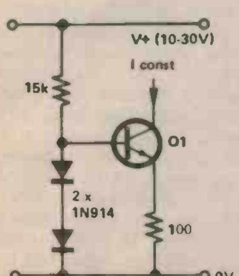

Fig. 1

The conventional type of constant-current source, as shown in Fig. 1, will drift in output current immediately after switch-on. This is because of the voltage drop across Q1, causing a significant amount of power to be dissipated in the transistor, heating it and its Vbe. Hence the output current slowly increases after switch-on, typically reach-

continued overleaf

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7408	40c	7474	90c
7410	40c	7490	80c
7420	40c	7492	80c
7430	40c	74107	1.00

LINEAR

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LM304	1.30	LM382	2.45
LM305	1.20	LM3900	1.50
LM307	70c	LM555	85c
LM308	2.30	LM566	4.50
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LM319	2.80	LM723	1.00
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LM339	3.20	8038	6.95
LM377	2.80	LM1458	1.50

CMOS

4000	40c	4014	2.25
4001	40c	4016	85c
4002	40c	4017	2.25
4006	2.50	4018	2.50
4007	40c	4022A	1.90
4008	2.75	4023A	45c
4009	80c	4024	1.35
4011	45c	4027A	1.00
4012	40c	4028A	1.90
4013	1.00	4030A	80c

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1	MFD	6.3	Axial	10c
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3.3	''	25	''	8c
4.7	''	10	''	8c
4.7	''	25	''	8c
22	''	10	''	8c
22	''	50	''	15c
25	''	25	''	8c
33	''	6.3	''	9c
33	''	16	''	10c
47	''	10	''	12c
47	''	25	''	14c
47	''	50	''	15c
100	''	10	''	13c
100	''	25	''	15c
220	''	6.3	''	17c
220	''	16	''	17c
220	''	35	''	22c
470	''	25	''	22c
1000	''	10	''	35c
1000	''	16	''	36c
1000	''	25	''	47c
1000	''	50	''	80c

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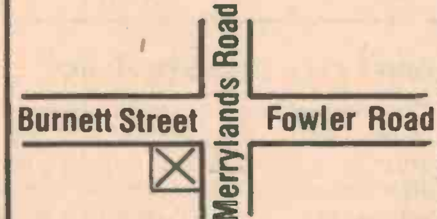

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Ideas for experimenters

continued from previous page

ing a stable value about two minutes later. In tests the current increased by about 4% for a small signal transistor dissipating 100mW.

This effect is greatly reduced by the configuration shown in Fig. 2, which fixes the voltage across Q1 at a very low level by virtue of the common-base transistor Q2. The main voltage drop occurs across Q2, leaving about 600mV across Q1, this being set up by the two extra diodes in the bias chain, (D1, D2) which fix the emitter potential of Q2.

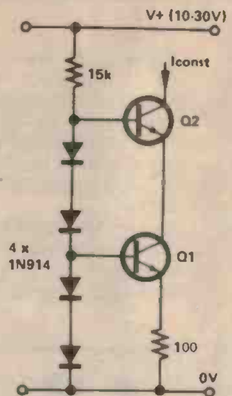
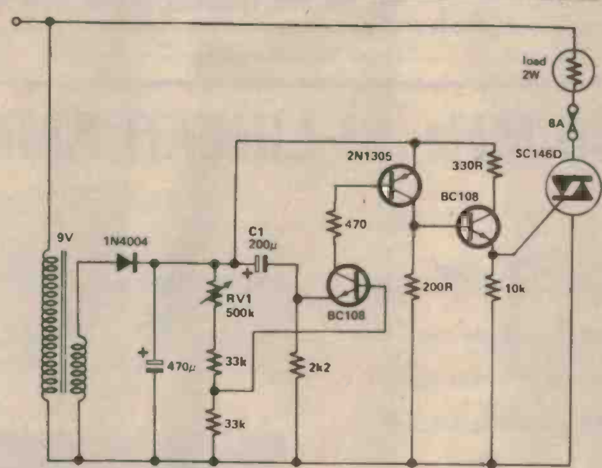


Fig. 2

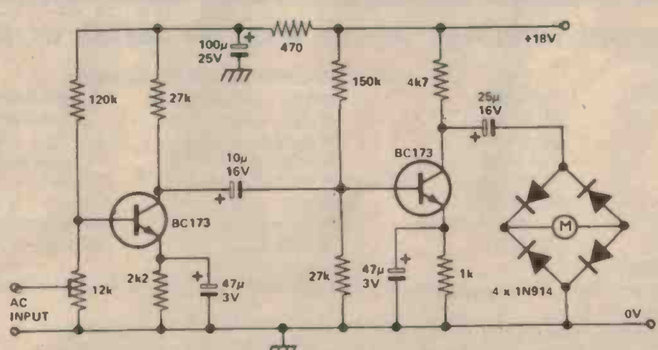


TRIAC LAMP FLASHER

The circuit is a relatively simple triac lamp flasher, probably of most interest to those in the disco business. The flasher will handle a load of up to 2kW with a variable flash rate of about 20/200 flashes per minute, achieved by altering the value of RV1.

C1, the timing capacitor, can be experimented with to obtain the most satisfactory results. Even though little power is dissipated in the triac (15W on full load), it should be mounted on a heatsink.

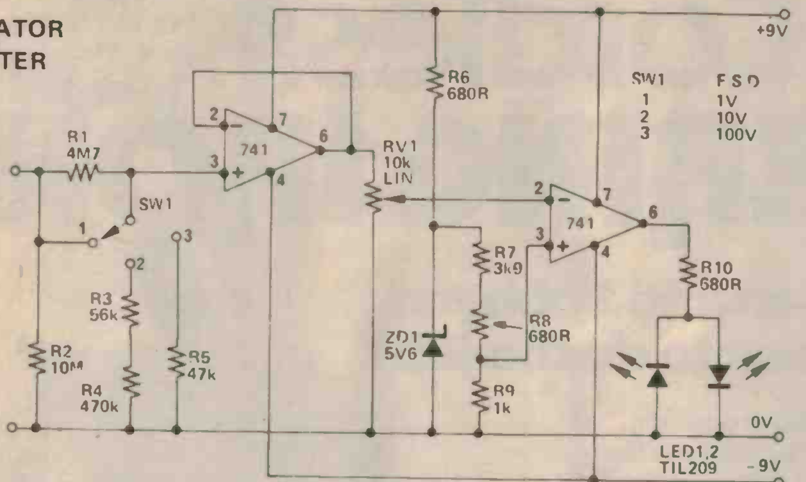
RECORDING LEVEL METER



The circuit shows a two-stage voltage amplifier driving a recording level meter. The AC signal input is amplified, rectified, and the resultant DC voltage shown on the meter. The circuit can be used with a tape-recorder or audio mixer and should be fed from a point early in the pre-amp. Current consumption in a no-signal state is 2.8mA. The 12K preset gives a variation in sensitivity. The meter can be any general purpose type.

Ideas for experimenters

COMPARATOR VOLTMETER



This circuit, although simple, is capable of accurate voltage measurement. The input is applied to the high impedance input of IC1 via the attenuator comprising of R1 to R5 inclusive.

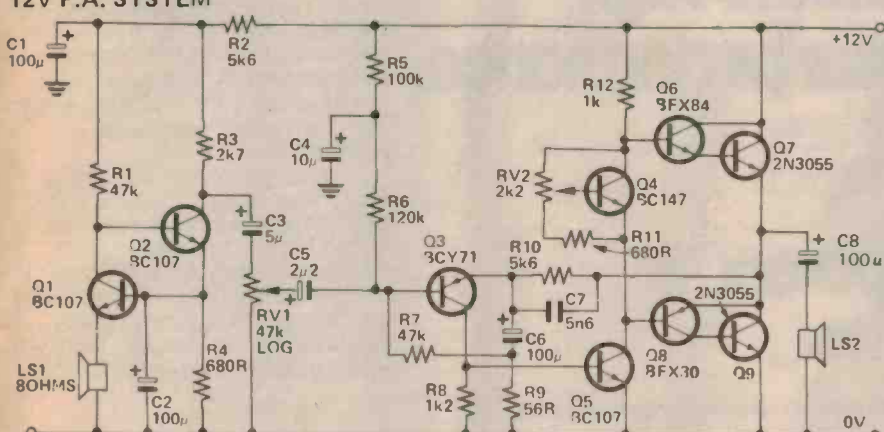
Since this IC is used as a unity gain buffer, the output at pin 6 is equal to the input voltage at pin 3, but at a low impedance. IC2 is connected as a comparator driving a pair of LEDs, D1 and D2.

The inverting input samples a portion of the unknown input voltage, whilst the non-inverting input is connected to a 1V reference obtained from the stable voltage across ZD1.

In use VR1 is adjusted till D2 just illuminates. At this point, if the control knob is of the 0 - 10 calibrated type, the pointer will indicate the input voltage.

For example, with SW1 in position 2, and with a reading of 2 on VR1, the input voltage will be 2V. With a little practice, the voltage can be read to ± 2%, comparable to a moving coil instrument. The input impedance on all ranges is 3.2MΩ.

12V P.A. SYSTEM



This circuit was originally built for use in a negative earth car. A miniature speaker, impedance immaterial, is connected in the emitter circuit of Q1, and acts as a microphone.

Q1 operates in the common base mode and a highly amplified signal appears at its collector. Q2, used in the common emitter mode, provides further amplification and the signal from its collector is fed via the blocking capacitor C3 to the volume control VR1.

Overall de-stabilisation is provided by obtaining Q1's base bias from the emitter of Q2.

The power amplifier is fairly conventional and fitted with a heavy duty output stage to enable a pair of 3Ω P.A. type horns to be driven in parallel. Under these conditions 8W is available. A single 3Ω unit can be driven to 4W.

Since the unit is intended for the reproduction of speech a wide bandwidth is not required and C7 is incorporated to roll off the response above 5kHz. C6 also provides a rapid roll off in the bass region. Q7 and Q9 should be fitted to a 5" x 4" finned heatsink and the body of Q4 should be thermally in contact with this.

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ADVERTISING

Sydney: Bob Taylor (Manager), Geoff Petschler (NSW Manager), 15 Boundary St, Rushcutters Bay 2011. Tel: 33-4282.
Melbourne: Tom Bray (Manager), Poppe Davis, Suite 24, 553 St. Kilda Rd, Melbourne. Tel: 51-9836.
Brisbane: Geoff Horne, 199 Jesmond Rd, Indooroopilly, Brisbane, 4068 Tel: 378-3273.
Adelaide: Ad Media Group of SA, 37 Fullarton Rd, Kent Town 5067. Tel: 42-4858.
Perth: Aubrey Barker, 38 Mounts Bay Rd, Perth. Tel:
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