OCTOBER 1975
75c*

electronics TODAY

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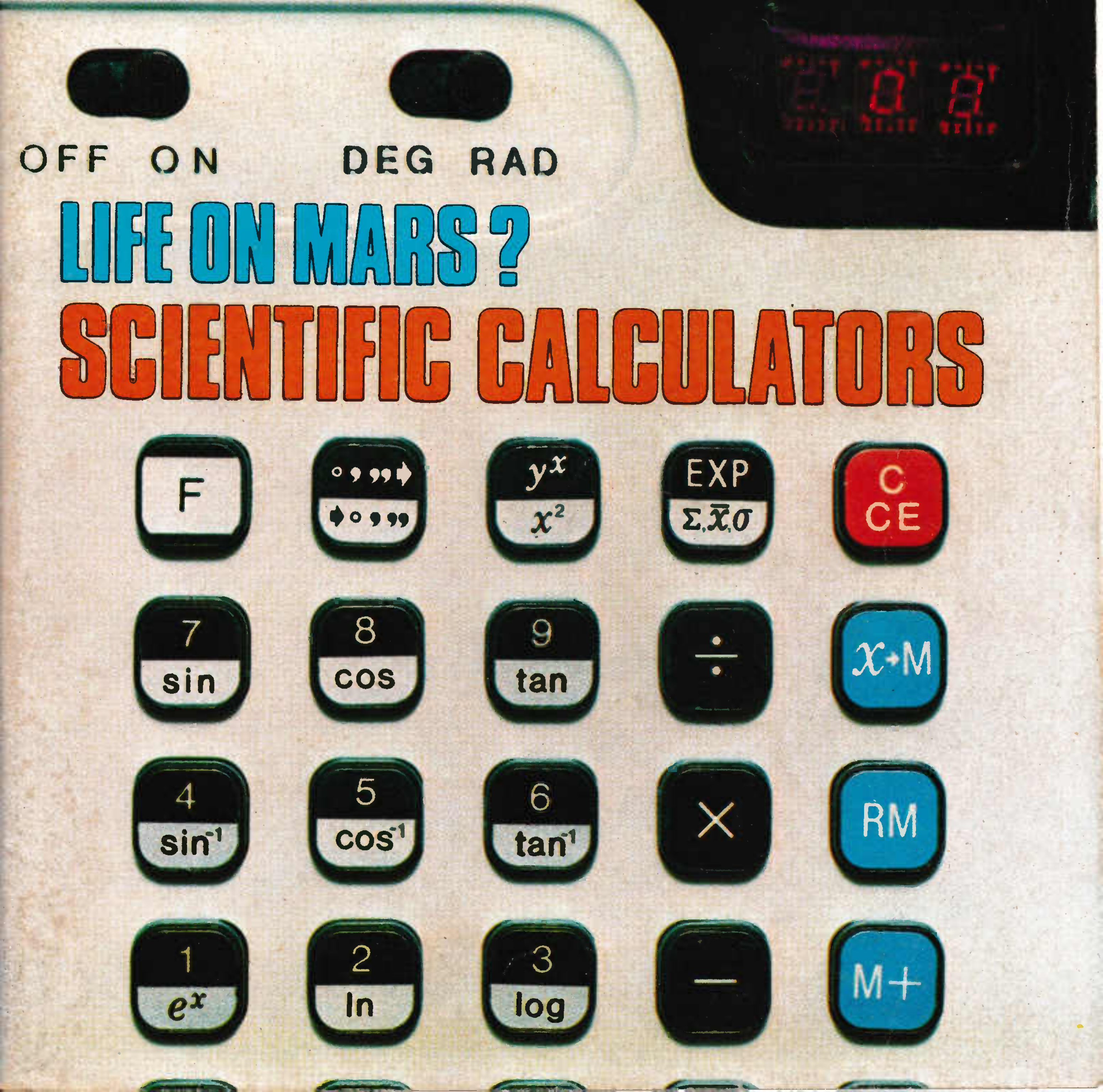
LIFE ON MARS?

SCIENTIFIC CALCULATORS



DIRECT DRIVE

SL 120

SL 120 BASIC

- Add tonearm of your choice.
- Direct-drive brushless DC motor.
- Wow & flutter: less than 0.03% WRMS.
- Rumble: better than −50 dB [DIN A], −70 dB [DIN B].
- Fast build-up time (within ½ rotation at 33⅓ rpm).
- 33 cm aluminium diecast turntable platter, dynamically balanced.
- Stroboscope speed indication on tapered rim for easier checking.
- Variable pitch controls (±5%).
- Aluminium diecast base.
- Audio-insulated legs.
- Removable dust cover

SL 1200

SL 1200 STANDARD

- Direct-drive brushless DC motor.
- Wow & flutter: less than 0.03% WRMS.
- Rumble: better than −50 dB [DIN A], −70 dB [DIN B].
- Fast build-up time (within ½ rotation at 33⅓ rpm).
- 33 cm aluminium diecast turntable platter, dynamically balanced.
- Stroboscope speed indication on tapered rim for easier checking.
- Variable pitch controls (±5%).
- Precision-engineered tonearm with lateral balance and direct read-out of tracking force.
- Anti-skating device.
- Adaptable for discrete 4-channel (CD-4) records.
- Aluminium diecast base.
- Audio-insulated legs.
- Removable dust cover stays open at any angle.

SL 1300

SL 1300 AUTOMATIC

- Automatic start, stop and return.
- Memo-repeat mechanism — plays same record up to 5 times.
- Direct-drive brushless DC motor utilising the platter as part of the motor.
- Wow and flutter less than 0.03% WRMS.
- Rumble: better than −50 dB [DIN A] −70 dB [DIN B].
- Pitch control range 10%.
- 33 cm dynamically balanced platter.
- Stroboscope speed indication on tapered rim for easier checking.
- Precision engineered tonearm with gimbal suspension, "S"-shaped tubular, universal 4 pin connector, direct read out stylus pressure.
- Anti-skating control.
- Adaptable for CD4 records.
- Audio insulated legs.
- Removable dust cover stays open at any angle.

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WT.GD75T

National Technics

electronics TODAY

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Contents

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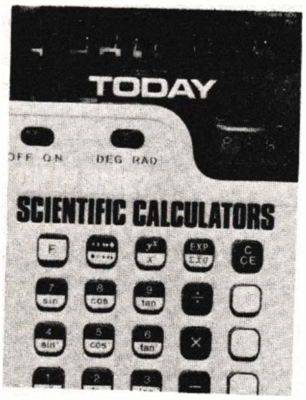

COVER: Scientific calculators cost from $39 to $1000 plus! Here's how to choose the right one for you. Featured in our cover pix is Sharp's EL-1100. (Cover pix by staff photographer John Knight).

PROJECTS

MAIN FEATURES

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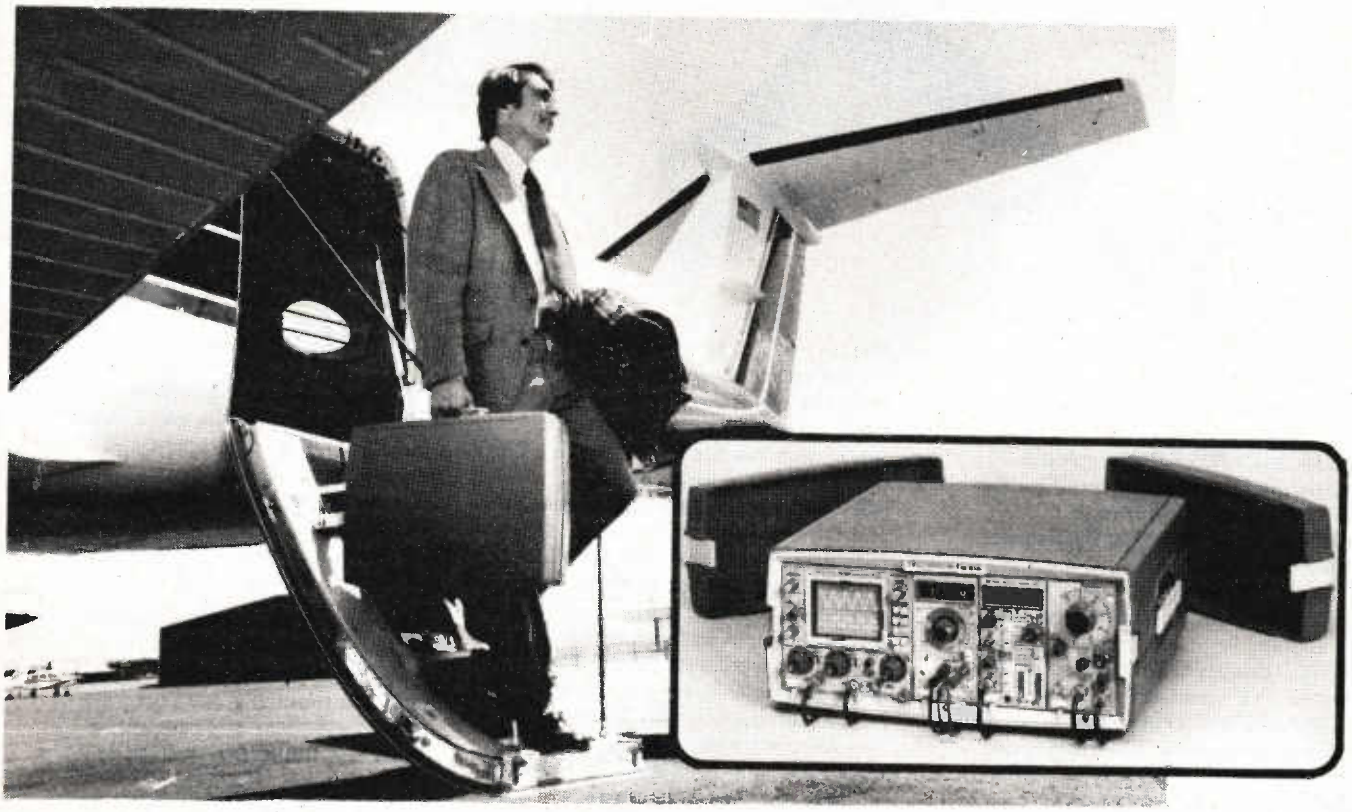
NEWS & INFORMATION

news digest

NEW CONCEPT IN PORTABLE INSTRUMENTS



The new TM 515 Traveller/Mainframe by Tektronix looks and feels like quality flight luggage! Unsnap the end caps and you discover full operating provisions for five TM 500 plug-in, modular test and measurement instruments.

Although the TM 515 may be used as a power module mainframe for any of the 29 or so TEKTRONIX TM 500 plug-in instruments, Tektronix suggests "building" a portable instrument package by starting with the new SC 502 Plug-in Oscilloscope that takes two compartments, and then adding up to three additional instruments that offer optimum facilities for the intended applications.

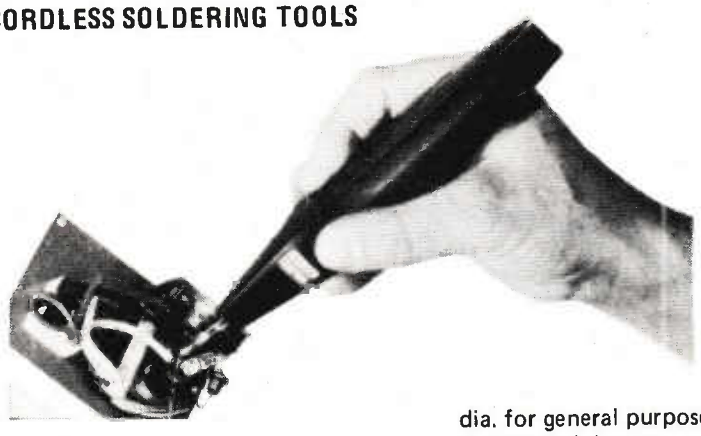
Outside, the TEKTRONIX TM 515 is a tough plastic travelling case. Inside, it's a mainframe for five TM 500 plug-in instruments, an interface circuitboard allowing the instruments to 'talk' to one another, and a shared power supply with forced-air ventilation. A factory-installed option (Option 5) allows TM 515 users to interconnect the plug-in instruments via the rear interface circuitboard without making soldered junctions . . . an advantage when the service technician may select a different group of instruments for separate trips into the field. A single line cord connects the TM 515 to primary power.

The power transformer of the TM 515 accommodates 100, 110, 120, 200, 220, and 240 Vac and 48 through 440 Hz. However, the range of line frequencies is limited to 48-60 Hz when the factory-standard ventilating fan is installed. An optional 48-100 Hz fan is accomplished with quick-change line selector blocks.

Details from Tektronix Australia Pty Limited, 80 Waterloo Road, North Ryde 2113.

news digest

CORDLESS SOLDERING TOOLS



The 'ISO-TIP' battery-electric soldering tool manufactured by the WAHL corporation is now distributed in Australia by Royston Electronics.

This 170g (6oz) unit is completely self contained, operating from long life nickel cadmium batteries. The manufacturers claim that 20 to 150 or more soldered joints can be made between battery recharges. Actual figures quoted are 20 terminations comprising 12 gauge, 3 twist wire joints, and 160 terminations comprising 22 gauge, 3 twist wire joints.

Two tip sizes are available — 1.8 mm dia. for printed circuits, and 4 mm dia. for general purpose soldering. A neat push-button controls the operation, switching on an indicator lamp, an inbuilt lamp to light the work area, and the heater circuit. The tip heats in five seconds. The 'ISO-TIP' (isolated tip) construction, and the low operating voltage, eliminates electrical leakage risk.

Recharging from ac mains is achieved automatically, simply by placing the tool in the recharging stand. It cannot overcharge. The charging power supply has been engineered by Royston Electronics, and Australian approval has been obtained from the Electrical Approval Authority of Victoria, under Approval No. v/74394/7578. The unit is also available for recharging from a 12 volt dc source, and an attachment to fit automotive cigar lighters makes it a convenient unit for outside servicement.

MINIATURE CHARGER

A new trickle charger from Melbourne-based A&R-Soanar is built into a double insulated moulded case that plugs straight into a three-pin mains outlet.

Output is 12 volts dc at one amp — ideal for trickle charging motorcycle and car batteries. A thermal overload switch safeguards the charger from overload which may occur if a totally flat battery is being charged.

Details from A&R-Soanar Electronics, 30 Lexton Rd., Box Hill, Victoria 3128.

NOTHING NEW . . .

It has recently been suggested that an electronic system be installed in Australia's Parliament House to record the votes of our legislators.

A basically similar system was suggested almost exactly 100 years ago!

NEW MICROWAVE DEVICE

A new solid-state microwave device, which it is claimed will make possible power amplifiers that operate at frequencies as high as 20 GHz, has been developed at General Electric's Research and Development Centre. The device is a marriage of transistor and Impatt diode designs.

GE's device, to be called the Controlled Avalanche Transit Time (CATT) triode, can be used in circuits without the need for frequency multiplication required by conventional microwave transistors, or other circuit arrangements such as those needed by Impatt diodes.

In addition, at lower frequencies, the CATT triode should be capable of higher pulsed (intermittent) power than available transistors.

The GE development should make possible the design of simplified solid-state equipment for higher-frequency radar and microwave communications, both space and terrestrial, according to the company. Microwave power transistors have been commercially available at frequencies up to about 3 GHz.

Initial steps toward the development of the device were carried out making extensive use of computer simulation. Later developmental confirmation of the concept was with devices designed for 1- and 2-GHz operation. Some phases of the work were supported by the US Army Electronics Command.

The devices have been operated recently at 2 to 3 GHz with 12-W output power. 13 —dB gain, and 30 per cent collector efficiency.

(continued page 11)

Philips totally automatic, 209 S electronic turntable.

The only thing it doesn't do is to take the record out of it's sleeve.

Philips 209S is one of the most outstanding examples of contemporary hi-fi engineering available. It not only performs every function automatically, but with a quality of precision that is equal to the best in the world. As soon as you place your record on the platter, the 209S automatically determines the record diameter and selects the correct speed. It uses 3 separate motors for drive, arm-lift and arm-return.

The cartridge is Philips famous GP 412, which is used by several professional Hi-Fi magazines to accurately test stereo equipment. The 209S features a sub-chassis to eliminate rumble, and of course, it is 4-channel compatible.

And whilst Philips 209S is totally automatic, it also features manual over-ride of all functions with electronic speed controls.

Check the specifications, then ask your Philips dealer to give you a demonstration.

We know you'll be impressed.

TECHNICAL DATA

(Subject to modification without notice)
(according to DIN 45 538/39 and 45 500)

Speeds:	33⅓ and 45 r.p.m.
Fine speed adjustment:	± 3%
Speed	Exact, using tacho generator
Wow and flutter:	less than 0.08%
Rumble:	better than 43dB (DIN A) (NAB) better than 65dB (DIN B) (ARLL)
Stylus force:	0.75 – 3 g
Anti-skating force:	adjustable
Pick-up arm bearing friction horizontal/vertical:	less than 10 mg
Tangential angle of error:	less than 0° 10'/cm
Nominal voltage:	120/240 v
Nominal frequency:	50 Hz
Power consumption:	10W
Dimensions:	435 x 325 x 166 mm
Weight (net):	approx. 8 kg

PHILIPS

367 0485

2000 AXT
INFINITY
THE WAVE OF THE FUTURE
SO TECHNICALLY ADVANCED IT SHOULD HAVE BEEN INVENTED TOMORROW

SPECIFICATIONS

Frequency Response:
30 to 21 KHz   3.5 db

Crossover Frequency:
500 Hz, 5000 Hz

Nominal Impedance:
8 ohms

Maximum Amplifier Power:
200 watts/channel program

Minimum Amplifier Power:
20 watts. RMS/channel

Dimensions:
27¾" high, 20" wide, 14" deep

The reviewers of Hi Fi Newsletter had this to say about the Infinity 2000A:

". . . The Infinity people have demonstrated with the 2000A that they know their way in the problematic and highly controversial speaker world. Their representative, then, deserves our highest rating, and until something better comes along it remains our standard in its price category."

Infinity is proud to announce that something better has come along – the 2000AXT. It is better because it is smoother in frequency response, has much better dispersion and has about 5 db added efficiency.

It is smoother in frequency response because we use three new drivers, each developed for its smoothness of frequency response and low distortion. It has better dispersion principally due to our patented wave transmission line tweeter. Finally, it has higher efficiency due to the application of our original research into the physics of transducers as applied to speaker systems.

The Infinity 2000AXT has the advantage of being used with various medium priced receivers as well as the super-power amplifiers of today.

THE TWEETER SECTION

The wave transmission line tweeter is probably Infinity's most stunning achievement. It's neither a cone nor a piston drive, not an electrostatic, not a ribbon and not an ionic device. In fact, it really doesn't appear in any textbooks on acoustics.

This Walsh tweeter, acting as a vertical, pulsating cylinder, is a purely coherent source of sound radiation – directly analogous to the light emitted by a laser beam. Therefore, it is transient perfect – a feat which no other speaker has achieved.

The drive mechanism of the tweeter is a voice coil in a very intense magnetic field. This drive mechanism was selected for its simplicity and inherent reliability, although any drive system could be used inasmuch as the cone is only plucked at the base.

Sound velocities much higher than the speed of sound in air are propagated up the metallic cone. Sound is emitted on various parts of the cone corresponding to the temporal and spatial scheme of Figure 1. Thus, each bit of audio information fed into the device is emitted intact at the same instant of time. This is true around the entire device so that 360° coherent radiation is a reality.

THE MIDRANGE SECTION

The midrange speaker is a very high efficiency 4.5" cone utilizing a large Alnico V magnet, the cone of which is treated for five times the stiffness to mass ratio of conventional speakers. The sound quality of this device is big and open with excellent transient response due to its low time delay distortion.

THE BASS SECTION

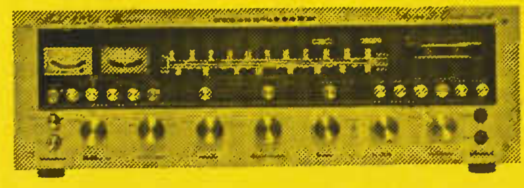
The bass driver is a 12" woofer with a full *one inch* movement capability. Its cone is treated twice – once to increase the stiffness to mass ratio by a factor of three, while the second treatment ensures proper cone damping to complement the added stiffness. The woofer is loaded into the "Infinity transmission line" enclosure for superb bass transients. It accurately reproduces the very lowest fundamental bass frequencies with excellent transient response and very low harmonic distortion.

The infinity fine family of speakers available from

INSTROL – CNR PITT & KING STREETS, SYDNEY; 91a YORK STREET, SYDNEY; 375 LONSDALE STREET, MELBOURNE ● **MIRANDA HI-FI** – SHOP 67 MIRANDA FAIR, 525-7800 ● **QUANTUM ELECTRONICS** – HOBART ● **TRUSCOTTS** – ADELAIDE

★ *starring 2 sensational bulk buys!*

THE BIG HI-FI SALE



$$SAVE! - BULK BUY FAMOUS MARANTZ FM/AM TUNER AMP.-

Recommended Retail ~~$639~~ now **$479**

Brand new with full 3 year parts & Labour warranty. 60 watts R.M.S. FM/AM Tuner. Inbuilt Dolby. It's Fantastic Value!

Another great Douglas HI-FI DISCOUNT

'AKAI' STEREO TAPE DECK & BUILT-IN AMPS.

Sensationally Discounted
Originally ~~$445~~
$199

Model 1722 W — A quality stereophonic HI/FI Tape recorder with every desirable feature. This 1975 AKAI has a recommended retail price of $445 and was discounted by us down to $269. Now we negotiated to take a shipment to sell at the unbelievable price of $199 — Tape spools not included!

Features
● Fantastic Frequency response 30 to 21000 HZ ±3DB at 7½ I.P.S. ● 6 watts R.M.S. output ● 2 Inbuilt 7 x 5 speakers & external speaker jacks ● pause control ● Complete P.A. facility ● Auto shut off at end of tape ● Monitoring while recording ● Tape selector switch for wide range of Tape ● Quality timber cabinet ● large Twin VU meters ● Magnetic Phono Input — one of the few recorders to have this quality feature.

$369

SANSUI 771 FM/AM TUNER AMP
45 x 45 watts RMS. A sensational buy!

'SOUND' HI-FI FM/AM TUNER AMP
delivers 25 x 25 watts RMS. **$249**

Douglas·hifi

MAIL ORDERS TO

VIC. — 191 Bourke Street Melbourne	63 9321
N.S.W. — 65 Paramatta Road 5 Dock	798 4177
W.A. — 883 Wellington Street Perth	22 5177

CW/218

CHECKING DEVICE FOR PRINTED CIRCUITS

'A scanning system to check printed circuit boards by both magnified and microscopic viewing has been perfected by Plessey UK and is available through Plessey Australia.

Known as VISTA (visual inspection systematic traversing apparatus), the ingenious equipment projects ten-fold magnification of PCBs on a large screen.

The boards are shown in natural colour and in stereo to enable easy identification of flaws or errors. Holes plated through can be checked and track dimensions measured direct on the screen. Microscopic viewing is also available for clearer definition.

VISTA enables faulty areas to be reworked without the board being removed. Once corrected, the operator can return the PCB to its original position and continue the checking process. The magnification capability and natural color of VISTA could also be used to check artwork and film.

The machine leads to considerable reduction in the scrap-rate of PCBs and Plessey UK reports orders from the British Post Office and several leading UK manufacturers.

Details from Professional Components, Plessey Australia Pty. Ltd., Christina Road, Villawood, NSW 2163.

OLYMPIC FLAME 'ELECTRIFIED'

The Olympic Flame for the 1976 Olympic Games will be transported to Canada from Greece via satellite as modern technology and Games tradition become one.

The process will start traditionally at 11 a.m. (local time) July 13, 1976, when the flame will be lit by sun rays at the Temple of Hera at Olympia, Greece.

Runners will carry it to Athens, arriving there July 15, and a Canadian athlete will light the flame at Panathenian Stadium. The torch will then be carried to another urn, where, through the use of an electronic sensor, the particles will be transformed into electric impulses which will be transmitted by satellite to Ottawa, Canada.

A laser beam at the receiving end will convert the impulses back to the flame's original form and Canadian runners will carry the torch to Montreal where, at 4.30 p.m. July 17, it will enter Olympic Stadium.

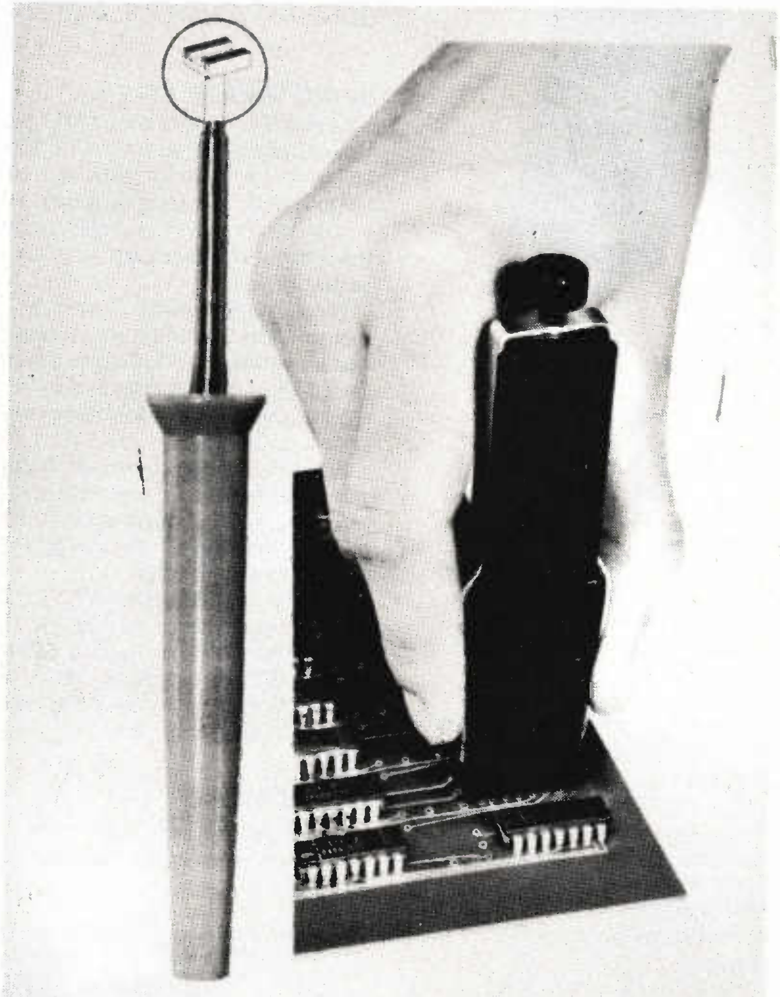
AIRBORNE OMEGA

The US government are now making positive plans to phase out the now ageing Loran A radio guidance system next year.

As a result avionics firms and world airlines are now speeding up their tests of airborne Omega receivers to ensure that the system is an acceptable alternative.

Omega is a very low frequency global radio transmitting system in which as few as six stations around the world can provide position location with better than 1.4 km accuracy.

DESOLDERING DIP'S



The frustration involved in desoldering and removing dual-in-line packages from printed circuit boards can now be overcome by a 'double-sided' approach suggested by Royston Electronics.

On one side, the solder is melted — all pins simultaneously — by a special Adcola capillary-action tip which fits either their desoldering or soldering tool (5 mm shank). This draws most of the solder from the joints. On the other side, a singularly useful device called a Pul-n-Sertic grips the IC for safe, easy removal. It also acts as a heat sink, giving double protection to the component.

Details from Royston Electronics Pty. Ltd., 22 Firth Street, Doncaster, Vic., 3108.

news digest

DRILL FOR PC BOARD

The minidrill, recently introduced by Dick Smith Electronics, will prove popular with constructors making their own printed circuit boards. It is battery powered by four penlight cells which fit inside the torch-like case. A socket is also provided for running the drill from a 6 Vdc supply.

Running at 2500 rpm, the drill is capable of making holes up to 0.060" in diameter. Current consumption is 600 mA under load. It is supplied with a drill bit suitable for most circuit board applications and a marking out punch.

Further information from Dick Smith Electronics Centre, 162 Pacific Highway, Gore Hill 2065

FIBRE OPTIC COMMUNICATIONS MAY USE INFRA-RED

The high attenuation characteristic of fibre optic cables may be overcome by using them at infra-red rather than visible light frequencies.

Workers at the Plessey Allen Clarke Research Centre have recently conducted a series of successful experiments using laboratory models of gallium indium arsenide light emitting diodes operating at 1.06 um,whilst Siemens have developed optical fibres having an attenuation of a mere 1.35 dB/km at 1.06 um.

The Siemens fibres are made by depositing synthetic quartz and a two-component glass inside a quartz-tube. The tube is then heated to a high temperature which causes it to collapse. The fibre is then withdrawn.

If an equally satisfactory IR detector can be developed it seems that short range (up to 10 km) fibre optic communication may soon be with us.

RADIO 'PIRATE' FINED

Craig Wilfred Krapkat of Mt Larcom, Queensland was fine a total of $500 earlier this month for illegally transmitting radio messages without authorisation, and for using equipment to receive messages without authorisation.

The Commonwealth Crown Prosecutor stated in court that Krapkat was a member of the Citizen's Band Radio Movement a type of 'underground organisation' lobbying for citizen band radio.

For transmitting messages, Krapkat was fined $400 or six months jail; for receiving messages he was fined $100 or three months jail. He was given until Oct 20 to pay the fines.

Later in the Magistrate's Court, Krapkat was fined a further $40 plus costs of using the call sign of another station (9QLJ) last November when not authorised to do so under the Wireless Telegraphy Act.

DPM MEASURES TRUE RMS VALUE OF AC WAVEFORMS

A digital panel meter that measures the true rms value of any ac waveform has been introduced by Parameters Pty Ltd, Australian agents for Analog Devices, Inc.

Most ac meters measure the rectified average peak voltage divided by 1.414. However, the AD2011 computes and displays the total effective dc heating value of its input, thus it does not depend on sinewave inputs for accuracy. With a total claimed error of ± 0.1% (full scale range) ± 1 digit, the AD2011 measures the true rms value of SCR chopped waveforms used in lighting, motor, and furnace control, pulse trains, square waves, triangle waveforms, and even noise.

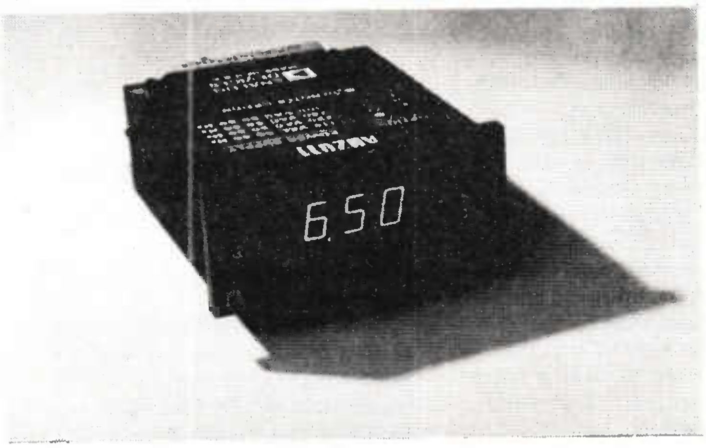
The unit can thus be used in vibration and fluid flow measurements, in the determination of transformer parameters, and for measuring any signal containing high distortion.

By using a computing technique, the AD2011 achieves a 170 ms response time, ten times faster than thermal conversion techniques and will measure inputs in frequency ranges of 45 Hz to 300 kHz. The computing technique offers the possibility of extending the low frequency sensitivity by adding an external capacitor. The computing method is also more reliable than the thermal one, say Parameters, which uses heater-resistor thermocouples that may burn out during signal overload conditions.

Details from Parameters, 68 Alexander St, Crows Nest, 2065.

STABLE DISPLAYS WITH DIGITAL DELAY ON ANY 'SCOPE WITH DIGITAL TRIGGER

Upon recognising a preset parallel 8-bit word in a stream of data, a new Hewlett-Packard instrument, small enough to be held in one's hand, deli-

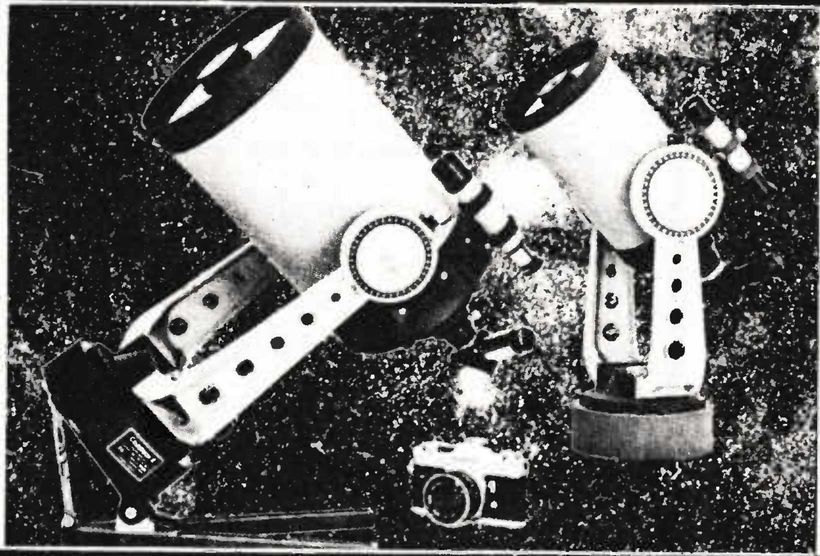


vers a pulse suitable to trigger any modern oscilloscope or logic analyser.

The HP Model 1230A Logic Trigger operates at rates up to 15 MHz. Recognition can be made to depend on a synchronised clock pulse or it may be independent, using a ninth-bit qualifier for asynchronous operation. The trigger can be delayed by a preset number of clock pulses, from 1 to 9998, to move the 'window' of observed events downstream from the recognition-word. Because this delay depends on a count, waveform displays remain jitter-free.

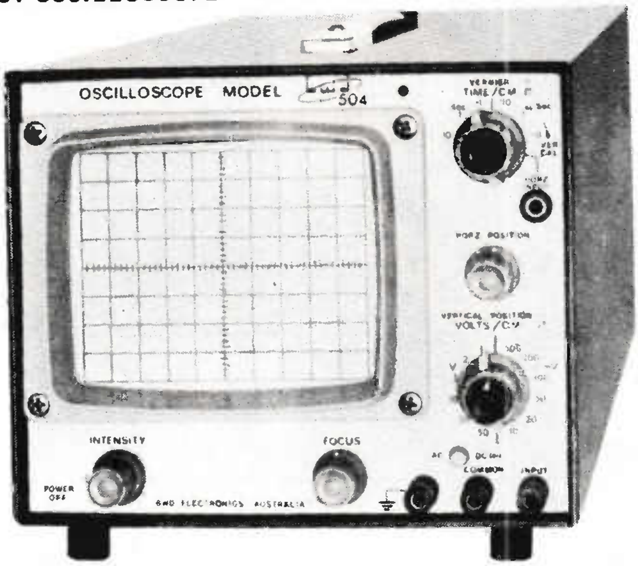
As an interface to make the analogue-type oscilloscope useful for analysis of digital circuitry, or as a pre-qualifier to enhance the seek-and-show ability of a modern logic analyser, the 1230A is a low-cost, compact aid to design and troubleshooting. Where microprocessors are used, where telecommunications equipment is designed or maintained, where digital circuitry is involved in system control, wherever ASCII signals are found, the 1230A will find application.

Setting up the 1230A is a simple matter: preset the recognition work on 8 switches, decide if trigger shall be on the word or delayed (in which case push buttons to preset the delay, shown on an LED readout), and set for positive-going or negative-going signals of TTL to CMOS levels (up to 15 V). Connection to the tested circuitry is aided by inclusion of a cable set for all inputs. Power required is 5 to 15 V dc 300 milliamperes. A compact accessory power supply is offered. Details from Hewlett-Packard Australia Pty. Ltd., 31-41 Joseph St., Blackburn, Victoria 3130.



news digest

NEW LOW COST OSCILLOSCOPE



At a time when costs of almost everything are escalating, B.W.D. Electronics have developed an instrument which reverses the trend. Their new oscilloscope, the (bwd 504) sells for $178 (plus tax if applicable) ex Australian Capital City distributors. The price includes instruction manual, a x1 signal probe, a ground probe, and a moulded protective pack.

Facilities provided include a bandwidth of dc to 6 MHz – 3dB. At 10 Hz it is only – 6dB down, and has a very useable sensitivity of 100 mv/cm at 25 MHz. Sensitivity range is from 20 mV to 50 V/cm in 12 calibrated steps. Time base sweeps from 0.5μ/sec to 0.1 sec/cm and the fully automatic stabilised TTL trigger circuit will lock to almost any waveform from 5 Hz to 15 MHz. X–Y operation is from dc to 1 MHz and is phase corrected to within 3° from dc to 50 kHz.

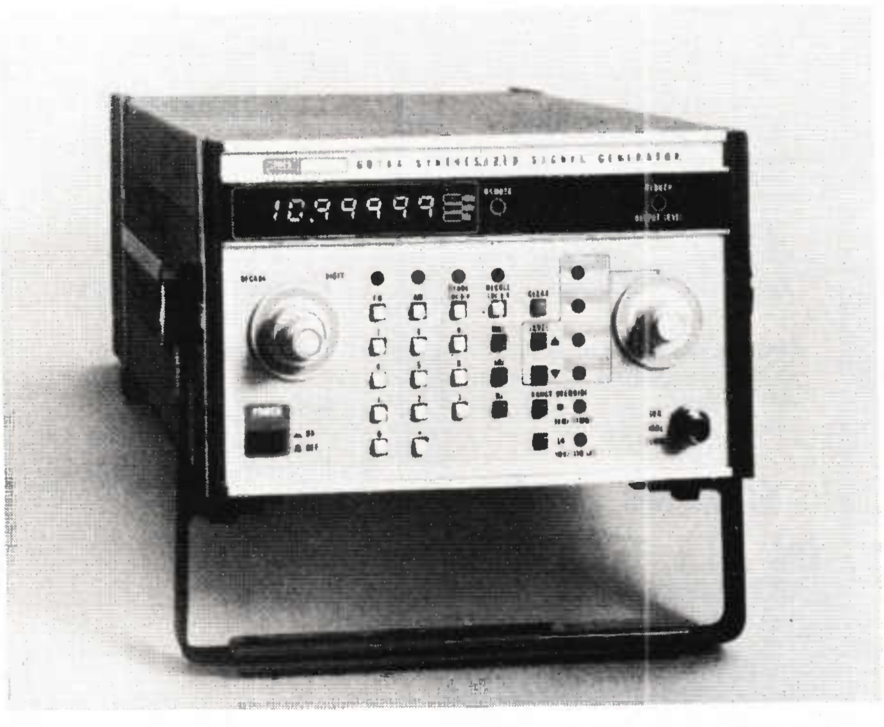
The display is 80 x 100 mm and the detachable graticule is subdivided at 2 mm on the main axis and has 10 and 90% lines to facilitate rise time measurements.

To enable measurements to be made with respect to voltage rails elevated above earth, input ground may be floated to ± 400 V by removing a front panel grounding link. The floating input is also a useful safety feature, particularly in educational use, by its ability to minimise accidental shorting out of a circuit if a live point is touched by a ground probe.

Overall size is 180 mm high x 200 mm wide x 400 mm deep. The weight of only 4.5 kg has been achieved by a skilful mechanical format and by the use of an astatically wound varnish-impregnated 'C' core transformer.

Details from B.W.D. Electronics Pty Ltd, 331-333 Burke Road, Gardiner, Vic 3146.

NEW SIGNAL GENERATOR INCORPORATES MICROPROCESSOR



John Fluke Mfg. Co. have introduced a general purpose signal generator which incorporates a small microprocessor.

The 6010A unit features a keyboard control that allows free-form entry of frequency in Hz, kHz, or MHz. Programmed frequencies are read on a 7-digit LED display. The real "secret" of the 6010A, however, is a sophisticated micro-processor that provides the instrument with a high degree of automation. Whenever an entry is made, the unit automatically justifies the number on the bright LED readout to give the greatest possible resolution. The instrument covers the frequency range from 10 Hz to 11 MHz.

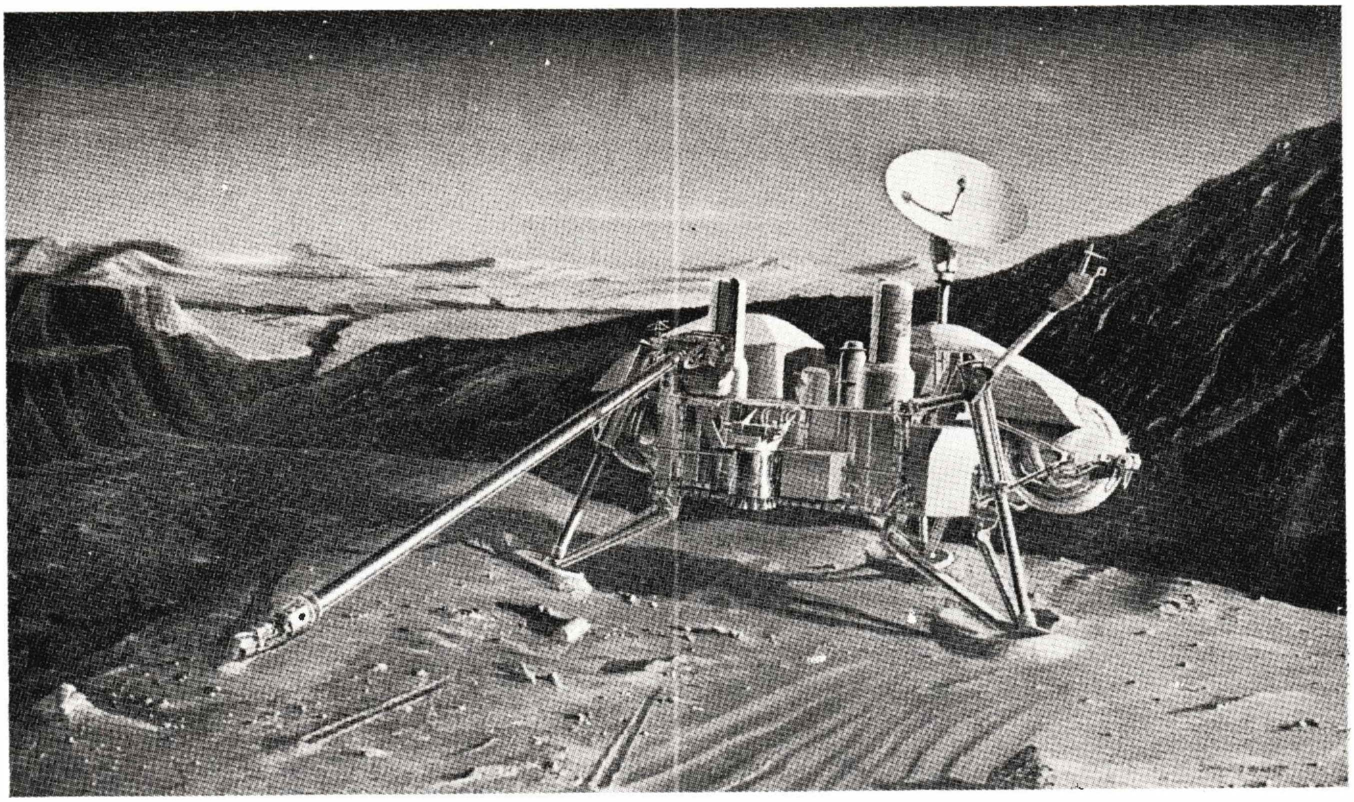
The instrument also protects the device under test. Although the 6010A has three ranges of added attenuation – 20, 40, and 60 dB – the instrument always starts out automatically with the maximum value.

Details from Elmeasco Instruments Pty Ltd, PO Box 334, Brookvale, NSW 2100.

(Continued page 107)

life on mars?

Latest Viking space mission specifically seeks for life on Mars



VIKING LANDER. This magnificent painting by Charles O. Bennett shows the mechanical scoop on the end of the spring-steel arm collecting a sample. Having grasped the material the scoop arm retracts to the spacecraft, swivels and stops over a cylinder covered by a wire grill. The lid of the scoop begins to vibrate and dust and soil particles drop through into a rotating conveyor in the spacecraft's interior which distributes measured quantities to a number of test cells for chemical analysis.

OUR GALAXY contains upwards of 100 000 million stars and their families of planets, and growing evidence suggests that Earth may not be the only life-bearing planet in this galaxy.

Telescope studies have, for example, shown that Earth's basic chemicals are distributed throughout the Universe — and organic compounds — life's building blocks — have been detected in inter-stellar space.

But *believing* that life may exist elsewhere is one thing — attempting to *prove* it is another.

At our present state of technology the most practical planet on which to search for life is Mars. For if we find that life exists or has existed in the harsh climate of Mars, we will have strong reasons to believe that planets with comfortable climates do support life and that other solar systems are inhabited.

At about the time that our readers will receive this issue of Electronics Today, two unmanned, automated Viking spacecraft should have been launched from Cape Canaveral to begin a 700 million kilometre journey to Mars.

Once there the two spacecraft will seek evidence of whether life existed on other planets, and obtain information to improve out understanding of how Earth developed as a life-supporting planet and how we can better protect its environment.

Viking is the most complex mission to be flown by NASA, requiring four highly complicated science stations — two orbiters and two landers — to carry out separate co-ordinated operations simultaneously and over an extended period of time.

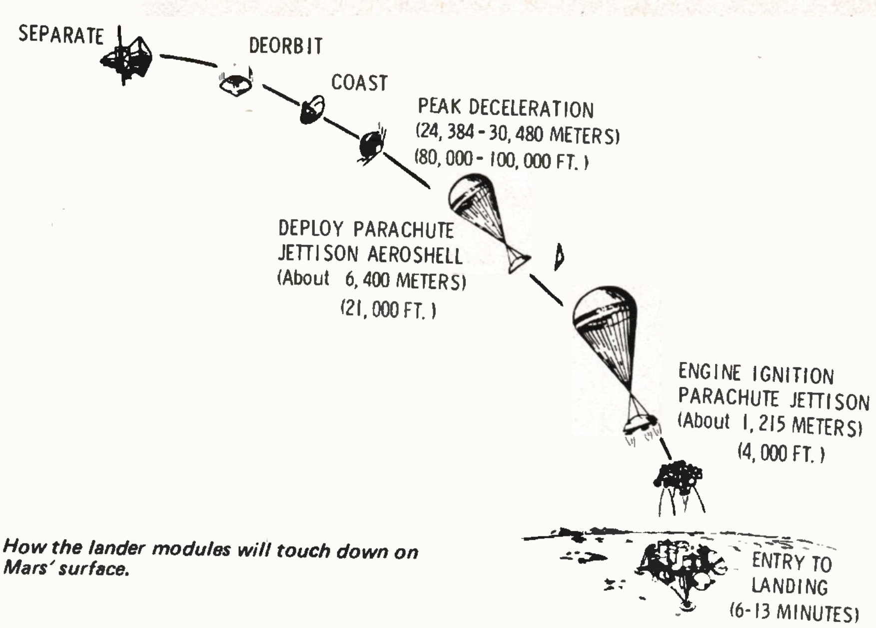
The 2300 kg orbiter will stay in orbit while the 1090 kg lander descends to the surface, as did the command module and the lunar module during the Apollo missions to the Moon. The Viking lander will use a parachute and retro-rockets to achieve soft landing. It will begin its programme of life-seeking biology experiments on about the 10th day after landing.

Photos from orbiters and landers and information from the science experiments will be transmitted back to Earth by radio. Radio signals will require more than 20 minutes to travel the 320 million kilometres from Mars to Earth. Spacecraft-tracking and communications will involve the Deep Space Network's stations at Goldstone, California, Madrid, Spain and Canberra, Australia.

VIKING SCIENTIFIC INVESTIGATIONS

The Viking spacecraft will make basically three investigations during their three-month observation of Mars from orbit and from two sites on the surface:

1. A photographic survey of Mars:
2. A search for forms of life; and
3. An analysis of the physical features and makeup of the planet and its atmosphere.



How the lander modules will touch down on Mars' surface.

PHOTOGRAPHIC SURVEY

Each Viking spacecraft has an orbiter and a lander. Each orbiter carries two high-resolution television cameras, and each lander a pair of facsimile cameras.

During the last 180 hours of approach to Mars, each spacecraft will obtain a series of photographs of the globe from progressively closer range. After entering orbit, the spacecraft will remain above the designated lander sites to photomap these regions for a number of days before and after the landers are released for descent to the surface. Then the orbiters will leave their fixed positions above the lander sites to photomap almost the entire surface of the planet.

Orbiter photomaps and thermal and water vapour maps will be used to direct the landers to sites where conditions are more favourable to life and where landing hazards are less extreme. Lander cameras will take high-resolution photos of the ground immediately next to the landers, 360-degree panoramic views of the terrain and distance features, and long-range photos of Mars' satellites and celestial objects.

The Orbiter cameras will be rapid-sequence vidicon cameras using 475 mm telescopes. Taken from low-point in orbit a photo shows 40 square kilometre area with resolution of 50 metres. Consecutive photos from one orbital pass show a 80 km by 500 km swath. Photos are stored on magnetic tape for playback to Earth.

Identical facsimile cameras are mounted one metre apart on top of the lander for stereoscopic black and white, colour, and infrared photos. Cameras can view from the ground beside the lander up to 40 degrees above horizon. Each uses a nodding mirror to scan a scene in tiny increments, requiring 20 minutes for a full scene. Light from the scene increments is converted into digital information bits which are radioed to Earth and reconstructed into a photograph.

SEARCH FOR LIFE

Life may exist on Mars in higher forms, like moss or lichens, or in microscopic forms like viruses or bacteria. Or a rich variety of life may have existed at one time but disappeared later in the planet's history.

The two regions chosen for landings are areas where conditions could be conducive to Earth-like life forms. They are relatively low, temperate-zone sites in the northern hemisphere where there are indications of atmospheric moisture now, and of surface moisture at least at some time in the past.

Higher forms of life and fossils, surface burrows or trails, and artifacts could be identified in the lander camera photos of the surface adjacent to the landers. The search for microscopic plant or animal life will be made in Martian soil samples. The samples will be scooped up by the 3 metre lander boom and fed into automated biology test chambers where they will be observed for signs of photosynthesis and metabolism. Chemistry of the organic compounds in the soil will be analysed for indication of whether they were produced by animal or plant life, or could evolve life.

Discovery of life on another planet would have a more profound effect on man's thinking than any other discovery in history.

TEST FOR PHOTOSYNTHESIS

Photosynthesis is the basic-life sustaining process by which Earth plant life uses light energy to combine basic compounds like carbon dioxide, water, and salts — forming carbohydrates. Steps in the Viking photosynthesis test are:

(a) Inoculate three soil samples with carbon monoxide and carbon dioxide that bear radioactive tracers.
(b) Inoculate soil and gases under a lamp that simulates Martian sunlight.
(c) Evacuate any remaining free gas.
(d) Heat samples to 590°C to vapourize organic materials.
(e) Measure and analyse the vapourised materials.

Liberation of a substantial amount of tracer gas from the samples will be taken as strong evidence that plant-like organisms in the soil consumed the carbon monoxide and carbon dioxide in photosynthesis.

TEST FOR METABOLIC ACTIVITY

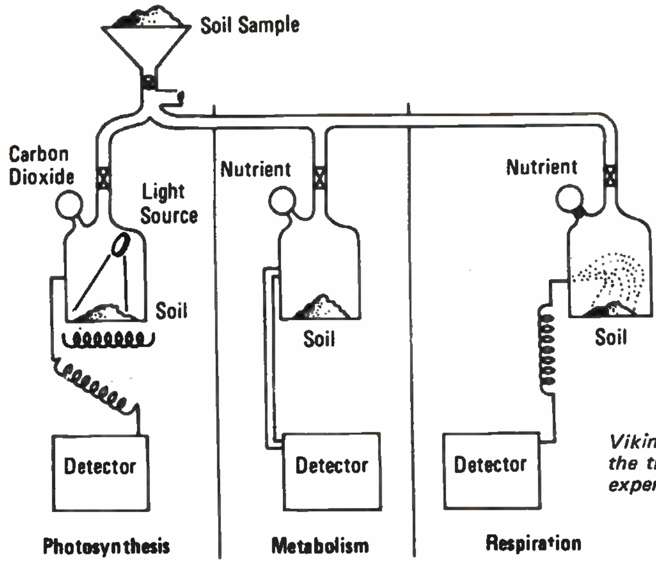
From a science standpoint, the Viking lander is the most complex spacecraft ever built. The biology unit will feed to three soil samples a nutrient or organic compounds like sugar which bear trace chemicals. Instruments will monitor gases given off by the samples over a period of about two weeks.

Steady production of gases by soil samples will be taken as evidence that organisms in the soil consumed the nutrient; steadily increasing production of gases will be taken as evidence of growth by the organisms.

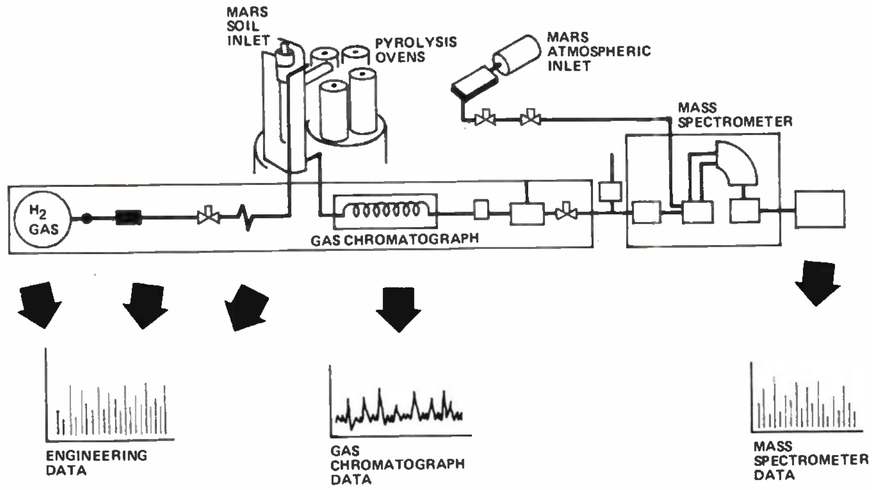
TEST FOR RESPIRATION

Soil samples will be moistened with nutrients and surrounded in the test chamber with air from the outside, principally carbon dioxide. Constituents of the atmospheric sample will be monitored over a period of about two weeks. Changes in composition of the atmospheric sample will be taken as evidence of

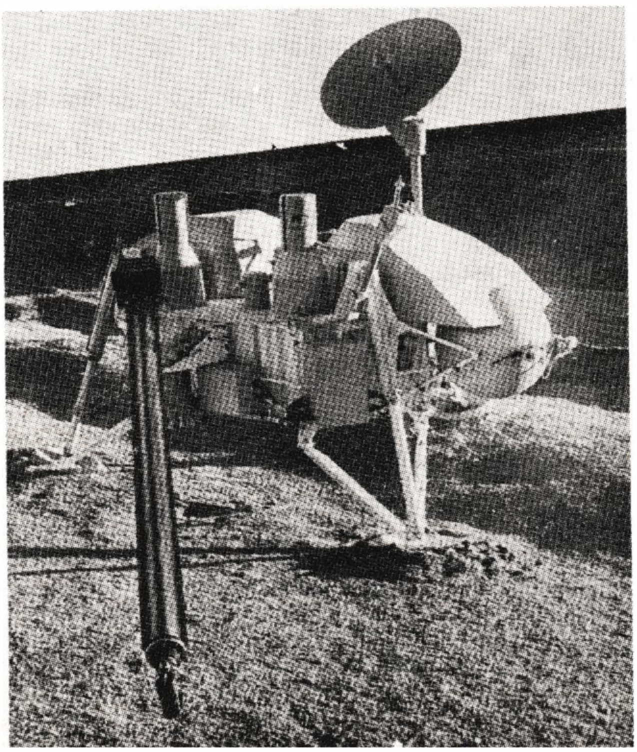
life on mars?



Viking biolab schematic: the three basic experiments.



Gas Chromatograph Mass Spectrometer.



The three-legged lander carries life detection experiments to determine if the Martian environment can, or in fact does, support life.

respiration from metabolism of organisms in the soil.

TEST OF STERILISED SAMPLES

In parallel, a soil sample will be sterilised and subjected to the same tests as further validation of any positive results in the tests.

BIOLOGY INSTRUMENT

The complete range of experiments planned for Viking, if conducted on Earth with today's standard science instruments, would require thousands of pounds of equipment which would fill several ordinary size laboratory rooms.

The lander biology unit, in 0.25 cubic metre of space, contains: three automated chemical labs, a computer, tiny ovens, counters for radioactive tracers, filters, sun lamp, gas chromatograph to identify chemicals, 40 thermostats, 22 000 transistors, 18 000 other electronic parts, and 43 miniature valves.

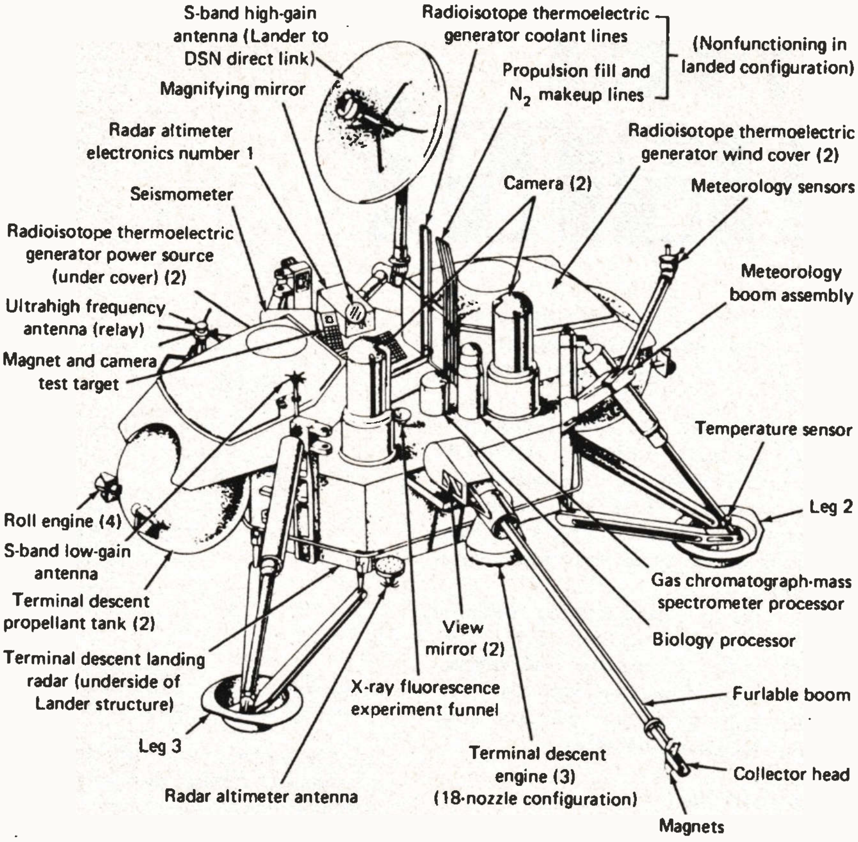
THE PLANET AND ITS ATMOSPHERE

Instruments of the orbiters and landers will examine the physical features and makeup of the planet and its atmosphere in minute detail. Comparison of the geology and climate of Mars with those of the much more complex Earth and the primitive Moon is expected to resolve many questions about the evolution of Earth and our Solar System.

One landing site is in a valley at the mouth of the giant surface rift, or grand canyon, of Mars. Here, deposits from exposure and erosion of geological features around the chasm are expected to be rich in information about the history and development of the planet.

We still lack a complete understanding of Earth's complex environmental systems; for example, what accounts for the patterns of movement of water vapour and pollutants in our atmosphere. Clues should be found in study of the dynamics of Mars' more rudimentary atmospheric system in the absence of civilised man.

The Viking Lender. After landing, the Lander's cameras will take pictures of the terrain — some in colour and some employing both cameras to produce three-dimensional stereo pairs. Other instruments will collect atmospheric and meteorological data, and a seismometer will record Martian quakes and learn about the planet's interior. Surface geology will be examined with the cameras, the soil sampler, the inorganic analysis of soil samples to determine what elements are present.



GEOLOGY

The orbiters and landers will conduct experiments to study surface geology and planet internal structure, and to determine whether the planet is geologically alive. Orbiter and lander photographs will identify types of land forms, stratification, folds, joints, faults, rocks, erosion, sediments, and soil, and will give indications of mineral and chemical composition. If there are Marsquakes in adequate number, lander seismic readings can determine whether the planet has a molten core, a mantle, and a crust as does Earth, and can allow comparison of the mantles of Mars and Earth.

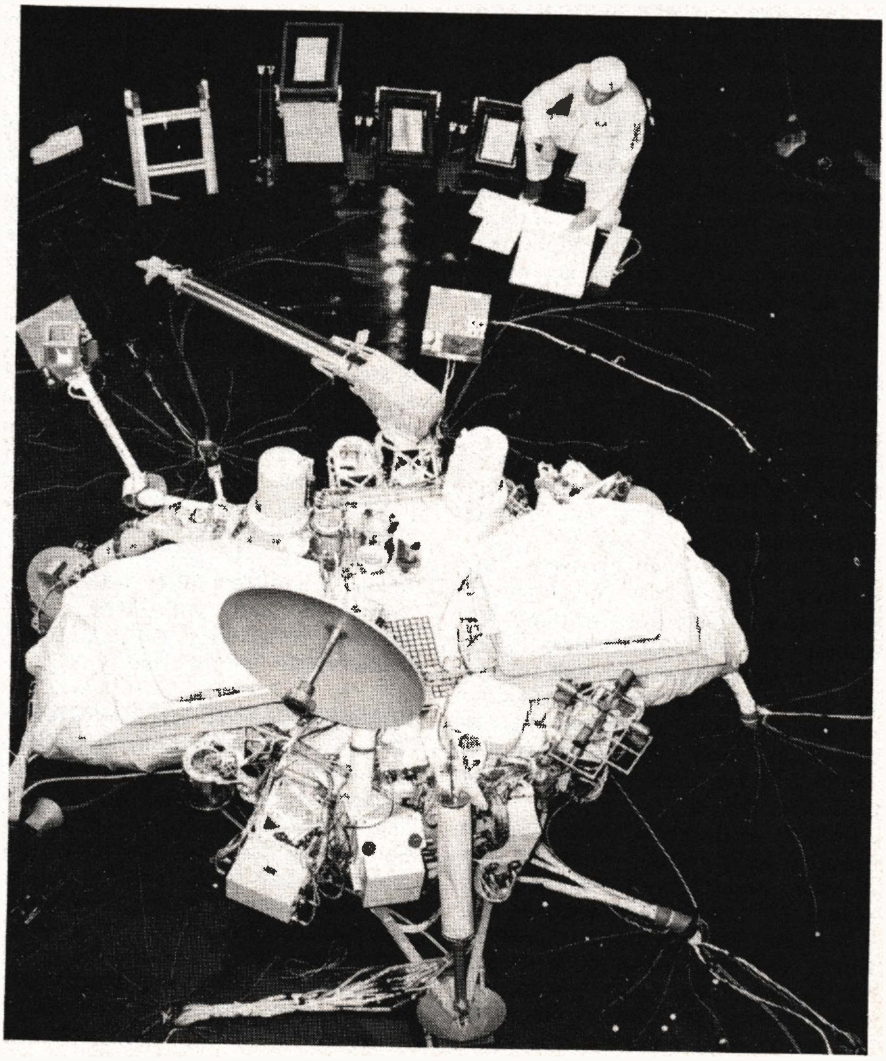
Lander instruments will identify elements and minerals in the soil. Thermal mapping by the orbiters will allow search for ground frost and evidence of planet internal heat, and will aid in identifying surface structural character from difference in heat conductivity.

Viking radio and radar systems will provide information to improve our knowledge of the planet's size, mass, gravitational field, surface density, and electromagnetic properties, and atmospheric density and turbulence, and will allow study of the solar wind.

SCIENCE INSTRUMENTS

An infrared radiometer from the orbiter measures heat radiating from the planet's surface. It can record temperatures in both the day and night hemispheres and is accurate within 2°C.

An X-ray fluorescence spectrometer identifies basic elements in soil by measuring their fluorescence after being exposed to radioactive Cadmium 109 and Iron 55. It can detect elements present in amounts as small as 200 parts per million.



Viking completes a month-long series of rigorous tests designed to qualify it for operating on the surface of Mars in 1976. The tests were conducted in a huge vacuum chamber at the space facilities centre of Martin Merietta Aerospace at Denver, Colorado.

life on mars?

A gas chromatograph-mass spectrometer identifies gases in the atmosphere and organic compounds in the soil.

A seismometer will detect volcanic activity, planet internal structure shifts, and impacts of meteorites on planet's surface. It will be used to determine whether landers are functioning properly by measuring their vibrations.

A soil boom scoop will be used to study characteristics of the soil: cohesiveness, porosity, hardness, particle size. Magnets mounted on sampler will determine whether soil contains magnetic materials.

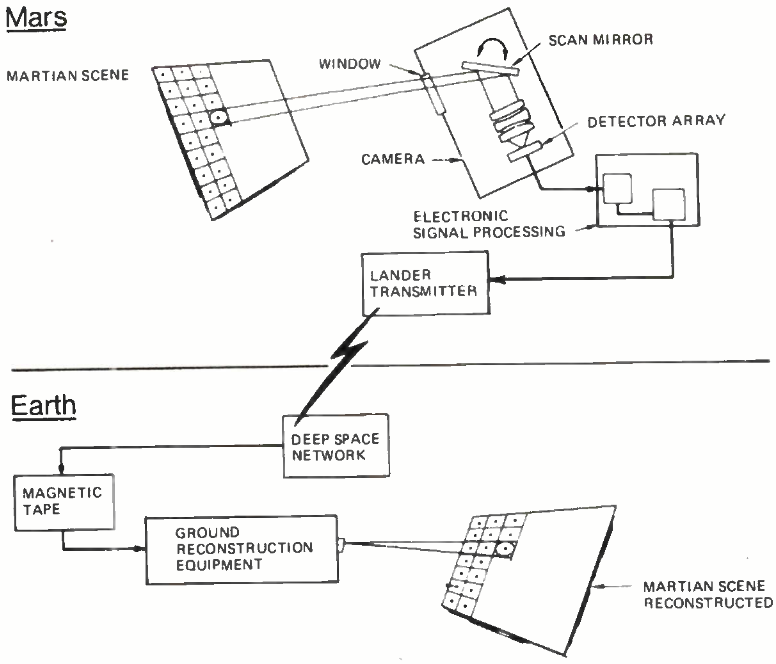
METEOROLOGY

Requirements for the Viking lander are space flight's most demanding: two days of sterilisation baking before launch; ascent gravity and vibration forces atop a 1.4 million pound rocket; 11 months' exposure to harsh space conditions; buffeting from Mars atmospheric entry, parachute opening and retrorocket firing; impact on surface of Mars at a speed of 1.20 metres/sec. Then it must function as a finely tuned, self-sufficient laboratory and data transmission complex for 90 days.

Landers, as they enter Mars' atmosphere, will analyse the ionosphere to determine the effect of the solar wind on the planet's atmosphere. As they descend they will record the temperature, pressure, and chemical content of the atmosphere at different altitudes.

The Orbiters will observe the formation and movement of clouds and record their temperatures for analysis of their composition. The lander mass spectrometer will analyse the amounts of carbon dioxide, oxygen, nitrogen, and other gases in the atmosphere at the surface during the first three days, before starting analysis of the soil.

Lander instruments will measure pressure, temperature, windspeed and direction periodically to log daily and season all variations in weather and will record the movement of weather fronts, thermals, and dust devils past the landing sites. Seismometers will record background noise from winds and temperature and pressure changes.



How pictures taken by the television system aboard the Viking Lander will be processed, transmitted and reconstructed on Earth.

In the meteorology unit transducers will measure temperature and pressure; an anemometer measures windspeed by its cooling effect on a heated wire. Accelerometers and radar altimeter are used to determine atmospheric density and pressure from their drag on the descending lander.

An infrared spectrometer will detect and measure moisture in the atmosphere from the changes in solar radiation, as it reflects from Martian surface through the atmosphere to the orbiter. It can detect water in amounts down to one micron.

A retarding potential analyser will measure the concentration and charge of ions and electrons in the ionosphere as they flow across the analyser's charged grid in lander capsule.

An upper atmosphere mass spectrometer will identify chemical content and concentrations in upper fringe of atmosphere.

Radio and radar systems consist of S-band Earth-Mars microwave link for commands and data relay; UHF lander-orbiter links; X-band orbiter-Earth link for science use.

COMMUNICATING WITH VIKING

The Viking Lander Communications subsystem consists of a relay link between the orbiter and lander and a direct link connecting the lander and Earth. UHF radio is employed to relay scientific data to the orbiter, and an S-band transmitter on the lander sends data directly to Earth.

The relay link is the primary means of communicating during descent and landing until a direct link between the lander and Earth can be established on the surface of Mars. The UHF circuits use compartmentalised, shielded discrete-element wired circuits.

When the lander separates from the orbiter and descends into the Martian atmosphere, UHF radio will begin transmitting real-time data at 4 000 bps and at a frequency of 381 MHz to the orbiter. This information will consist of entry science data, such as the pressure and temperature of the Martian ionosphere and atmosphere, and engineering information related to the lander's operating performance.

The subsystem utilises split-phase pulse code modulation and frequency shift keying. A fixed, crossed-dipole antenna radiates signals to the orbiter. Any one of three power modes may be selected.

Prior to separation from the orbiter, the lander will under-go a series of system checks in the lower power mode (1 watt). During descent, the 10 watt mode will be used. After touch-down, the transmitter will be switched to 30 watts power to handle a data stream rate of 16 000 bits per second. With successful completion of the soft-landing on Mars, the lander will continue to broadcast for about three days via the UHF system before switching over to the direct S-band link. Imagery showing the area surrounding the landing site as well as data received from the meteorological and biological sensors contained on the lander can then be transmitted to the orbiter for relay to Earth.

The orbiter will be able to receive this data from the lander an average of 20 minutes each pass. It will be orbiting Mars once every 24.6 hours.

S-BAND DIRECT LINK

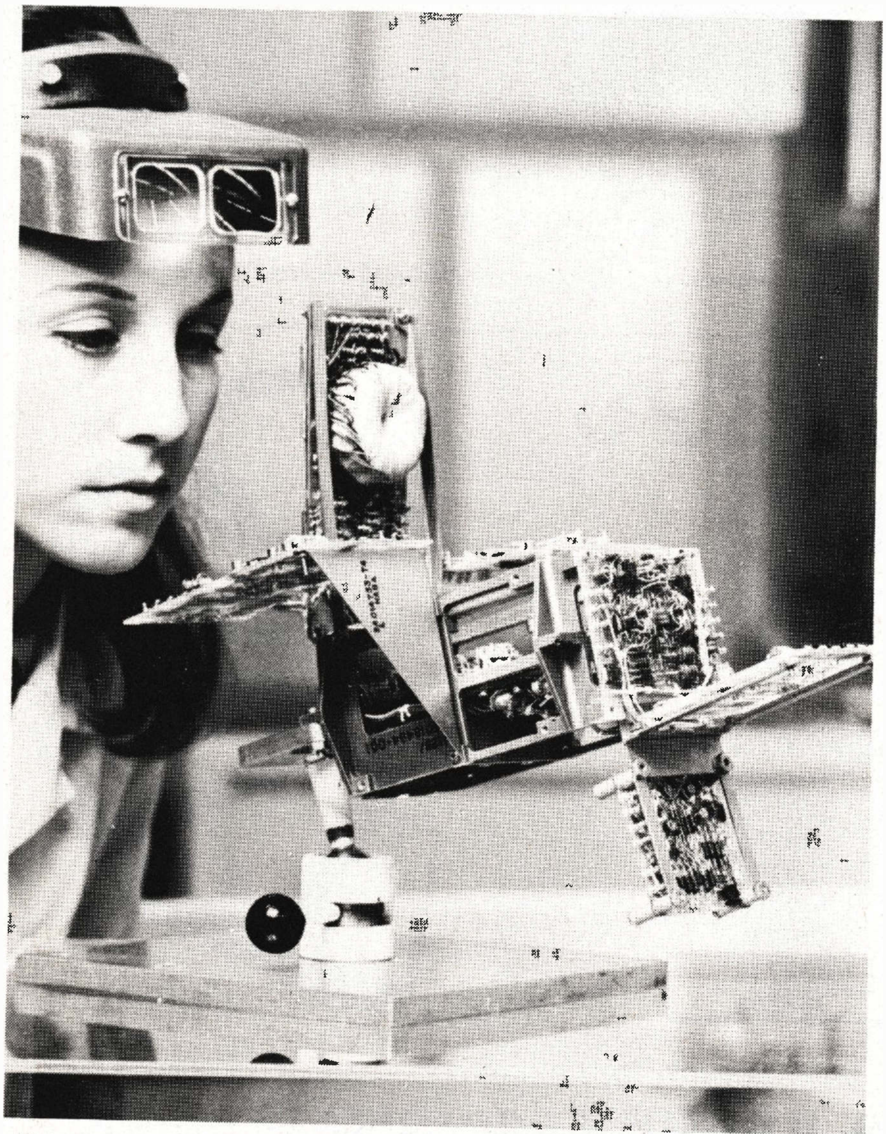
The lander S-band link directly transmits high-volume scientific and imaging data, Doppler tracking planetary ranging and command reception. The subsystem operates at 2.2 GHz and is coherently locked to Earth frequency references.

Engineering data is transmitted at a rate of 8 1/3 bits per second and scientific information may be sent at selectable rates of 250 500 and 1,000 bits per second. Coded (32/S), phase shift keying-pulse code modulating information is received at 4 bits per second.

A 760 mm parabolic reflector high-gain antenna will be used to transmit information from Mars directly to Earth. The high-gain antenna is steerable and utilises a two-axis gimbal. The mast for this antenna is deployed and locked into position immediately upon landing on Mars. Powered by a d-c driven motor, the antenna is stepped to follow the Earth by an open-loop command and control system. A fixed, crossed dipole S-band low-gain antenna will receive the commands from Earth.

Redundant modulator-exciters and a 20 watt travelling wave tube amplifier transmits the telemetry and imaging data at a frequency of 2295 MHz for approximately two hours each day.

Two S-band receivers operate on the same frequency and use the same receiver selector. The receiver selector furnishes signals to the modulator-exciters and the command detectors. One of the receivers is connected to the low-gain antenna and is the primary command receiver. The other receiver is linked to the high-gain antenna to detect the ranging signal. This receiver also serves as a backup command receiver when the high-gain antenna is pointed toward Earth.



Kathy Daniels of Honeywell's aerospace Division exemines part of a speciel-purpose computer which will control experiments in the Viking Lander.

VIKING ANTENNA

The RCA Viking antennas are specially designed and built to operate in the hostile Martian environment. They must withstand harsh surface winds, sand and dust storms, low pressure, and a temperature range from +111°C to −126°C.

The UHF low gain antenna is 450 mm high and is located on the Viking Lander Capsule (VLC). It provides for the rapid, high volume transmission of data from the VLC to the Viking Orbiter for relay to Earth. The antenna will operate during both the descent of the VLC to the Martian surface and at programmed times during the mission after touch-down.

An insulating foam designed to minimise power disruptions during transmission in the low pressure Martian atmosphere is enclosed in cylindrical containers on the ends of the antenna elements.

UHF LOW GAIN ANTENNA
Specifications:

Use:	Communications to Earth *via* orbiter relay.
Operation:	During Martian entry and from surface
Type:	Crossed dipoles, circularly polarized.
Frequency:	400 MHz.
Power:	60 Watts.
Weight:	1.3 kg.

The S-Band Low Gain Antenna is 150 mm. high and is also located on the VLC. It will receive signals from Earth and will operate according to the mission programme after the VLC lands on the planet's surface.

S-Band LOW GAIN ANTENNA
Specifications:

Use:	Receive commands from Earth.
Operation:	Martian Surface.
Type:	Broad pattern, circularly polarized.
Frequency:	2100 mHz.
Weight:	0.11 kg.

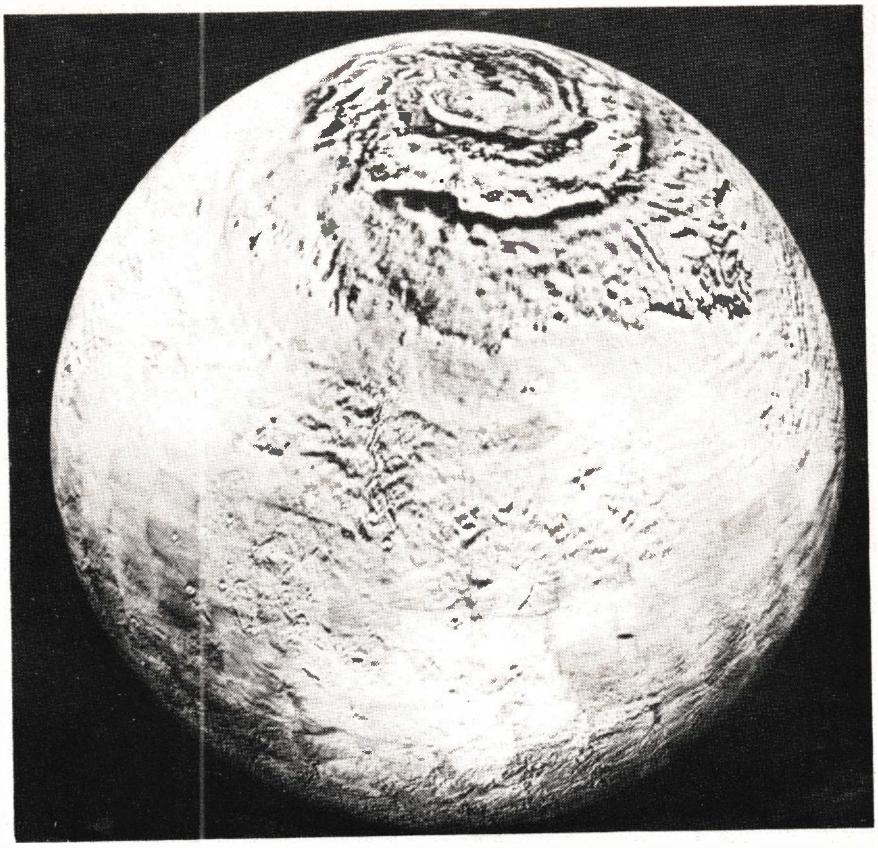
The S-Band High Gain Antenna has a 750 mm. parabolic dish of traditional appearance. It will be used to transmit and receive radio signals between the VLC and Earth and will operate after touchdown according to the mission programme. Since Mars, like Earth, rotates on its axis, it is necessary for the S-Band High Gain Antenna to be facing toward Earth for maximum effective transmission. Once the VLC has landed safely on Mars, an on-board computer will calculate the necessary alignment (both azimuth and elevation) for the antenna. The Viking Command and Control, or controller, will transform this information into commands to motors which will then reposition the antenna relative to Earth. Continuous adjustments will be computed during each transmission. It will take approximately 20 minutes for signals to travel the more than 362 million kilometres between the Viking spacecraft and its home planet.

S-Band High Gain Antenna Specifications:

Use:	Transmit data Mars-to-Earth.
Operation:	Martian surface.
Dish:	760 mm diameter.
Frequency:	2100-2300 mHz;
Power:	40 Watts.
Pedestal:	Elevation over azimuth

Controller Specifications:

Use:	Pedestal drive and encoder processor.
Operation:	Martian surface.
Input:	Commands from on-board computer.
Output:	Drives pulses to two stepper motors sine/cosine from two resolvers.
Weight:	0.22 kg.
Size, Max:	100mm x 140mm x 178mm
Configuration:	Two 2-sided four-layer printed circuit boards



Another view of the spectacular 'photo globe' of Mars — the first ever made of any body in the Solar System. It was prepared by the Jet Propulsion Laboratory of California Institute of Technology which managed the Mariner project for NASA.

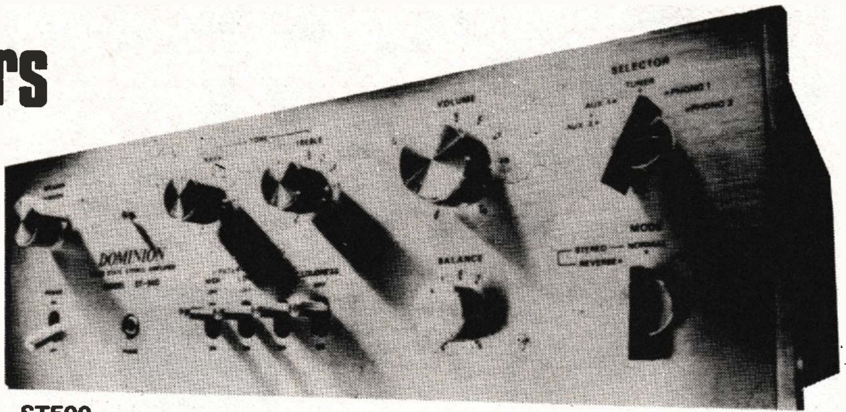
Electronics today would like to thank the British Interplanetary Society and the Martin Marienatta Corporation for their assistance with the preparation of this article.

CENTRES – FOR EXPERT ASSISTANCE !

Dominion Stereo Amplifiers

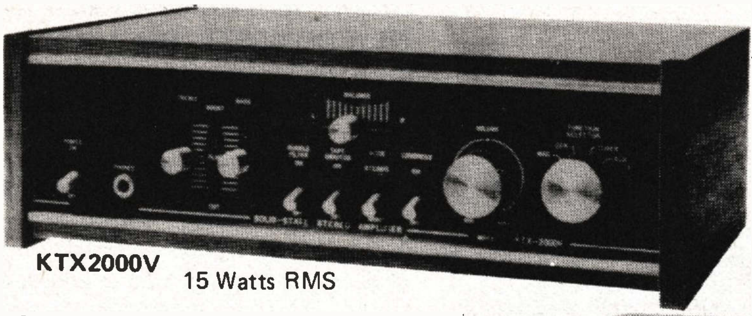
A superb Stereo Amplifier designed and built to compete in the highly sophisticated American market. The ST–500 is now available in Australia for the first time. It has a precision engineered cabinet and circuitry of the latest design, incorporating such luxury features as:–

- Brushed "Dull Silver" non mark facia panel,
- A, B speaker selector.
- Straight bar switches for high & low filters, loudness and tape monitor.
- 25 watts per channel.
- Total harmonic distortion less than .5%.



ST500 25 Watts RMS

$159.38 including tax



KTX2000V 15 Watts RMS

- Minimized distortion and high damping due to its OTL circuitry.
- Designed for use with magnetic, ceramic and crystal cartridge.
- Independent "SLIDE" tone control devices, "TREBLE" and "BASS".
- Rumble (Bass) filter and loudness control.
- Furnished with tape recorder output terminal.
- 15 watts RMS per channel.

$100.73 including tax

KTX4000V 25 Watts RMS

- Designed for use with magnetic, ceramic and crystal cartridge.
- Independent "SLIDE" tone control devices, "TREBLE" and "BASS"
- Convenient AB speaker selector. Two pairs of speakers can be driven simultaneously or independently.
- Furnished with tape recorder output terminal.
- 25 watts per channel.

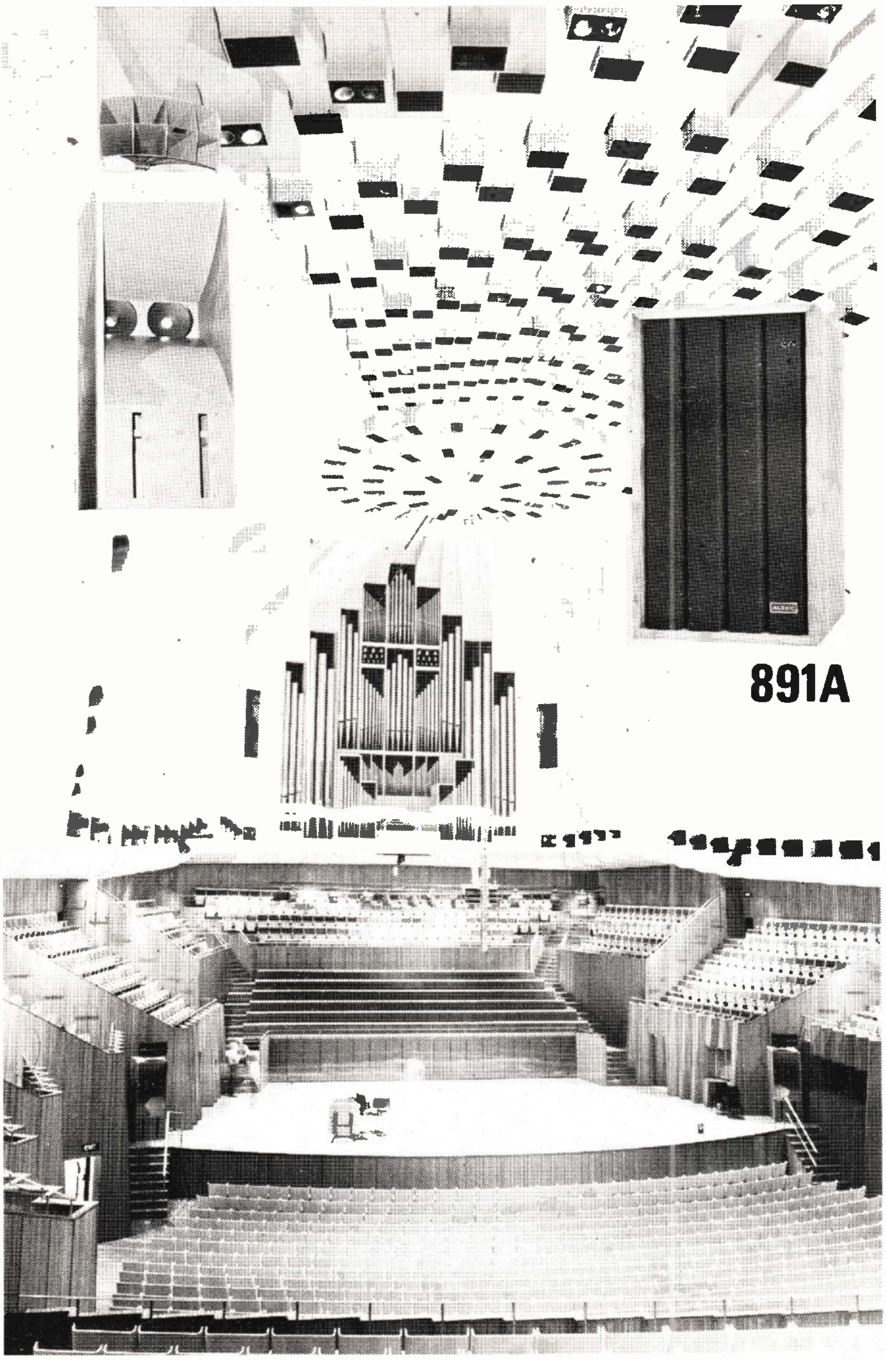
$119.85 including tax

SX9000R AM–FM Receiver 25 Watts RMS

- Twin Microphone mixing Panel combining dialogue, or musical instrument output on tape with other source material.
- Large Scale Vu Meters for monitoring output signal.
- A,B Selector Switch for 4 speaker systems.
- 25 watts RMS per channel output at less than .2% Distortion.

$243.53 including tax

ALTEC FOR THOSE WHO ARE SERIOUS ABOUT SOUND



891A

ALTEC. AT THE OPERA HOUSE

For years now on the international scene the most discriminating sound engineers have specified ALTEC quality monitors. Look around the leading television, radio and recording studios — anywhere in the world — *and you'll find ALTEC monitors.*

Sales in the U.S. have reached new peaks — and in the highly competitive and selective European market demand for ALTEC systems has never been greater.

In Australia ALTEC enjoys an ever increasing proportion of the professional market.

Ask any of the sound engineers who specify and enthuse over ALTEC quality monitors. Once you've heard and enjoyed ALTEC sound, *you'll never be satisfied with anything else.*

NEW DOMESTIC SPEAKERS

***Altec 891A.** In just a year, this model has become a best seller. It features a 12 inch woofer and a high-frequency radiator tweeter and comes in an enclosure measuring 25-1/2 x 14-1/2 x 12-1/2 inches with a charcoal-colored sculptured foam grille. ALTEC have said it was designed for "younger people who want good sound but want to pay less." Our tests revealed it to produce an open, realistic sound and a crisp high end. It delivers this sound with only 12 watts of amplifier power.

***Quoted from Consumer Guide Magazines, USA 1974. Publishers Lawrence Teeman.**

SEE THE 891's AND FULL RANGE ALTEC PRODUCTS AT

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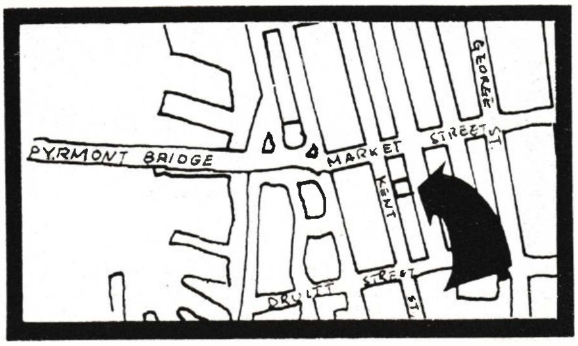


OPERATIONAL AMPLIFIERS Part 1

In this down-to-earth three-part series, J.T. Neil explains the basic theory and practical applications of op amps.

OPERATIONAL AMPLIFIERS are small in size, provide very high, stable voltage gains, and are readily available at well under a dollar each.

Unfortunately these immensely practicable devices tend to be described by their manufacturers and countless technical writers in terms that are virtually meaningless to the home constructor.

The purpose of this short series of three articles then, is to show, with the minimum of theory and mathematics, how to extract the essential information from data sheets and how to apply it to practical designs.

The units to be described, each using a single operational amplifier, are a compact sine-wave audio-signal generator, a high-impedance audio amplifier (with various switched frequency-responses available) and a dc amplifier to increase the effective sensitivity of an ordinary 1 mA meter to 10 μA fsd.

Each of these units can be run from batteries or any other suitable source; however, since operational amplifiers usually require dual supplies (which could become expensive if batteries were used for long) the first actual constructional project will be a power supply unit giving ± 12 V fully stabilised and short-circuit protected. This latter feature is rather important, for the operational amplifiers to be used have their lead out wires only 2.5 mm apart which, in experimental setups, will, sooner or later, lead to short circuits of the supply rails by solder blobs, touching wires etc.

Accordingly, a protected power supply, specifically designed for use with op. amps. and which automatically reverts to correct operation on removal of an unwanted short-circuit is essential.

WHAT IS AN OPERATIONAL AMPLIFIER?

Originally, the term was used to describe an amplifier suitable for performing mathematical operations in analogue computers. It has since come to include almost any high-gain dc amplifier capable of having its actual performance, in terms of gain, frequency response and input impedance, determined by external components arranged to provide feedback (usually negative feedback).

An *ideal* op. amp. has the following characteristics:–

1., Infinite gain
2. Infinite bandwidth
3. Infinite input impedance
4. Zero output impedance
5. Constant phase shift between input and output.

Obviously, such a device is impossible in the real world, but it *is* possible to manufacture amplifiers that have gains etc. so large, and output impedances so low that any departures from the ideal have little effect in practical circuits.

For example, if a working gain of 100 is required and the op. amp. to be used has a gain (without feedback) of 50 000 then 50 000 ÷ 100 (500) is such a large margin that we can say that, for practical purposes, the reserves of gain available are so large that the gain is infinite. Similar reasoning applies to the other parameters whose ideal values were mentioned earlier.

FEEDBACK

Operational amplifiers are most often arranged to function with negative feedback applied, although there are cases where either no feedback, or indeed *positive* feedback, is employed. The op. amps. we shall be considering have, in fact, two input terminals, and feedback is considered to be either negative or positive according to which of these inputs it is connected.

The two input terminals are arranged in the following manner. Consider that one input terminal is earthed; then if the application of a positive going signal to the other input results in a *positive* going output signal, then that latter input terminal is termed the "+ve" input terminal. Conversely, again with one input earthed, if the application of a positive going signal to the other input results in a *negative* going output signal, then that latter input terminal is termed the "–ve" input terminal. Sometimes the +ve input is called the "non phase inverting" input and the –ve input is called the "phase inverting" input.

By convention, the op. amp. itself is shown as a triangle, with the output being taken from the righthand apex; the two inputs are on the left, one input being the –ve and the other the +ve.

The arrangement of Fig. 1a will result in a phase reversal of the signal, while that of Fig. 1c will not.

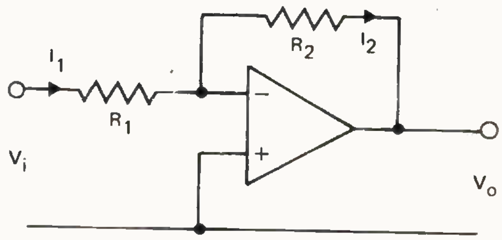


Fig. 1a. Inverting amplifier.

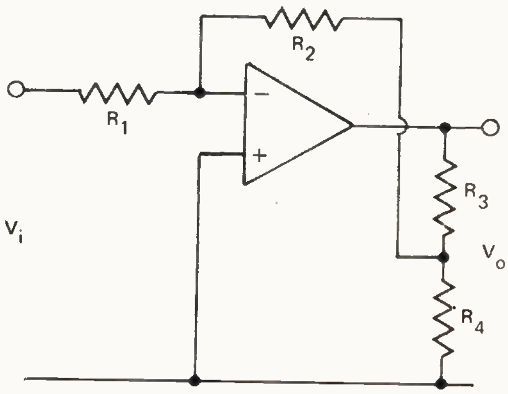


Fig. 1b. Inverting amplifier (high gain).

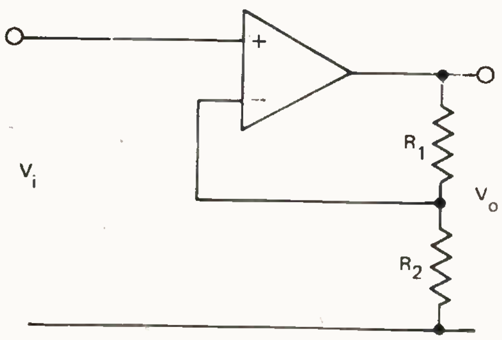


Fig. 1c. Non-inverting amplifier.

Accordingly, the first configuration is called an "inverting amplifier" and the second a "non-inverting amplifier". Each configuration has its own properties, which we shall now consider.

INVERTING AMPLIFIERS

Referring to Fig. 1c, consider an input, V_i at, say 1 kHz. Imagine that the input resistance of the op. amp. itself is so large compared to the values of R_1 and R_2 that it can be said to be infinite. This will be the case if R_1 is, say, 1 k, for the input resistance of a typical op. amp. is 1 M. Imagine also that the gain of the op. amp. is very much larger than the final gain of the whole circuit. Once again this will be so, for the gain of a typical op. amp. is 50 000 and the overall gain of the whole circuit will be very much less than this extremely high value, as will be shown.

This latter assumption is very important, for it means that the actual level of signals at the –ve input terminal will be so close to nothing that we can consider it to be zero. By Ohm's Law

$$I_1 = \frac{V_1}{R_1} = I_2 = \frac{V_2}{R_2}$$

where

V_1 is voltage across R_1

V_2 is voltage across R_2

But with zero signal at the –ve input

$V_1 = V_i$ and $V_2 = V_o$

so that the gain, A, is

$$A = \frac{V_o}{V_i} = \frac{V_2}{V_i} = \frac{R_2}{R_1}$$

which is independent of the actual gain of the op. amp., provided that the latter is very much larger than the value of A – very likely in practice.

It will be instructive at this point to consider the level of signal actually present at the –ve input of the op. amp. With an input signal of 1 volt and a circuit gain of x2, there will be an output of 2 volts. If the op. amp. gain is 50 000, then the level at the –ve input must be

$$\frac{2}{50\,000}.1 = 40\,\mu V,$$

quite close to the zero level assumed.

Note that when the amplifier output is fed back to the –ve input, the output voltage adjusts itself to such a value that the actual voltage between the two inputs becomes so close to zero that the difference can be neglected. The greater the gain of the op. amp. itself, i.e. the better it approximates to the ideal of infinite gain, the less the voltage at the –ve input becomes.

Since the –ve input has such a low level signal present, it is virtually at earth potential, and consequently the input resistance of the whole circuit is equal to R_1. Such an arrangement as illustrated in Fig. 1a is sometimes called a "virtual earth amplifier".

If a very high value of gain is required, complications can arise if a high input impedance is called for at the same time, for if R_2/R_1 is large, either R_2 will need to be such a high value that it is impracticable or R_1 will be too low for the required input impedance.

In that case, the configuration of Fig. 1b can be used. An analysis of this circuit gives, for the voltage gain

$$A = \frac{R_2}{R_1} \cdot \frac{(R_3 + R_4)}{R_4}$$

provided that R_2 is large compared to R_4.

Now R_1 can be kept at a reasonably high value (to raise the input impedance) with R_3 and R_4 making up the gain to the required level).

NON-INVERTING AMPLIFIERS

Now consider the non-inverting amplifier of Fig. 1c. As before, imagine that, due to the high gain of the op. amp., there is virtually zero signal between the two inputs and that the input resistance of the amplifier is very much greater than either R_1 or R_2.

Then $V_2 = V_i$ where V_2 is the voltage across R_2

$$\text{But } V_2 = \frac{R_2}{(R_1 + R_2)} \cdot V_o$$

$$\therefore V_o = \frac{R_1 + R_2}{R_2} \cdot V_2$$

so that gain A is

$$A = \frac{V_o}{V_i} = \frac{(R_1 + R_2)}{R_2} \cdot \frac{V_2}{V_2} = \frac{(R_1 + R_2)}{R_2}$$

which again is independent of the actual gain of the op. amp. itself.

The input resistance of a non-inverting amplifier is very high, being determined largely by the impedance from the two input terminals to earth. Typically, it is of the order of 200 – 400 M at low and medium gain levels. It is this extremely high value of resistance that makes the non-inverting amplifier so useful, although, of course, there are disadvantages. For example, it might appear that a non-inverting amplifier would be ideal to accept the output from a high resistance source, but in that case the resistance seen by the op. amp. +ve input would be that source resistance, while the resistance seen by the –ve input will be R_1 and R_2 in parallel (Fig. 1c). The input bias currents (see later) at each input would then give rise to a voltage difference across the inputs and hence, of course, unwanted voltage offset at the output.

These two circuit configurations, namely, the inverting and the non-inverting, form the basis of all op. amp. circuitry and are well worth remembering. In a number of uses, the simple resistors used in the examples quoted are replaced by complex impedances of one kind or another in order to modify the frequency response in some way. By such means it is possible to make op. amps. respond as frequency selective amplifiers, integrators etc.

Examples of this tailoring of frequency responses will arise in the case of the audio amplifier to be described in part 3.

At this stage it would be as well to introduce and explain a number of terms that are frequently used in dealing with op. amps. and which could otherwise cause confusion. Many of these terms are necessary because actual op. amps. do not have the ideal characteristics noted earlier; for example:—

Open loop gain is the voltage gain of the amplifier at low frequencies with no feedback applied, ie with the feedback loop open. The value of 50 000 used as an example earlier is the open loop gain of the amplifier discussed.

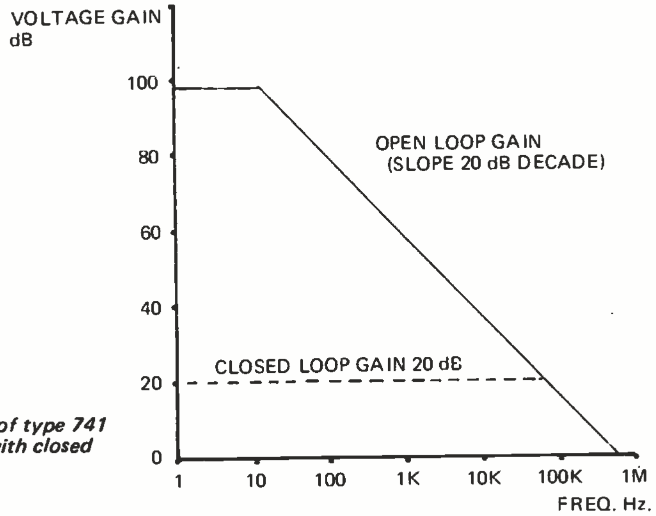
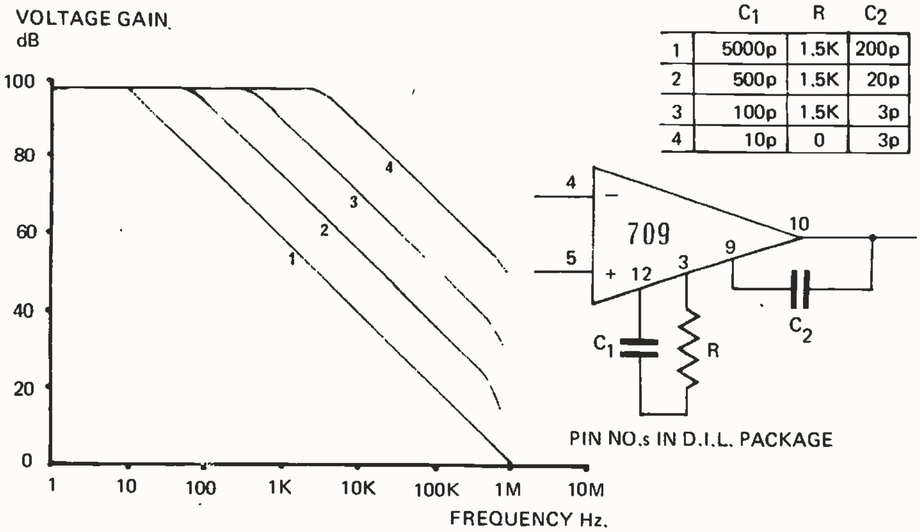


Fig. 2. Open loop gain of type 741 op amp and response with closed loop gain of 20 dB.



	C_1	R	C_2
1	5000p	1.5K	200p
2	500p	1.5K	20p
3	100p	1.5K	3p
4	10p	0	3p

Fig. 3. Open loop frequency response of type 709 op amp for various compensation component values.

Closed loop gain is the voltage gain of the amplifier when negative feedback is applied, ie with the feedback loop completed. It is thus the gain of the whole circuit and is analogous to the stage gain of valve and discrete-transistor circuits. The value of x2 we used earlier is the closed loop gain in that case.

Input bias current is that current that must be fed into the input terminals in order to make the output voltage zero. This current is necessary since the input transistors of the op. amp. require some base current, however small, in order for them to conduct and so amplify.

Input Offset Voltage is that voltage that must be applied across the input terminals to make the output voltage zero. It is not usually as important as input bias current in the type of application that we shall be considering.

Common Mode Rejection is a measure of how good the amplifier is in rejecting signals applied to both inputs together. Once again, we will not need to pay great attention to this characteristic in our applications.

Frequency Response is usually quoted by stating the frequency at which the voltage gain falls to unity; it is then normally assumed that, as the frequency is reduced, the gain rises at a rate of 20 dB per decade (i.e. the voltage gain rises by a factor of 10 for a ten-fold change in frequency) until it reaches the open loop value. It is then possible, with a knowledge of the open loop gain, to sketch the frequency response, see Fig. 2. Operational amplifiers have a response down to zero frequency, that is, they are dc amplifiers.

Towards the top end of the frequency range, slewing rate becomes important.

Slewing rate is the fastest rate of change of output voltage that the op. amp. can generate. Provided that the output voltage swing is small, say 1 V peak-to-peak, the slewing rate limitation is unlikely to be a problem, even at a frequency close to the op. amp's maximum. However, if a large output voltage swing is called for, say 20 V peak-to-peak at the same frequency, then slewing rate limitation can give rise to distortion; for clearly, at the zero crossing a large-amplitude signal will be changing its voltage at a faster rate than a signal of smaller amplitude.

For example the popular 741 IC may have a bandwidth of 100 kHz to a small signal but the maximum slew rate of 1 volt/microsecond will limit bandwidth to 10 kHz, if an output swing of 20 volts peak-to-peak or more is required, or to 40 kHz at four volts peak-to-peak.

Slew rate thus limits the ultimate output swing available at high frequencies and is also a source of high-frequency distortion at high output levels.

The use of negative feedback will not cure the distortion for it is inherent in the op. amp. itself.

FREQUENCY COMPENSATION

Figure 2 shows the frequency response of a type 741 op. amp. it can be seen that the open loop gain starts to fall at frequencies above about 10 Hz. This is not to say that at higher frequencies useful gain cannot be obtained — it most certainly can. At 100 kHz for example, a closed loop gain of 20 dB is possible. However, the response of the 741 can be a limitation in some applications and then the 709 type amplifier is possibly preferred. The 709 is *never* used without some form of frequency compensation — it readily oscillates at around 10 MHz if none is employed — but does have the advantage that the values of the components used can be varied to provide various bandwidths, (Fig. 3). In practice, the values of the frequency compensation components are chosen to give just sufficient bandwidth for the application being considered. There is no real objection to employing values to give a greater bandwidth, but instability probems may then arise, and the noise level is liable to be greater.

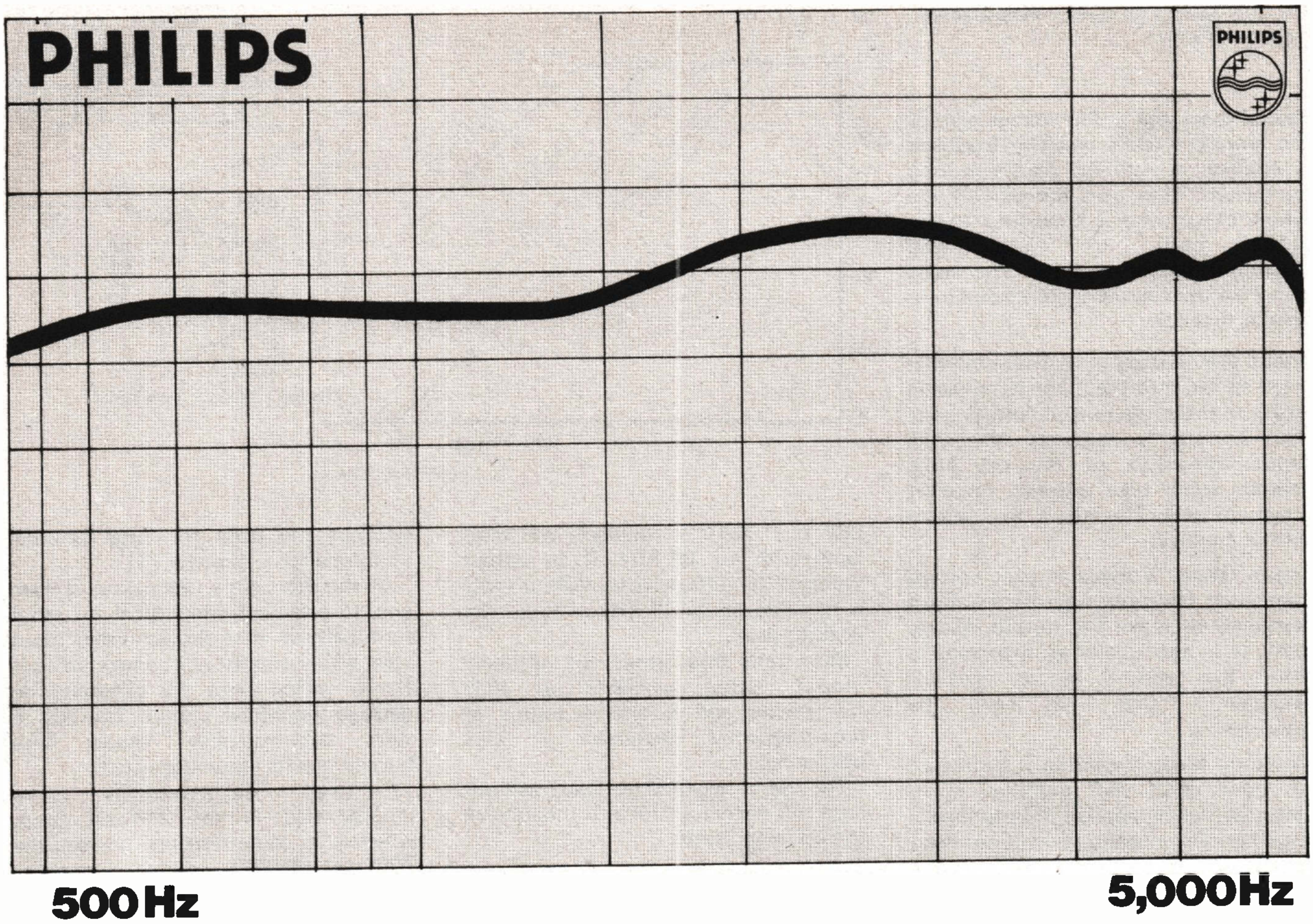
As a point of historical interest, the 709 came before the 741 (it was itself preceeded by other op. amps. of reduced performance) and the need for the provision of external components proved irksome. Advances in technology enabled manufacturers to incorporate capacitors on the integrated circuit chip itself and so provide an op. amp. that was stable without the need for large external components — thus the 741.

At the same time, the designers were able to provide protection at the input terminals, so that should either input have either supply rail connected to it (by a wiring error for example) no damage would be caused. The 709 in such circumstances, would have burned out its input transistors.

Further improvements were incorporated in the 748 op. amp. which is in some respects between the 709 and the 741, in that it requires one small external capacitor but provides a greater gain-bandwidth product than the 741.

With so many external connections — two supply rails, two inputs, one output and perhaps terminals for frequency compensation components — a special form of packaging was required and in fact there are two in common use. One, the T099, is similar to the common T05 transistor encapsulation in size of can but has eight lead-out wires. The other is the dual-in-line (DIL) package and it is recommended that the constructor uses this style, together with the appropriate holders. This will make it possible to check, to some extent, the dc conditions of the circuit when first wired up. This is done before the op. amp. itself is inserted thus perhaps preventing catastrophic failure of the device due to a wiring fault. Further, in those cases where a 709 is called for, it is possible to use a 741 for initial testing (although of course full performance in respect of frequency response might not then be obtained). Should an important wiring error have been made, damage is less likely to be caused to a 741 due to the built-in overload protection at its input terminals.

This for the average experimenter is all the theory that need be covered at the moment. Hence next month a start will be made on practical circuits, with details of the power supply and of the compact sine wave audio oscillator. ●



500–5,000Hz and it's almost flat. How's that for about $50 worth!

It's the performance curve of Philips new mid range speakers. That curve is so flat it gives a variation of as little as ± 1 dB over the same frequency spread. And even beyond those levels the drop is gradual on either side. And to think this performance is now available for about the $50 mark. Not bad for a 50 Watt dome squawker speaker. For further information please contact

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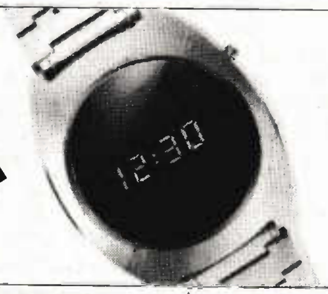

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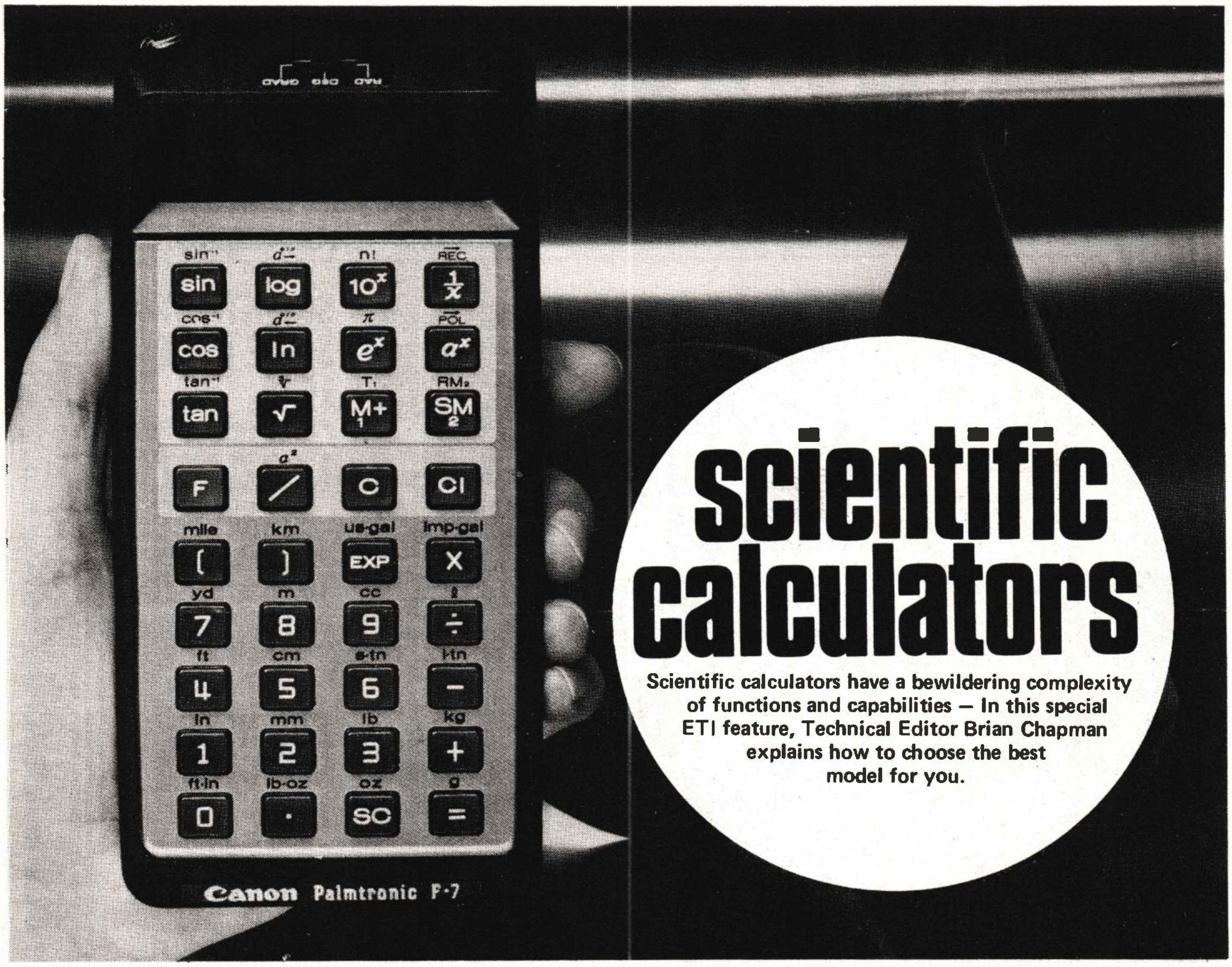


scientific calculators

Scientific calculators have a bewildering complexity of functions and capabilities — In this special ETI feature, Technical Editor Brian Chapman explains how to choose the best model for you.

SINCE our first calculator survey published two years ago in the July 1973 issue of Electronics Today there has been an astonishing change in prices and capabilities of electronic calculators. At that time the cheapest four-function calculator in the survey was $67 with the average being around $120. Now, the cheapest four-function machine sells for $10! And the average price is around $30 for machines that include a memory.

The market is so large and the competition so fierce that many companies have dropped out of the calculator scene and it now seems to be that companies having their own integrated circuit manufacturing capabilities are dominating the market. This is exemplified by the entry of National Semiconductor into the field with their very competitively priced "Novus" range that extends from the cheapest four-function machine to several 100 step programme machines.

The price war seems to be largely over in the four-function category and has shifted to the scientific models. Prices are continuing to drop on these models and new models with ever greater capabilities are released almost continually. It seems that soon the price of machines having HP35 capability will fall to around $30, and fully programmable types (eg HP65) to around $150.

The size of the market may be gauged from the sales of the Sharp Corporation. In the 1974 financial year Sharp manufactured 14.9 million calculators for a claimed 40% share of the world market.

All in all the scientific calculator field is an interesting and exciting one. It has one disturbing aspect however. If you have bought a calculator 12 months ago it is not nice to know that the same calculator is now selling for from half to one quarter of what you paid for it.

SELECTING A CALCULATOR

To select a scientific calculator requires some careful thought. One must first decide what kind of problems must be handled and how much capability is really required. Fully programmable calculators are very nice indeed but cost a lot of money — do you really need the programme capability?

As an aid to selection the following sections describe the salient features of scientific calculators, and the survey chart provides details of most of the makes and models at present available on the Australian market.

ENTRY MODES

Algebraic:

Most people would be familiar with the algebraic-entry mode used on the majority of simple four-function calculators and on many scientific calculators. This problem entry method closely follows the manner in which equations are written. That is, the key sequence for multiplying two by three would be:—

[2] [x] [3] [=]

An alternative entry mode is used on an occasional simple calculator and on many scientific machines. This entry mode is known as "Reverse Polish". The key sequence for the above problem is:–

[2] [ent] [3] [x]

The ENTER key causes the previously entered number to be transferred from the working register to a temporary storage register and instructs the calculator to treat the next digits keyed in as a new number entry, and not as additional digits of the first number. The command for the desired operation is then keyed in to complete the calculation.

At first sight it would appear that there is no advantage in using this latter procedure as, in the example given, there are exactly the same number of key presses required to solve the problem. Further it is an unfamiliar procedure to which one must become accustomed.

But suppose we had a slightly more difficult problem such as:

(3 + 7) x (9 – 3)

To solve this problem we must perform the calculations within the brackets first. We therefore need to store the result of one bracketed calculation whilst we perform the other. The key sequence would therefore be:

[3] [x] [7] [=] [M+] [9] [–] [3] [X] [RM] [=]

Notice that we need a memory and a total of 11 key presses to solve the problem.

More advanced algebraic machines incorporate facilities to key in the parenthesis brackets. With such a machine the key sequence would be:

[3] [+] [7] [X] [(] [9] [–] [3] [)] [=]

An improvement as we now need only 10 keystrokes and do not need to use our memory.

Reverse Polish:

With machines that have Reverse Polish entry a three or four deep stack of registers is used to perform the working calculations. For example in the Hewlett Packard calculators there are four registers labelled X, Y, Z and T with the X register being the one that contains the displayed number. These working registers or "stack" as it is called are completely independent of the normal memory registers.

The key sequence for our problem when done on these machines would be:–

1	2	3	4	5	6	7	8	9
[3]	[ENT]	[7]	[+]	[9]	[ENT]	[3]	[–]	[X]

Note that now there are only nine key presses required and that the registers automatically shift contents up and down as the problem proceeds. The stack contents for the above key sequence would be as shown in the table.

	1	2	3	4	5	6	7	8	9
T									
Z						10	10		
Y		3	3		10	9	9	10	
X	3	3	7	10	9	9	3	6	60

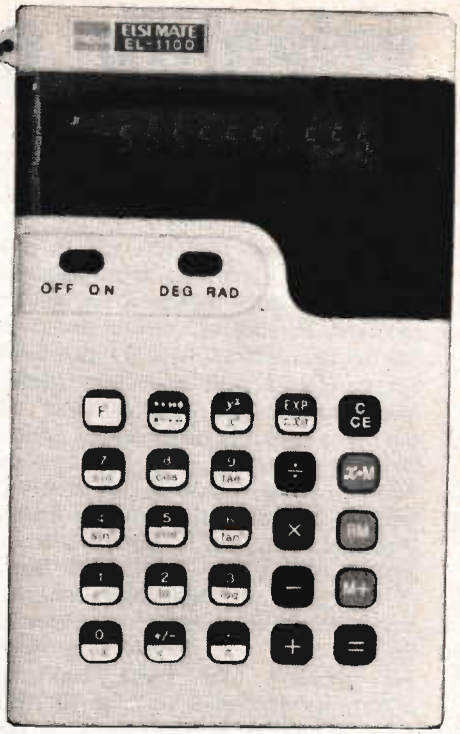
Reverse Polish notation is thus very economical in terms of key presses required, especially as problem difficulty increases. A four-high stack allows very complex problems, with several nested brackets, to be solved without the need to store data in the main memory. To solve a complex problem with a Reverse-Polish organised machine we start from the middle of the problem and work outwards.

This is not a real disadvantage as it is less confusing than to write the equation out with all the brackets required for a direct algebraic solution. Additionally in algebraic machines the single-key function commands (logs, trig functions, square root etc) follow the entered number just the same as in Reverse Polish machines, eg [3] [0] [sin] so algebraic entry mode is in fact inconsistent.

Reverse-Polish machines usually incorporate roll-down and possibly a roll-up key so that the contents of the stack may be reviewed at any time. We therefore recommend Reverse-Polish machines because the method facilitates the solving of complex problems with less chance of keying errors. Algebraic machines however, especially those with two levels of parenthesis, are just as powerful and may be preferred by some people.

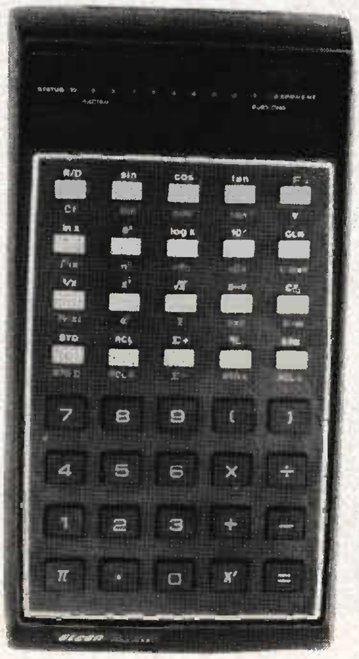
NOTATION

There are three methods of number notation used in calculators, standard fixed or floating point, scientific and engineering.



The Sharp EL 1100 has some unusual features. The exponent is displayed in a separate 2-digit display. The key with the unusual notation immediately to the right of the F key converts decimal degrees to degrees, minutes and seconds and vice versa.

This machine from Adler will perform most common business calculations.



The SC60 from Elcon incorporates a selection of statistical functions and has the ability to overflow the normal 10 -99 to 10 +99 range by a further 100 decades at each end.

scientific calculators

Standard Notation.

In standard notation the number is represented by an integer and decimal with a number of digits up to the maximum provided in the machine. The minimum number of digits required for useful calculations is 8 but some machines have 14 or more. Fixed point operation is very useful for financial calculations and is therefore essential on machines which incorporate business functions. With floating point operation the decimal point is automatically positioned such that maximum use is obtained from the available display digits. With both floating and fixed point operation the maximum range without overflow is from 1×10^{-7} to $9.9^{\cdot} \times 10^{7}$ a total of 15 decades. The lower limit is sometimes extended to 1×10^{-8} by eliminating the zero in front of the decimal point and the upper range may be extended by displaying the result of a computation that exceeds $9.9^{\cdot} \times 10^{7}$ with the decimal point shifted eight places to the left of its true position. When overflow occurs the machine is locked out and an overflow symbol generated. Calculation is therefore usually not possible on a result which has put the machine into the overflow condition.

Scientific Notation.

For most engineering and scientific applications an eight digit display is inadequate, for such machines are limited to the multiplication of two four-digit numbers. Whereas many constants and measured quantities require representation by more than eight digits. For example how do you enter Boltzmann's constant (1.38×10^{-23} joule) into an eight-digit machine? Scientific notation is a method of representing the number by means of a mantissa and a, typically, two-digit exponent. Thus Boltzmann's constant would be displayed as 1.38 –23 where the –23 represents the power of 10 by which the mantissa must be multiplied. All calculators having scientific notation are capable of automatically switching from standard to scientific notation when the number exceeds the standard capacity (or vice versa). Such machines have a key marked EE or EXP which allows numbers to be entered in scientific form. The number of digits in the mantissa varies from 5 to 12 digits depending on the machine.

Scientific notation can extend the range of a calculator from 15 to 200 decades — an enormous increase.

Engineering Notation.

The scientific method of notation is not ideal for practical engineering problems because physical units in the SI system are represented in a modified scientific notation where the exponents of 10 are always a multiple of three. For example a calculated capacitance value may appear in scientific notation as 1.28 –05 Farads, this needs interpretation as 12.8 microfarads. This is automatically done in engineering notation, the result would be expressed as 12.8 –06 thus expressing the quantity in the needed units.

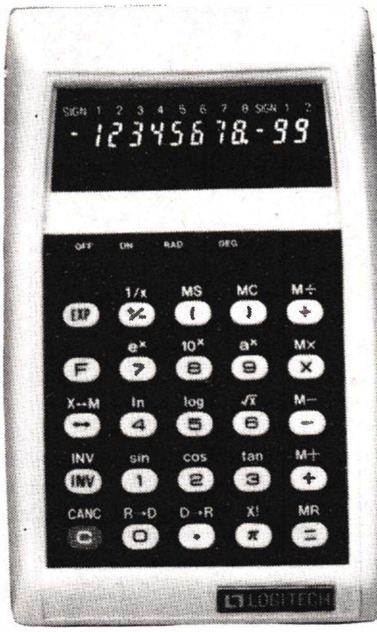
Only one of the calculators surveyed has this feature, the Hewlett Packard HP25. We venture to predict that this feature will be incorporated into most future designs.

PREPROGRAMMED FUNCTIONS

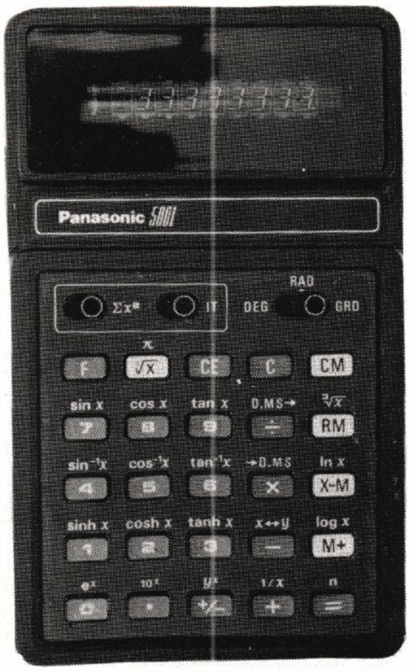
The number of pre-programmed functions incorporated into a machine depends firstly on the price of the machine and secondly on the primary applications for which it is designed.

The first additions to the basic four functions are usually 1/x, $\sqrt{x}$ and π for scientific applications and 1/x and % for business applications. It is also at this level that a memory is added. Such machines as these, although more advanced than basic four-function machines are not covered in this survey.

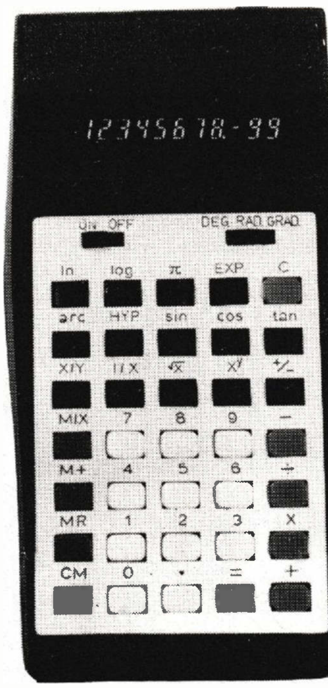
Machines of greater capability than



The Logitech 1233.S is an attractive looking machine that has far more power than is suggested by its price.



The Panasonic 5001 from National incorporates angular measure in grads, $3\sqrt{X}$ and sum of the squares.



The Qualitron 1419 is unusual in incorporating hyperbolic functions.

the above become even more dedicated to specific applications. The categories which seem to be most catered for are general purpose scientific, statistics, business and metric conversion.

In general-purpose scientific machines the functions that are generally added to those discussed above are trigonometric functions and their inverse, logarithmic functions both common and natural, e^x and sometimes 10^x and x^y. Additionally a switch is incorporated which allows operation in either degrees or radians.

Other functions that are added in more expensive machines are rectangular — to — polar conversion, decimal degress to degrees, minutes and seconds conversion and vice versa, extra memory registers, factorial X and, on a few machines, hyperbolic-trig functions and their inverse.

Statistical Machines.

There are a number of machines which have many standard statistical functions built into them. They may also incorporate a number of basic scientific functions.

Typical statistical functions are summation of x and y values, mean and standard deviation, sum of squares, square root of sum of squares and linear correlation of regression. Some advanced scientific models will also incorporate a few of these functions such as summation, mean and standard deviation.

Business Machines.

Those machines which are dedicated to business applications appear to have relatively few functions, when compared to other machines, but the relatively few keys can be used to solve dozens of different problems — everything from discounts and markup to interest rates, remaining principal on a mortgage, the future value of an annuity, or depreciation.

More advanced machines may also solve problems associated with statistics, bond prices and yields and, because these functions are based on calendar intervals, a calendar may be built into the machine. For example the HP80 incorporates a 200 year calendar (1900 to 2099) such that you can find the number of calendar days between two dates; the day of a week a date falls on; a future or past date given the number of days from a known date.

Metric Converters.

Whether machines devoted to metric conversions can be classified as scientific calculators is debatable but we thought they were worthy of inclusion because of their dedicated nature. Some general purpose scientific calculators have a number of metric conversions built in. There are a few machines available which can, convert any metric quantity to US or imperial and vice versa. It seems a pity that some calculators convert to US standards only and not to imperial, a serious drawback in non-US standard countries.

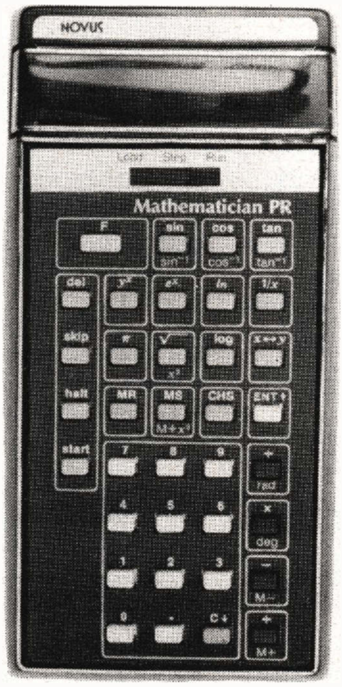
Perhaps the most outstanding conversion calculator is the Sharp EL8300 which has several unusual features. Apart from its 29 standard conversions from metric to and from imperial or US it has three registers available for storing other conversion factors and is capable of adding numbers expressed in integer and fraction form, eg, 1 7/8 may be added to 4 2/3 without first converting the fractions to decimals.

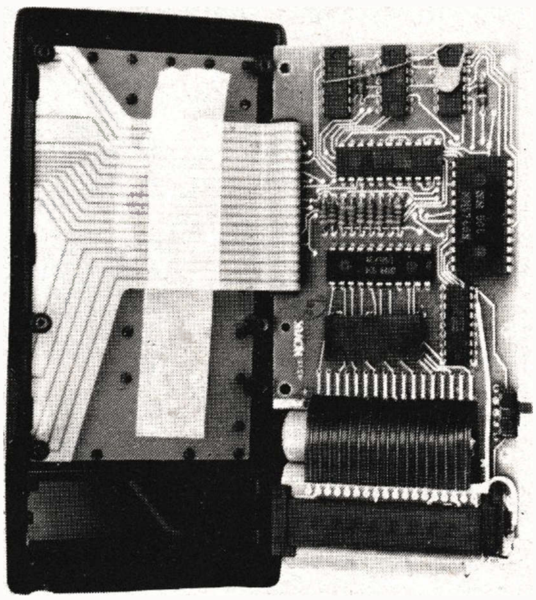
Advanced Scientific.

Calculators of an advanced scientific nature may have, in addition to the standard scientific functions, the most important functions from some of the other categories. For example the HP45 has, as well as standard functions, three metric conversions, three statistical functions and nine addressable memories. Further, programmable calculators can be organised to solve almost any specific problem.

Advanced calculators usually have to organise the keys to perform dual or even triple functions. This is done by incorporating function change keys. For example, the HP45 provides 48 functions and 9 memories with just 40 keys.

Top the Hanimex range, the ESR MASTER has an excellent selection of functions and a very flexible memory.





The Novus Mathematician PR has a 100 step programme and Reverse-Polish notation, although very sophisticated the internal view shows the constructional simplicity.

scientific calculators

The new HP25 from Hewlett Packard has a 49 step programme with editing and conditional branching. As with all Hewlett Packard calculators very comprehensive owner's and applications manuals are provided with the machine.

PROGRAMMING

With the aid of an advanced scientific calculator one can solve just about any problem that one might encounter. But, say you wanted to plot the response of a filter network versus frequency. The individual data points must all be calculated using the same basic formula — a laborious process even with an advanced calculator.

If a calculator incorporates a programme capability the problem need only be entered once. The problem may then be repetitively solved simply by inserting the data for each point and pressing the start key — the calculator does the rest.

Of course, as with everything, the power of the programmes fitted to scientific calculators varies considerably. The first thing that one notices is the number of programme steps available. On the calculators reviewed this varies from 49 to 300. However the effectiveness of the number of steps depends greatly on other programme features and on the available number of storage registers.

The simplest kind of programme capability is where the programme simply remembers the key stroke sequence used to solve the problem. Such a programme is fitted to the Sharp PC-1001. It is not possible to modify the programme in any way or to review the contents of the programme memory.

A step up from this is the programme as fitted to the Novus 4515. This is basically the same as that used in the Sharp except that a SKIP key has been provided which allows several small programmes to be stored within the 100 step programme memory. The Novus however has the disadvantage that it has only one storage register. Thus if more than one constant is required in a programme it must be written into the programme each time it is used (an eight digit constant will consume eight programme steps). The Sharp calculator on the other hand has eight storage registers thus the contents of any memory can be recalled with one or two programme steps.

The next stage of programme development is to incorporate programme editing. In the HP programmables, for example, when the machines are switched to programme mode, the display shows the line number and the key code for the programme step. Single-step, back step and delete keys allow the programme to be debugged without rewriting the whole thing. Pressing a further key

THE PROGRAMME SPECIFICATION OF THE HP65

These keyboard controls give you full programmability in a pocket calculator . . .

These keys take the HP-65 out of the realm of the calculator and into the sophisticated world of computer technology. They permit you to write, record, save and read back your programs. They also set in motion the HP-65's other powerful programming functions.

To write or run your program . . .

W/PRGM RUN

Set this switch to "WRITE PROGRAM" to enter or change any steps in the program memory and for recording programs, without altering any data stored in the four-register automatic memory or the addressable registers.

Set to "RUN" for all other operations.

To structure your program . . .

LBL — This "LABEL" key enables you to indicate and identify a series of steps within your program. Up to 15 labels are available by pressing this key and any digit (0-9) or letter (A-E) key.

GTO — This "GO TO" key, in conjunction with a digit key, sets off a search in the program memory for the label with the same digit. It can be used from the keyboard when editing, or as part of a program.

A B C D E — These User Definable keys are just what their name implies. They are letter labels for parts of your program which can be executed directly from the keyboard. Or, they can be used to call a sub-routine when used within a program.

RTN — When this "RETURN" key is pressed, it enables you to start at the beginning of your program again. If this key is used as part of your stored program, it stops execution of your program and returns control to the keyboard for manual operation. When used as part of a letter subroutine, it returns control to the calling program.

R/S — When this "RUN/STOP" key is included in your stored program, it will halt execution of the program and return control to the keyboard for manual operation. When used from the keyboard, it can stop a running program or start a stopped program at the next step.

To include conditional functions in your program . . .

SF1 SF2 — Like a computer, the HP-65 can take alternate computational paths based on the condition of the two flags. With the "SET FLAG 1" and "SET FLAG 2" keys, the flags can be set or cleared manually from the keyboard or automatically by an appropriate program step.

TF1 TF2 — The condition of the flags can be tested automatically at any point in your program by using these "TEST FLAG 1" and "TEST FLAG 2" keys to include an appropriate test flag instruction. Your program will either advance sequentially or skip over the next steps, depending on the condition of the tested flag.

x≠y x≤y x=y x>y — These keys allow you to compare the values in the X and Y registers. If the test condition is not met, the program skips over the next two steps. If the test condition is met, the program continues with the next step. This allows the HP-65 to perform conditional branches based on the results of the test.

DSZ — The "DECREMENT AND SKIP ON ZERO" key subtracts a "1" from the integer previously stored in addressable register 8, then advances your program depending on the value remaining in the register. If the value in register 8 is not equal to zero, the program advances to the next step. If it does equal zero, it skips the next two steps. "DSZ" allows you to loop through a portion of your program a predetermined number of times.

NOP — If this "NO OPERATION" key is included in your stored program, it will advance the program to the following step. It is often used in conjunction with conditional-skip instructions.

To edit your program . . .

PRGM — Use this "PROGRAM" key to clear the entire 100-step program memory, so you can begin keying in a new or revised program you have developed.

DEL — This "DELETE" key erases a single program step and automatically moves the remaining steps up one place in the program memory to fill the resulting gap. To insert the corrected step, just key it in and the following steps will move down automatically.

SST — When the HP-65 is in the "WRITE PROGRAM" mode, this "SINGLE STEP" key lets you step through each program instruction in the program memory, as the display shows a number for each step. This number represents the location (row and column) of the key corresponding to that particular instruction. For example, "34" refers to the key in row 3, column 4—"RCL." (Exception: digit keys are represented by the numbers 00 to 09.)

If the "SST" key is used with the HP-65 in the "RUN" mode, you can execute a program one step at a time.

called "GO TO" (GTO) followed by a programme step number allows you to get to any particular step in the programme.

An important addition to the repertoire of programmable calculators is the ability to to make logical decisions. Such capability makes them akin to computers in that alternative paths can be taken within the programme conditional upon the results of a test. Other additions such as "decrement and skip if zero" and user definable keys can make the calculator extremely powerful even with a limited number of available programme steps.

STORED PROGRAMMES

The ultimate in programmable calculators is one which has the ability to permanently store programmes for future use. There are three methods in use with portable scientific calculators. The HP65 stores its programmes on tiny magnetic cards, the card reader being built into the calculator. Pre-programmed cards are available for a variety of applications. Each card can store 100 programme steps.

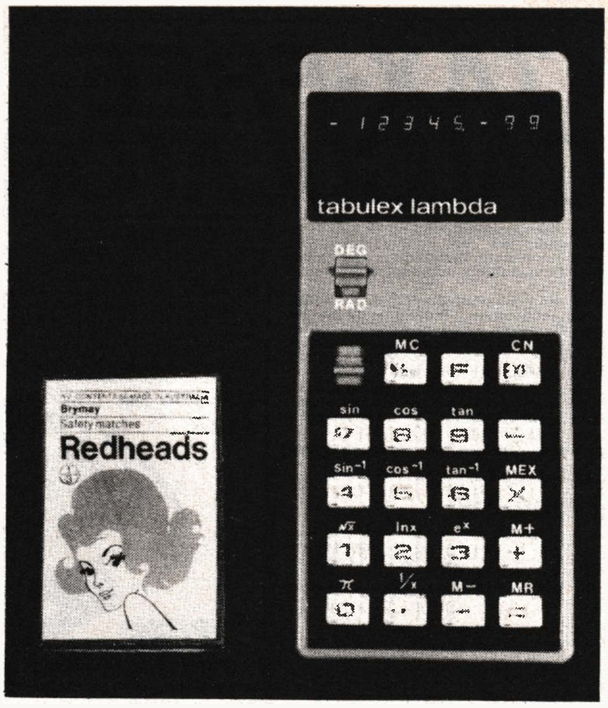
The Compucorp 326 has a cassette recorder for programme storage and again pre-recorded cassettes are available for a variety of applications. Each cassette is capable of storing 14 blocks of data. Each block may contain the data for 12 data registers or 160 programme steps. The calculator has manual or programmable controls for writing or reading data registers or programmes onto or from the tape cassette.

Both the Compucorp and the HP65 are extremely well backed up with comprehensive operating instructions, sample problems and data on the pre-recorded programmes for each pack of programme cards or cassette.

The third method of programme storage is that used by Sharp in its PC1002. This calculator has interchangeable, programmable read-only memories, each being programmed for different applications. There are PROMs available programmed for statistics, business etc, or Sharp will programme the PROM to the customer's specification. When the PROM is interchanged the functions of the keys are changed, the new functions being indicated by a keyboard overlay card.

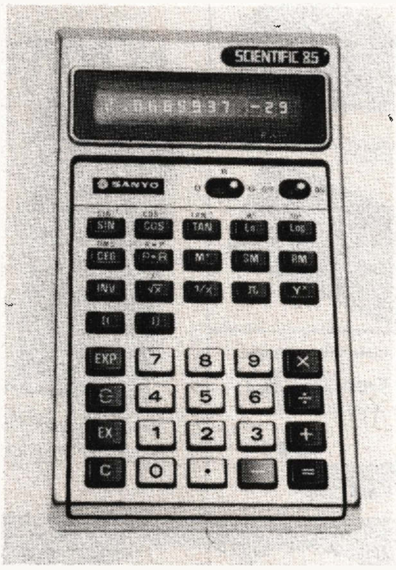
The Sharp system does not allow the user to store his own programmes and thus is less flexible. But it does extend the capabilities of an inexpensive programmable calculator considerably. Each pre-programmed PROM is available, we understand, for around $45.

This calculator although of limited capability was the smallest in our survey and is inexpensive.

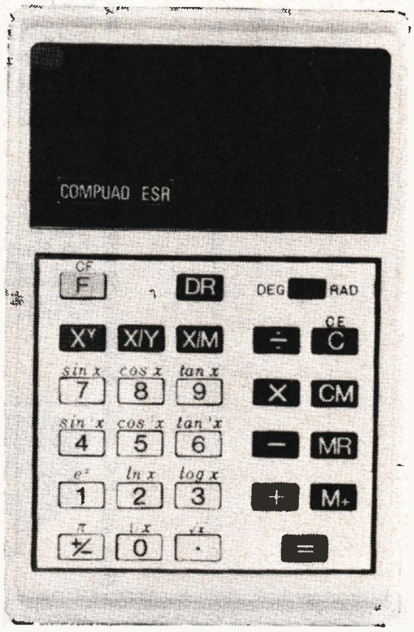


Many other machines are available with ever greater capability but these are desk-top models costing up to $3000 or more. They include machines with print-out, graph plotters and even machines with interactive programmes, using BASIC computer language, that tell you what to do next and advise you of any entry errors by means of an alphanumeric display. Such machines are beyond the scope of this article, but who knows how many of the sophisticated features of these machines will eventually appear in pocket and portable machines.

Comparison chart — pages 40-41.



ie Sanyo Scientific 85 (CZ 0123)



The machine from Compuad, although not having scientific notation, is quite powerful for the price.

TAX-FREE CALCULATORS

With so many calculators on the market, how do you know which is best? Easy, ask Dick. He's checked 'em all and chosen eleven that are top value. So there's no need to spend hours comparing: we've done it all for you!
And to add to the value, we can supply TAX-FREE to approved purchasers. Does anyone else offer such service? Even if you can't complete the Tax Declaration, you won't beat our prices because we've bought large quantities. So check which one you fancy. NOW.
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Try any of these calculators at our expense. Simply send your remittance and if not satisfied return the calculator within 7 days. We will refund your money less cost of P. & P.

How To Claim Tax Exemption

Simply get the whole of this declaration typed out & completed, attach to the coupon and forward with your remittance. Or if applicable quote your tax number. We will despatch INSURED by post for $2.00.
Fill in the relevant words or signature where brackets are used below.

I hereby certify that the (Make, Model) calculator purchased by me from Dick Smith Wholesale Pty Ltd on (date) is for use in (school, university or organisation etc.) in or directly and essentially in connection with the production of facts by means of observing, measuring, testing or otherwise experimenting with material phenomena or the purpose of proving or illustrating natural principles and laws or in the study of pure and mixed mathematics. Exemption is accordingly claimed under Item 63.1 in the 1st section of the Sales Tax exemption and classification act. Signature of officer of school, university or organisation: (sign and name in capitals). Designation: (job title) Name of school, university or organisation (name) Signature of student: (your signature) Name and address of student: (yours in capitals) Date: (date).

Please send me a ....calculator.

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I understand that the $2.00 for post and packing includes insurance.

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....POSTCODE..........

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Including Tax $39.75

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YES!

A REAL SCIENTIFIC CALCULATOR FOR $37.50 TAX FREE

NOVUS Statistician

6030 Statistician features single key summation of x,x2, and n* single key calc of mean and standard deviation* single key sum of x and y values for linear correlation and regression* single key calc of linear correlation coef. and slope of curve * single key calc of y-axis intercept of any point on y-axis* Mean and standard deviations * *separate key for removing incorrect x or y* square, square root and change sign * 8 digit LED display * Auto repeat add or subtract * Full accum memory * auto constant * live percent key * single key clears statistical summations.

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INTERNATIONAL CONVERSION COMPUTER

Tax Free $55.40
Inc Tax $59.95

Complete conversion calculator to convert metric to metric, imperial to imperial, metric to imperial, imperial to metric, for volume, area, temperature and weight and square root, reciprocal, PI, auto constant, percent and full accumulating memory, 8 digit, floating decimal four function. 12 month guarantee, 9 V battery. Ideal for builders.

NOVUS 826

826 has single storage memory, percent, constant and display recall. 8 digit floating decimal $19.95 ($18.20)

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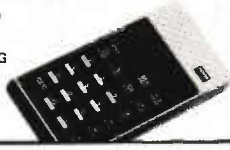

824R

824R full accumulating memory plus manual keyed memory, line percent key, constants. change sign, exchange repeat add/subtract, chaining 8 digit floating decimal Rechargeable cells plus charger 5 x 2½ x 1in $48.95 ($44.50)

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6025 Programmable Financier features 100 step key-board programming facility * 8 digit * Full accumulating memory plus and equals keys * Live % key * Separate memory registers for storing amount, interest * Single key calculations of complex financial problems of loans, repayments, savings etc.* Single key calc. of profit and margin * Powers, roots and change sign etc $135.95 ($123.95)

TAX FREE $123.95
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NOVUS 650~Matchbox

650 features 4 function operation, fixed 2 place decimal point, 6 digit LED readout Measures 5 x 2½ x 1 in.

Tax Free $11.40
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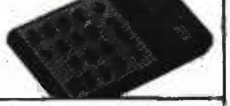

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850 full 4 function, floating decimal, 6 digit LED, display recall, 9V operated 5x2½x1 in.

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NOVUS 4510 MATHEMATICAL CALCULATOR

Features Reverse Polish Notation, 3 level stack plus separate accumulating memory display, 8 digit memory, 8 digit display. Logs, antilogs, sine, cos, tan etc., square root, squares squares, pi, reciprocals. We can't do it justice here so call in & see one or check page 59 of our new Catalogue.

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SPECIAL TAX FREE PRICE PRICE $54.00
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GUARANTEED FOR 12 MONTHS

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M91ED ELLIPTICAL STYLUS DELUXE CARTRIDGE
Optimized design parameters in the stylus ass assembly give this new Deluxe cartridge superb high frequency trackability, and overall performance second only to the incomparable V-15 Type 111.
Specifications: Tracking Force: ¾ to 1½ grams
Frequency Response: From 20 to 20,000 Hz.
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M75—6S
Spherical Stylus Hi-Track Cartridge.
SPECIFICATIONS: 2 grams tracking force:
Frequency Response: from 20 to 20,000 Hz.
Rec. Retail: $19.00 OUR PRICE: $13.50

M55E
A popular cartridge that gives professional performance within a moderate budget. Incorporates Bi Radial elliptical stylus.
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- Head phone jack, Pause, Dual VU meters, Rotary (no dust) volume controls. Tape Dolby selectors, 3 digit counter (355W x 116H x 244D mm) 240V a.c.
- Output 0.42V @ 50k headphone 45mV @ 8ohm
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This month only save $30 at our bottom-of-the-barrel price of only **$199**

p&p Road freight $3.50

LATEST NEWS: Extra duty on headphones, buy now & SAVE!

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De-luxe headphones featuring adjustable head band plus soft padding for the ears and for the top of the head.
Individual volume controls + stereo mono switch Impedance 8ohm.
Curl-cord extends to a full 9' with standard stereo jack fitted.

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An 8ohm headphone at a realistic price.
Cushioned pads on these phones let you drift into another world. Expanding headband suits egotists and diet watchers.
Enter the world of stereo with the SM220
Complete with lead and stereo jack.
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Dick has the answer with the 'Cassette Tension Winders'
Use them to take up slack or for easy editing and repairs.

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Now everyone can have Quadraphonic Sound with these fantastic little extension speakers.

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Comprising balanced arm bug + ionizer + liquid. SAVE $3.95 on this item.
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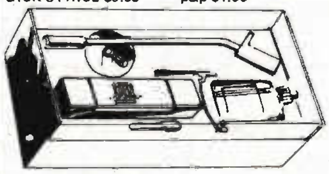

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Dual purpose Wet & Dry cleaning arms
SAVE $2.25
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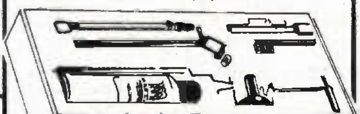

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Clean your records the easy way.
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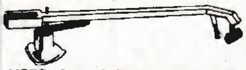

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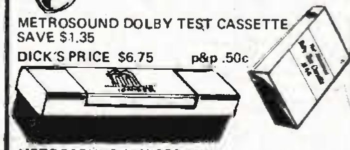

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Improved model of humid, soft velvet containing a special anti static agent.
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AM.FM STEREO/MONO Fantastic F.M.Tuner

SAVE $10

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"Very good value indeed" Neville Williams, Electronics Australia, Feb. 75

~~$75~~ $65

Don't take our word for it, see the review in Feb. E.A. The Echosound Tuner is incredible value for money. Has separate AM and FM front ends. 10 transistors and 14 diodes. Covers FM 88 to 108 MHz AFC, 60db S/N, 35 db sepn. 600mV output AM 535 to 1605kHz, ferrite rod antenna. Features multiplex adaptor complete with built-in stereo indicator. 240V operation. Complete in Walnut case.
Guaranteed for 12 months.

SAVE on Hi-Fi

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CONCORD 15 ... A NEW SPEAKER SYSTEM FROM EXPO

A system using an 8" woofer and 2" tweeter in a box measuring 530mm (H) x 330mm (W) x200mm (D). Power handling rated at 15Wrms at 8ohm.

These units have a real beaut moulded black front. The cabinets have a Walnut finish. Come along to DICK SMITHS and listen to this new system.

SPECIAL PRICE $75 pair
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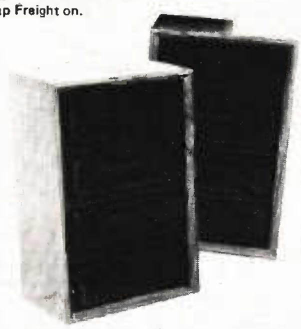

DYNACO SPEAKER SYSTEMS

A10 15–50 watts RMS 8½"x15"x8"(deep) 8ohms. A bookshelf system with a superb sound.

A25 20–60 watts RMS 11½"x20"x10" deep 8ohms. A slightly better bass than the A10.

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All three speaker systems use the Aperiodic System. This essentially means a non resonant sound. i.e: very good sound.

All units freight on.

A10 PER PAIR **$149.00** SAVE $9

A25 PER PAIR **$240.00** SAVE $18

A35 PER PAIR **$290.00** SAVE $28

All Dynaco speakers designed for vertical or horizontal operation!

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We continue our superb Prices on cassettes

BASF	Singles	5	10	20
C60LHSM	2.50	2.00	1.85	1.55
C90LHSM	3.00	2.50	2.20	2.00
C90SMCrO2	3.50	3.00	2.75	2.50
And now HITACHI Cassettes				
C60LN	1.69	1.49	1.39	1.29
C90LN	2.25	1.99	1.84	1.69
C60UD	2.60	2.45	2.29	1.99
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For SONY enthusiasts, we have a few Sony HF Tapes left:				
C60		2.75	2.50	2.30
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SUPER SPECIAL

CANNOT BE REPEATED OFFER ON CrO_2,C60

SPECIAL MECHANICS LIBRARY PACKS
Singles Price $1.75
10 or more $1.50
Dick has a few thousand only get in early on this item.
SAVE AT LEAST $2.40!!

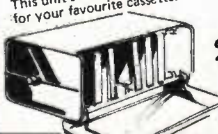
p&p			
1 tape	.50c	10 tapes	$1.00
5 tapes	.75c	20 tapes	$1.75

don't forget P&P

p&p	
1 tape	.50c
5	.75c
10	$1.00
20	$1.75

DON'T SLING YOUR CASSETTES AROUND IN THE CAR

Dick offers an under-dash cassette holder moulded in black plastic with clear front lid. Holds ten cassettes and cases complete with bracket and labels.
This unit saves the inconvenience of searching for your favourite cassette.



$3.99 p&p 75c

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Electric antenna that goes up and down at the flick of a switch. 39" extension in 5 sections. Beat the vandals . . . .

AND BEAT THE PRICE RISE . . . .

Duty on these units will put price up at least 40%. BUY NOW AND SAVE.

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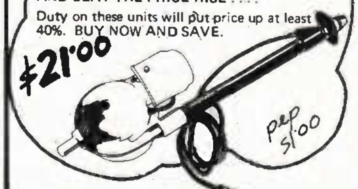

p&p $1.00

This months BIG SAVERS

No.	Product	List	Our Price
20	Expo TA3100 Stereo Amp	$95.00	$80.00
30	Expo CR50 Tuner Amp	$119.00	$99.00
3	Monarch SA800 Stereo Amp	$249.00	$210.00
3	Pioneer SA6200 Stereo Amp	$239.00	$199.00
1	Crown TV + Radio	$199.00	$179.00
6	AWA Stereo Cassette Decks	$125.00	$99.00

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(Nr Chapel Rd)

Prices to nearest dollar asterisk indicates sales tax must be added.
AR – price available on request.

ORGANIZATION

MANUFACTURER (Distributor)	MODEL	RPN logic	Algebraic logic	No of digits	SN No of Digits	Exponent digits	Engineering notation	Range (decades)	RPN stack – No.	Addressable memories	Roll down stack	LAST x' register	Program steps	M↔x
HEWLETT PACKARD	HP21	•		10	8	2		200	4	1	•	•		
	HP25	•		10	8	2	•	200	4	8	•	•	49	
	HP35	DISCONTINUED REPLACED BY HP21												
	HP45	•		10	10	2		200	4	9	•	•		
	HP46	•		10	10	2		200	4	9	•	•		
	HP55	•		10	10	2		200	4	20	•	•	49	
	HP65	•		10	10	2		200	4	9	•	•	100	
	HP70	•		10	10	2		200	4	2	•			
	HP80	•		7	10	2		200	4	1	•			
	HP81	•		7	10	2		200	4	20	•			
NOVUS (National Semi-conductor)	4510	•		8				16	5	1				
	4515	•		8				16	3	1			100	
	4520	•		8	8	2		200	4	1	•			
	4525	•		8	8	2		200	4	1	•		100	
	6010		•	8				16		1				
	6020		•	8				16		2				
	6025		•	8				16		2			100	
	6030		•	8				16		1				
	6035		•	8				16		1			100	
HANIMEX	VP8SR		•	8						1				•
	ESR100		•	8						1				•
	ESR1010SN		•	8	8	2				1				•
	ESR Master		•	8	8	2				1				•
PANASONIC (Haco)	JE5001U		•	8				15		1				•
QUALITRON (Photo Import)	1438		•	8						2				
	1439		•	8						4				
	1445		•	8						1				•
	1408		•	8						1				
	1448		•	8	5	2				1				•
	1419		•	14	10	2				1				•
	1420		•	14	10	2		200		1				•
KINGSPOINT ELCON (EMAIL) (EMONA)	SC33		•	8	8	2		200		1				
	SC40		•	10	10	2		200		1				
	SC44		•	8	8	2		200		1				
	SC60		•	10	10	2		200		2				•
CASIO (Peacock Bros)	FX11		•	8										
	FX15		•	8	6	2		80		1				
COMPUCORP (Datanamics)	BETA 326		•	13	10	2		200		12		•	160	•

PREPROGRAMMED FUNCTIONS

MODEL	%	1/x	x²	√x	yˣ	log x	ln x	eˣ	10ˣ	x!	π	Δ%	x↔y	Trig	Hyperbolic Trig	Rectangular↔Polar	Deg/Radians	Grads	Vector arithmetic	Metric Conv	No Statistics function	No Business functions
HP21		•		•	•	•	•	•	•		•		•	•		•	•					
HP25		•	•	•	•	•	•	•	•		•		•	•		•	•	•	•		4	
HP35																						
HP45	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	3	3	
HP46	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	3	3	
HP55	•	•	•	•	•	•	•	•	•		•		•	•		•	•	•	•	7	5	10
HP65		•	•	•	•	•	•	•	•	•	•		•	•		•	•	•	•		5	17
HP70	•											•	•									6
HP80	•			•	•							•	•								4	10
HP81	•			•	•	•						•	•								5	19
4510		•	•	•	•	•	•	•			•		•	•			•				1	
4515		•	•	•	•	•	•	•			•		•	•			•				1	
4520		•			•	•	•	•	•		•		•	•								
4525		•			•	•	•	•	•		•		•	•								
6010	•	•		•							•									20		
6020	•			•	•							•	•									11
6025	•			•	•							•	•									11
6030	•		•	•																	9	
6035	•		•	•																	9	
VP8SR		•		•			•	•			•			•			•					
ESR100		•		•	xʸ	•	•	•			•		•	•			•					
ESR1010SN		•		•			•	•			•			•			•					
ESR Master		•		•	•	•	•	•	•	•	•		•	•		•						
JE5001U		•		•	•	•	•	•	•		•		•	•	•		•	•			1	
1438																				24		
1439	•			•								•									14	
1445		•		•	xʸ	•	•	•			•		•	•			•					
1408		•		•																12		
1448		•		•			•	•			•			•			•					
1419		•		•	xʸ	•	•	•			•		•	•	•		•					
1420		•	•	•	xʸ	•	•	•		•	•		•	•			•				14	
SC33		•	•	•	xʸ	•	•	•	•					•								
SC40		•	•	•	xʸ	•	•	•	•		•		•	•			•					
SC44		•	•	•	xʸ	•	•	•	•	•	•		•	•			•				1	
SC60		•	•	•	xʸ	•	•	•	•	•	•		•	•			•				9	
FX11				•	aˣ	•	•	•			•			•								
FX15		•	•	•	xʸ	•	•	•			•			•								
BETA 326		•	•	•	aˣ	•	•	•	•	•	•			•		•	•	•	•	15	5	

PROGRAMMING / GENERAL FEATURES

MODEL	Single Step	Editing	Run/Stop	Conditional Branching te	Conditional Branching fla	Direct Branching	Decrement and skip if zer	User definable keys	Perm. Prog. Storage	Labels	Timer	Printer	Battery saver feature	Battery operation	Charger	Mains adapter	Mains operation	PRICE $	
HP21														•	•			119*	
HP25	•	•	•	8		•								•	•			179*	
HP35																			
HP45														•	•			225*	
HP46												•					•	630*	
HP55	•	•	•	2		•					•			•	•			360*	
HP65	•	•	•	4	2	•	•	5	•	15				•	•			760*	program cards available for most common problems.
HP70														•	•			152*	
HP80														•	•			268*	
HP81												•					•	950*	
4510													•	•		A		60	
4515	•	•	•										•	•	•			100	
4520													•	•	•			80	
4525	•	•	•										•	•	•			150	
6010													•	•		A		60	US/metric convertor
6020													•	•		A		80	sum of digits depreciation.
6025	•	•	•										•	•	•			136	
6030													•	•		A		86	
6035	•	•	•										•	•	•			136	
VP8SR														•		A		40	
ESR100														•		A		60	
ESR1010SN														•		A		70	
ESR Master														•		A		90	D° → R°, R° → D°. 2 levels of parenthesis.
JE5001U														•				70	DMS → → DMS, $\sqrt[3]{x}$, item counter
1438														•	A			AR	Universal converter, land nautical, Imperial, US to metric
1439														•	A			AR	item counter incorporated
1445														•	A			AR	
1408														•	A			AR	Imperial to metric converter
1448														•	A			AR	
1419														•	A			AR	
1420														•	A			AR	1 level of parenthesis.
SC33													•	•	•			42*	Two levels of parenthesis on 40, 44 and 60
SC40													•	•	•			70*	
SC44													•	•	•			65*	ever-flow and underflow possible
SC60													•	•	•			115*	to 10^{199}, argument limits permitting.
FX11														•		A			no inverse trig.
FX15														•		A		86	sexagesimal to decimal conversion
BETA 326	•	•	•	7			•		•	13				•	•			1067	Resting of parenthesis to four levels. Cassette recorder for program storage included in price. Pre-prog. cassettes avail.

MANUFACTURER (Distributor)	MODEL	RPN Logic	Algebraic logic	No of digits	SN No of digits	Exponent digits / Engineering notation	Range (decades)	RPN Stack – No.	Addressable memories	Roll down stack	LAST x' register	Program steps	M↔x
HORNET (Kitsets)	SR30		•	8					1				•
SHARP	EL1100		•	10	10	1	200		1				•
	EL8104		•	8					1				
	EL8300		•	8									
	PC1001		•	10	10	2	200		8			64	•
	PC1002			10	10	2	200		8			300	•
	PC1802		•	8					1				
FORDS (Dick Smith)	SC85M		•	8					1				•
LLOYD'S	999		•	8					1				•
(WHK)	333		•	8	5	2	200		1				•
COMMODORE (WHK)	F4146R		•	10	10	2	200		2				
	SR414		•	10	10	2	200		2				
	SR8120D		•	8	8	2	200		2				
	SR9120D		•	8	8	2	200		2				
RICOH (J. Renwick)	1623		•	16					2				
SANYO	CZ0111		•	8	8	2	200		1				
	CZ0123		•	8	8	2	200		2				
	CZ2171		•	10	10	2	200		1				
	CZ8109		•	8					2				
	CZ8125		•	8	5	2	200		1				
COMPUAD	ESR		•	8					1				•
ADLER	84F		•	8					4				
	88T		•	8					1				•
	108T		•	8	8	2	200		1				•
FARAD	310		•	8					4				
	330		•	8	8	2			1				•
	808		•	8					1				•
	1233 S		•	8	8	2			1				•
TABULEX LAMBDA (FARAD)			•	8	5	2			1				
CANON	F2		•	8	8	2	200						
	F5		•	8					1	•	•		
	F6		•	8	8	2	200		2				
	F7		•	8	8	2	200		2				

PREPROGRAMMED FUNCTIONS

MODEL	%	$1/x$	x^2	$\sqrt{x}$	y^x	log x	ln x	e^x	10^x	x!	π	Δ%	x↔y	Trig	Hyperbolic Trig	Rectangular↔Polar	Deg/Radians	Grads	Vector arithmetic	Metric Conv	No Statistics function	No Business functions
SR30		•		•	a^x	•	•	•			•		•	•			•					
EL1100		•	•	•	•	•	•	•			•			•			•			3		
EL8104		•		•		•	•	•			•			•			•					
EL8300	•																			29		
PC1001				•	•	•	•	•			•			•	•		•					
PC1002				•	•	•	•	•			•			•	•		•			•	•	•
PC1802		•		•		•	•	•			•			•			•					
SC85M		•		•	x^y	•	•	•			•		•	•			•					
999		•		•	x^y	•	•	•	•		•			•			•					
333		•		•			•	•			•			•			•					
F4146R	•	•			•							•	•								•	
SR414		•	•	•	•	•	•	•	•		•		•	•		•				2		
SR8120D			•	•		•	•	•	•		•			•			•					
SR9120D		•	•	•	•	•	•	•	•		•		•	•			•			2		
1623	•			•																3	3	
CZ0111		•	•	•	•	•	•	•	•		•			•		•	•			1		
CZ0123		•	•	•	•	•	•	•	•	•	•		•	•			•					
CZ2171		•	•	•	•	•	•	•	•		•		•	•		•						
CZ8109	•			•								•										
CZ8125		•		•			•	•			•			•			•					
ESR		•		•		•	•	•			•		•	•			•					
84F	•											•								2	•	
88T		•		•		•	•	•			•		•	•			•					
108T		•		•	•	•	•	•	•	•	•			•			•					
310	•			•								•								2	•	
330		•		•	x^y	•	•				•		•	•	•		•					
808		•		•	x^y	•	•	•			•		•				•					
1233 S		•		•	•	•	•	•	•	•	•		•				•					
TABULEX LAMBDA		•		•			•	•			•			•			•					
F2		•	•	•	•	•	•	•	•													
F5		•	•	•	•	•	•	•	•		•		•				•					
F6		•	•	•	•	•	•	•	•	•	•					•	•	•				
F7		•	•	•	•	•	•	•	•	•	•					•	•	•	•			

PROGRAMMING / GENERAL FEATURES

MODEL	Single Step	Editing	Run/Stop	Conditional Branching tests	Conditional Branching flags	Direct Branching	Decrement and skip if zero	User definable keys	Perm. Prog. Storage	Labels	Timer	Printer	Battery saver feature	Battery operation	Charger	Mains adapter	Mains operation	PRICE $	
SR30														•		A		39	
EL1100														•		A		100	Decimal to DMS conversion
EL8104														•		A		70	3 conversion factor memories, fractional calculation.
EL8300														•		A		80	Nautical/land US/IMPERIAL to metric converter
PC1001																	•	295	Interchangeable PROMs available for business
PC1002								•	•								•	395	statistics etc. also programmable to customer specification.
PC1802														•		A		70	
SC85M														•		A		39*	
999														•		A		63	Key for $m + x^2$
333														•	A	A		47	
F4146R														•	A			71	full range of financial computations $x\sqrt{y}$
SR414														•	A			71	Parenthesis keys.
SR8120D														•	1	A		47	
SR9120D														•		A		53	Parenthesis keys. $x\sqrt{y}$
1623																	•	265	
CZ0111														•		A		79*	grads, decimal degrees to DMS, radians grads to degrees.
CZ0123														•	·	A*		99*	2 levels of parenthesis.
CZ2171														•	A			79*	2 levels of parenthesis, nicad batteries
CZ8109														•		A		62*	financial calculations, summations and averages, sell, cost margin trend
CZ8125														•		A		58*	
ESR														•		A		49	rad to deg, deg to rad.
84F														•	•			80	standard financial calculations
88T														•	•			80	
108T														•	•			119	
310														•	•			65*	Standard financial calculations.
330														•	•			70*	
808														•	•			55*	Rad to deg, deg to rad.
1233 S														•	•			75*	
TABULEX LAMBDA														•				40*	
F2														•		A	1	AR	No inverse trig functions
F5														•	•			AR	F6,F7 dec deg — DMS, grads. 8 deep parenthesis. F5,6,7
F6														•	•			AR	interchangeable nicads or dry cell cassettes and charger
F7														•	•			AR	supplied. F7 full range of metric conversions, fractional arith.

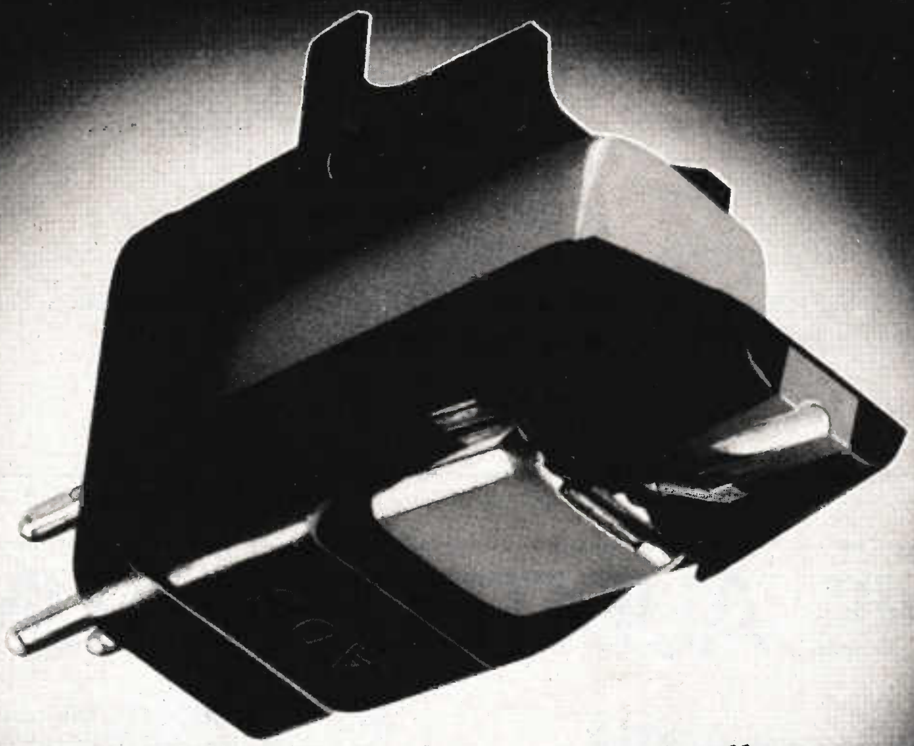
FREQUENCY RESPONSE "The CBS STR-100 test record showed less than ± 1.5dB variation up to 20,000Hz". *Stereo Review.*
"...response is within ± 2dB over the entire range". *Audio*
"Frequency response is exceptionally flat". *High Fidelity*

TRACKING "This is the only cartridge we have seen that is really capable of tracking almost all stereo discs at 0.4 grams". *Stereo Review*
"The XLM went through the usual torture test at 0.4 grams (some top models require more than a gram)". *High Fidelity*
"The XLM is capable of reproducing anything found on a phonograph record". *Audio*

DISTORTION "Distortion readings...are almost without exception better than those for any other model we've tested". *High Fidelity*
"The XLM has remarkably low distortion in comparison with others". *Audio*
"At 0.6 grams the distortion was low (under 1.5 per cent)". *Stereo Review.*

HUM AND NOISE "The XLM could be instrumental in lowering the input noise from the first stage of a modern transistor amplifier". *Audio*
"The cartridge had very good shielding against induced hum". *Stereo Review*

PRICE "This would be a very hard cartridge to surpass at any price". *Stereo Review*
"We found it impossible to attribute superior sound to costlier competing models". *High Fidelity*
"Priced as it is, it is a real bargain in cartridges". *Audio*



..."in a class by itself."

That's the way *Stereo Review* described our ADC-XLM.

High Fidelity headlined their review, "superb new pickup from ADC" and went on to say, "...must be counted among the state of the art contenders."

Audio echoed them with, "The ADC-XLM appears to be state of the art."

With the critics so lavish in their praise of the XLM, there's hardly any necessity to add anything. Far better to let experts continue to speak for us.

ADC AUDIO DYNAMICS CORPORATION
Distributed by Auriema (A'asia) Pty Ltd
15 Orchard Road, Brookvale 2100. Phone: 939 1900

11104

Publisher's Announcement

B & W LOUDSPEAKERS

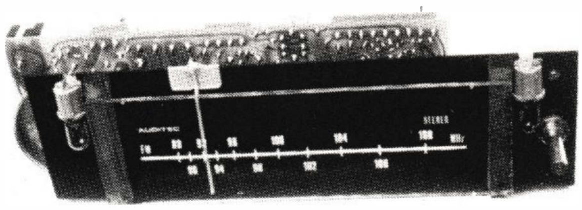
We regret that due to an error, the incorrect prices were shown in an advertisement for B&W loudspeakers published on page 117 of our September, 1975 issue.

The correct prices should have been as follows:-

D5 — $249 pair
DM4 — $399 pair
DM2 — $599 pair
DM70 — $1299 pair

All the above are recommended retail prices (including tax). We regret any inconvenience that may have been caused.

THE AUDITEC FM TUNER



ALL THIS

- Mounts easily against front panel
- Stereo/mono switching facility
- R.F. sensitivity control
- Low distortion (0.2% Typ.)
- Wide response (—3dB 15Hz — 15kHz)
- High pilot tone suppression (43dB)
- High O/P (1 volt)
- Tuning range 88-108 MHz
- Interstation muting, with control
- Stereo indicator lamp
- Edge-lit dial scale
- Tuning meter output
- High stereo separation
- Varicap diode tuning
- D.C. supply 30 volts to 50 volts
- Fully Australian designed and manufactured

For only

$69.95
+ 27½%
sales tax
(recommended)

AUDITEC MODULES ARE AVAILABLE FROM:

ALAN OLIVER ELECTRONICS PTY. LTD., 188 Pacific Hwy., St. Leonards, NSW 2065. PH: 43-5305

DELSOUND PTY. LTD., 35 Logan Rd., Woolloongabba, Qld. 4102. PH: 91-7048

BUNDABERG HI-FI, 244 George St., Bundaberg, Qld. 4670. PH: 71-3176

CUSTOM AMPLIFIERS, 64 Talbragar St., Dubbo, NSW 2830. PH: 82-3793

HI-FI GALLERY, 186 Bridge St., Tamworth, NSW 2340. PH: 65-7788

AND FROM: AUDITEC AUSTRALIA

AUDITEC AUSTRALIA
P.O. Box 228, Hornsby, NSW 2077. Phone: 47-4166

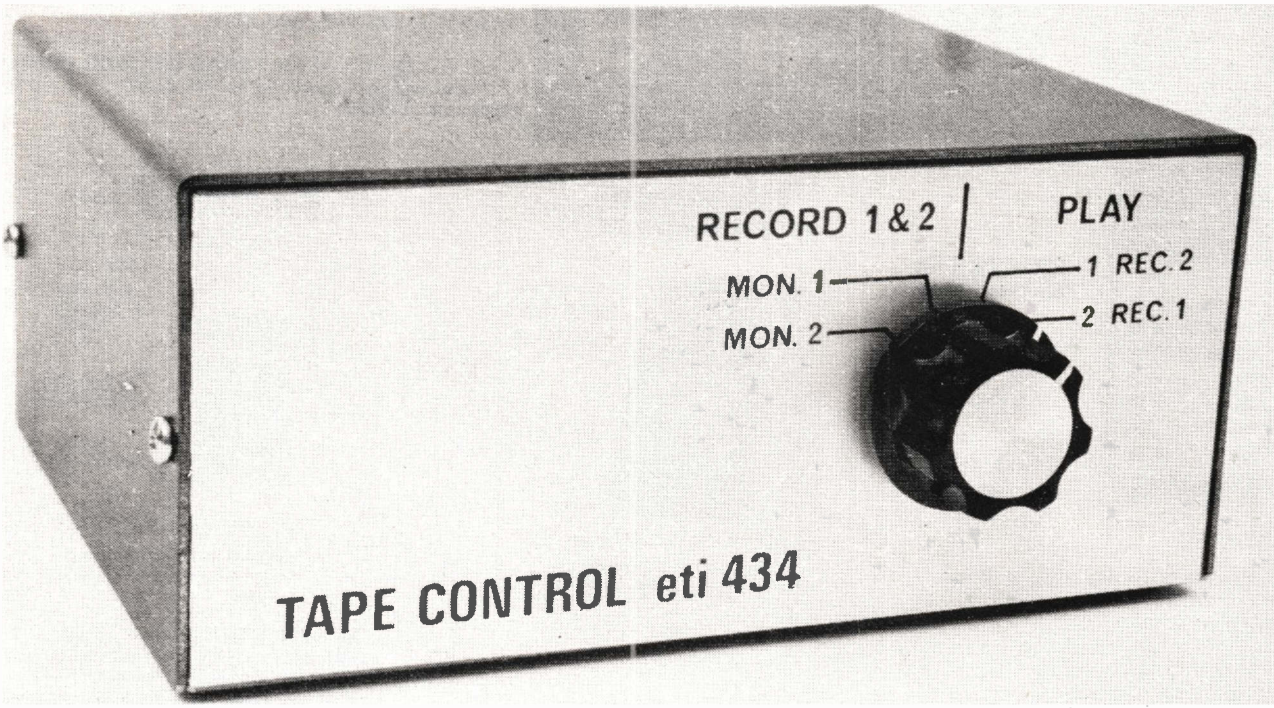
Please send details of the 030 F.M. stereo tuner, and other modules to:

Name ....

Address ....

.... Postcode ....

ET 10/75



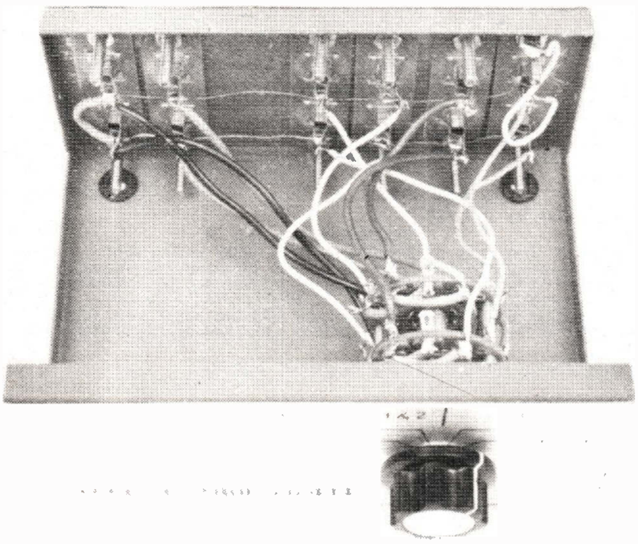
eti PROJECT 434

TAPE CONTROL UNIT

Use two tape recorders in any combination with this simple control unit.

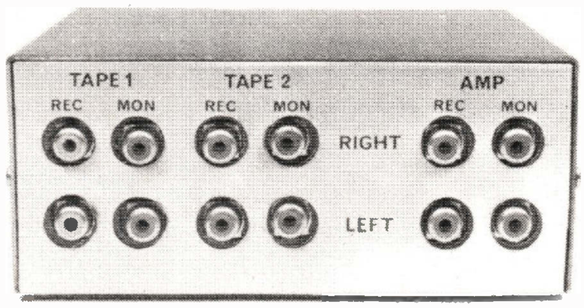
QUITE often the situation arises where it is required to transfer material recorded on one tape format to tape of another format, eg, reel-to-reel to cassette or vice versa. Or alternatively to copy material previously recorded on cassette by a friend to a cassette of your own. To do this one usually has to reconnect the system so that such a transfer may be made.

This simple little control box may be permanently installed in your system such that reconfiguration of leads is not necessary. It will greatly simplify



LEFT: Internal view of the control unit.

BELOW: Rear panel of the completed unit.



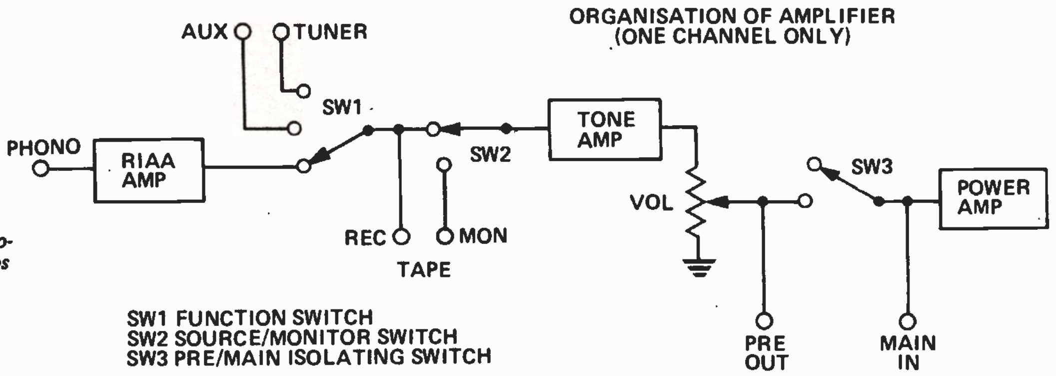


Fig. 1. Typical setup of an amplifier that incorporates facilities for one tape recorder only.

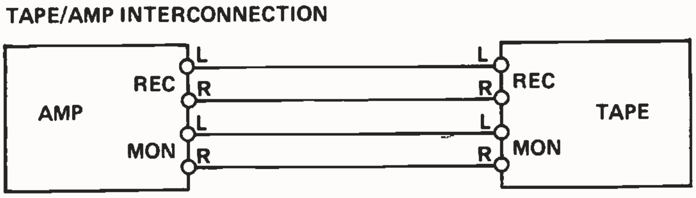


Fig. 2. How the amplifier of Fig. 1 is connected to the tape recorder.

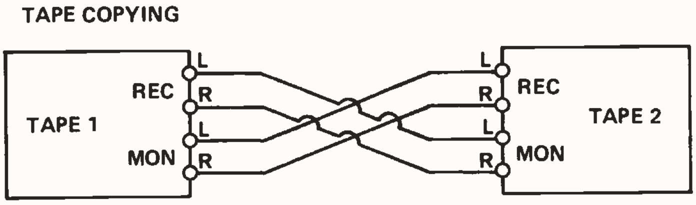


Fig. 3. For exchanging data between two tape recorders they must be configured like this.

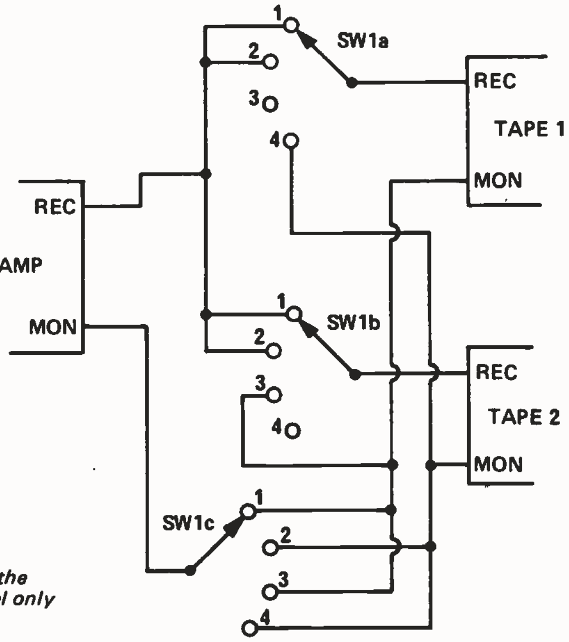


Fig. 4. Circuit diagram of the control unit – one channel only shown.

the task of copying taped material and will also allow the simultaneous recording of the source onto two tape recorders.

Most amplifiers have facilities for a single tape recorder and have switching typically organised as shown in Fig.1. The function switch, SW1, selects the desired input source and makes it available at the RECORD output socket for recording by the tape recorder. Switch SW2 selects this same output to the main amplifier and the speakers or, the MONITOR output from the tape recorder. Monitor switch SW2 thus allows you to listen to the source itself, eg the record player, or to the monitor of the tape recorder. A further switch, SW3, is sometimes incorporated to allow the preamplifier to be disconnected from the main amplifier.

Such an amplifier would be interconnected to the tape recorder as shown in Fig. 1. Left and right RECORD on the amplifier go to left and right RECORD on the tape recorder. The monitors are similarly interconnected one to one. If two tape recorders are to be interconnected for copying however, the RECORD socket of one must be connected to the MONITOR socket of the other as shown in Fig.2. This poses a problem where DIN leads are normally used as a crossover of connections is required that makes the normal DIN lead (as used between amplifier and tape recorder) useless. A special DIN lead is therefore required or, RCA sockets must be used. Once configured this way the recorders are completely disconnected from the amplifier. Thus the leads must be changed over again to restore normal system operation.

There are other lead configurations possible, with an amplifier and two tape recorders, but all methods suffer from various restrictions on flexibility and all require frequent changing of the leads. All these problems may be overcome by the use of a tape control box.

The interconnections of one channel only on our unit are shown in Fig.4. Switch SW1 is a six-pole, four-function rotary switch (three poles per wafer) where one three-pole wafer is used for each channel.

In positions one and two the source, as selected on the amplifier, may be recorded onto both recorders with the tape monitored being selectable. The amplifier monitor switch will of course still select tape or source for the power amplifier and speakers.

In position three of SW1 tape recorder one is monitored by the amplifier and is also fed to the input of tape recorder two. In position four tape recorder two is monitored and may be recorded onto tape recorder one.

In positions three and four the amplifier source/monitor switch can override the tape monitor and thus records etc, may be played whilst tape copying is being carried out completely independently.

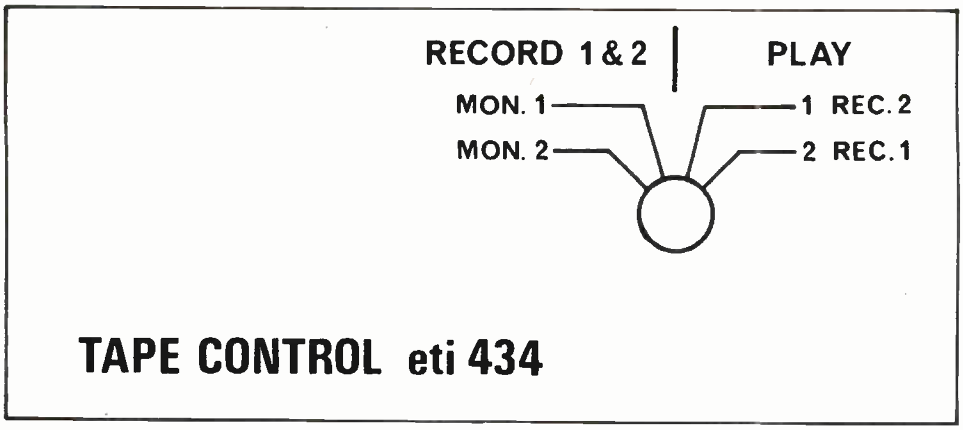


Fig. 5. Front panel artwork. Full size 134 x 58 mm.

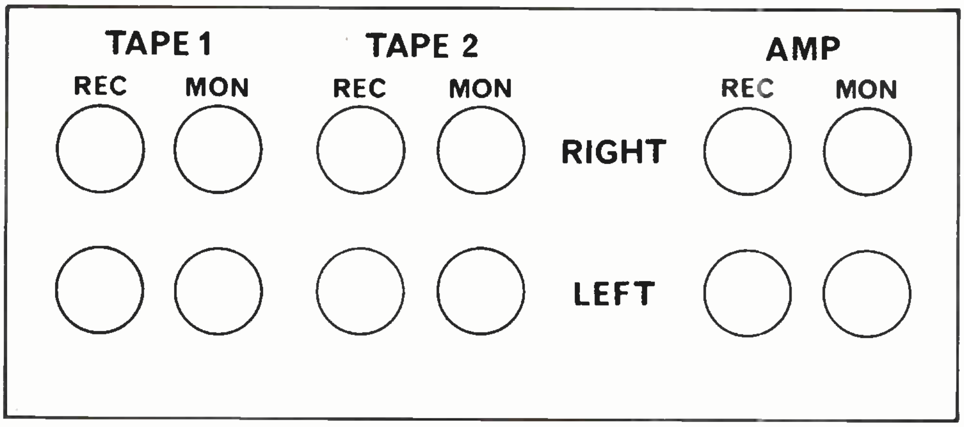


Fig. 6. Rear panel artwork. Full size 134 x 58 mm.

TAPE CONTROL UNIT

CONSTRUCTION

The smallest box that can readily be used is 135 x 58 x 105 mm. This size box is high enough to accommodate the twin RCA sockets (mounted vertically on the rear panel) and wide enough to accommodate three pairs of them without undue crowding.

The switch as supplied will probably have two wafers each of which has three poles. Two of the poles will be on the top side of the wafer and the other pole will be on the underside. Each of these wafers should be wired in accordance with Fig.4. To reduce confusion we found it best to use the two top poles for SW1a and SW1b and the underneath pole for SW1c. Prewire the switch leaving leads long enough for later connection to the sockets and then mount the switch in position on the front panel.

Mount the dual RCA sockets to the rear panel, link all the earth lugs with tinned copper wire and earth them to the metal case by means of a solder-lug under one of the screws.

Finally connect the switch wires to the sockets. ●

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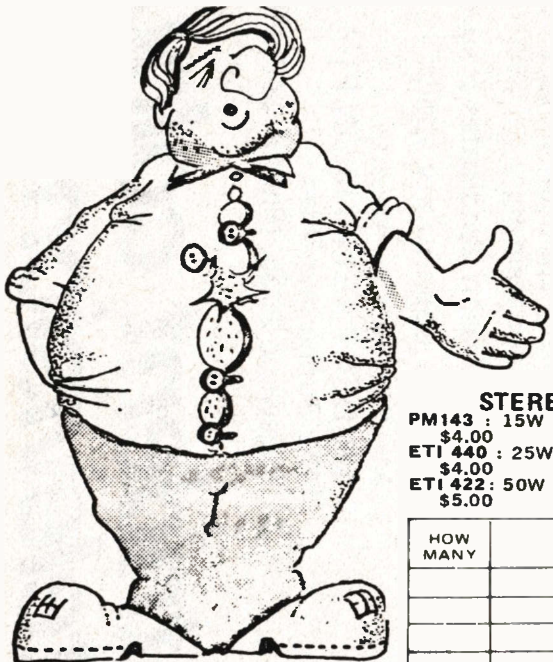

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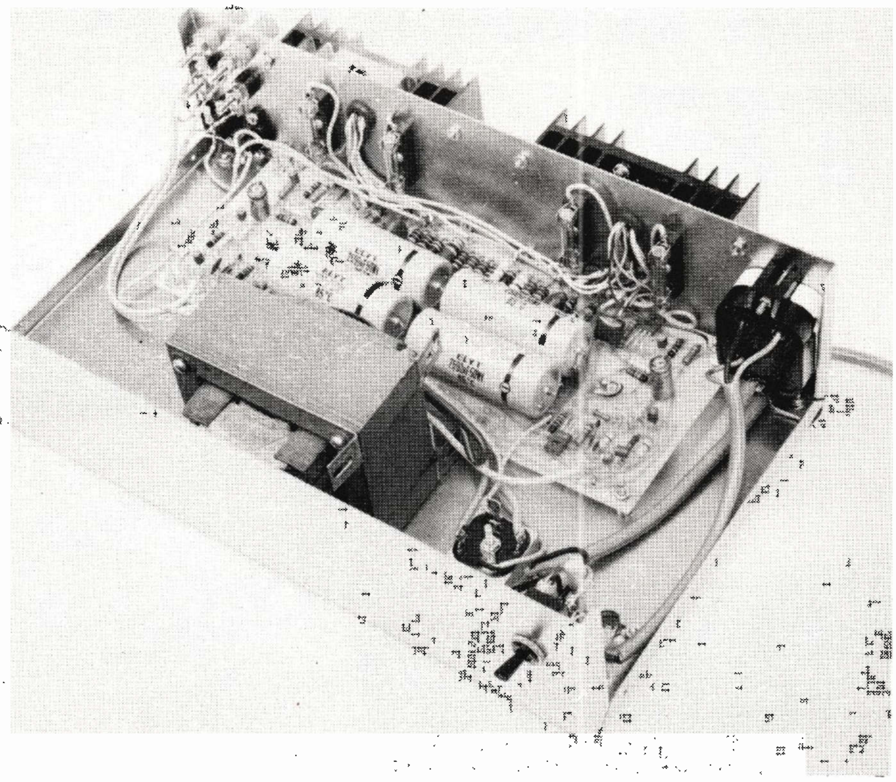
BOOSTER AMPLIFIER



The booster amplifier (cover removed).

PROJECT 422B

Increase the output from your existing amplifier to 50 watts per channel.

MEASURED PERFORMANCE OF THE PROTOTYPE

POWER OUTPUT			
Both channels driven into 8 ohm load		50 watts RMS	
FREQUENCY RESPONSE.			
20 Hz – 20 kHz		± 0.5 dB	
CHANNEL SEPARATION			
at rated output and 1 kHz		80 dB	
HUM AND NOISE			
With respect to rated output		–100 dB	
SENSITIVITY			
For 50 watts output		500 mV	
DISTORTION	100 Hz	1 kHz	6.3 kHz
1 watt	0.14%	0.11%	0.12%
5 watts	0.17%	0.13%	0.15%
10 watts	0.16%	0.11%	0.13%
50 watts	0.27%	0.38%	0.60%
DAMPING FACTOR		>70	

AFTER many years of faithful service you have finally decided to update your old Hi-Fi system with a new pair of speakers. Upon evaluation however, you find that the modern speakers you have chosen are much less efficient than those you presently have. This means that not only do you have to get new speakers, but you also have to replace an otherwise perfectly good amplifier because its five-to-fifteen watts output is no longer anywhere near enough. A pity, because there may be nothing wrong with the preamplifier and you may have to pay out $200 or more just to get that additional power.

An obvious solution is to retain your existing amplifier, which has all the facilities that you require, and obtain the extra power required by means of a booster amplifier. Unfortunately commercial booster amplifiers are very rare, if available at all. The ETI 422B is designed to fulfill this need and thus save the person updating his system a considerable number of dollars that need not be spent in replacing the preamplifier.

The ETI 422B is designed to be used as a main amplifier, driven from the existing preamplifier, or as a booster amplifier driven directly from the speaker output of the existing power

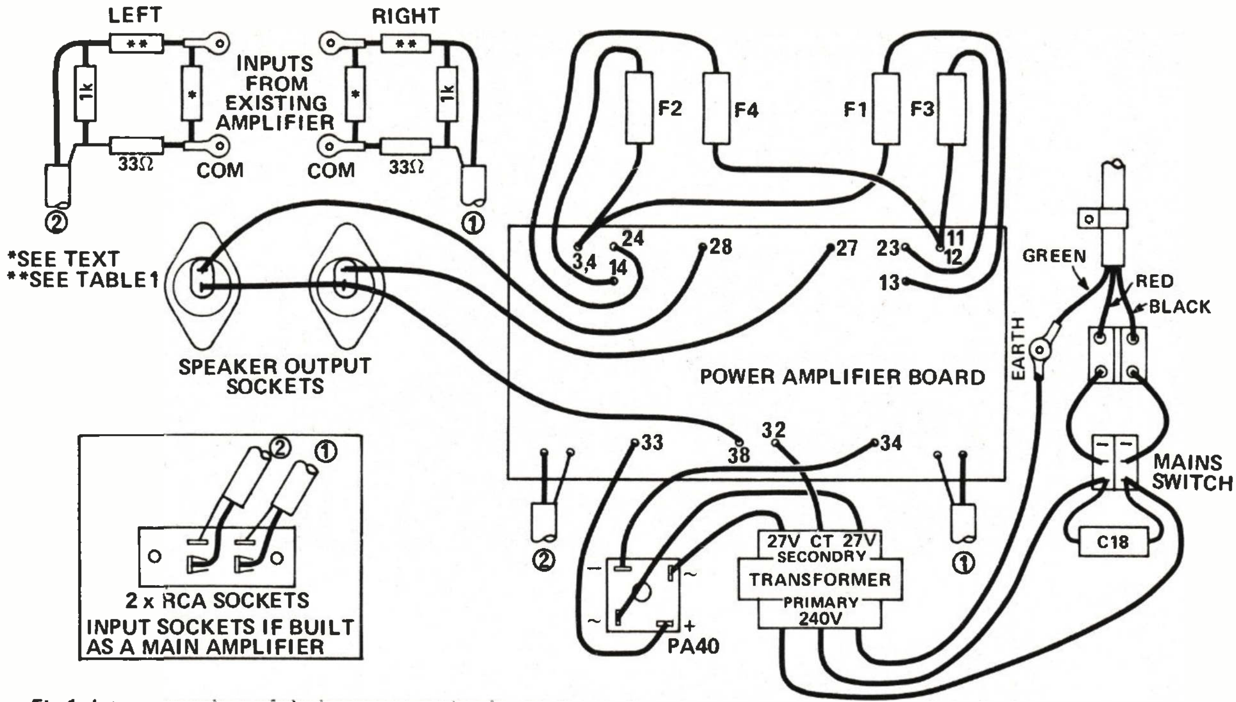


Fig. 1. Interconnections of the booster amplifier (heatsink not shown).

amplifier. It provides an output of up to 50 watts into 8 ohm speakers with a distortion that is typically around 0.2%.

It must be noted however that the distortion and noise cannot be less than that available from the existing amplifier and you must ensure that this amplifier is of good quality if this add-on technique is to be successful.

HOW IT WORKS

The amplifier is constructed around the power module from the ETI 422 first described in the May 1974 issue of ETI. The details of its construction and of how it works are reproduced elsewhere in this issue. The only additional circuitry required is that for the input attenuator or for a direct input depending on whether a booster or main amplifier approach is being used. We have used 33 ohm resistors in the earthy side of each input to prevent the damage which may occur to some amplifiers if the leads to the booster amplifier are inadvertantly connected the wrong way around.

CONSTRUCTION

Assemble the main amplifier printed-circuit board and the heatsink assemblies in accordance with the component overlays and drawings for the 422.

We mounted our prototype into the same size box, undrilled, as was used for the ETI 440 amplifier (July 1975). However any conveniently sized box would be suitable. To minimize hum pickup the transformer was mounted centrally to keep it as far away from the input circuits as possible. If a larger box is used put the transformer as far away as is possible from both inputs. Chassis mounting fuses were used as they are less expensive than the rear-panel mounting types, and only need to be changed on the very rare occasions when the speakers leads are accidently shorted.

The heatsinks used are the Mullard 35D type which are smaller than those originally used in the 422 amplifier. For domestic applications the larger heatsinks have been found to be unnecessary.

A power outlet socket was fitted to the amplifier so that the existing amplifier may be powered from it if required. The individual constructor may include or omit this socket as required. The interwiring details (except for the heatsinks) are given in Fig. 1. For the values of resistors required in the divider networks reference should be made to Table 1 as these will vary depending on the power output of the existing amplifier. If required these may be made adjustable by substituting a potentiometer (10 k) for the series resistor.

Most modern amplifiers can work into a high impedance without trouble. However some older types, especially those with an output transformer need to be terminated into the correct load. The resistors shown across the inputs are for this purpose and should be made equal in value to the nominal output impedance of the existing amplifier. The rating of these resistors should be about two watts. ●

TABLE 1

AMPLIFIER POWER (8 ohms)	VALUE OF SERIES RESISTOR
2W	2.7 k
5W	4.7 k
10W	6.8 k
15W	8.2 k
20W	10 k

PARTS LIST ETI 422B

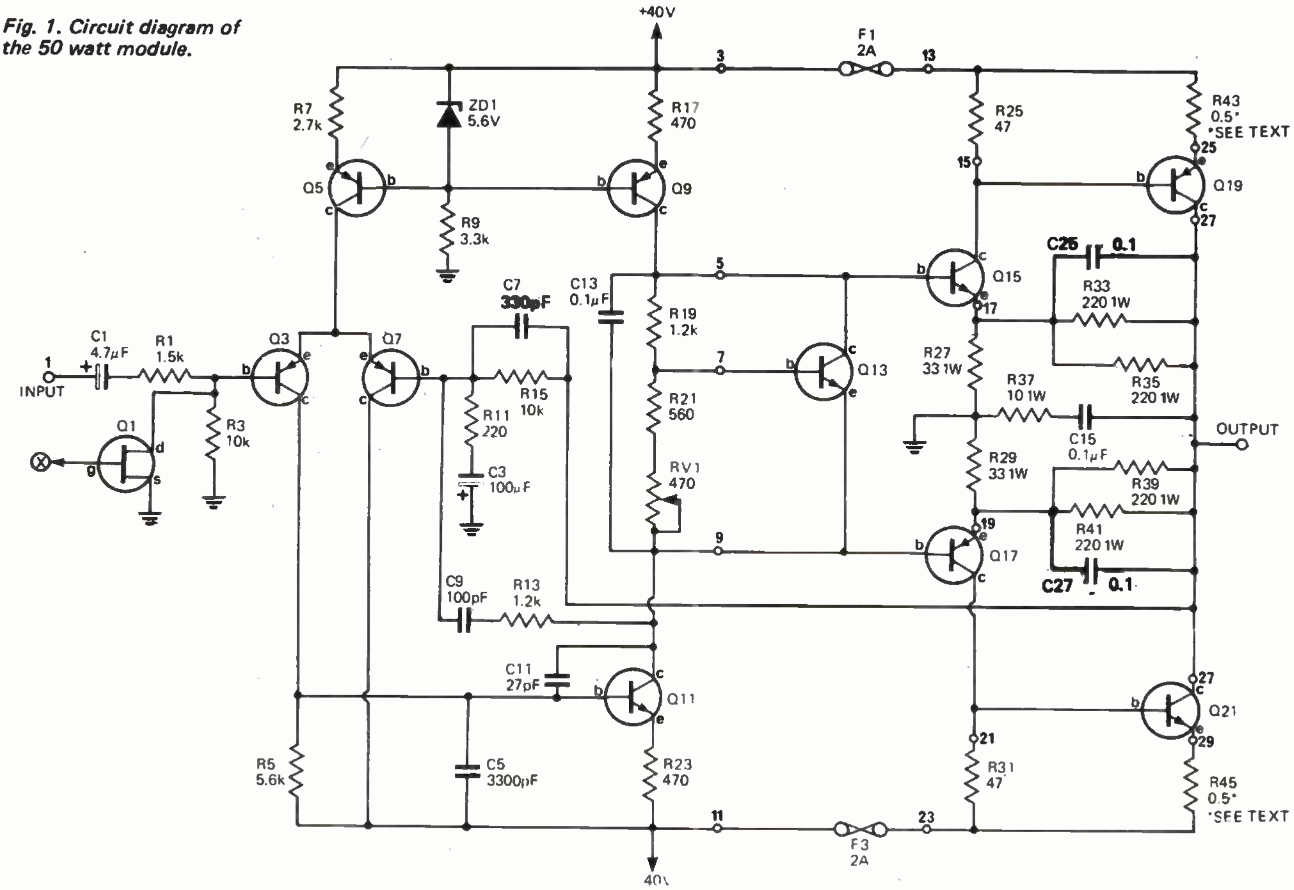
All components as per 422 parts list (page 58).
Chassis and cover as required.
4 input terminals
2 speaker sockets
Power outlet socket (if required)
Power switch (2 pole)
Neon indicator (If required)
Nuts, bolts, spacers etc.

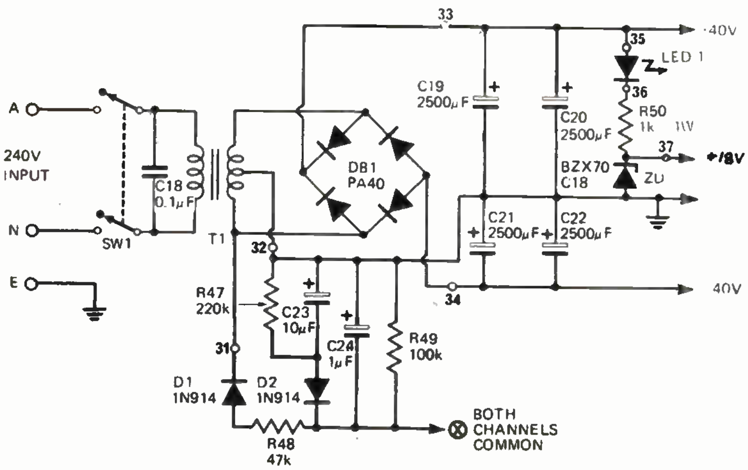
PROJECT 422

50 WATT POWER MODULE

Details of the basic amplifier used in the Booster and Crossover amplifier.

Fig. 1. Circuit diagram of the 50 watt module.





NOTES

Q1 2N5485
Q3,5,7 BC557,BC177
Q9,17 BD140
Q11,15 BD139
Q13 PN3643
Q19 MJ2955
Q21 2N3055

RIGHT CHANNEL ONLY SHOWN LEFT CHANNEL IS IDENTICAL EXCEPT COMPONENT NUMBERS ARE THE EVEN NUMBERS ie, R16 IS THE SAME AS R15

COMPONENTS D1,2 Q1,2 R47,48,49, C23,24 ARE ARE FOR THE DETHUMP CIRCUITRY AND MAY NOT BE REQUIRED

LED 1, R50 AND ZD3 ARE USED ONLY IF THE 422 PREAMPLIFIER IS USED

BOTH the add-on power-booster and crossover amplifiers described elsewhere in this issue use the power amplifier module out of the International 422 amplifier – described in the May 1974 issue of Electronics Today. As it is some time since this was published we are presenting details of this module again.

Most of the electronics is mounted on either the printed circuit-board or on the heatsinks. The board may be assembled in accordance with the component overlay diagram given. Note that capacitors C25, 26, 27 and 28 do not have holes provided for them and they are therefore mounted directly across resistors R33, 34, 41 and 42 respectively.

The heatsink should be assembled as shown in the photograph and the drawing. The transistors Q13 and 14 should each be epoxied into a hole in one of the heatsinks to ensure good thermal contact. Also secure all leads to the heatsink with epoxy. The interconnections between the printed circuit board and the heatsink should be carried out in accordance with the wire numbering on the diagrams. Final wiring details are given in the respective separate projects.

HOW IT WORKS – MAIN AMPLIFIER

The input signal is fed via C1 and R1 to the base of Q3 which, with Q7, forms a differential pair. Transistor Q5 is a constant current source where the current is [5.6 V (ZD1) – 0.6 (Q5)]/2700 (R7) – that is about 2 mA. This current is shared by Q3 and Q7. Transistor Q9 is also a constant current source supplying about 10 mA which, if no input signal exists, flows through Q13 and Q11. The differential pair controls Q11 and thus the voltage at its collector.

The resistors R19 and R21, together with potentiometer RV1, control the voltage across Q13 and maintain it at about 1.9 volts. But as Q13 is mounted on the heatsink, this voltage will vary with heatsink temperature. Assuming that the voltage at points 5 and 9 is equally spaced about zero volts (ie ± 0.95 volts), the current will be set at about 12 mA through Q15 and Q17. The voltage drop across the 47 ohm resistors (R25 and R31) will be enough to bias the output transistors, Q19 and Q20, on slightly to give about 10 mA quiescent current. This quiescent current is adjustable by means of potentiometer RV1.

Local feedback is applied to the output stage by the network R33, R35, R39 and R41, giving the output stage a voltage gain of about four. The overall feedback resistor, R15, gives the required gain control.

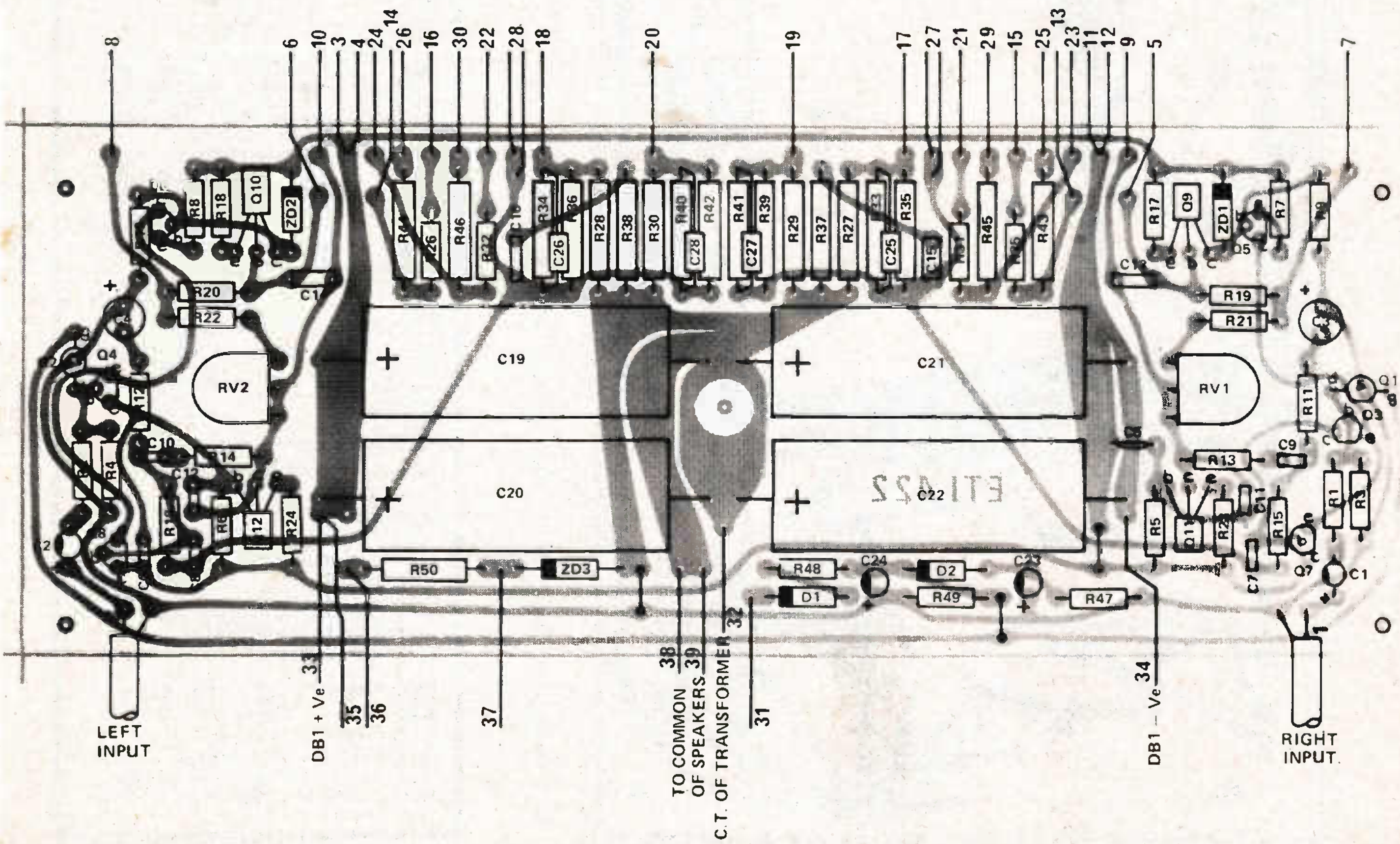
Protection to the amplifier, against shorted output leads, is provided by fuses in the positive and negative supply rails to both amplifiers.

Temperature stability is obtained by mounting Q13 on the heatsink. Q13 will thus automatically adjust the bias voltage. Frequency stability is ensured by C9/R13, C5, C7, C11, C25 and C27.

Although the power amplifier itself does not produce a thump in the loudspeakers on switch on, the preamplifier used may. To reduce any thump to an acceptable level, Q1 is used to short the input for about two seconds on switch-on and immediately after switch-off.

The power supply is a conventional full-wave bridge with centre tap, providing + 40 volts and –40 volts. Diode D1 is used to rectify a second negative supply which is used to control the FETs. Due to the resistance in series with the diode, the charge of C24 is slow. In addition, during the charge period, C23 is also being charged increasing the delay. On switch off, however, C23 cannot assist the voltage on C24 and the off-timing is much shorter than the on-timing.

Fig.3. Component overlay.



50 WATT POWER MODULE

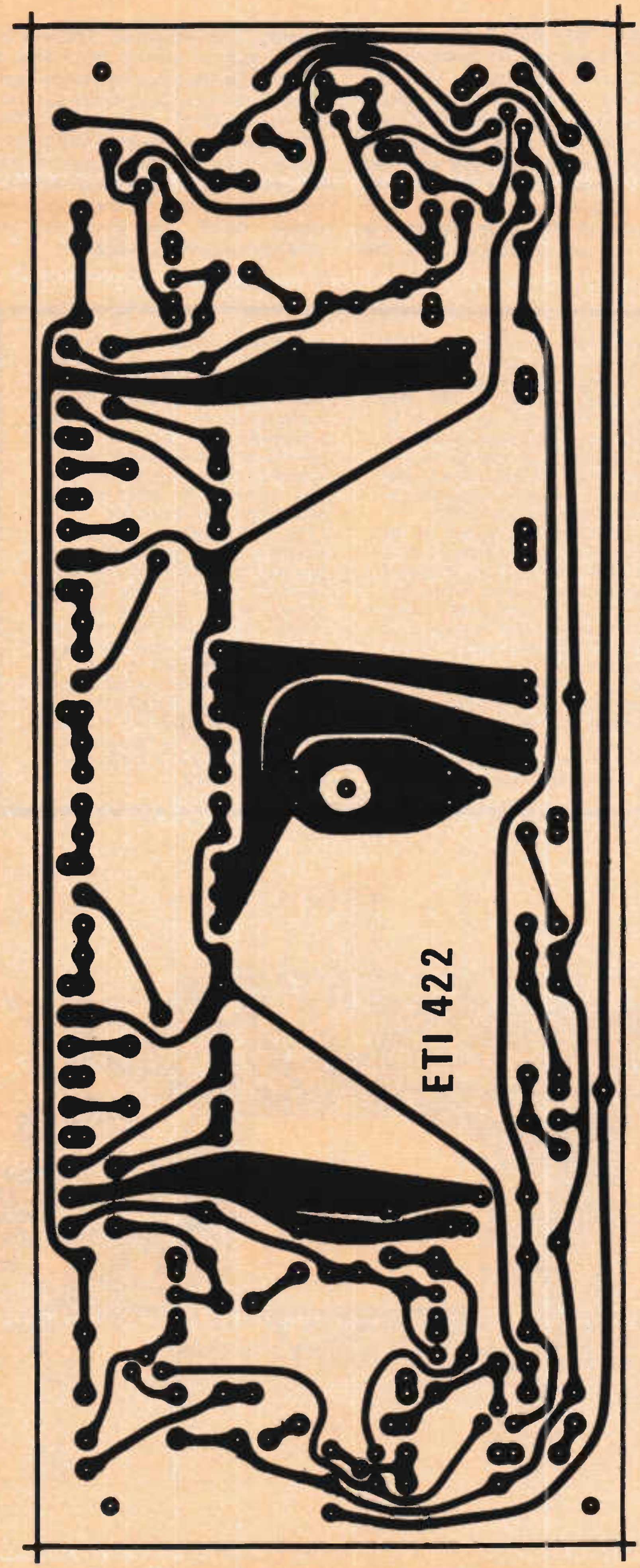


Fig. 4. Printed circuit layout for the amplifier. Full size 255 x 97 mm.

PARTS LIST
ETI 422 MAIN AMPLIFIER

R43,44,45,46	Resistor	0.5	ohm	2W*	
R37,38	"	10	"	1W	5%
R27,28,29,30	"	33	"	"	"
R25,26,31,32	"	47	"	½W	"
R11,12	"	220	"	"	"
R33,34,35,36	"	220	"	1W	"
R39,40,41,42	"	220	"	"	"
R17,18,23,24	"	470	"	½W	"
R21,22	"	560	"	"	"
R13,14,19,20	"	1 k2		"	"
R1,2	"	1 k5		"	"
R7,8	"	2 k7		"	"
R9,10	"	3 k3		"	"
R5.6	"	5 k6		"	"
R3,4,15,16	"	10 k		"	"

*If difficult to obtain, these resistors may be fabricated from a short length of electric jug element — about 90 mm is sufficient for each. Wind securely around a 1 watt resistor (100 ohms or higher) and solder into place.

RV1,2 Potentiometer 470 ohm Trim

C11.12	Capacitor	27 pF	ceramic
C9,10	"	100 pF	ceramic
C7,8	"	330 pF	ceramic
C5,6	"	0.0033 μF	polyester
C13,14,15,16	"	0.1 μF	"
C25,26,27,28	"	0.1 μF	"
C18	"	0.1 μF 250 Vac	
C1,2	"	4.7 μF 10V	Electro
C3,4	"	100 μF 10V	"
C19,20,21,22	"	2500 μF 50V	"

Q3,4,5,6,7,8	Transistor	BC177, 2N3645
Q9,10,17,18	"	BD140
Q11,12,15,16	"	BD139
Q13,14	"	PN3643
Q19,20	"	MJ2955*
Q21,22	"	2N3055*

*with mounting hardware

ZD1,2 Zener diode 5.6V 400mW

DB1 Diode bridge PA40

PC Board ETI-422
F1-F4 Chassis mounting Fuse holders and 2 Amp. Fuses.
T1 Transformer 56V CT PF3577 or similar
Heatsinks 2off 75mm of 35D (Philips)

If the dethump circuitry is required add the following components.

R47 Resistor220 k

R47	Resistor	220 k	½W	5%
R48	"	47 k	"	"
R49	"	100 k	"	"
D1,2	Diode	1N914		
Q1,2	Transistor	2N5485		
C23	Capacitor	10μF 25V	electro	
C24	"	1μF 25V	"	

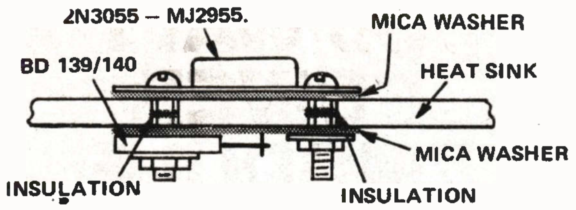
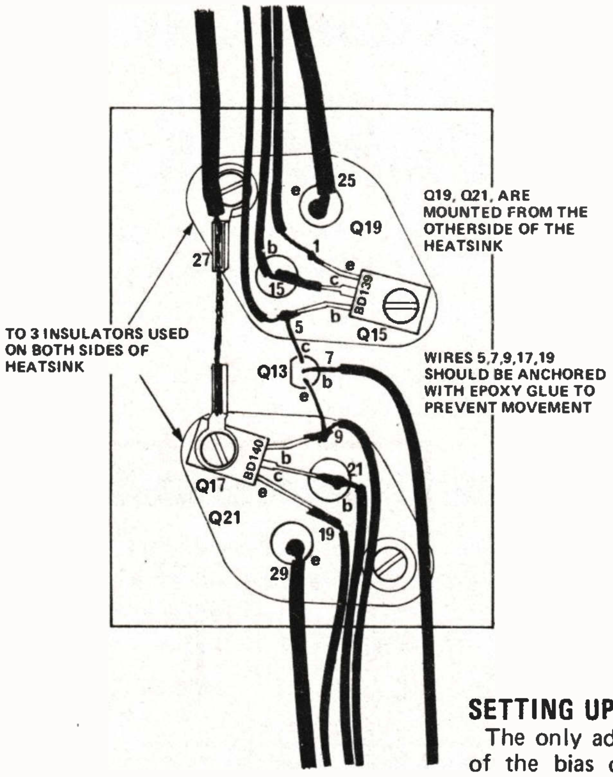
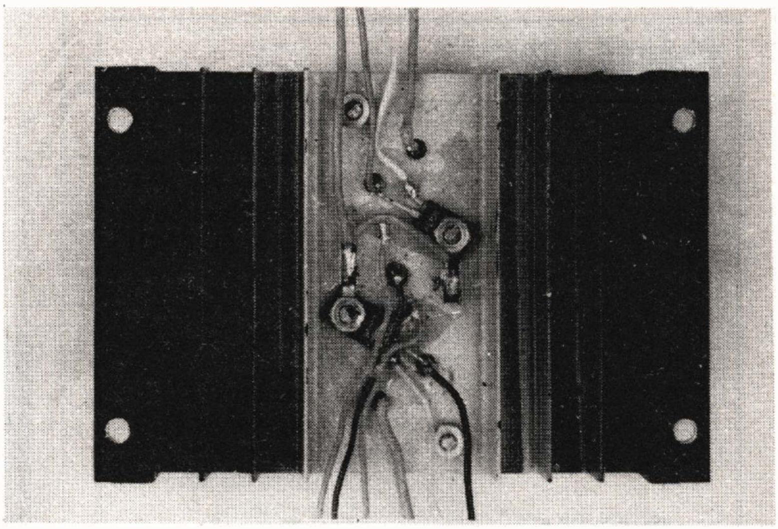


Fig. 2. How the heatsinks are assembled.





How the completed heatsink assembly appears.

SETTING UP

The only adjustment required is that of the bias current. This is normally done with an ammeter in the power-supply lead to the output stage and, with the speaker disconnected and no signal, RV1 is adjusted to obtain a current of about 20 milliamps. However if a major fault exists, or occurs, with the above method the meter as well as the output transistors may be damaged.

To obviate this we recommend a different approach as follows. Take out the fuses and temporarily connect a 220 ohm half-watt resistor across the fuse holder. Adjust RV1 to obtain about four volts across these resistors. If a major fault exists these resistors will get hot and possibly burn out. However no other damage will occur to the amplifier as the resistors limit the maximum current that can flow. After bias adjustment these resistors are removed and the fuses replaced.

It may be found that the voltage across the resistor in the positive lead is slightly different from that across the resistor in the negative lead. This is due to a slight offset in the output voltage but as long as the average is about four volts it will be satisfactory.●

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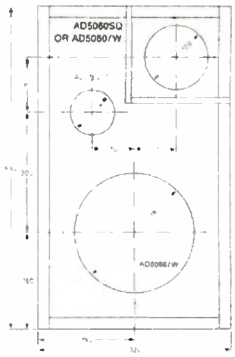

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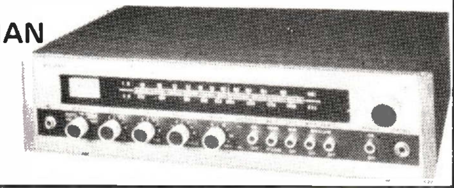

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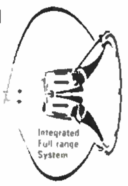

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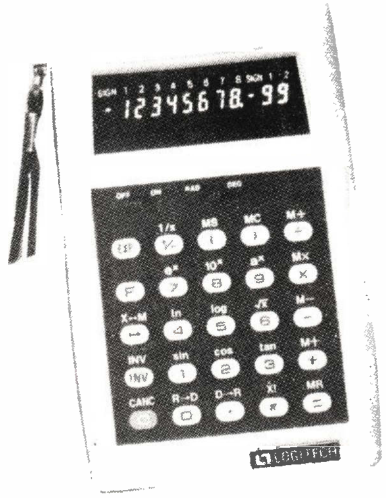

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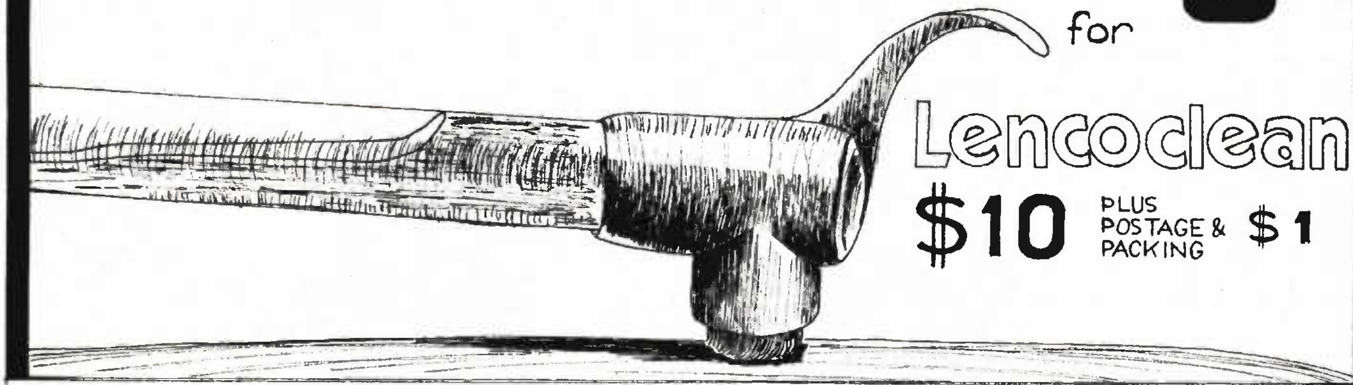

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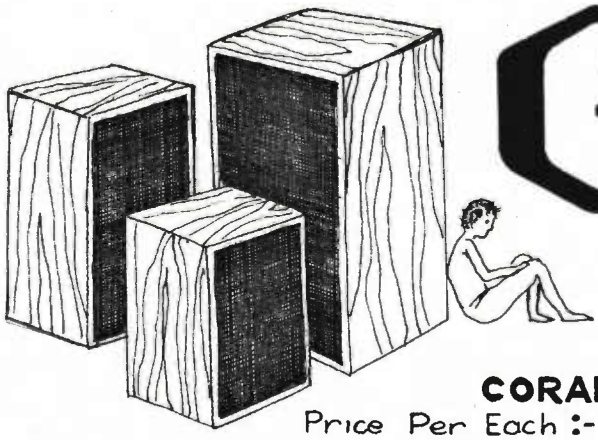

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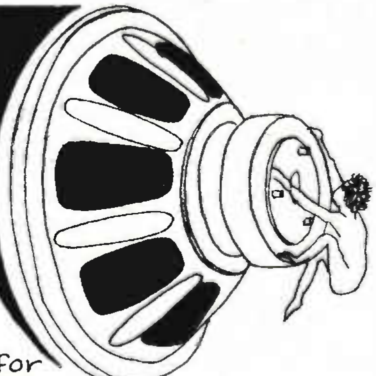

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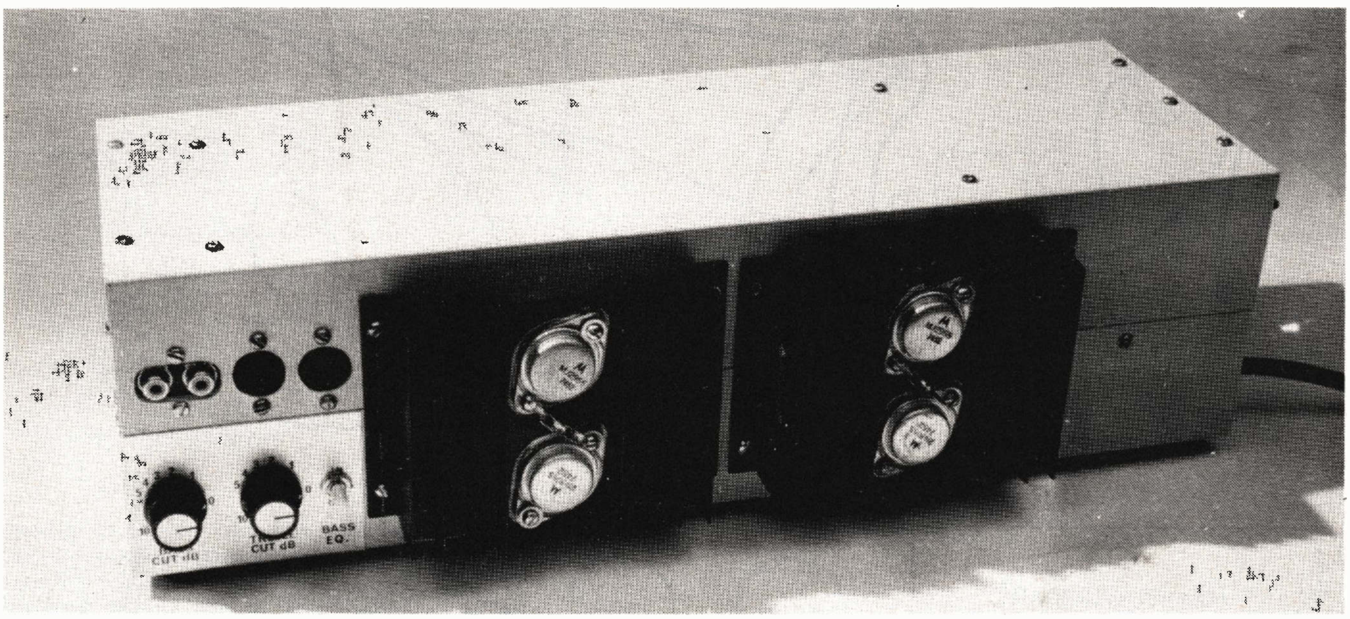


One approach to an electronic crossover system.

LAST month we published the details of active-crossover boards for use with high-fidelity speaker systems. This month we give details of a typical complete system. The system described is not intended to be considered as the only possible way, merely as an example of the way in which a system may be built.

The system described uses two 422 power-amplifier modules, but any other amplifier could equally well be used eg, the 440 amplifier. A two-way system is described, that is, one amplifier is used for the high frequencies and one amplifier is used for the low frequencies for each speaker system. Thus only two two-way crossover boards are used together with the two amplifier boards and the power supply to make the complete system.

CONSTRUCTION

We build our prototype into two pieces of channel aluminium as may be seen in the photographs. The aluminium channel used had dimensions of five inches by two inches and we used a piece 380 mm long for each side. Unfortunately this particular extrusion seems to have fallen a victim to metrication, the only section that seems to be available now is 100 x 50 mm which unfortunately is too small. However an equivalent can readily be made from 1.6 mm aluminium bent up as required. We suggest that you make your chassis about 430 mm long as we found ours to be a little cramped.

The heatsinks used were the Mullard 35D x 75 mm and these were assembled as detailed in the 422 amplifier section. The printed circuit boards were also assembled as detailed in that section. Printed-circuit pins should be used for all connections to the board as this makes interconnection of the unit much easier.

The location of the individual modules and components can be seen from the internal photograph of the unit. If construction similar to ours is used, with the transformer close to one end of the printed circuit boards, some trouble with hum may be encountered in the main amplifiers closest to the transformer. We overcame this problem by using these amplifiers for the high channels and by reducing their bass response by changing C4 from 100 microfarad to 2.2 microfarad. With this modification the response of the amplifier will drop off below 300 Hertz, thus reducing hum, but will still be adequate for high channel use. If the high channel response is required to be lower than 300 Hertz then the transformer must be mounted further away from the amplifier modules.

Some care must be taken to prevent earth loops causing problems. The wiring of the power cables is as shown in Fig. 1, the most important being the zero volt line. The zero volt lines of both boards are linked by a heavy cable and the common side of the transformer is joined to the centre of this link. The common for the speakers is also joined to this same point. Make sure that this junction is insulated so that a short does not occur when the unit is closed up. The plus and minus 40 volts are taken to the crossover board which has the regulator on it, and the plus and minus 7.5 volts is linked between the two boards. The zero volt line for the crossover boards is taken via the signal output leads to the appropriate amplifier board.

Due to the power dissipation in the regulator for the crossover, a heatsink must be used. We simply bolted the crossover boards onto the end panel by means of a piece of angle aluminium, and bolted the transistors onto the end panel using insulating washers. We used a piece of cardboard

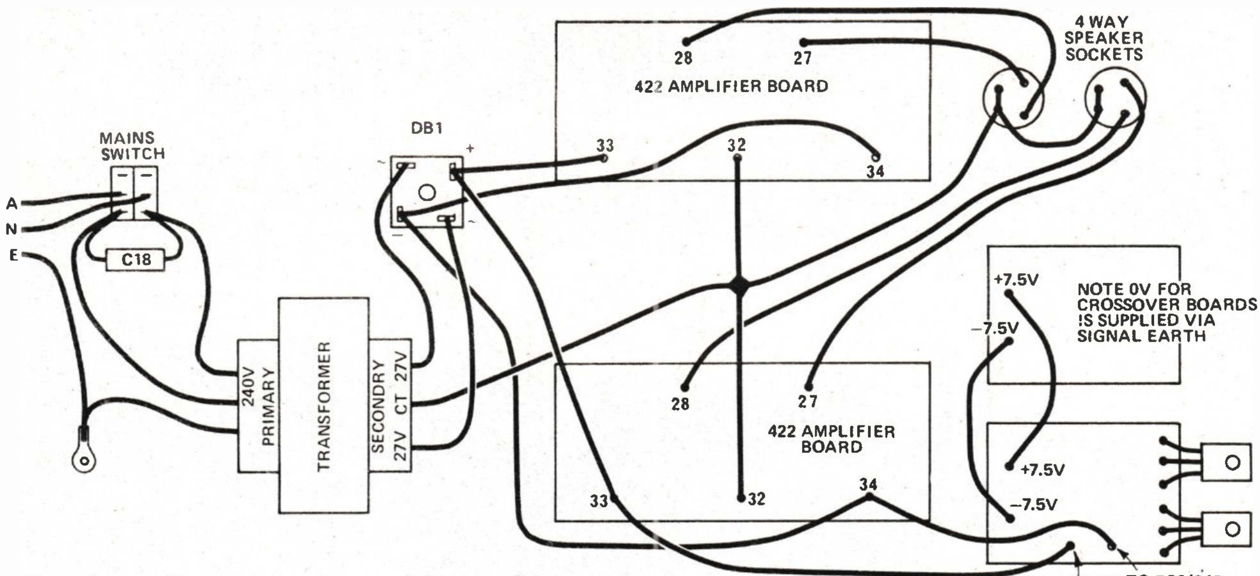


Fig. 1. Power wiring of the crossover amplifier.

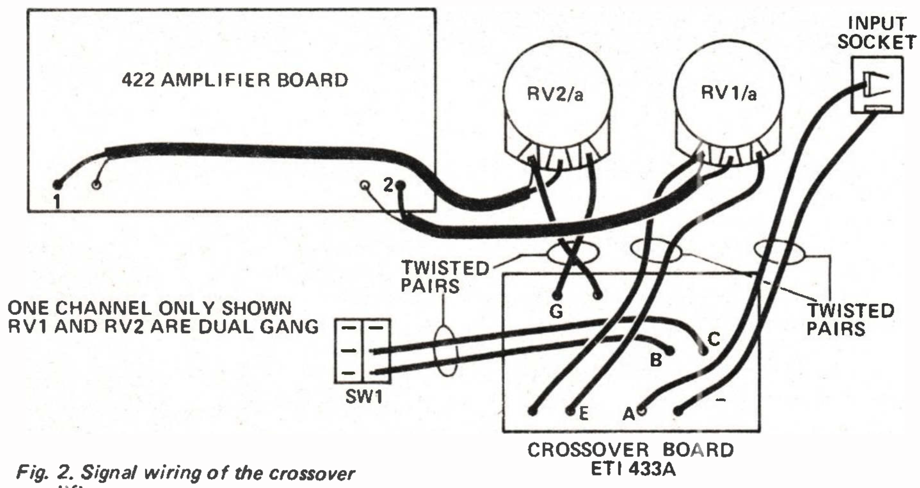


Fig. 2. Signal wiring of the crossover amplifier.

between the two boards to prevent any shorts occuring between the two boards. We also installed cardboard under each of the power amplifier boards similarly to protect them.

Coaxial cable was used to connect the inputs from the potentiometers to the main amplifiers but only twisted pairs from the crossover boards to the potentiometers. Coaxial cable could have been used here but was found to be not necessary as these leads are a long way from the power transformer.

Finally, a word about the power transformer. We have only used a single power transformer, as used in the 422 amplifier, to power the two complete 422 amplifier boards. But remember that the frequency spectrum is split up between the high and low channels and hence each amplifier, although called upon to provide the same peak power, only has to handle half the average power. The transformer is thus quite capable of handling the total load as the system is still nominally 50 watts per channel.

PARTS LIST – CROSSOVER AMPLIFIER

Two complete sets of components as detailed for the 422 power amplifier module except that only one transformer and rectifier bridge is required for domestic use – especially if the crossover is above 2 kHz.

Two ETI 433A boards with the following exceptions. The transformers, D1 to D4, C11 and C12 are not required for either, and C13, C14, R19, R20, Q1, Q2, ZD1 and ZD2 are not required on the second board. The value of R19 and R20 on the first board should be 8.2 k.

Switch SW1, if required, should be a double pole switch and RV1 and RV2 should be dual gang linear potentiometers.

Chassis.

Input and output sockets as required.

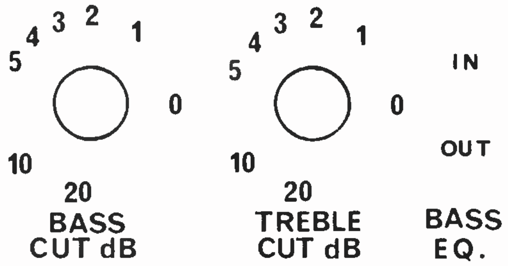
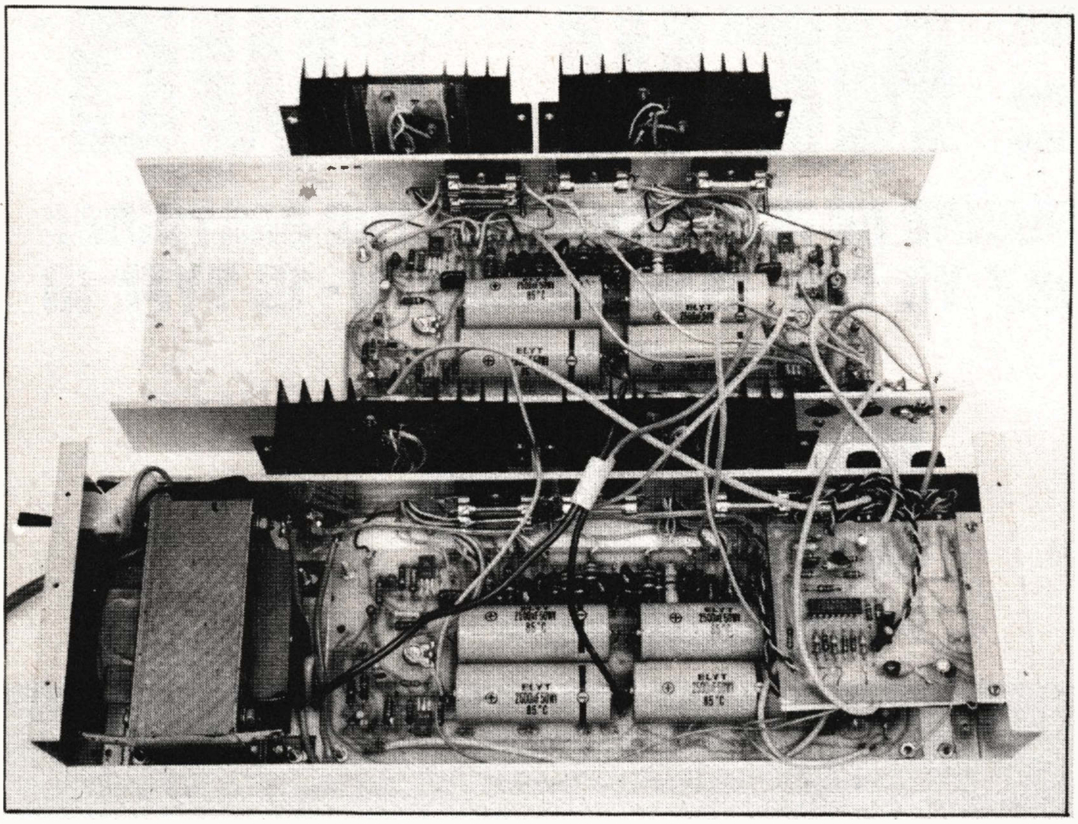


Fig. 3. Artwork for the level control panel. Full size 73 x 50 mm.



This internal view of the unit shows positioning of major components and boards. When joined together the two channel assemblies are locked by the heatsinks. ●

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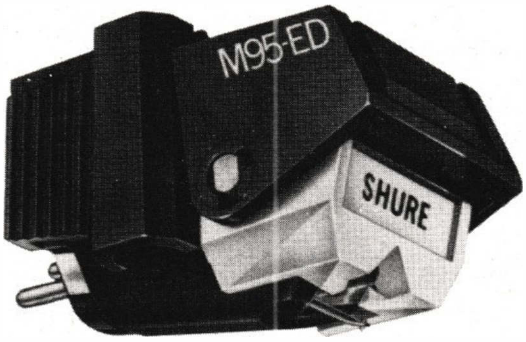

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M95ED SPECIFICATIONS

Trackability at 1 gram tracking force using a Shure/SME Arm:
- 24 CM/SEC at 400 Hz
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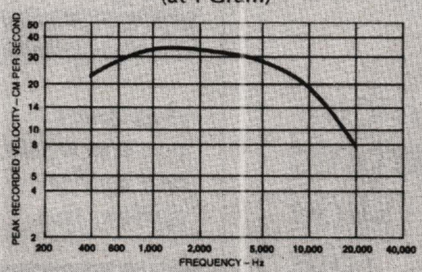
Tracking Force: ¾ to 1½ grams
Frequency Response: 20 to 20,000 Hz

TRACKABILITY CHART
(at 1 Gram)



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47,000 ohms resistance in parallel with 400 to 500 picofarads total capacitance per channel. (Load resistance can be as high as 100,000 ohms and total capacitance can be as low as 100 Picofarads with only minor audible change.) Total capacitance includes the capacitances of the tone arm wiring, phono cables, and the amplifier input circuit.

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Channel Balance: Output from each channel within 2 dB

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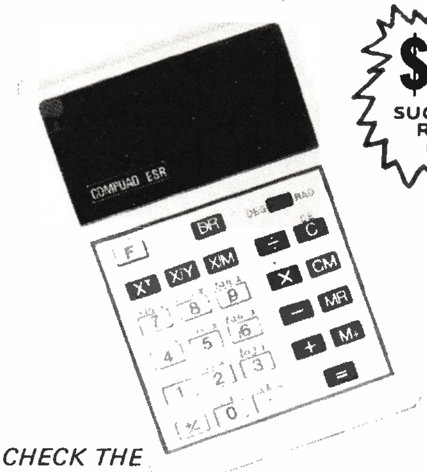

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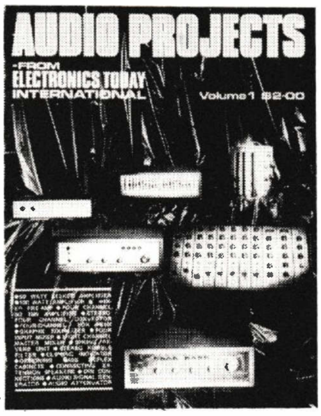

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Input Impedance: 1.5 TΩ (1.5 x 10^{12} Ω).
Input Current: 5 pA.
Input Offset Current: 0.5 pA.
Input Offset Voltage: 0.8 mV (CA3130B).
Settling Time: 1.2 μsec.
An output voltage swing to within 10 mV of either supply rail.
Strobing terminals.
Package: 10 lead T05.

	CA3080E	CA3100T	CA3094E	CA3078T	CA3130
Gateable plus programmable gain control	>60 dB				Gateable
Unity gain crossover frequency, MHz		40			15
Slew Rate, V/μsec		25			10
Output, mA (peak)			300		22
Power consumption, mW				.0015	2.5
Single supply voltage required, V				1.5	5.0

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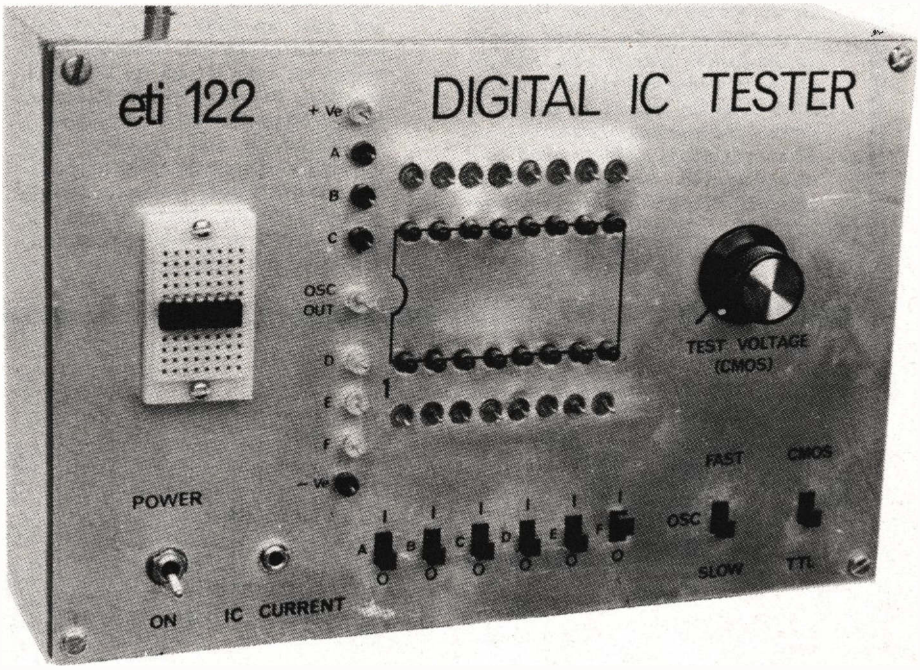
eti PROJECT 122 LOGIC TESTER

Test CMOS and TTL with this versatile instrument.



WARNING:

When using the tester, remember that manufacturers recommend that CMOS ICs should not be inserted or removed from a circuit without first switching off the power supply.

EXPERIMENTERS often damage ICs in the process of developing a new circuit and often try a new IC in a circuit that is not working to eliminate that as a possible cause. The result of this is that one usually finishes up with a box full of ICs which are of dubious value. To sort out these ICs one must use a tester that is capable of testing the wide range of differing ICs that are available in the most commonly used families.

Until recently the most commonly used family has been TTL. But CMOS is rapidly gaining widespread usage and any tester, to be of value these days, must be able to test both these families. The ETI Logic Tester is capable of testing both families, and is also capable of being used to breadboard and test simple circuits based on single ICs.

An LED indicator is associated with each pin of the IC under test and these are arranged around the perimeter of a box representing the IC under test. This allows a small card, which has the schematic of the particular IC drawn on it, to be fitted to the front of the tester as an aid to the interpretation of the LED test indications.

We will publish drawings for these cards covering the most commonly used types in the future, about three or four cards per month which can be cut out and pasted to pieces of cardboard for use on the tester.

CONSTRUCTION

The most expensive single component in the tester, after the transformer, is the case. For this reason we decided to make a wooden case and a plain aluminium front panel. Some people may however wish to mount the unit in a diecast box and for this reason the printed circuit board has been sized to fit in a standard 222 x 146 x 51 mm die-cast box. The following description is for a wooden box specifically, but applies equally well to the metal box.

The printed-circuit board is mounted to the rear of the front panel, copper side to the panel, such that the LEDs and patch pins, mounted on the printed-circuit board, project through the front panel. This greatly simplifies construction as it saves some 48 leads and solder joints. The switches are secured to the front panel by first glueing two pieces of printed-circuit board to the rear of the board and then soldering the switches to the copper side of the board. This procedure avoids the necessity of a multitude of screws passing through the front panel.

The printed-circuit board should be assembled with the aid of the component overlay by fitting all components with the exception of IC1, 5, 6 and 7, and LEDs 1 through 16, and the patch pins. Check that the ICs are orientated correctly as are also C2, 5, 7, 9 and D1, 2 and 3. Now solder these parts into position using the least amount of heat necessary on ICs 2, 3 and 4.

Position the LEDs and patch pins onto the copper side of the board but do not solder them in place as yet. Now fit the board to the front panel so that the pins and LEDs protrude through the panel evenly. Secure the pins and LEDs in position by using a very small drop of five minute epoxy for each, on the component side of the

(Text continued on page 73)

HOW IT WORKS.

The tester consists of four basic sections. The socket for the IC under test, the output level-detect logic, oscillators and switches for the inputs, and the power supply.

The socket for the IC under test has the pins in each row electrically connected to each other. These rows are the groups of five holes which are perpendicular to the central groove on the socket. Each row (ie, each pin on the IC under test) is connected via a 10 megohm resistor to ground to prevent the build up of static charges. The resistors also hold all unconnected inputs at ground potential thus preventing any damage to the IC.

Each row is also connected to a pin on the front panel. Test connections are made to these pins by patchable links from the oscillator and test switches so that the correct test conditions may be set up.

Resistors R19-26 and R43-R50 connect each row (ie pin) to a logic level detector, ICs 5, 6, and 7. These CMOS hex-inverters buffer each pin and drive an LED to indicate the logic state of the pin. When the logic voltage on a pin is high the LED will be alight. Resistors R19 to R26 and R43 to 50 protect the internal diodes of ICs 5, 6 and 7 against the possibility of a pin being taken above the positive supply voltage or below ground potential. Resistors R11 to R18 and R51 to R58 in conjunction with the five volt supply set the operating currents for the LEDs.

A 555, IC4, is used as an astable oscillator which initially charges C8 via R9 and R10 until the 2/3 supply threshold is reached. C8 is then discharged via R9 and pin 7 of the 555 to the lower threshold of 1/3 supply volts. Switch SW6, when operated, puts a larger value of capacitance into the circuit which gives a frequency of about one hertz. This is slow enough so that the eye can follow each logic state transition. The high speed operation is used for checking very long counters and shift registers and can also be used in conjunction with an oscilloscope. The square wave output of the oscillator is made available at a

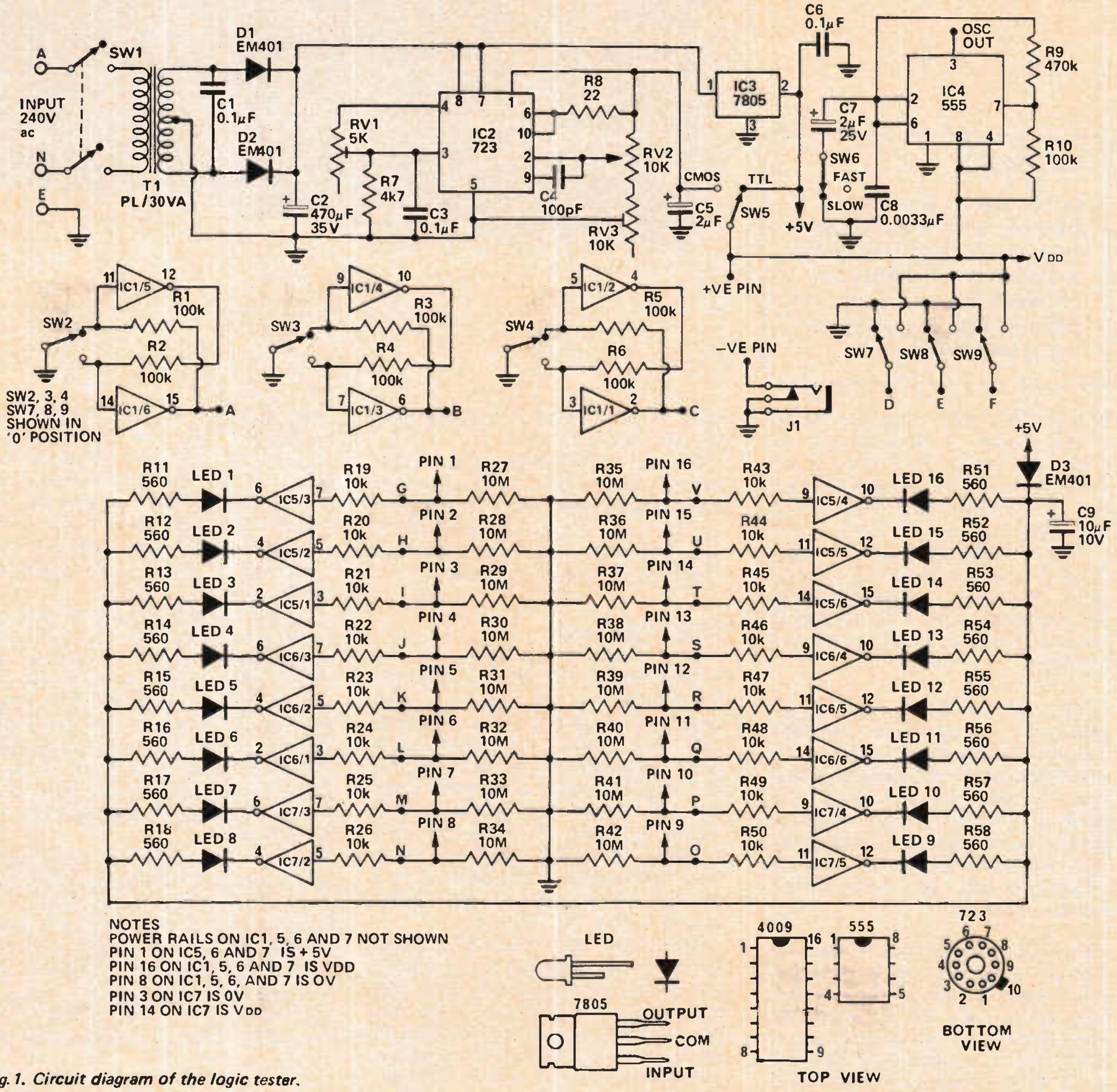


Fig. 1. Circuit diagram of the logic tester.

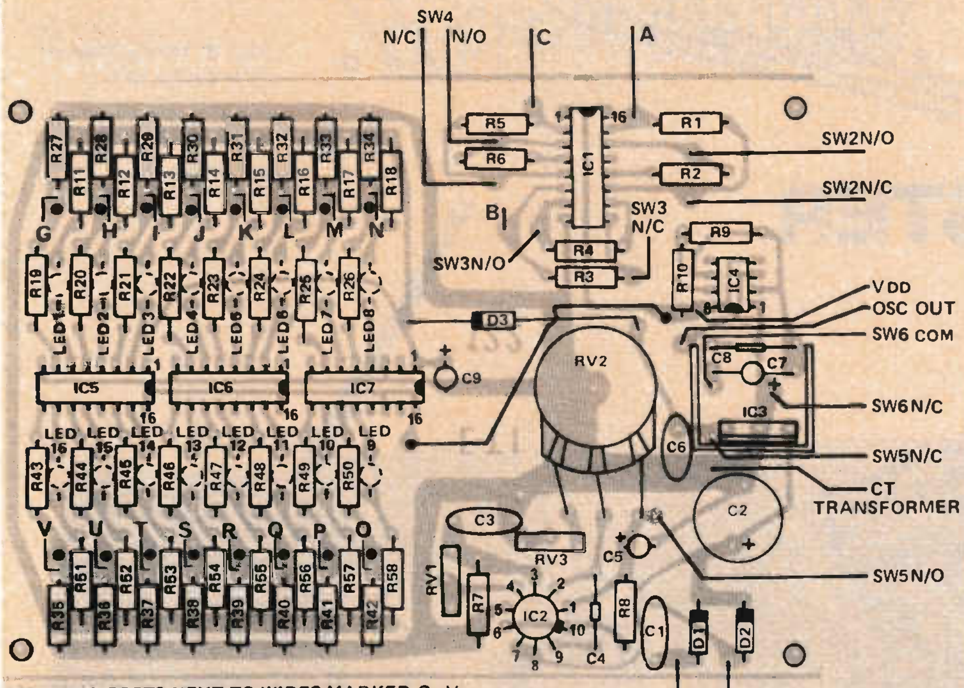
patch-pin on the front panel.

There are six further output pins on the front panel three of which, D, E and F, are set to negative or positive supply by means of toggle switches. As there is no debounce logic associated with these pins they can only be used to set up static conditions and not for clocking counters and shift registers. The remaining three pins are also programmed by switches but these switches are connected to IC1 which contains three RS flip-flops to effectively remove any contact bounce of the switches. This operates as follows. If initially the input of IC 1/5 is earthed by SW2 its output will be high and hence the output of IC 1/6 will be low. When IC 1/6 SW2 is operated again it earths the input of IC 1/6 sending the output of IC 1/6 and input of IC 1/5 high and the output of IC 1/5 low. Since the input of IC 1/6 is connected to the output of IC 1/5 it is held low even if the contacts of SW2 bounce several times when the switch is operated. Thus the output at A is one single transition from high to low (low to high when next the switch is operated). The output of the three debounced switches are labelled on the front panel as A, B, and C.

In the power supply diodes D1 and D2 full-wave rectify the output from the power transformer. The output from the rectifier is smoothed by C2 and regulated to five volts by IC3. The resulting five volt supply is used to drive the LED indicators and to power the TTL device under test. Integrated circuit IC2, a type 723, is a regulator the minimum output of which is set to five volts by RV1 and the maximum of 15 volts by RV3. Front panel control RV2 allows the output voltage to be adjusted between five and 15 volts. The current limit on the output is set to 30 mA by means of R8. SW5 selects the high current five volt supply for testing TTL or the low current variable supply for CMOS. Terminal J1 in the negative supply lead is provided for checking the current drawn by the IC under test. ●

LOGIC TESTER

Fig. 2. How the components are mounted on the pc board.



TERMINAL POSTS NEXT TO WIRES MARKED G—V AND THE LED'S ARE MOUNTED ON COPPER SIDE OF THE PC BOARD

PARTS LIST — ETI 122

R8	Resistor	22Ω	¼W	5%
R11,18	"	560	"	"
R51,58	"	560	"	"
R7	"	4 k7	"	"
R19,26	"	10 k	"	"
R43,50	"	10 k	"	"
R1,6	"	100 k	"	"
R10	"	100 k	"	"
R9	"	470 k	"	"
R27,42	"	10 M	"	"
RV1	Potentiometer	5 k	Trim type	
RV3	"	10 k	"	"
RV2	"	10 k	Linear	
C4	Capacitor	100 pF	Ceramic	
C8	"	0.0033μF	polyester	
C1,3,6	"	0.1μF	"	
C5,7	"	2μF	25V electro	
C9	"	10μF	10V "	
C2	"	470μF	35V "	

D1,2,3 Diode EM401 or similar

LED 1 — LED 16 Light Emitting Diodes RL4484 or similar

IC1,5,6,7	Integrated	Circuit 4009 (CMOS)
IC2	"	Circuit 723 (metal can case)
IC3	"	Circuit 7805 (TO-220 case)
IC4	"	Circuit 555

J1 Jack small earpiece type

SW1 DPST toggle 240V rated

SW2-SW9 miniature slider switch 2 pole 2 position

PC BOARD ETI 122

IC Socket SK20 see text

Wooden case see text

Transformer 240 V primary 30V CT secondary or 2 x 15 V windings PL30/20VA

25 patching Pin McMurdo type FT-1 feed throughs

front panel

3 core flex and plug

heatsink for IC3 (see Fig.6)

(Text continued from page 71)

board. Do not glue the LEDS to the front panel. Once the glue has set, carefully remove the board from the front panel and then solder the LEDs and pins into position. Fit 250 mm long leads to the board for later connection to the switches and power transformer and then, using a minimum amount of heat, solder ICs 1, 5, 6 and 7 into position.

If using the recommended test socket prepare it by removing the paper from the rear of the socket, cut the paper in half and then remove about 12 mm from each side. The paper is then replaced on each side so that leads can now be soldered to the metal forming the pins of each row. The front panel must also be cut out so that these leads may be passed through. Now affix the socket to the front panel and install the printed circuit board. Mount the transformer into the base of the box and interconnect the board and switches etc.

The wooden box was constructed from 12 mm thick pineboard such that the outside dimensions were 225 x 148 x 70 mm. We finished our box with coloured Estapol high-gloss

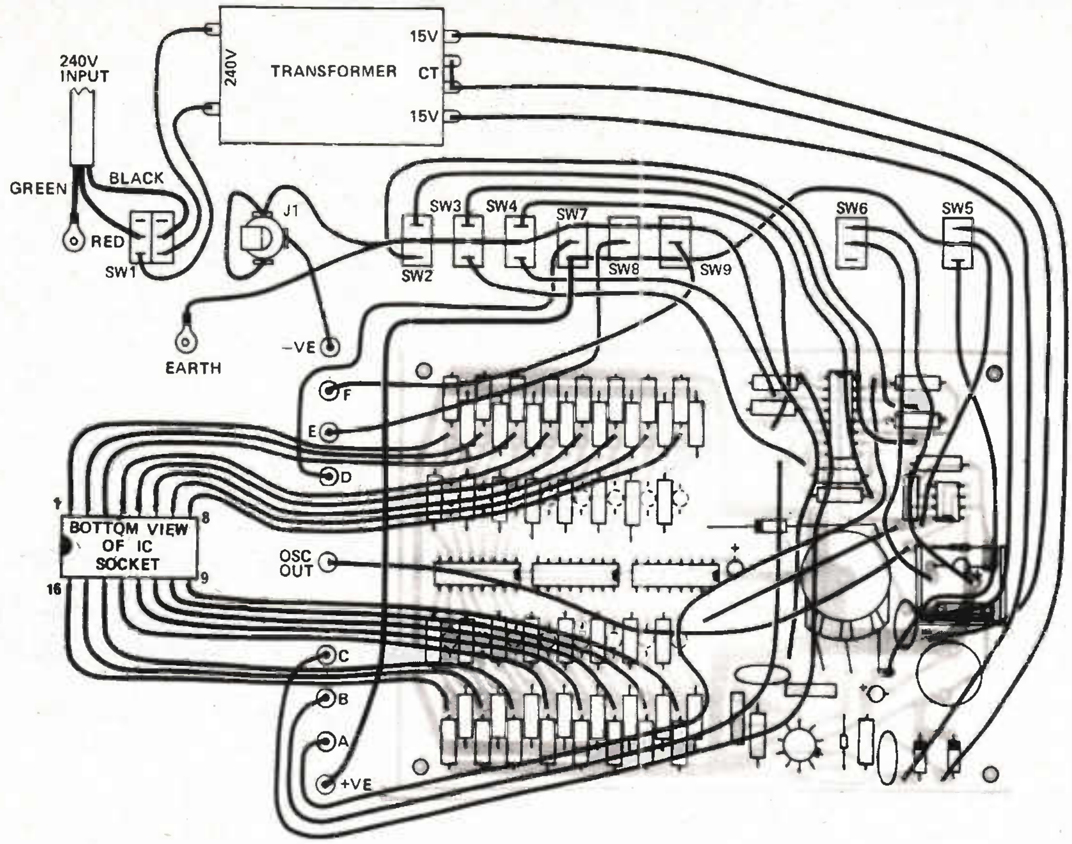
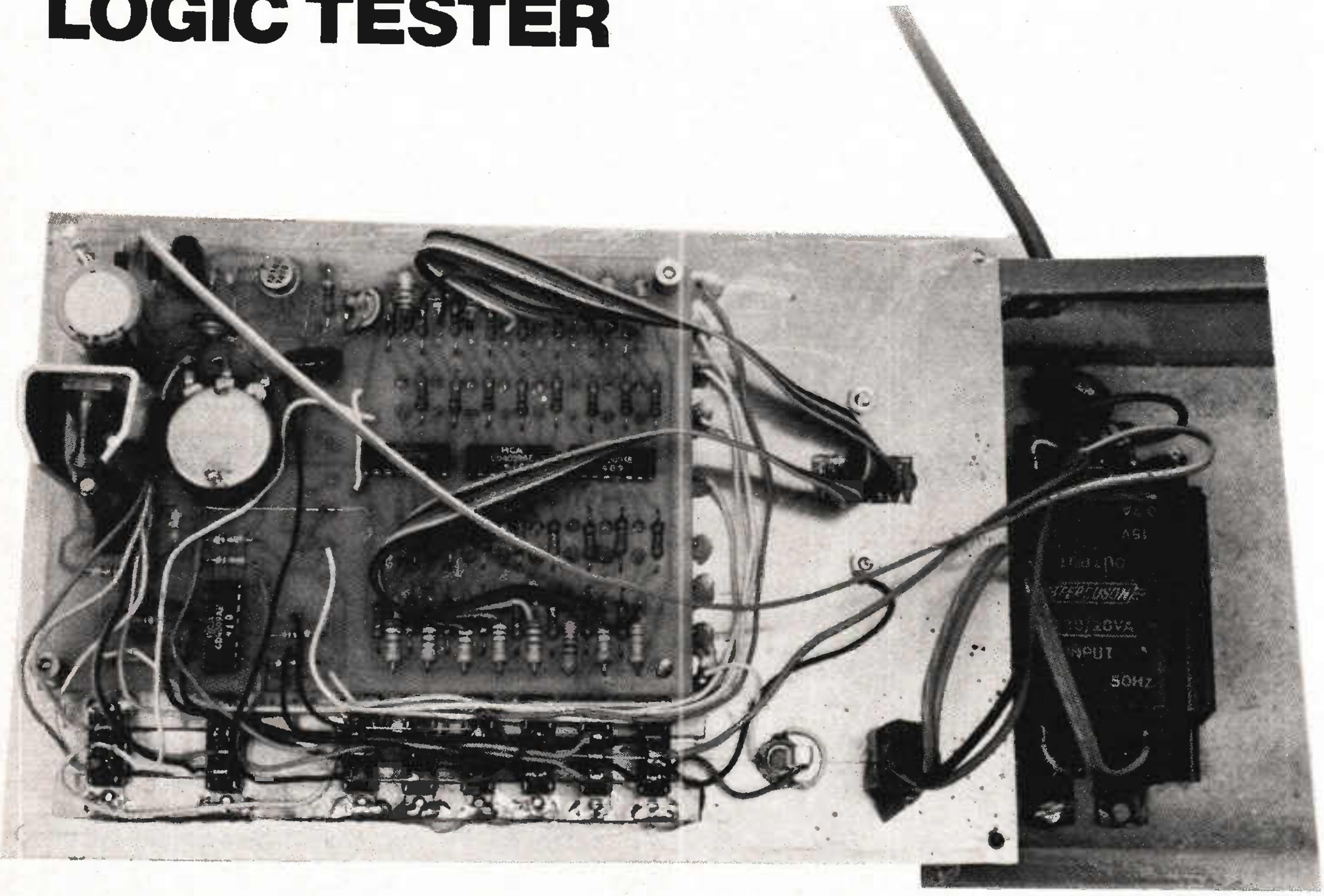


Fig. 3. Wiring diagram of complete unit.

LOGIC TESTER



enamel which resulted in a very pleasing final appearance.

DESIGN FEATURES.

There are several design requirements which must be met in a unit which is designed to test both CMOS and TTL devices. These may be summarized as follows.

1) The unit must be capable of correctly testing both types of logic.

2) Simple gate functions should be tested by go no/go checks and complex functions such as counters and shift registers should also be reliably checked.

3) There should be the least possible chance of damaging the device during testing.

4) CMOS ICs must be testable with a variety of supply voltages.

5) A clock oscillator and a means of setting up the input conditions must be provided.

One of the major design difficulties with a unit such as this is coping with the many different pin configurations

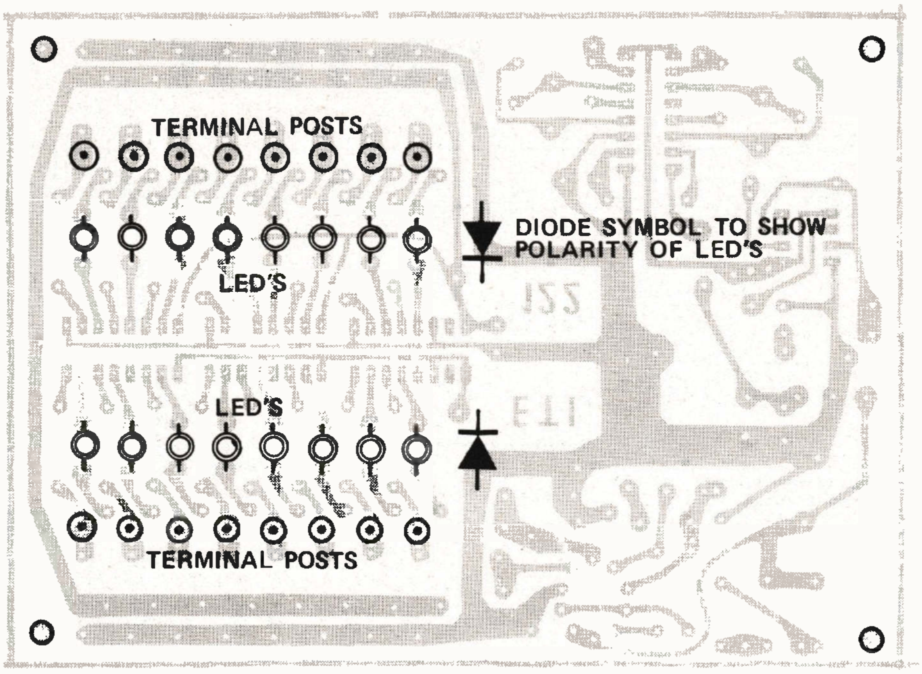


Fig. 4. Positioning of LEDs and terminal posts on the copper side of the printed-circuit board.

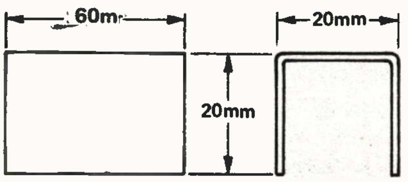


Fig.6. Heatsink for IC3. The IC is mounted (by a screw) through a 3.2 mm hole in the base of the heatsink (see photograph of inside of unit).

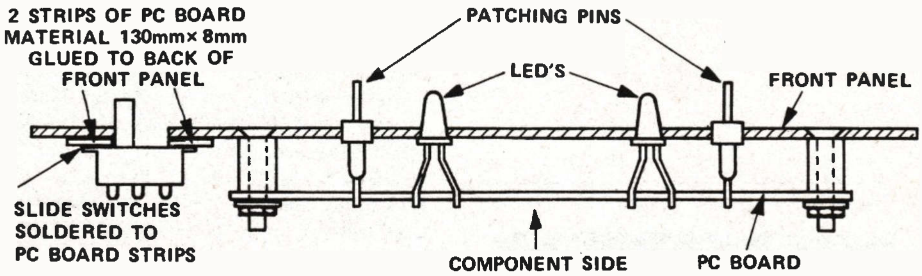


Fig. 5. How the front panel and printed-circuit board are assembled.

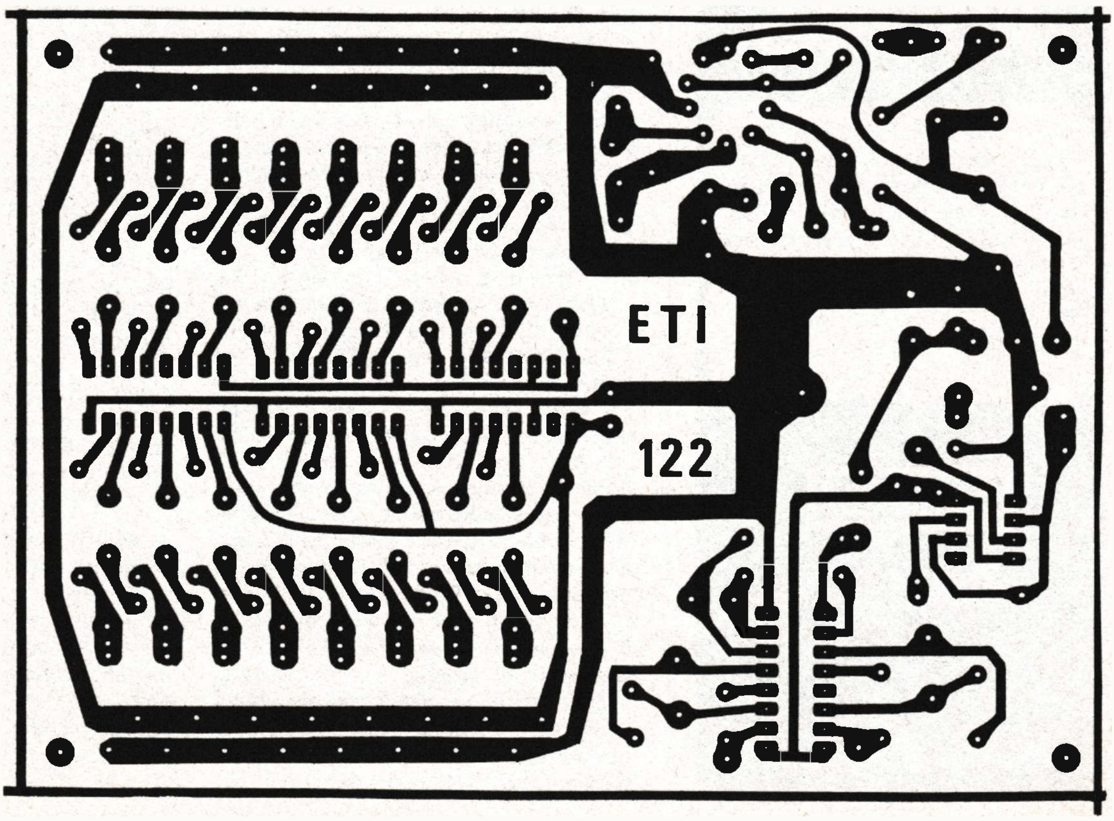


Fig.7. Printed circuit-board artwork. Full size 142 x 104 mm.

LOGIC TESTER

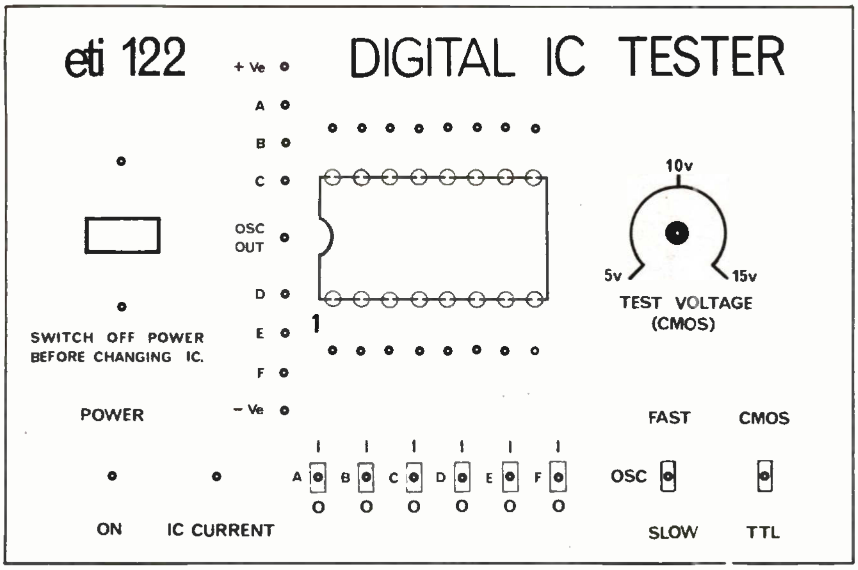


Fig.8. Front panel artwork (shown half-size — full size should be 223 mm x 148 mm).

of the differing functional requirements (eg a shift register versus a two-input NAND gate) of devices within the one family, as well as those between different families. A multi-way switch could be used for each input pin but would greatly increase the expense of the unit. A good alternative is to use patchable links, and this is the approach that we have chosen to use in our unit. In addition we have used a small breadboard socket as the test socket, rather than a standard 16 pin dual-in-line socket, as this allows us to improvise special test circuits for the more complex logic ICs, and the means to breadboard simple circuits.

The need for a variable power supply for CMOS testing presented two additional problems. The first of these was the danger of plugging a TTL IC into the unit when it is set up for CMOS and for some higher supply voltage than the five volts required for TTL. Secondly the LEDs used for monitoring each pin would draw more current as the supply voltage increased. The current ratio could be as high as four to one and a corresponding variation of LED intensity would occur. To overcome this problem it was decided to provide a second supply of five volts to operate the LEDS which will also provide the higher current required by TTL for its operation. The other supply is a variable one for testing CMOS and is not capable of supplying more than 30 mA. Thus a TTL gate inadvertently connected to this supply would not be damaged.

The regulator used for the five-volt supply is a three terminal IC which has built in current limiting and thermal shutdown. It will not therefore be damaged by a short circuit due to testing a faulty IC. It is not possible to construct a discrete design, as cheaply, that has the same performance.

Next we need a device that will detect the state of each pin on the device under test and drive an LED to indicate that state. The device has to be driven by TTL and CMOS outputs, that is, by voltages anywhere between 5 and 15 volts. A suitable IC is the CMOS 4009 IC which has six inverters in one package. Each inverter will monitor a pin without drawing appreciable current. The 4009 is also designed to translate logic levels. Thus we may use it to monitor a 5 to 15 volt input level at its input but provide a five volt signal only at its output.

Switches are provided which have debounce logic associated with them. This is necessary so that single bounce free rise and fall transitions can be generated for the testing of more complex logic. The debounce logic must be capable of operating on 5 to 15 volts and of sinking at least two milliamps for TTL tests. The 4009 IC with its high output current capability was again considered to be most suitable for this task.

We would also like to have used the 4009 as the oscillator, but RCA do not recommend using CMOS that has a high output capability in a linear mode as the power dissipation of the device may be exceeded. The oscillator must provide pulses that swing between the positive and negative supply rails (in order to drive CMOS) and must be capable of sinking the two milliamps required by TTL. It must also be capable of operating on supply voltages of 5 to 15 volts. Since the standard CMOS devices cannot provide the current requirement it was decided to use a 555 IC as the oscillator.

CMOS devices should not be operated with inputs left floating as some devices may drift into the linear mode and be destroyed by excessive power dissipation. For this reason a 10 megohm resistor is connected between each pin, on the test socket, and ground. These resistors also conduct away any static charge that may build up. ●

FANE

HI-FI LOUDSPEAKERS FROM ENGLAND

10" The model B101/10LR is a 10" loudspeaker with a 2" voice coil working within a 10,000 guass magnet structure, total flux 100,000 maxwells. The free air-resonance of the loudspeaker is 25Hz thus making it suitable for a small sealed cabinet of between 1½ and 2 cu.ft.
Efficiency is higher than might be expected from a sealed cabinet and power handling is 20-25 watts r.m.s. **$34.50**

12" The model B122/10LR is a 12" bass speaker featuring a rubber suspension which allows a fundamental resonance of 17Hz in free air. This low-resonance, combined with a 2" voice coil working within a carefully selected magnet structure makes the speaker ideal for a sealed cabinet of about 2 cu.ft. capacity. Efficiency of the B122/10LR is surprisingly high for this type of loading and the speaker is ideal for amplifiers with an output of 20-25watts r.m.s. per channel at 8ohms. **$39.50**

12" The model B122/12LR, like the B122/10LR described above, is also suitable for sealed cabinets but because of its more powerful magnet structure a volume of about 3 cu.ft. is required to ensure the speaker gives its optimum performance. **$49.50**

15" The Fane model B152/12LR is a 15" bass driver with a fundamental resonance of 15Hz in free-air. Once again a sealed cabinet provides ideal loading for this unit and the volume can be varied from 3 to 5 cu.ft. The performance in 5 cu.ft. is particularly outstanding as the resonance is kept in the region of 30Hz. This results in firm, non-resonant bass without any of the "boxiness" often associated with conventional speakers. Efficiency is reasonably high and power-handling is up to 30watts r.m.s. at 8ohms. **$59**

5" The Fane 505 x 5" mid-range loudspeaker employs a special cone material which is doped to remove any irregularities in response. Useful frequency range is 400-4,000Hz and sound quality is very neutral. **$24.50**

1" The Fane 1" Dome Tweeter DD1 is a newly developed soft-dome tweeter with a useful frequency response from 4,000Hz to 20,000Hz. Efficiency is medium to high. **$23.50**

FANE PUBLIC ADDRESS & MUSICAL INSTRUMENT UNITS

12" CRESCENDO 12A — Super High Efficiency, Wide Frequency Response and 100 Watt r.m.s. power handling. This beautifully finished loudspeaker is particularly suitable for lead guitar, organ and public address work. VOICE COIL DIAMETER: 2", FLUX DENSITY: 20,000 Guass, IMPEDANCE: 8 ohms. **$79.00**

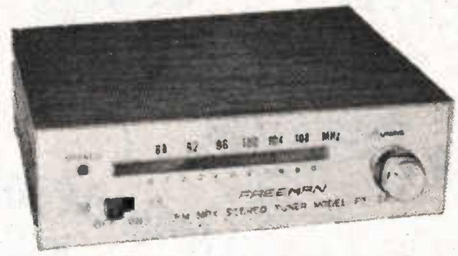
15" CRESCENDO 15/100 BASS. Specially designed for high power, high efficiency bass performance. This magnificent unit is rated at 100 watts r.m.s. and has a resonant frequency of 40Hz. VOICE COIL DIAMETER: 3", FLUX DENSITY: 15,000 Guass, IMPEDANCE: 8 ohms. **$99.00**

920 HORN UNIT. This unit has just been released on the Australian market and features super high efficiency of 109 dB and power handling of 100 Watts r.m.s. above 600 Hz. VOICE COIL DIAMETER: 2", FLUX DENSITY: 20,000 Guass, IMPEDANCE: 8 ohms. **$149.00**

12" POP 50. A general purpose 50 watt r.m.s. loudspeaker of high efficiency, but economically priced. VOICE COIL DIAMETER: 2", FLUX DENSITY: 13,000 Guass, IMPEDANCE: 8 ohms. **$39.50**

18" POP 100 An outstanding 18" bass loudspeaker for musical instruments, the POP 100 handles 100 watts r.m.s. at high efficiency. Resonant frequency is 55 Hz. VOICE COIL DIAMETER: 3", FLUX DENSITY 14,000 Guass, IMPEDANCE: 8 ohms. **$79.00**

FREEMAN FT-3A STEREO TUNER



The Freeman FM Stereo tuner features 2 IC'S, 1 FET, 2 transistors and 4 diodes. Stereo reception is automatic and indicated by light emitting diode visible on the front panel. The FT-3A measures 165mm (w) x 140mm (D) x 60mm (H). Specifications are as follows:
Frequency range 88-108MHz, Sensitivity 5μV, Output over 150 mV, Stereo separation 30 dB, The FT-3A FM TUNER.

OUTSTANDING VALUE **$49.50**

NEW CHALLENGE TURNTABLE SEMI-AUTOMATIC BELT-DRIVE

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Cast non-ferrous 12" platter belt-driven by a 4-pole syncronous motor,
wow & flutter: less than 0.1% WRMS
rumble: — 50 dB weighted.

S-shaped tone arm with removable lightweight headshell fitted with magnetic cartridge and diamond stylus, 0.7mil conical. (Standard ½" mounting).

Anti-skate mechanism and lateral balance weight are incorporated in the tone arm.

Tone Arm return is automatic at the end of the record and may be operated at any stage of the record by using the reject lever located at the front right hand corner of the CSP-1. This return mechanism is simple and effective to ensure years of trouble-free service.

An independent oil-damped cueing lever is also incorporated into the CSP-1 and allows selection of the required record tracks without having to activate the auto-return mechanism. Very handy for safely "skipping" unwanted tracks.

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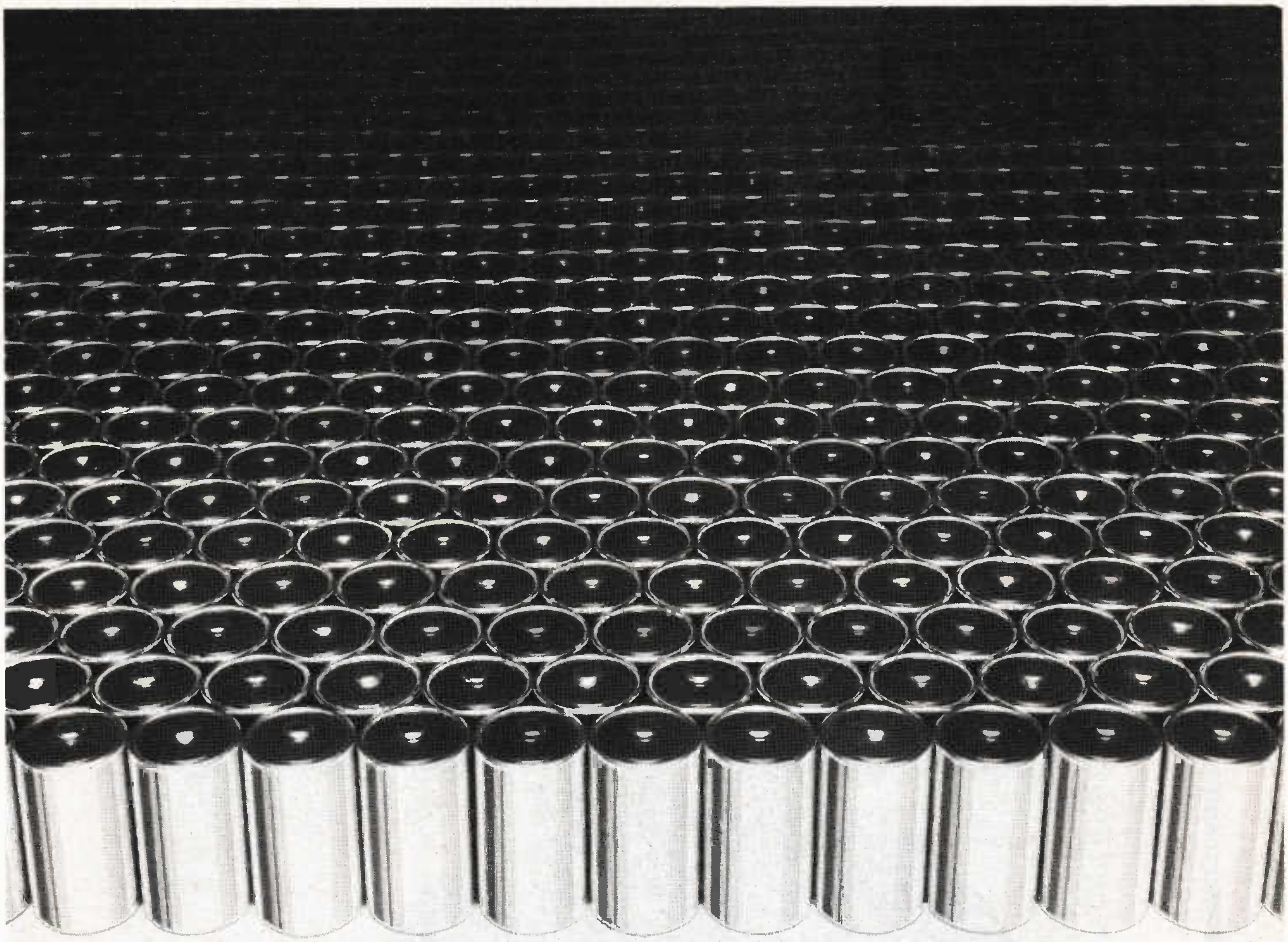

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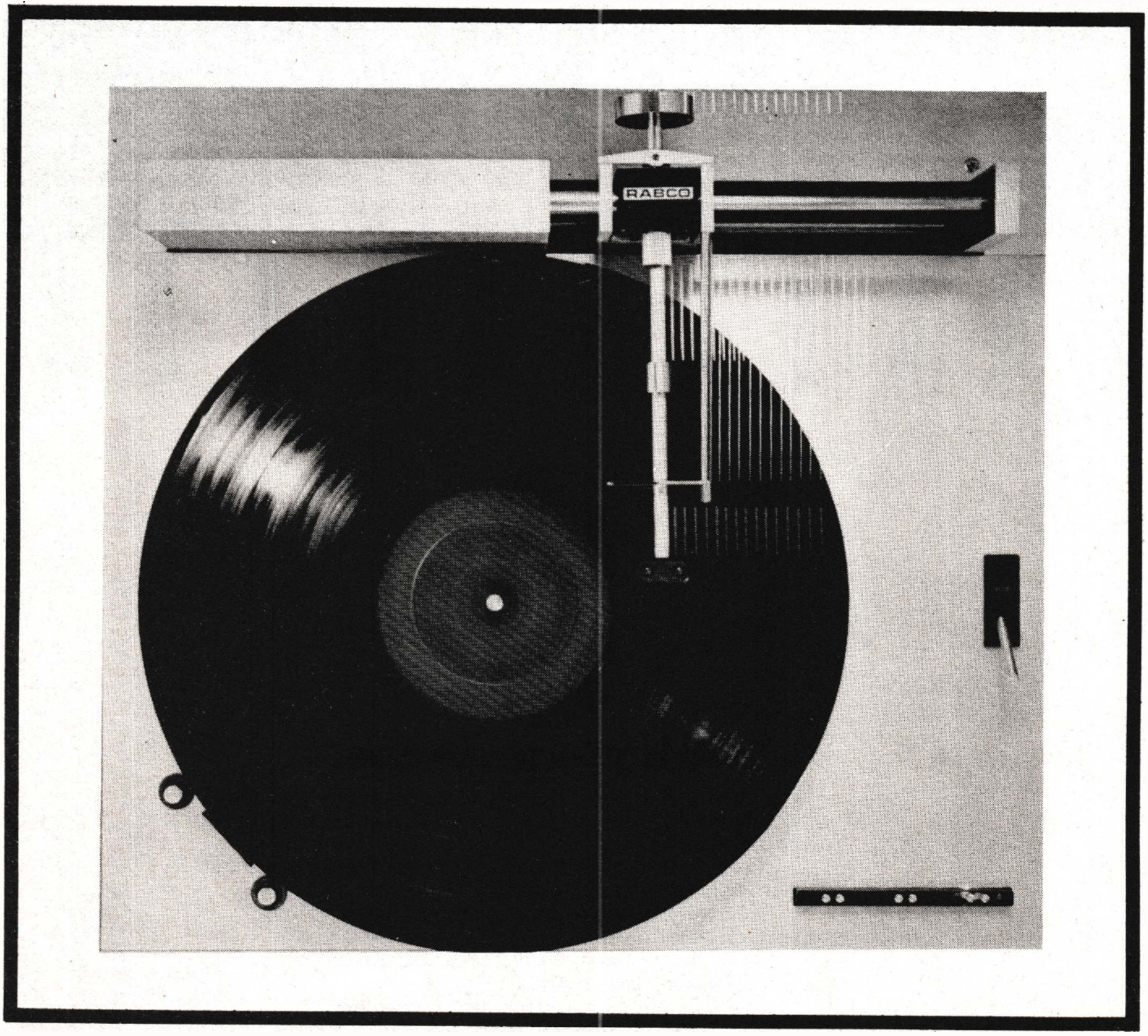
eti PRODUCT TEST

RABCO ST-7 straight line tracking turntable

Harman Kardon's latest turntable produces unexpected benefits.



Recommended retail price $680
(excluding cartridge)

Agent: Harman Australia
271 Harbord Rd.,
Brookvale, NSW
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OF ALL the media available in the domestic high fidelity field, the record player, and the best recorded material available for it, still stands head and shoulders over other types of input. When this is coupled with the convenience, cost and availability of material for the record player, it is not hard to understand why tape recorders, cassette recorders and radio inputs have been unable to usurp it.

Nevertheless, record players are still far from perfect although there is a slow but definite improvement and perfection in the state of the art.

Cartridges have been getting steadily better year by year but tone arms have tended to lag behind in quality and performance. The reasons for this is quite simple, for whilst the cutting lathe which initially produces the record cuts in a straight line from the outer edge to the inner, the majority of tone arms have been of the pivoted type thus introducing a tracking error which is a function of the angular position of the cartridge and the tone arm.

MEASURED PERFORMANCE OF RABCO ST-7 STRAIGHT LINE TRACKING SYSTEM SERIAL NO. 1750011

TURNTABLE		
Wow and Flutter	=	0.25% rms
Hum & Rumble Equalized but unweighted re 1 kHz at 5 cm/sec	=	–47 dB
Speed Variation	=	+8.1% –2.3%
Turntable Weight	=	1.1 kg
CARTRIDGE (Shure V15 MkIII)		
Tracking force	=	1 gram
Frequency response	=	20 to 20 kHz $^{+0}_{-2}$ dB
Channel separation at 1 kHz	=	28 dB
Improvement in channel separation	=	3 dB
Channel difference at 1 kHz	=	1 dB
Output re 1 kHz at 50 mm/sec	=	1.75 mV
Channel separation difference between right & left channel	=	less than 2 dB
DIMENSIONS (incl. dust cover)		
Height	=	157 mm
Width	=	419 mm
Depth	=	413 mm
WEIGHT	=	10 kg

STRAIGHT LINE TRACKING

Ideally, the pick-up arm should track the record on a radial line and the stylus should be connected to the cartridge by a bar at a 15° angle to the plane of the record. If this were achieved, the playback system would duplicate the characteristics of the original recording system. Even the shape of the stylus with the elliptical point is a (reasonable) compromise in terms of its copying the original wedge – shaped stylus used in the cutting lathe.

The anomaly has long been realised, and over the past 60 years, a number of ingenious linear or parallel tracking arrangements have been produced. While some of them have been simply ingenious and moderately effective, there has always been at least one limitation in the system offered in terms of either bearing friction and, even in some cases, a turntable inferior to the tone arm system itself.

We have previously shown that errors in tracking angle introduce second-harmonic distortion as given by the equation:–

$$\text{THD (2nd)} = k\phi \frac{V}{v}$$

where V is the velocity of the groove modulation v is the groove velocity and ϕ is the tracking error in degrees.

This is modified by the anti-skating characteristics of a conventional tone arm.

Whilst the best conventional tone arms do provide a measure of improvement in this region, none of them (that we have seen) approach the perfection which a true straight-line tracking system theoretically has to offer.

The Rabco ST-7 turntable is an ingenious and elegantly simple straight-line-tracking unit. In appearance it is simple but impressive: satin brushed aluminium plinth; substantial rubber isolators at the four corners; neat straight-line tracking system at the rear.

At the front right-hand corner is a touch bar control system for selecting 33 1/3 rpm or 45 rpm speeds and stop. At the left-hand front corner there are two control knobs for fine speed adjustment (speed is monitored by a strobe light visible through a window between the two knobs). The cueing lever is located in the normal position on the right-hand of the unit.

A touch bar switch is used for selecting the various operating modes.

Each mode is selected by momentarily touching a pair of contacts. When this is done, a light behind each contact pair indicates the mode that has been selected – red for stop, green for 33 1/3 rpm and blue for 45 rpm.

The cueing lever operates with virtually zero pressure, however, in the unit tested at least, its operation was too fast and harsh – furthermore it was difficult to cue reliably onto a specific record groove as the arm did not always drop completely vertically. Having become used to better viscous damping systems, we feel that some slight redesign is warranted in this area.

MECHANICAL SERVO

The mechanical servo system used to ensure straight-line tracking could be classified under that common heading of "Why didn't somebody think of this sooner," for it is both neat and yet elegantly simple.

Basically it is a mechanical feedback system.

A smooth cylindrical shaft is located at the rear of the turntable. This is belt driven from the turntable motor. A tracking wheel, directly connected to the tone arm gimbals, rests on this shaft.

The pick-up stylus will of course always attempt to follow the record groove in a straight line. As the tone arm attempts to pivot at the correct angle to track the pitch variations, the angle of the tracking wheel changes relative to the tracking shaft. This change in direction of the tracking wheel varies the lateral motion of the carriage relative to the pitch of the record groove. Being a mechanical

RABCO ST-7 straight line tracking turntable

feedback system, the correction is continuous and automatic (provided the system is in good repair).

Compared to the other systems available, which use optical or electrical servos, we believe that the Rabco technique has distinct advantages. It is simpler, has greater overall reliability and minimises the 'dead zone' (hysterisis) from which all electrical servo systems suffer.

TONE ARM

The tone arm is elegantly simple yet extremely practical. It is very short and light. It provides a range of tracking weight adjustments between zero and three grams and overall comes closer to the theoretical requirements of perfection than almost any other arm that we have seen.

Because it does not require an anti-skating adjustment, it requires less adjustment than a conventional pivoted arm and has a smaller number of pivot points than found in the conventional arm. The pivots are so-called Rolamite bearings — a radically new form of bearing claimed to be frictionless. Certainly we found vertical friction to be too low to measure.

To facilitate correct positioning of the pick-up cartridge a special location gauge is provided which clips onto the tone arm.

One drawback of the system is that it is necessary manually to position the one arm carriage system above the record lead-in groove before lowering the tone arm. Likewise, at the end of the record, where although the tone arm is automatically raised, it is necessary to slide back the carriage roller before removing the record. But is a small price to pay for the other advantages that the system offers.

We have not included our normal measurements of horizontal and vertical friction in our data table.

Vertical friction — if any existed — was too low to measure. A figure of (less than) 40 milligrams was obtained for horizontal friction but this figure is more correctly a measure of the self-aligning torque of the tracking wheel — it is not necessarily related to friction — and is included here for interest only.

IMPROVED CHANNEL SEPARATION

Perhaps the most interesting and certainly unexpected result of our objective tests was that the straight-line tracking arm considerably improves channel separation — particularly at high frequencies. As our level recording shows, the improvement is about 3 dB with our V15 Mk III. However, other cartridges showed almost dramatic improvements — an Empire 4000D III for instance showed no less than 8 dB improvement compared with the same cartridge fitted to a conventional top quality arm!

As we said earlier in this review a conventional tone-arm must introduce second harmonic distortion as it sweeps in a arc across a record.

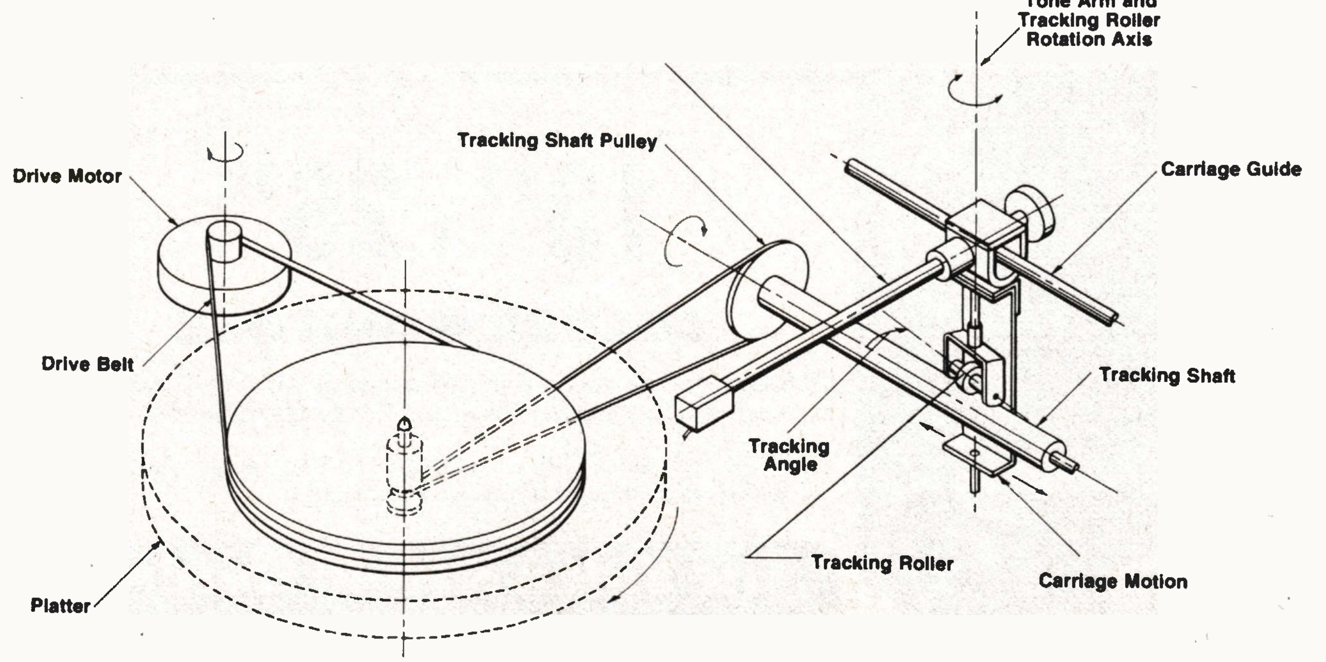
Manufacturers of straight-line tracking turntables emphasise this point. Their products are so designed to eliminate or substantially reduce this form of distortion.

The big question of course is whether or not second harmonic distortion really matters. It is generally a fairly unobjectionable low level phenomena and unless the turntable mechanism is otherwise impeccable the distortion will be masked by other audible imperfections in the rest of the system.

Our experience with the Rabco ST-7 is that there is a measurable and audible reduction in second harmonic distortion at tracking velocities of 100 mm/sec and over. Below this tracking velocity, distortion is still of course reduced, but the inherently poorer signal/noise ratio tends to mask the improvement.

Tracking performance of the ST-7 is marginally better (with the Shure V15

HOW THE STRAIGHT-LINE TRACKING ARM WORKS



RABCO ST-7
straight line tracking turntable

Mk III) than turntables with conventional arms at tracking velocities of 300 mm/sec and beyond. However other cartridges fitted to the Rabco arm did not show any significant improvement except in terms of slightly reduced distortion in the region of 50 to 200 mm/sec.

HALL-EFFECT MOTOR

In keeping with other leading manufacturers, Rabco have made use of a Hall-effect controlled dc motor. The motor used is quite small but develops considerable torque.

The drive from the motor to the turntable platter is via a carefully ground belt which of course effectively prevents motor vibrations being transmitted to the platter. As the manufacturer points out, any residual rumble in the system is generated by the turntable bearings. In the unit tested these bearing generated vibrations in excess of the manufacturer's specifications.

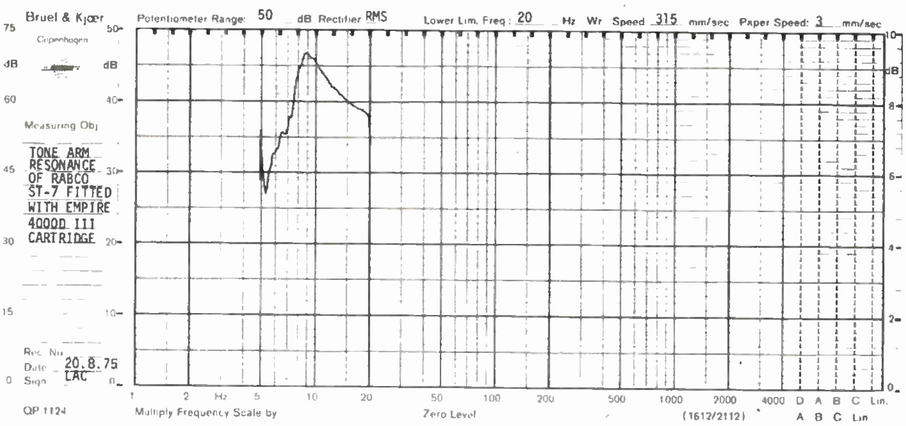
In all other respects the drive system was adequate. Turntable speed was particularly constant, varying a mere 0.2% from start to finish of a 12 inch LP.

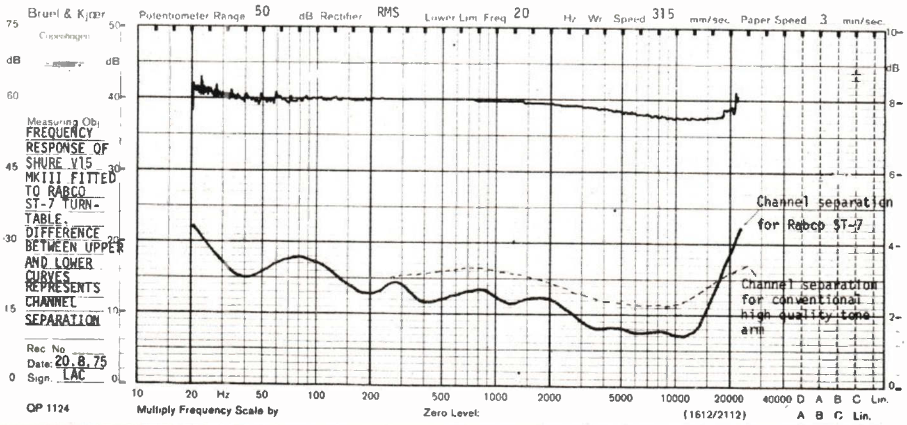
Our evaluation showed that the Rabco ST-7 offers very good performance when used with a really good cartridge (the choice of which is sensibly left to the purchaser). Its simplicity of operation combined with attractive styling should ensure its commercial success.

On the debit side the level of rumble was higher than desirable and the cueing lever operation is clumsy especially when one is trying to locate a particular track on the record. These points really should be improved.

Overall though, the Rabco ST-7 offers exceptional performance, the audible and measurable distortion is low and trackability when used with a good cartridge is enhanced. The reduction in number of user controls makes this system most suitable for either the novice or the faddist.

We do not believe the Rabco ST-7 is perfect, as evidenced by the rumble figures, but as a state of the art improvement, we consider nevertheless that it is one of the finest turntables currently available. ●





The Dual 701 automatic single-play turntable with electronic direct-drive system

The Dual 701 is in every respect the finest turntable ever made. Its full measure of superiority can be appreciated best by the most serious of discerning listeners who impose the highest possible standards on their high fidelity equipment.
The specifications for wow, flutter and rumble are a triumph for its totally new kind of motor designed by Dual expressly for the 701. It is an all-electronic, low-speed, brushless, DC motor with Hall-effect feedback control, and energized by a regulated power supply. Its gapless rotating magnetic field eliminates the magnetic surges typical of all other motor designs.
There are no hysteresis or eddy-current losses, and the rotational drive is uniform and vibration-free.
Further evidence of the 701's advanced technology can be seen in the tonearm counterbalance, where two mechanical, anti-resonance filters absorb the resonant energy that would otherwise transfer spurious signals to the stylus.

The 701's many technical features set new standards for high fidelity record playback equipment, and form the nucleus of the highest quality component systems.

Dual CS601–Dual's first medium priced belt driven turntable

With the CS 601, Dual introduces its second fully auto matic single-play turntable. The CS 601 drive system consists of an 8-pole synchronous motor, developed especially for this new model, and a precision belt running directly from the drive shaft to a flywheel beneath the 305 mm dynamically-balanced platter.

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LM340 (7800 Equivalent) (Specify voltage required 5, 6, 8, 12, 15, 18, 24)	T0220	2.25
LM380 2W Audio Amp	DIP	1.75
LM382 Low Noise Dual pre amp	DIP	2.00
NE540L Power Drive Amplifier	T018	2.95
NE555 Timer	mDIP	.95
NE556 Dual 555 Timer	DIP	1.80
NE565 Phase Locked Loop	DIP	2.50
NE566 Function Generator	mDIP	2.75
NE567 Tone Decoder	mDIP	3.50
LM723C Voltage Regulator	DIP	1.00
LM741C Op Amp	mDIP	.65
LM3900 Quad Amplifier	DIP	1.10

OPTO

	$ c
5023 or equivalent red LED	.30
NSN71 (DL707 equivalent) C Anode 7 segment LED display	2.40
NSN74 (DL704 equivalent)	2.40
NSN61 (DL747 equivalent) C Anode 7 segment LED display	3.50
NCT200 Photo transistor opto coupler	1.50

ETC

		$ c
1N4148 (1N914) Signal Diodes	10 for	.80
2N3055 NPN Power Transistors T03 (Metal)		1.20
C122D 8A SCR		2.25
IC Sockets 8 pin mDIP		.45
14 pin DIP		.55
16 pin DIP		.55

DIGITAL

4000 Series CMOS

	$ c		$ c
4001	0.35	4023	0.45
4002	0.35	4024	2.75
4006	2.90	4025	0.45
4007	0.35	4027	1.40
4009	1.00	4028	2.75
4010	1.00	4029	2.90
4011	0.35	4030	1.30
4012	0.35	4035	2.90
4013	1.30	4040	3.00
4014	2.95	4044	2.45
4015	2.50	4049	1.30
4016	1.05	14511	3.20
4017	2.90	14553	7.60
4019	1.00	74C90	2.35
4020	2.95	74C192	2.90

74 Series TTL

	$ c		$ c
7400	.35	7460	.35
7401	.35	7470	.50
7402	.35	7472	.60
7403	.35	7473	.90
7404	.35	7474	.90
7405	.35	7475	1.00
7408	.35	7476	.80
7409	.35	7480	1.70
7410	.35	7482	1.80
7413	.85	7483	1.40
7420	.35	7486	.60
7430	.35	7490	.80
7437	.60	7491	1.20
7440	.35	7492	.80
7441	1.20	74121	.60
7442	1.00	74123	.85
7447	1.50	74154	2.60
7450	.35	74164	2.40
7451	.35	74165	2.40
7453	.35	74192	2.50
7454	.35	74193	2.50

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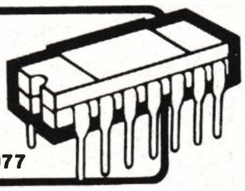

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PART 23

Integrated circuit forms of logic functions.

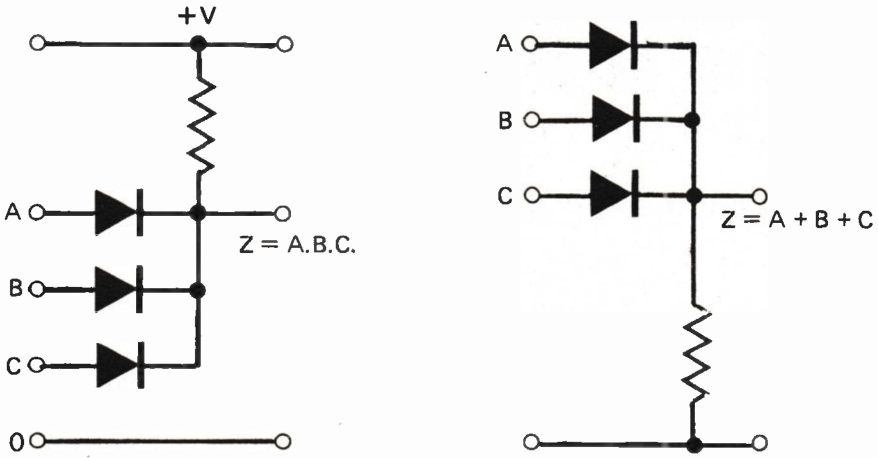


Fig. 1. The implementation of AND and OR gates using diode logic.

NOW that we have a basic understanding of switching circuits and the algebra used to mathematically describe logical operations we can look at the modern methods used in solid-state circuitry to produce the various logic functions in integrated circuit packages.

LOGIC FAMILIES DIODE LOGIC – DL:

In part 21 it was explained how a single diode could be used as a switch by altering the bias or the input signal level. If more than one diode feeds the bias node the circuit becomes a gate. Three input AND and OR gates are shown in Fig. 1. The circuits are the same; the different class of gate arising because of different bias conditions in each case. Fig. 13 of the previous part showed the use of diode logic.

Diode logic is the simplest form of solid-state logic, it is not available in integrated form but is often used in discrete designs to obtain logic functions at high, or unusual (compared to standard IC logic) voltage levels.

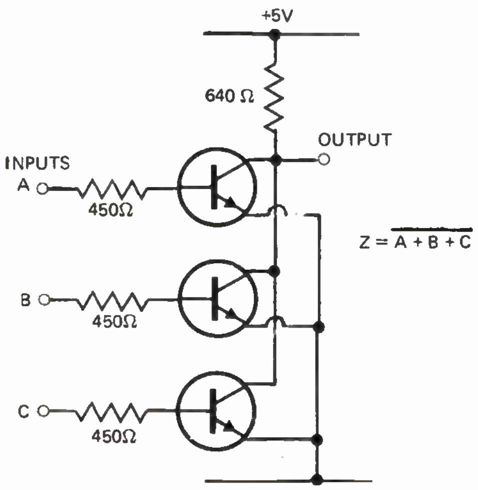


Fig. 2. Typical RTL circuit of a NOR gate: any logical '1' input will give a logical '0' output.

RESISTOR-TRANSISTOR LOGIC – RTL:

Logic gating operations can also be obtained using transistors acting as switches in various ways. Fig. 2. shows a typical RTL NOR gate for which Z = $\overline{A + B + C}$. Base current appearing at A, B or C will cause the respective transistor to switch to the ON state taking the output to ground which is a '0' in a positive logic system.

This family was the first to be used in the now more usual integrated-circuit form based on the planar manufacturing technique (one in which a mask is used to selectively diffuse impurities into a pure substrate in order to produce and separate active device junctions).

RTL is based on a supply of 3.6 V. Propogation delay is 12 nS for a medium power gate and 40 nS for a low power gate. It is a reasonably economic family to use but needs more space than the alternatives developed since. This form of logic was very much in vogue in the early 1960s but, although still manufactured by some companies for replacement purposes, is an obsolete type not used in new design.

DIODE-TRANSISTOR LOGIC – DTL:

This was the next family developed. The devices of the family use resistors, diodes and transistors. Initially DTL logic was constructed with discrete components. These designs were then integrated as shown in Fig. 3. Later devices used transistor input logic instead of diodes, thus reducing the input current requirement and allowing higher fanouts. Typical noise immunity (for a 5 V supply level — the standard used) is around 1 V. The delay time for a pulse signal to travel through, that is, the propagation delay between input change causing output change, is around 30 ns. Output is $>$ 3.5 volts for a '1' and $<$ 0.4 volts for a '0'.

It has a generally lower speed and lower noise immunity than other families. The advantages of DTL are the reasonably high fanout of 10 and the ease of interfacing or coupling a stage to the TTL family to be considered next.

A similar family is HTL (high threshold logic) which uses 15 V supply lines and zener diodes. This is useful in situations where high noise levels occur because this logic is more immune to noise effects than is DTL.

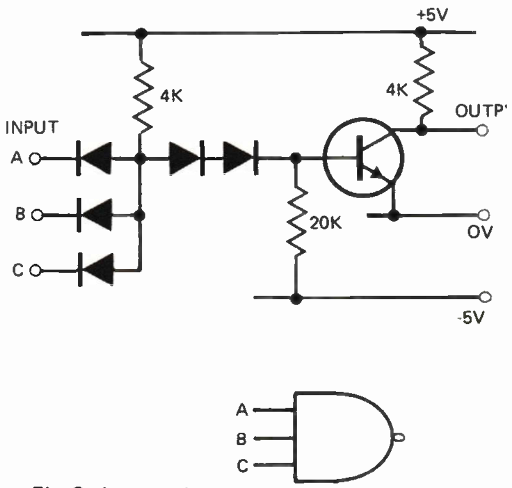


Fig. 3. An early integrated circuit design for a NAND gate in diode-transistor logic — DTL.

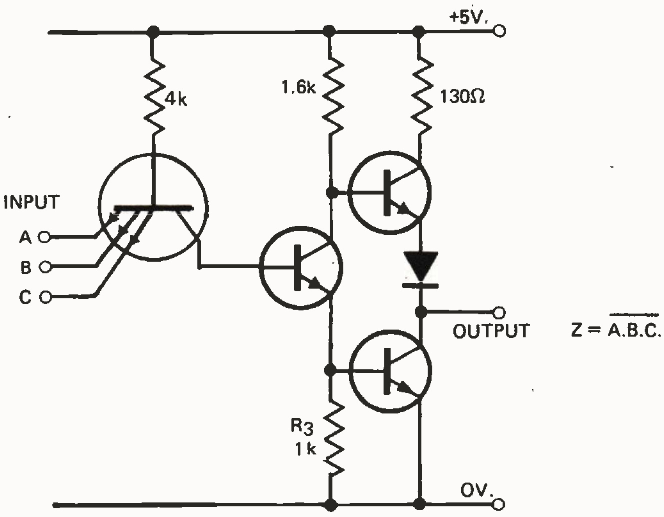


Fig. 5. Typical output signal from TTL, note the transient ringing at each transition.

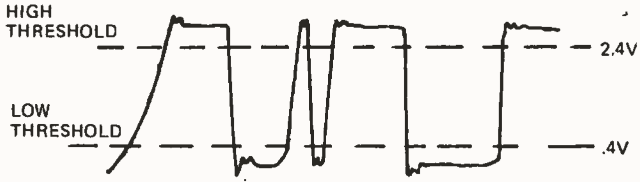


Fig. 4. In the TTL (transistor-transistor logic) form of NAND gate a multi-emitter transistor replaces the diodes of DTL.

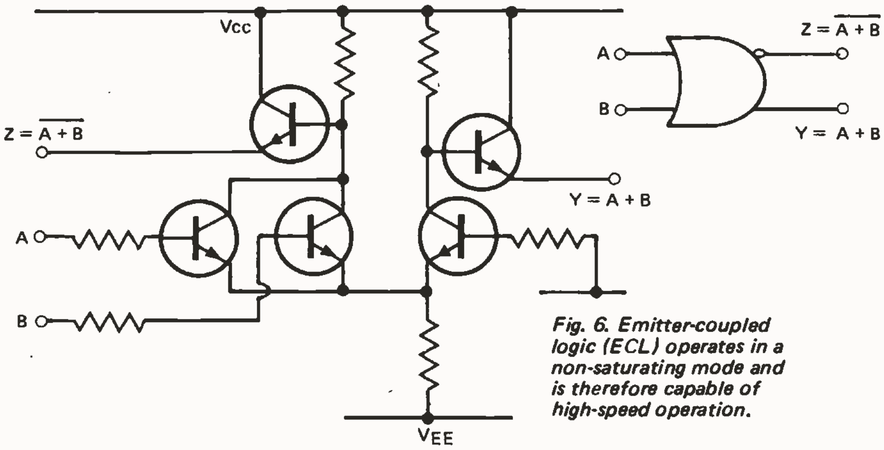


Fig. 6. Emitter-coupled logic (ECL) operates in a non-saturating mode and is therefore capable of high-speed operation.

TRANSISTOR-TRANSISTOR LOGIC – TTL:

This is the most popular logic family in current use. It has higher speed and driving capability than DTL. The propagation delay is around 12 ns which is quite fast enough for the majority of computing applications.

A typical TTL gate circuit for Z = A.B.C. is shown in Fig. 4. Note how the diode input gate has been replaced with a multi-emitter transistor. This multi-emitter technique reduces the input capacitance thus speeding up the switching time, as well as simplifying manufacture. In TTL the supply is +5 V, the output switching between around >2.4 for a 1 to <0.40 for 0 (in positive logic). Fig. 5. shows a TTL signal switching state with time.

For all of its popularity TTL is not ideal, especially for the fastest circuit operation or where the lowest power consumption is required. Another difficulty with TTL is that switching transients occur (see Fig. 5) at the transitions. It is also not particularly suitable for large-scale integration by virtue of the relatively large amount of space and power required by each gate function.

EMITTER-COUPLED LOGIC – ECL:

A typical ECL stage is shown in Fig. 6. As this operates in the linear mode, that is, without allowing the active devices to go into saturation, it gives high-speed 2-3 ns switching times. It, however, needs a moderate power requirement, is not particularly noise immune and needs an extra power supply line. Supply voltages used for ECL vary but when typical supply rails of 0 V and –5.2 volts are used the output is –1 volt for the '1' state and –1.6 volts for the '0' state.

Each of the above logic families is based on the use of the transistor semiconductor junctions – the so-called bi-polar technique. Around 1970 ECL emerged as a possible future contender to TTL and at the same time another quite different kind of semiconductor active device became freely available – the field effect transistor FET. A variation of this is the insulated-gate field-effect transistor IGFET. Fig. 7 lists the symbols of the basic FET structures used in logic. This technique is manufactured using metal-oxide-semiconducting materials;

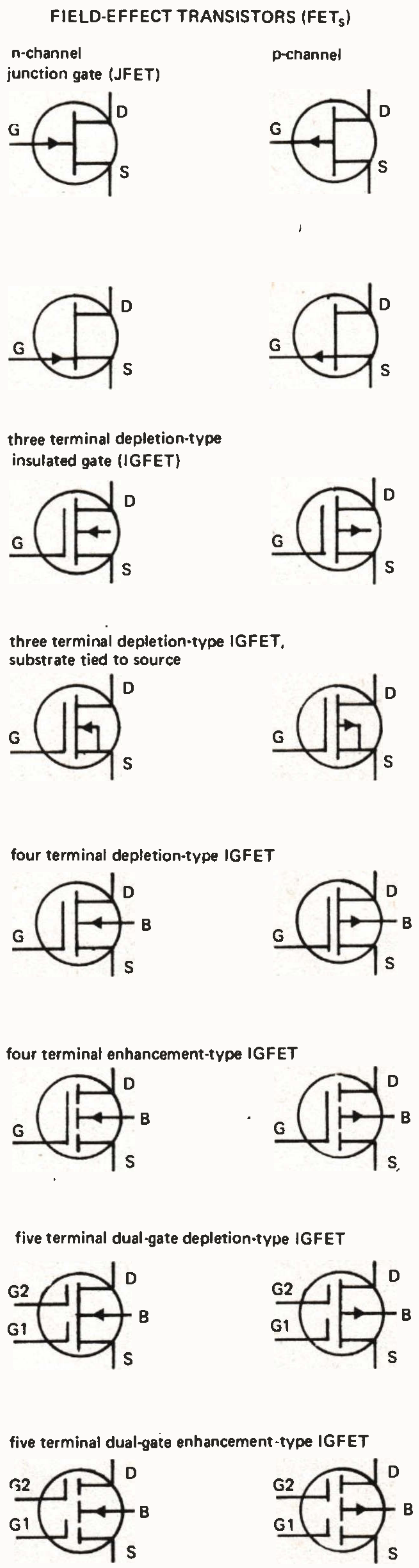


Fig. 7. The symbols used for the various types of FET device.

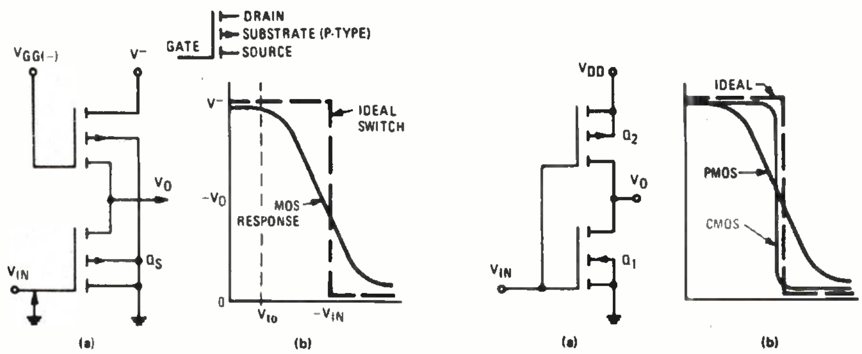
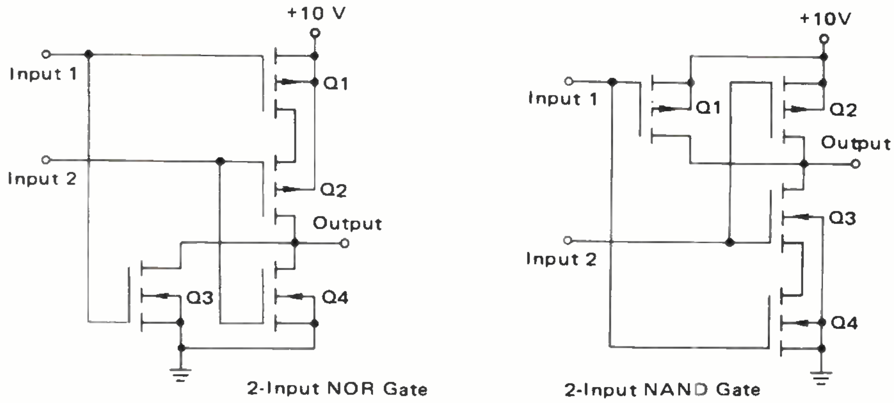


Fig. 8. A comparison of PMOS and CMOS inverters.



"0" = 0 V	"1" = +10 V	
Input 1	Input 2	Output
0	0	1
0	1	0
1	0	0
1	1	0

"0" = 0 V	"1" = +10 V	
Input 1	Input 2	Output
0	0	1
0	1	1
1	0	1
1	1	0

Fig. 9 (a). A CMOS 2-input NOR gate.
(b). A CMOS 2-input NAND gate.

abbreviated to MOS. Hence, the MOSFET is a metal-oxide-semiconductor field-effect-transistor. They can be made in the two complementary ways, P or N, of which the first is most conventional giving the PMOS technique. With improvements in technology the NMOS technique is also being used for very complex circuit blocks.

The attraction to manufacturers and users of MOSFET devices is that the packing density of the active devices is the highest of all types — much better than TTL. It is, however, not as fast as TTL but adequate for a large part of the consumer market. FETs have extremely high input impedance, 1.0 TΩ (1 000 000 M Ω) is common.

THE CMOS FAMILY

IC device designers went a step further in the early 70's to produce yet another family — the complementary metal oxide semiconductor logic — CMOS. This combines both the P and N, MOS technique in a complementary manner to produce a more ideal switching action than PMOS — Fig. 8 illustrates the difference between the two. Fig. 9 is the schematic of a CMOS two-input NOR gate. One of the most significant advantages of CMOS is its low power dissipation. Because of the extremely-high off-resistance of MOS transistors, and because only one transistor of the series-inverter CMOS pair is ever on at the one time, the dc current drain of a CMOS inverter is in the low nano-ampere range as compared to 0.2 milliamps for a low-power TTL inverter. At the system level a CMOS system typically requires one-twentieth to one-thirtieth the power required by an equivalent TTL system. In fact torch batteries are adequate to run quite complex CMOS devices.

Because of the complementary configuration CMOS has high common-mode noise immunity (such as power supply variations). It will operate with supplies from 3 V to 16 V and needs only a single positive supply. In addition the high packing density has allowed the building of low cost large-scale-integrated (LSI) packages. Interfacing to conventional transistor logic is easy because it has a low output impedance. It generates low noise because of nicely conditioned rise and fall times. The fan-out factor of 50 is the highest of all logic because of the extremely high input impedance. Its speed is better than PMOS but not quite up to that of TTL — propagation delays being from 12 to 60 nanoseconds depending upon supply voltage used.

We have merely glossed over these various kinds of device because we are mainly concerned here with digital systems in general. To design systems requires little in-depth understanding of the manufacturing method used for the actual logic element. The logic IC is merely a black-box with certain input-output characteristics as stated on a data sheet. (The April 1973 issue of Electronics Today International featured two state-of-the-art summaries that provide greater depth than we have allocated here.)

Why do new families keep emerging? The facts are that there is still a cost saving to be had and the market is huge. The estimated value of the total market for IC devices in 1975 runs to around $300 000 000. CMOS offered new horizons in cost savings in manufacture. As a bonus from the power requirements of CMOS systems, the so-often neglected power supply cost drops remarkably. One example published in 1973 gave the comparison that a given transistor-based logic (called bipolar to distinguish it from MOS) would have a power supply cost of 33c per MSI bipolar function compared with 2c for CMOS. In fact one watt will power 50 CMOS devices.

We have all experienced the remarkable increase in the use of active devices in the last decade or so. A transistor radio now costs $1.50 to make commercially — and there the semiconductors are but a small part of the cost. (Just one common thermionic valve costs more than this today!) A calculator using hundreds of devices can be bought for $10.

LOGIC DIAGRAMS AND TERMINAL CONNECTIONS FOR SN7400 SERIES

P = positive supply voltage
Ø = earth

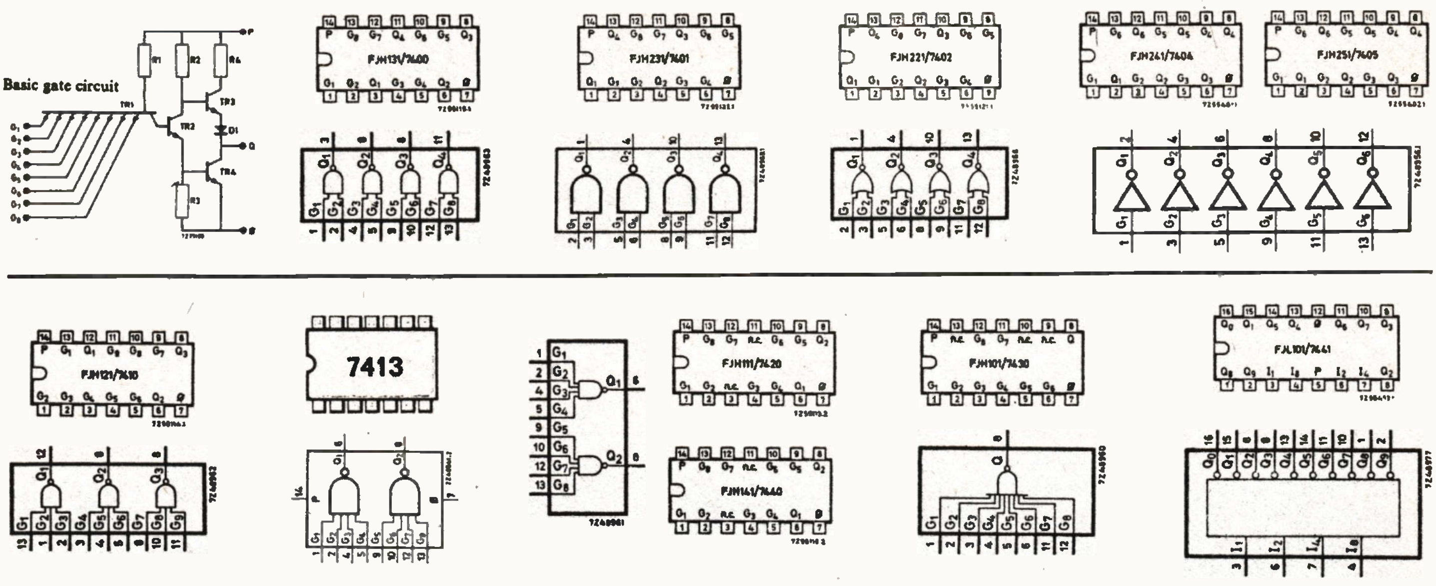


Fig. 10. The basic logic gates of the TTL family.

Minicomputers and microprocessors are rocketing down in price — tens of thousands of elements for a few hundred dollars. It might be argued that reducing the price will soon reduce the makers' total income but as prices fall, applications for digital circuitry widen at an even faster rate, thereby keeping up an expanding demand.

THE DUAL-IN-LINE PACKAGE

The most commonly used form of IC logic package in small batch production is the dual-in-line arrangement with 8, 14 or 16 pins. Large-scale integration LSI used by specialist manufacturers will vary in number of connection, but systems based on these require very large volume sales to make a large special system economic. Thus LSI chips are largely restricted to computers or very high volume things such as calculators and digital clocks.

The number of connections decides the available combination of functions or inputs and outputs. Assuming a need for two power-supply terminations, of which one is the common for all functions, a 14 pin device will have 12 pins available to produce various combinations of input. Fig. 10 shows the main units that are marketed. Available are the sextuple inverter (6 inverters with one input and one output each); the quad 2 input NAND (four two-input NAND gates); the quad two-input NOR, triple three-input NAND, dual four-input NAND, single eight-input NAND plus other more special combinations such as a more powerful dual four-input NAND buffer and others to be discussed below. Each gate function is a quite separate entity on the substrate; when schematic circuits are drawn the individual gates can appear anywhere on the system schematic, as shown in Fig. 11, where part of a digital-voltmeter circuit is given. Fig. 12 shows a component overlay and actual circuit boards for the same voltmeter.

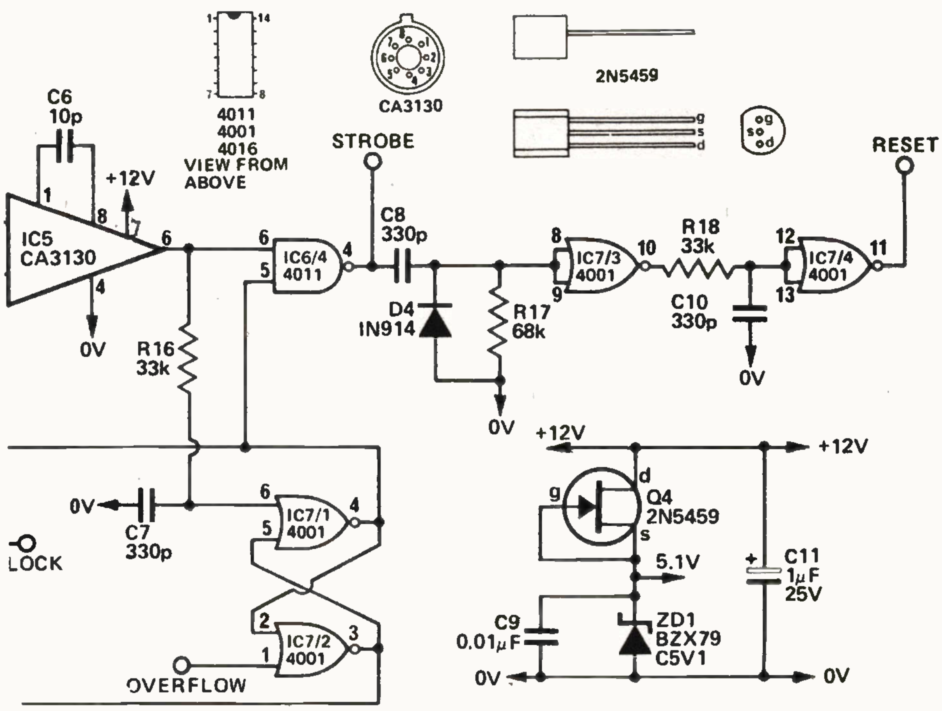


Fig. 11. In a schematic diagram the individual gates in a common IC package are drawn to suit the system layout — not the actual wiring layout. This is illustrated above by part of a digital voltmeter circuit.

As well as gates there are several other basic digital-system building blocks. These are the flip-flop, (more correctly called the bistable), the monostable, the astable and the Schmidtt trigger. Let us look at each in turn.

THE FLIP-FLOP

Gates are used to perform logical arithmetic, such as, allow event A to occur when B or C have operated. Digital systems can be greatly enhanced by the addition of blocks

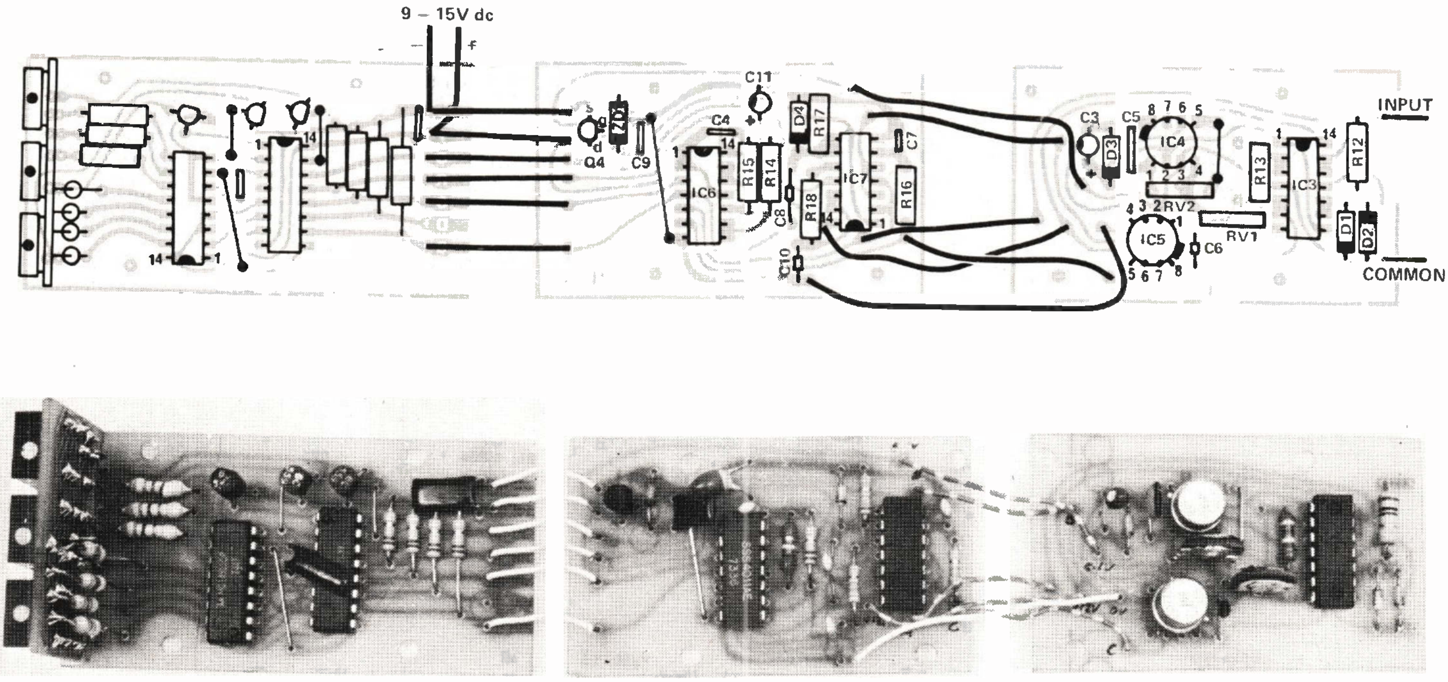


Fig. 12. Wiring layout and actual circuit boards of the DVM shown in Fig. 11.

that remember and count the digital numbers. It is quite possible to use the gates we have discussed to form counting stages but it is more economical to build specific circuitry that will count pulses and/or store values in a binary form. The basic block of modern counting technique is the flip-flop — FF or bistable — one of the multivibrator family.

The most elementary flip-flop circuit is repeated from Part 18 as Fig. 13. It consists of two-transistors and several resistors which are dc coupled in such a way that each stage provides a signal which controls the state of the other.

In essence the characteristic behaviour is that one stage will be held ON when the other is OFF, or vice versa. To reverse the situation a pulse or change in input signal level (which can be applied to either the base, emitter or the collector) will cause the system to toggle over to the other state. Because of the heavy degree of positive feedback provided, the circuit does not dwell in the in-between state. State change is very rapid — nanoseconds in well designed IC flip-flops.

A decade ago flip-flops were built from two, or in the faster toggling circuits, four transistors. Considerable effort was expended to provide a fast, reliable flip-flop action. Today a typical IC equivalent, see Fig. 14, uses many active elements for less cost than two discrete transistors. As discrete designs play no real part today we will only give the characteristics of the flip-flop, not its design details.

Flip-flops provide a counting action because each pulse at its input causes the system to switch over one state — the output, therefore, switches state at each *second* input pulse providing a divide by two action. The output is a switched level which can then be used to pulse a following stage dividing by two again and so through cascaded flip-flops.

The most commonly used flip-flop symbol is given in Fig. 15. Outputs are denoted by the symbol Q. A flip-flop has two outputs, one of which is the inverted value of the other, that is, Q and $\bar{Q}$. The pulsing input is denoted T for trigger. As well as these connections we need a set and reset input denoted S,R. (Although often only R is provided). These enable the flip-flop to be set up on demand with the output Q set to either 0 or 1 state as is needed. This is essential firstly because a flip-flop can come up in any state when the power is energised, and secondly because it may be necessary to set counterstages to a given binary number.

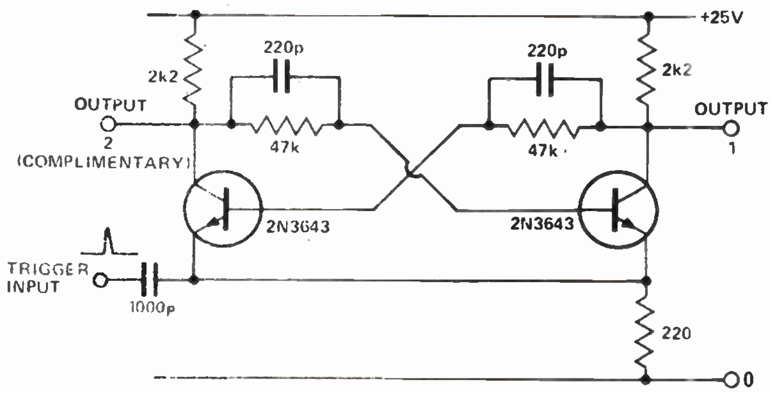
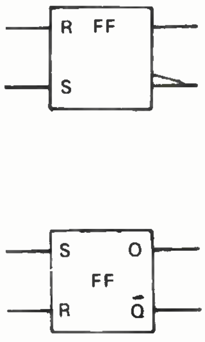


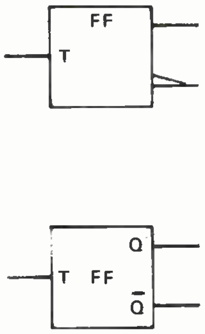
Fig. 13. A basic flip-flop built with discrete components.

FLIP FLOPS

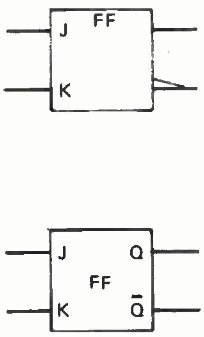
R-S (set-reset) flip-flop



Toggle flip-flop



J-K flip-flop



D-type flip-flop

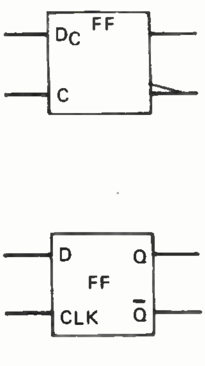
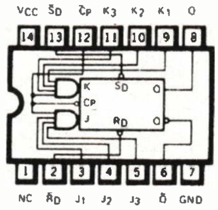


Fig. 14. Schematic symbols used for different types of flip-flops.

DIP (TOP VIEW)



SCHEMATIC DIAGRAM

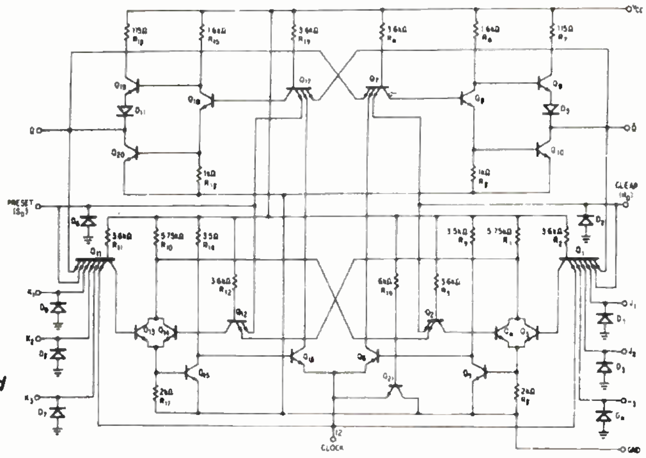
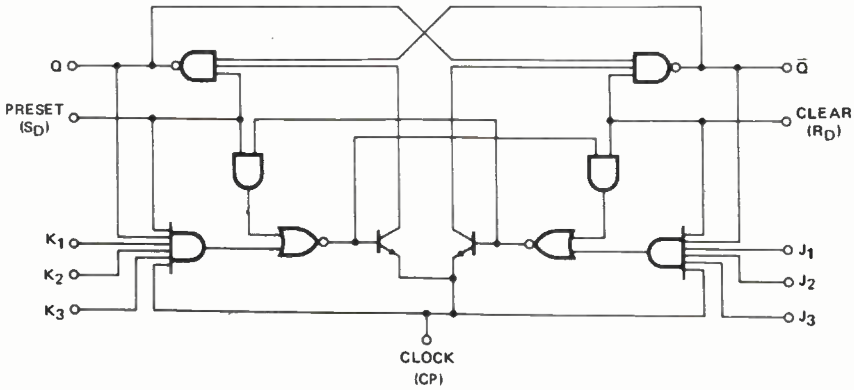


Fig. 15. Schematic and logic diagrams of an integrated circuit flip-flop using bipolar devices.

Component values shown are typical.

LOGIC DIAGRAM



Some flip-flops provided in IC form also may contain three-input AND gates that feed the set and reset inputs. These are known as the J and K inputs giving the name J-K flip-flop. The JK flip-flop overcomes an ambiguous output state, when both inputs are high, that occurs with the RS flip-flop. We will see, when counting systems are discussed, why the reset ability is vital in many counters. Fig. 16 gives the schematics of some of the available flip-flop ICs.

THE MONOSTABLE

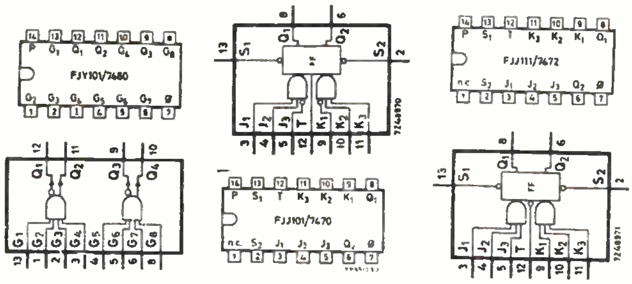
If one of the bias resistors of the bi-stable circuit is replaced by a capacitor, as shown in Fig. 17, the circuit provides a different action from the normal flip-flop. When triggered the circuit changes state, but only stays toggled in the changed state for a time decided by the product of the values of the capacitor and its "charging" resistor R. (T = 0.7RC) Hence a pulse input will cause the output to change state and remain there for a chosen time interval before it triggers back to the original state.

The monostable, also called a one-shot or single-shot provides, as we saw in Part 18, an output pulse having a designed length and height which remains the same irrespective of the input pulse shape. It, therefore, finds application as a pulse reshaper. As the duration is fixed it can also be used to generate a pulse that is delayed from the triggering pulse by the length of the monostable pulse. Monostables are available in IC form, and can provide pulses of duration from 20 ns upwards to minutes or more by appropriate choice of values.

THE ASTABLE

If both feedback paths use capacitive coupling the circuit becomes self-toggling with the stages alternating in state without being externally driven. We considered this circuit in Part 18 when discussing signal generation. The astable is important in digital systems for it provides the square wave signal that increments the digital system along pulse by pulse. It acts as the 'clock' regulating a digital system's sequential operations.

Astables are not usually produced directly in IC form, for the same action is obtainable with other elements, for instance, with the next element to be



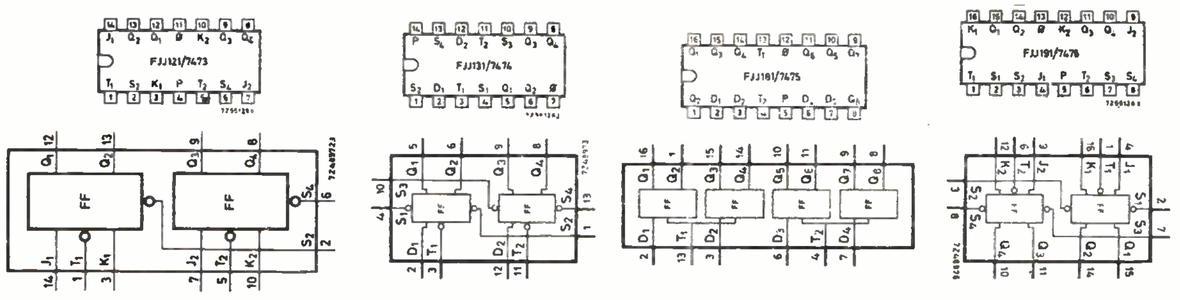


Fig. 16. A variety of flip-flops are available in integrated form.

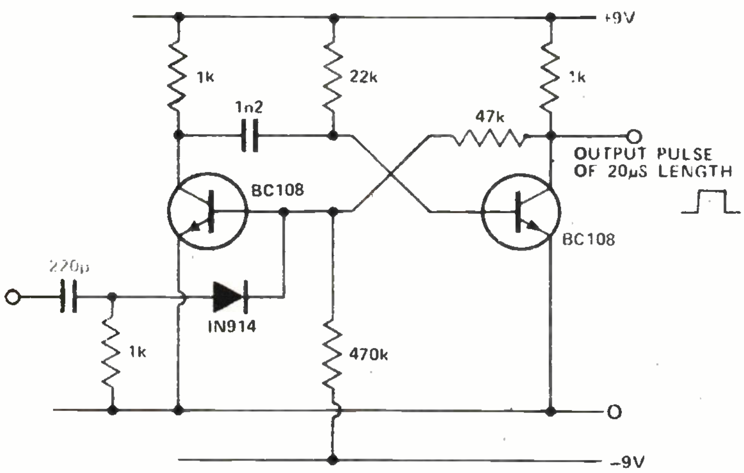


Fig. 17. A basic monostable constructed with discrete components.

considered, the Schmidtt trigger. Fig. 18a shows a clock source based on a Schmidtt trigger IC. Fig. 18b shows one based on two NAND gates.

THE SCHMIDTT TRIGGER

This unit, also introduced in Part 18, toggles over from one state to the other at a certain input voltage level. It remains in the opposite state until the voltage falls below the threshold level. The Schmidtt trigger is used to produce digital signals from analogue signals providing the two necessary binary levels at the output which indicates whether the analogue signal is above or below the threshold and, which are compatible with the rest of the digital system.

The Schmidtt function is available in

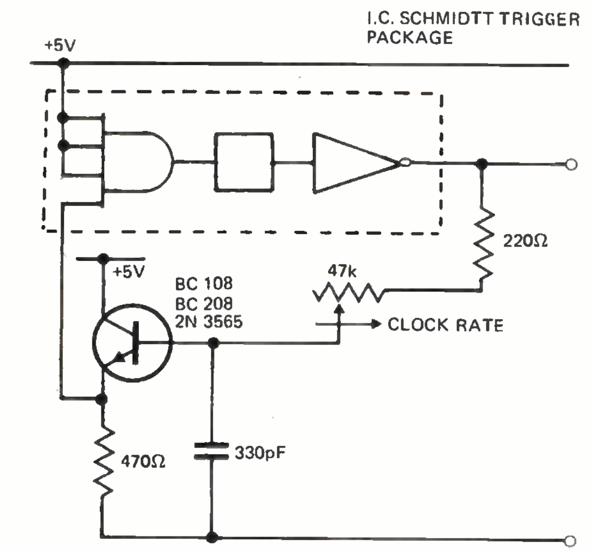
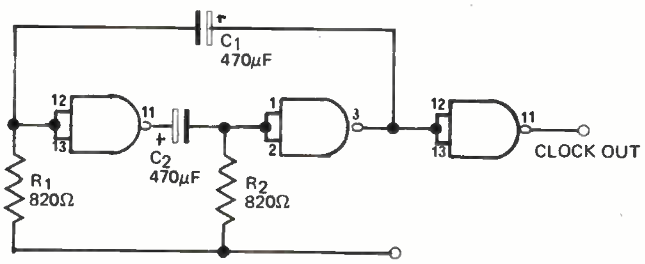


Fig.18(a) LEFT: A Schmidt trigger combined with a transistor provides an astable multivibrator action.
Fig.18(b) BELOW: Astable action may also be produced with two NAND gates.



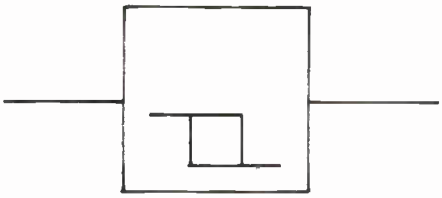


Fig. 19. Standard Schmidtt trigger symbol.

IC form as a dual-in-line pack. It has a four input AND gate feeding the actual trigger circuit and is buffered with an inverter. The Schmidtt trigger is readily identified in Fig. 18. Its preferred symbol is given in Fig. 19.

YOUR LIBRARY

There are a bewildering number of digital ICs and to identify them correctly it is wise to have a good range of manufacturers' catalogues and application notes.

FURTHER READING

The reading list given in Part 22 is also relevant to this part.

A brief article explaining how to interface MOS to TTL systems appeared in the MAY, 1972 edition of ETI. ●

AUDIO FACTS

CASSETTE DECKS FOR LOCAL HI-FI MAKERS

The growing popularity in Australia of taped music in home hi-fi equipment will be boosted by a new agreement with a company which claims to have 30 percent of the world market for cassette tape deck mechanism.

Under an agreement with Japan's Tanashin-Denki company, the Garrard Division of Plessey Australia, Villawood, NSW, will have exclusive distribution rights to Tanashin-Denki's range of mechanical chassis in Australia and New Zealand.

The mechanisms will be sold to manufacturers by the Plessey Garrard Division, either for use in equipment using Garrard turntables or for adding to other forms of pick-up.

Tanashin-Denki produce more than 4.5 million cassette mechanisms a year for manufacturers such as National, Pioneer, Victor, NEC and Marubeni to install in their equipment.

Manager of Plessey Australia Professional Components, Mr. Brian P. Cleaves, who arranged the agreement, said that direct importation of Tanashin-Denki units would help meet the growing demand for cassette tape deck mechanisms as an addition to modular type record-playing equipment.

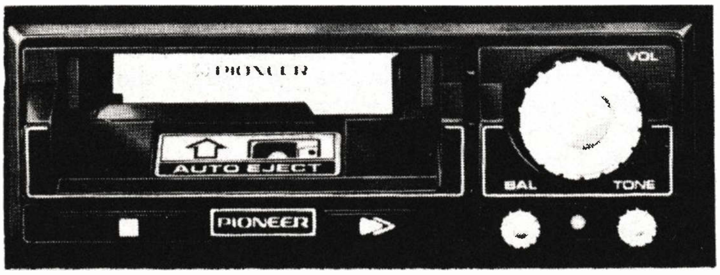
The Japanese company, which claims to lead the world in tape recorder mechanism production, makes more than 26 models.

$99 CAR STEREO FROM PIONEER

A fourth model has been added to Pioneer's range of car cassette stereos — the KP-151 with a recommended price of $99. "Many people buying car stereo for the first time want a cassette player that is low in cost yet reliable," said Doug Bell, Pioneer Marketing Services Manager. "This new model can be fitted under the dashboard if a radio is already installed, or in the dash using our custom fitting kits."

A unique point about Pioneer's cassette stereo is that all models in the range use exactly the same mechanism, so the quality in the $199 model is the same as the $99 KP-151.

The new release gives Pioneer four cassette players and five 8-track cartridge players with recommended retail prices from $75.



AWA FORMS NEW BROADCAST SYSTEMS GROUP

A new group has been formed by Amalgamated Wireless (Australasia) Limited to market a complete range of equipment and services to the broadcasting industry.

Mr. Eric Phillips (Group Manager — Broadcasting, Television and Instrumentation), said today that the AWA Broadcast Systems Group will bring together experience from all parts of the industry. The group will set up a Demonstration and Sales area on the 5th floor of the AWA Building at 47 York Street, Sydney.

In addition to the Automation Equipment, AWA Broadcast Systems will offer a complete range of Station hardware including AKG Microphones, Revox Recorders, Studer Recorders and Consoles, Cetec equipments, Marconi and Sparta Transmitters, and other AWA locally produced broadcast equipment.

NAKAMICHI VERSUS REVOX

The Nakamichi cassette recorder 1000 costs about $1465 — A Revox A700 reel-to-reel machine $1480.

If you're lucky enough to be able to afford either, which should you choose?

A direct comparison has been included in the September issue of our associated magazine Hi-Fi Review — on sale now at all newsagents.

Also in this issue is a survey of cartridges in the $30-$60 range — plus a check against under $10 and over $80 units. The results are surprising!

HI-FI BRIEFS

* Four channel is not yet dead — but don't expect any change in the status quo for at least twelve months.
* Yamaha have an all-FET pre-amp to match their FET power-amp — more details soon.
* Nikko will soon launch a Class A power amplifier.
* Way out speaker of the year is Jordan Watt's 'Flagon'. This looks like an Assyrian drinking vessel and is actually made from a ceramic material.
* ESS have produced headphones incorporating the Heil driver — price (in the USA) is less than US$100.
* Class D switching power amplifier from Infinity should be on sale within two months.
* Fisher are about to re-enter turntable manufacturing.
* There's yet another new speaker from ESS. Called the Evaluator, it has a newly designed Heil driver, 12 inch woofer in a ported enclosure and an 'environmental equalizer'.

IDEAS FOR EXPERIMENTERS

SOUND EFFECT GENERATOR

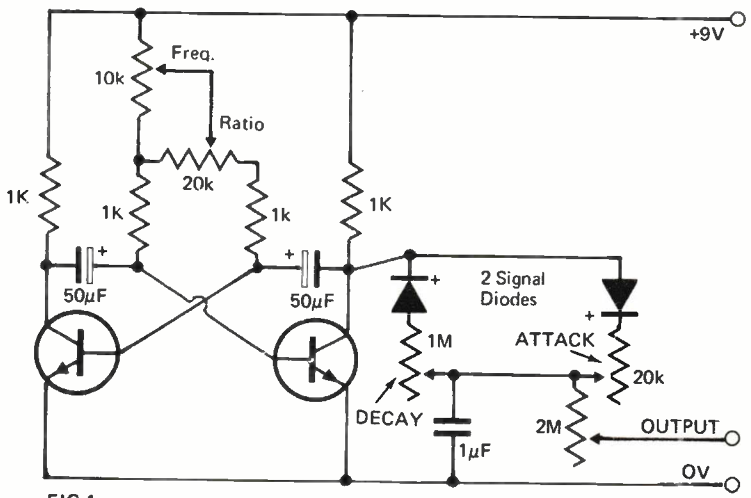


FIG 1

FIG. 2

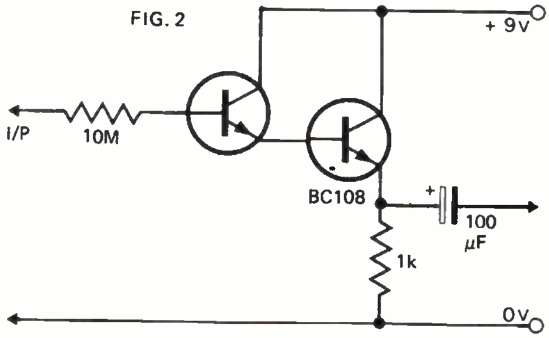
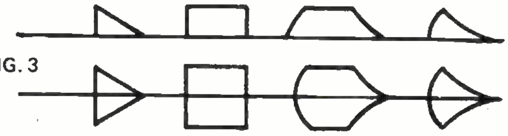


FIG. 3



AFTER MODULATION

The waveshape generator shown in this circuit will interest those readers experimenting with sound effects.

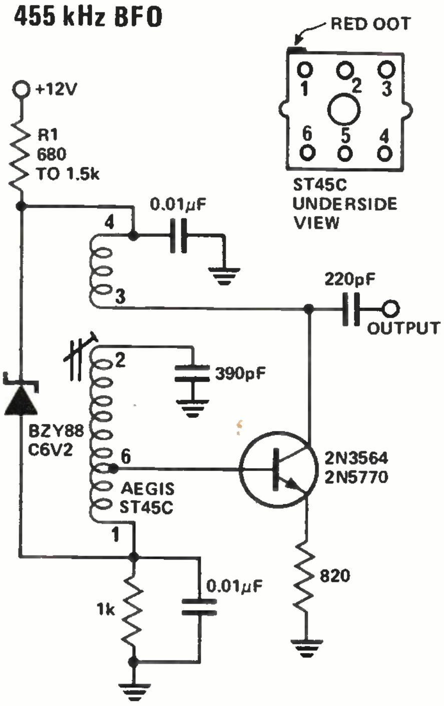
Basically the circuit is a slow running oscillator with variable attack and decay. A variable amplitude (high impedance) output is available via the 2 meg potentiometer. Figure 2 shows an add-on circuit which should be used if a low impedance output is required.

Some of the output waveforms that can be produced are shown in Fig 3.

J.C. Stacey,
Merriville, NSW

---

455 kHz BFO



This simple BFO delivers about one volt peak output with very low harmonic content. The coil is actually an IF transformer, the Aegis ST45C, which is readily available. The output can be varied by varying R1, which vanes the collector current. A trimmer or varicap can be used to pull the frequency for SSB detection. This can be placed in parallel with the 390pF resonating capacitor or, alternatively, in parallel with the 820 ohm emitter resistor. Keep leads short, otherwise construction is non-critical. The coil slug can be used to set the BFO initially on frequency.

Roger Harrison

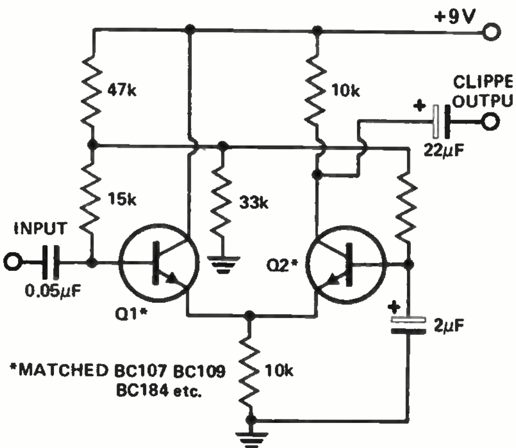
TINNING WITH SOLDER WICK

Do not discard the lengths of solder saturated solder wick. Further use can be made of them to plate printed-circuit boards by pre-tinning the joints, prior to inserting components and soldering.

The simple operation is as follows — place the saturated solder wick on the printed board and apply a heated soldering iron to melt the solder in the wick. At the same time, move the wick and iron along sections or joints requiring tinner. A neat plated copper print will result.

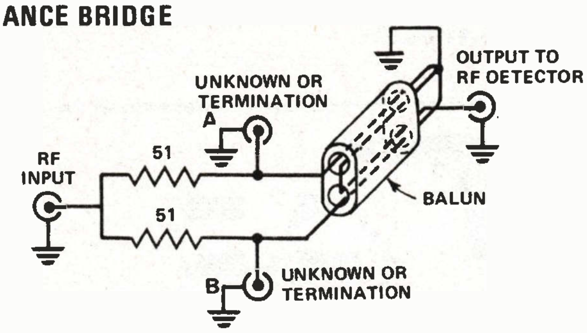
R.F.M. Andree
Brisbane, Qld.

PRECISE AUDIO CLIPPER



A differential amplifier makes an excellent audio clipper and can provide precise, symmetrical clipping. The above circuit commences clipping at an input of 100 mV. The output commences clipping at ±3 V. Matching Q7 and Q2 is necessary for good symmetrical clipping, however, if some asymmetry can be tolerated this need not be done.

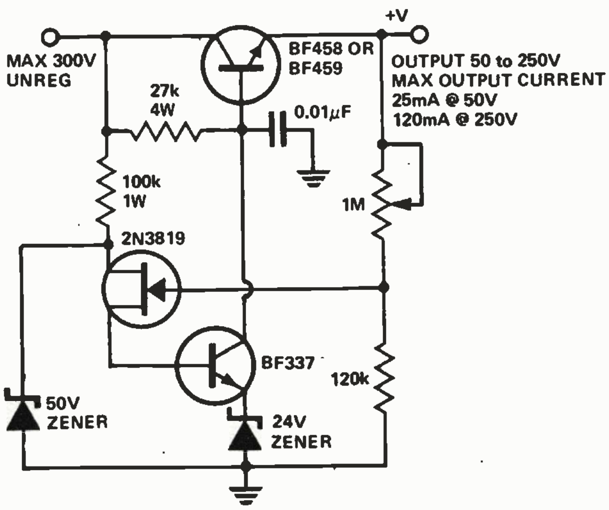
RF IMPEDANCE BRIDGE



This works on the familiar Wheatstone bridge principle. The unknown impedance is connected to A and the termination (50 ohm dummy lead) plugged into B. The balun uses the Philips balun core 4322-020-3150 or the Neosid 1050/2/R29. For use from about 30 MHz to 200 MHz only a single turn is necessary as shown. For better results between 1 and 30 kHz several turns (centre-tapped) should be used. A receiver makes the best RF detector. When the unknown impedance matches the termination, a null occurs in the output. Keep leads short and well placed to preserve balance. Mount in a shielded box.

Roger Harrison

VARIABLE, HIGH VOLTAGE REGULATOR



This regulator is ideal for SSB linear amplifier tube screens. It would also have application in the repeller supply for a reflex-klystron microwave oscillator. CRO deflection amplifier supply is another possible application.

Regulation is about 0.5%. The output transistor will need to be mounted on a small, insulated heatsink. A BF459 is preferred (30°V Vceo) as the BF458 is sailing a bit close to the wind when the output is down to 50 V.

FLICKER-FREE FLUORESCENT STARTING

Here is an extremely simple, yet effective modification which will eliminate the annoying flickering when a fluorescent lamp is first switched on.

The modification consists of inserting a diode (P.I.V. about 600 V) in series with the starter. This results in a fairly heavy current on initial switch-on, which heats the filaments quickly. When the starter contacts open again, the lamp fires immediately.

NOTE: The effectiveness of the modification, depends largely upon the characteristics of the starter; try and find one that is quick-acting.

My original unit has been working successfully in my desk lamp for the past three years, and I've had no problems with dc magnetisation of the ballast, or excessive power consumption on switch-on.

M. Chuda

HOME-MADE LDR

I had to find a cheap and easy way to improvise for an LDR or photo-transistor. I took several medium power silicon transistors from my surplus box and carefully cut off with a saw and filed the top part of the can, exposing only the silicon chips. They worked quite well as substitutes for LDRs or photo-transistors.

For use as an LDR use only the collector and emitter legs. As a photo-transistor use all three legs — emitter base, collector.

In some circuits the component values need not be changed, while in others a change is necessary for the circuit to work.

High powered silicon transistors also give a similar effect but they are costly unless found in the surplus box. Germanium transistors cannot be used because of the 'grease' present in them.

K.P. Khoo,
Penang, Malaysia.

COLOUR CODING COMPONENTS

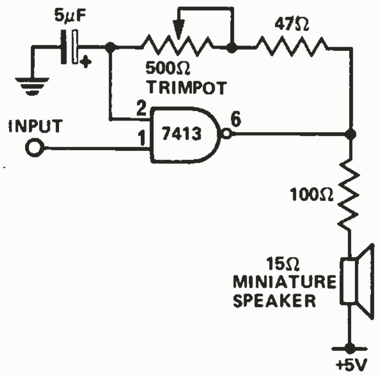
The resistor colour code can be extended for use in codifying all manner of other components.

Zener diodes for example can be thus coded once their parameters have been established. Similarly it assists when building a unit to mark the leads of transformers, coils transistors etc with short lengths of coloured insulating spaghetti. If for example one has a centre-tapped transformer then — from the top of the winding inwards — the code could be top = brown, centre = red, bottom = orange.

With a transistor base (B) = 2 = red; collector (C) = 3 = orange; emitter (E) = 5 = green. Just follow a numerical sequence equating numbers with letters of the alphabet.

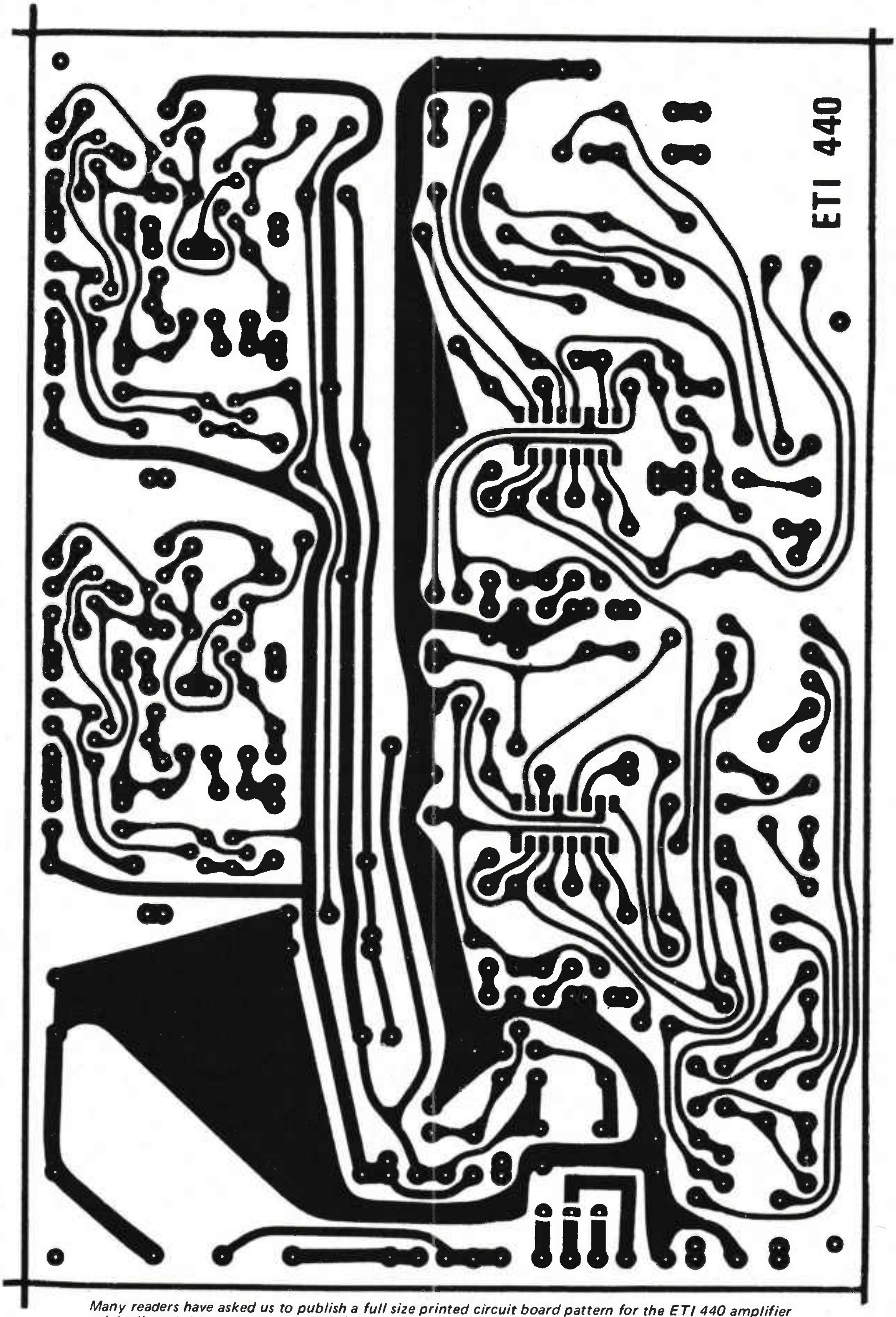
C. Christie,
Whangarei, N.Z.

MAKING SLOW LOGIC PULSES AUDIBLE

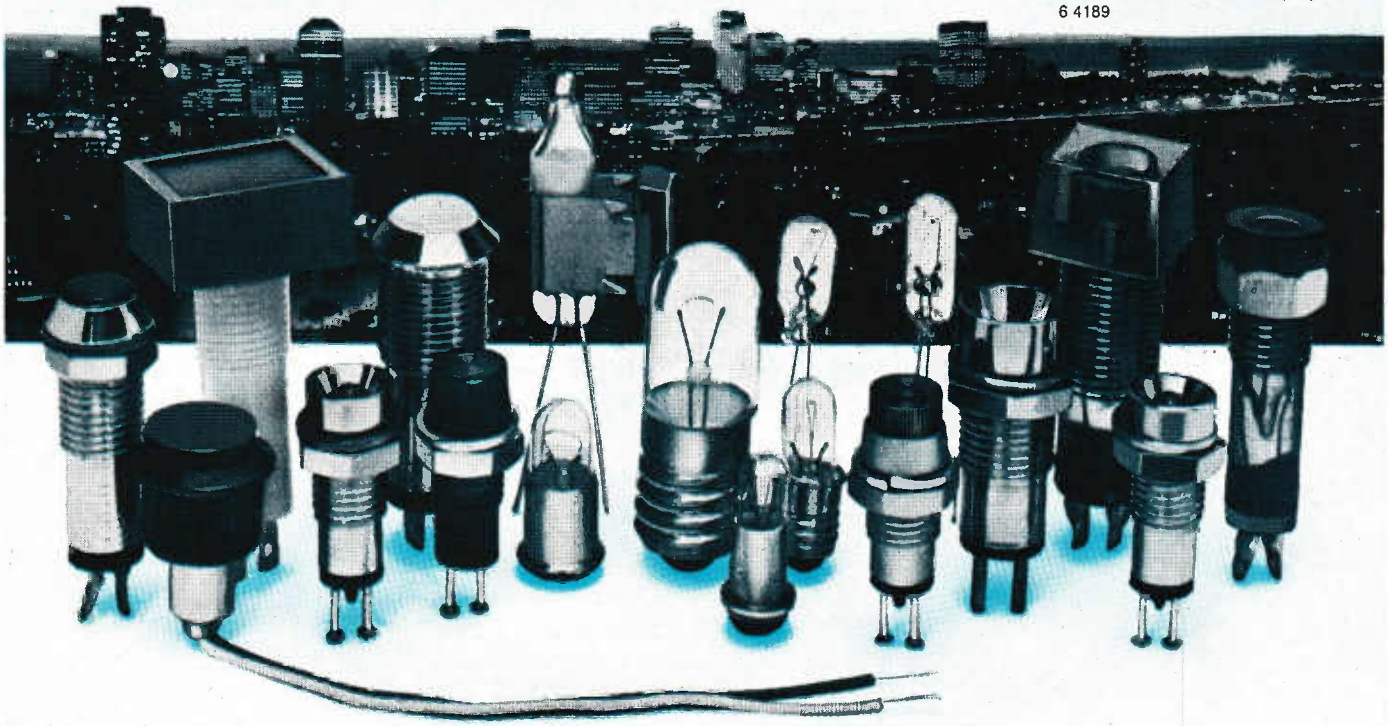


For monitoring slow logic pulses a schmitt trigger is connected as an oscillator. The trimpot controls the pitch of the output. Very useful as a keying monitor or digital clock alarm. When the input goes high, the 7413 will oscillate.

ADDENDA – ETI 440 AMPLIFIER



Many readers have asked us to publish a full size printed circuit board pattern for the ETI 440 amplifier originally published in our July 1975 issue.
Here it is.



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	KIT	BUILT	P&P
15 Watt RMS per channel, PM 143	$65.00	$95.00	$4.00
25 Watt RMS per channel, ETI 440	$85.00	$115.00	$4.00
50 Watt RMS per channel, ETI 422	$105.00	$135.00	$5.00

COUNTER-DISPLAY, ETI 533

Runs off 5-15 volts, 1 MHz. maximum counting speed. Three digits.

KIT $24.00, MODULE $29.50, P&P $1.50.

DIGITAL DC VOLTMETER, ETI 117.

Requires ETI 533 display, few resistors, switch and power supply to measure from 1-1000V.

KIT $16.00, MODULE $19.50, P&P $1.00

CROSSHATCH GENERATOR, ETI 704.

Operates from a standard 9V battery, has 75 ohm output, kit includes case, module is assembled board and board components only.

KIT $25.00, MODULE $19.50, P&P $2.50.

LOGIC PROBE, ETI 120

Kit including case, $13.95. Module excluding case, $10.95. Probe case only, $4.95. P&P on each $1.00.

LOGIC PULSER, ETI 121

Kit including case, $12.95. Module excluding case $9.95. Probe case only, $4.95. P&P on each $1.00.

Frequency Counter ETI 118.

As featured in the August issue of this magazine. The ETI 533 is required to be purchased for this unit. Kit includes case and power supply, module is assembled board and board components. KIT $49.50., P&P $2.00. MODULE $32.50, P&P $1.50.

NOTE: ½ watt, 1 watt resistors, ceramic and green-cap capacitors are supplied only in complete packs — one value per pack. Because of high labor costs we are unable to supply mixed value packs to order.
Other components are available in any quantity. Simply calculate price and add 20% to portion not in standard park.
EXAMPLE: 60 x CES25V 10 uF Electrolytics Pack of 50 $5.00, plus 10 $1.00, 20% loading on 10 $0.20 = $6.20 Plus 10% P&P 62cents = $6.82.

BIPOLAR, CROSSOVER CAPACITORS

	Quantity in pack	Bulk discount price
4.7uF	20	$3.60
6.8uF	20	$4.40
10uF	20	$4.40
22uF	20	$5.40
33uF	20	$5.40
47uF	10	$3.60
100uF	10	$5.60

TAG TANTALUM CAPACITORS

	Qnty in pack	Bulk discount price
35 Volt, .10uF	25	$3.10
35 Volt, .15uF	25	$3.10
35 Volt, .22uF	25	$3.10
35 Volt, .33uF	25	$3.10
35 Volt, .47uF	25	$3.10
35 Volt, .68uF	25	$3.10
35 Volt, 1.0uF	25	$3.40
35 Volt, 1.5uF	25	$3.75
35 Volt, 2.2uF	25	$4.35
25 Volt, 3.3uF	25	$4.45
25 Volt, 4.7uF	25	$5.10
25 Volt, 6.8uF	25	$5.60
25 Volt, 10uF	25	$6.20
25 Volt, 15uF	10	$3.85
16 Volt, 22uF	10	$4.00
10 Volt, 33uF	10	$4.25
6 Volt, 47uF	10	$4.45
6 Volt, 68uF	10	$4.75
3 Volt, 100uF	10	$6.40

GREENCAP POLYESTER, 100 VOLT

	Quantity in pack	Bulk discount price
.001uF	100	$5.25
.0012uF	100	$5.25
.0015uF	100	$5.25
.0018uF	100	$5.25
.0022uF	100	$5.25
.0027uF	100	$5.25
.0033uF	100	$5.25
.0039uF	100	$5.25
.0047uF	100	$5.25
.0056uF	100	$5.25
.0068uF	100	$5.25
.0082uF	100	$5.25
.01uF	100	$5.60
.012uF	100	$5.80
.015uF	100	$5.80
.018uF	100	$5.80
.022uF	50	$3.00
.027uF	50	$3.25
.033uF	50	$3.25
.039uF	50	$3.50
.047uF	50	$3.75
.056uF	50	$4.00
.068uF	50	$4.60
.082uF	25	$2.75
.1uF	25	$3.00
.12uF	25	$3.25
.15uF	25	$3.75
.18uF	25	$4.00
.22uF	25	$4.25
.27uF	10	$2.50
.33uF	10	$2.70
.39uF	10	$3.00
.47uF	10	$3.50
.56uF	10	$3.56
.68uF	10	$4.30
.82uF	10	$5.25
1.0uF	5	$2.75
1.2uF	5	$3.25
1.5uF	5	$3.25
1.8uF	5	$3.25
2.2uF	5	$4.00
2.7uF	5	$4.75
3.3uF	5	$5.25
3.9uF	5	$6.75
4.7uF	5	$7.65
5.6uF	5	$8.50
6.8uF	5	$9.35
8.2uF	5	$9.95

		Qnty in pack	Bulk dis. price
PGP1	Mains plug, piggy back	10	$6.50
PGP2	Mains plug, two pin	10	$3.00
PGP3	Mains plug, three pin	10	$3.80
PGS1	Mains socket, surface mount	10	$5.50
PGS2	Mains socket, two pin	10	$4.00
PGS3	Mains socket, recessed mount	10	$5.50
PH143	Heavy duty alligator clip	10	$3.00
PH252	Single side solder lug	100	$2.00
PH266	Double side solder lug	100	$2.00
PH906	Mains cable clamp	100	$8.00
PH1071	Quick connect socket	100	$3.00
PH1135	Quick connect cover	100	$3.00
PH1909	Quick connect adapter	100	$6.00
PH1925	Quick connect plug	100	$4.00
PH1938	100 pin IC terminals strip	100	$3.00
PID8	IC socket, 8 pin minidip	10	$4.30
PID14	IC socket, 14 pin dip	10	$5.70
PID16	IC socket, 16 pin dip	10	$6.10
PIR8	IC socket, 8 pin round	10	$8.00
PIR10	IC socket, 10 pin round	10	$9.90
PLC1B	RCA line socket, hard, black	10	$2.10
PLC1R	RCA line socket, hard, red	10	$2.10

		Qnty in pack	Bulk dis. price
PLC2B	RCA plug, hard cover, black	10	$1.90
PLC2R	RCA plug, hard cover, red	10	$1.90
PLC3	RCA uninsulated chassis socket	10	$2.30
PLC4B	RCA plug, soft cover, black	10	$1.00
PLC4R	RCA plug, soft cover, red	10	$1.00
PLC5	RCA insulated chassis socket	10	$1.70
PLC6	RCA two way chassis socket	10	$2.90
PLC7	RCA four way chassis socket	10	$6.20
PLC8	RCA five way chassis socket	10	$9.50
PLC9	RCA six way chassis socket	10	$9.50
PMS1B	Spade terminal, black	10	$1.90
PMS1R	Spade terminal, red	10	$1.90
PMP1B	Push terminal, black	10	$4.40
PMP1R	Push terminal, red	10	$4.40
PN216	9 Volt battery clip	10	$1.00
PN4A	four battery holder, A type	10	$3.80
POC1	octal plug cover	10	$2.20
POC2	octal socket cover	10	$2.20
POP1	octal line plug	10	$3.40
POP2	octal chassis plug	10	$3.20
POS1	octal line socket	10	$3.40
POS2	octal chassis socket	10	$2.50
AC1B	Alligator clip, black	10	.90
AC1R	Alligator clip, red	10	.90
AC2B	Alligator clip, black insulated	10	.70
AC2R	Alligator clip, red insulated	10	.70

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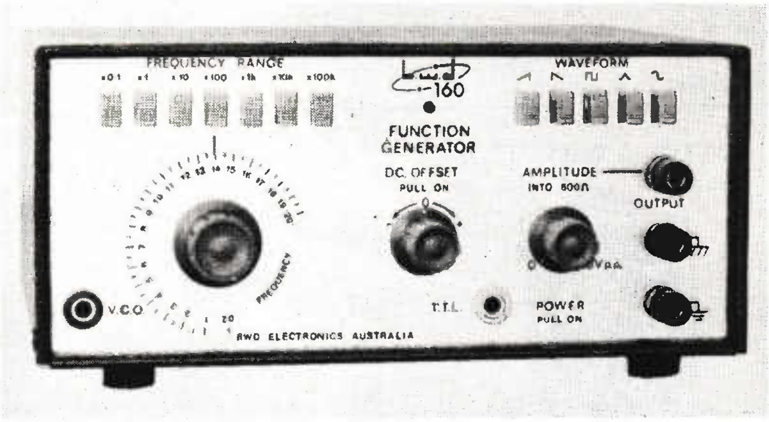
RETAIL OUTLETS IN METROPOLITAN AND COUNTRY AREAS NOW BEING APPOINTED — ENQUIRIES WELCOME

(Continued from page 14)

NEW BWD FUNCTION GENERATOR

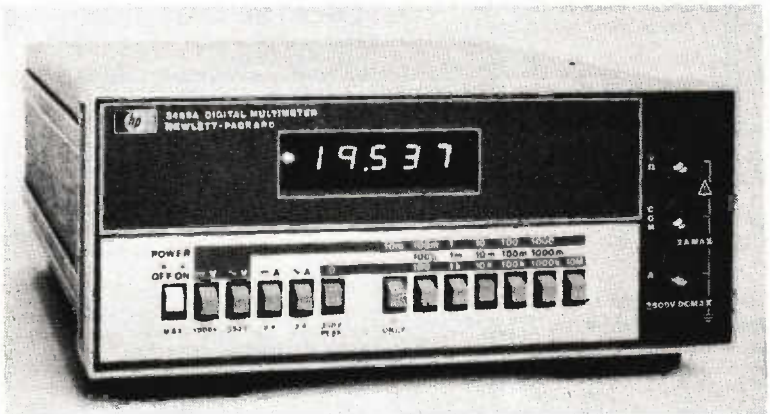


A new high performance, modestly priced function generator (BWD 160) has now been added to the BWD instrument range. The new unit has a frequency coverage from 0.02 Hz to 2 MHz in seven decade ranges, with the selection of 12 different waveforms and five simultaneous outputs. It may also be swept over any four decades by an externally applied log sweep.

The main outputs of sine, square and triangle are available simultaneously at 1 V p-p level on the rear panel, in addition to the front panel TTL output which will handle 20 TTL loads and the main 600 ohms output. Maximum output is 20 V p-p O/C or 10 V pp into 600 ohms and is continuously variable over a 100 — 1 range.

Calibration is claimed to be 3% of full scale above 2 Hz and output is maintained within 2% into a 600 ohms load paralleled by 15 pF. Sine wave distortion is below 1% between 10 Hz and 200 kHz and triangle linearity is better than 99% from 1 Hz to 200 Hz.

NEW DIGITAL MULTIMETER FOR BENCH OR FIELD USE



This new 4-½ digit, five-function digital multimeter from Hewlett-Packard combines low cost with high accuracy for both bench and field use. Called the model 3465A, the DMM covers a dc measurement range from 1μV to 1 kV with a mid-range accuracy of ± (0.02% of rdg. + 0.01% of range). AC measurement range is 10μV to 500 volts with a mid-range accuracy of ± (0.15% of rdg. + 0.05% of rge) over a 40 Hz to 20 kHz bandwidth. AC and dc current measurement range is from 10 nanoamps to two amps. DC current accuracy for the 10 mA range is ± (0.1% of rdg. + 0.01% of rdg.)

AC current measurements are made over a frequency band of 40 Hz to 20 kHz with a mid-band accuracy of ± (0.25% of rdge. + 0.25% rge.). Resistance range is 10 milliohms to 20 megohms with mid-range accuracy of ± (0.02% of rdg + 0.01% of rge). Open circuit voltage on the ohms terminal when set to its lowest range does not exceed 5 volts, preventing damage to most solid-state devices.

Input protection is provided to 1 kV on any dc range, 500 Vrms on any ac range, and 350 V peak on any resistance range. A front-panel fuse protects the instrument from overload when measuring current.

A choice of four power supplies is offered: four standard size "D" cells, battery eliminator, internal ac power supply and rechargeable nickel cadmium batteries. The standard 3465A DMM comes with an internal ac power supply and rechargeable nickel-cadmium batteries. Option 001 eliminates the nickel cadmium batteries. Option 002 is the "D" cell version with a rear panel connector for dc from most HP hand-held pocket calculator battery chargers. The charger is used as a battery eliminator for AC mains operation.

A high-efficiency LED display reduces power consumption and dissipation. Besides the obvious advantages of longer battery life, instrument reliability is improved due to the low temperature rise within the DMM.

Input terminals are recessed to meet safety requirements. The input terminal for current also contains the fuse and is easily extracted from the front panel. International symbols as well as voltage limitations are shown on the front panel.

Several factors contribute to the low cost of the 3465A. For example, its input attenuator uses a custom built tantalum nitride thin-film resistor on a sapphire substrate. Resistors are laser trimmed in production to better than 50 ppm. All resistors are in a ratio set on a single sapphire substrate adding to the resistors of the A/D converter which are on the same substrate, providing better accuracy at lower cost. Production costs are further cut through the use of automatic component insertion and computer test. Only four potentiometers and two capacitors require periodic adjustment during routine calibration cycles, reducing service and calibration time.

Another circuit innovation uses a single reference instead of two tra-

(Continued from page 107)

ditionally used in most dual slope DDM's. The advantage of one reference is significant component reduction, improved instrument stability and simplified calibration.

Details from Hewlett-Packard Australia Pty. Ltd., 31-41 Joseph St. Blackburn, Victoria 3130.

MINI-ANTENNAS SOON

The familiar 'rabbit ear' antenna fitted to most portable TV's may soon be obsolete.

Plessey's Allen Clark Research Centre are currently working on ceramic dielectric antennas made of low cost materials such as lead titanate zirconate.

Operating principle is ingenious, in essence a low-loss material having a high dielectric constant surrounds a miniature antenna. The antenna can be small since the propagation velocity of the electromagnetic radiation is slowed down-in a similar manner to that of light passing through glass that has a high refractive index.

The resultant antennas are about a quarter of the size of their conventional counterparts.

NEW TECHNIQUE SPEEDS PC BOARD MANUFACTURE

A very rapid method for making printed circuit boards has just been developed by the US General Electric Company.

The new technique was required to ensure economic production of the company's 'Flipflash' eight flashbulb photographic array, which are scheduled to be produced in tens of millions annually.

Traditional methods of fabricating printed circuits, such as etching or die cutting, would have been too slow or too costly. The only alternative was in screen printing, a process by which a conductive ink can be printed rapidly on to a suitable base.

However, standard conductive inks have to be baked and dried slowly and GE chemists had to develop a low-cost fast drying conductive ink that could be applied by a screen-printing process and dried in a matter of minutes. A proprietary resin solution that meets these specifications was evolved.

Total production time for the flash device circuit boards, from screen printing to curing, is only a few minutes, compared with up to 60 minutes for printed circuits made by conventional techniques.

General Electric has applied for several patents to cover these inventions. The company's Laminated and Insulating Materials Business Department in Coshocton, Ohio, U.S., is exploring other applications of this advance in printed circuit technology.

KICKLESS RELAYS

Electromagnetic relays used in electronic circuits tend to damage electronic components because a high amplitude electromagnetic pulse is generated as the relays open and close.

In an attempt to overcome this problem Oak Industries have developed a 'kickless' relay.

Rather than using an inductance coil (which is of course the offending component), the new Oak relay uses a thermal bi-metallic actuator coated with an insulating material and screened with a resistor network that heats when current is applied to it — then snaps the contacts into the closed position.

The thermal relay is of course slower than electro-mechanical devices — but can be made just as compactly — if not more so. One projected dual-in-line form can handle up to five amps and should sell for US$1.00.

CLOCK RADIO CHIP

The US General Electric Company have introduced a multi-feature MOS chip containing all the logic, control switching, segment drivers and timing facilities required for clock radios.

Included within the chip is an oscillator circuit that will maintain the timing system in operation (less display of course) within an accuracy of 30 seconds an hour if mains power is disconnected. When power is subsequently restored, an indicator notifies the user that the (now) displayed time may be in error.

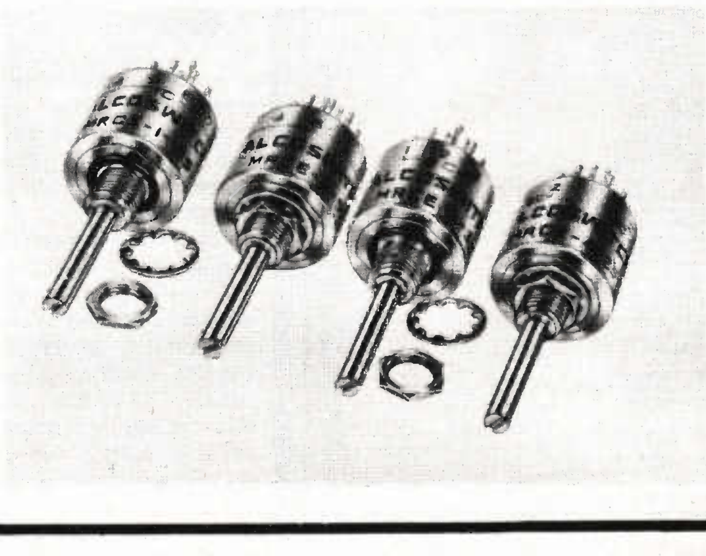
Also included is a facility to enable a clock to turn on any electrical equipment at a pre-determined time — plus a 'pre-alarm' switch that could for instance turn on an electric jug or tea maker a few minutes before the alarm goes off.

WATERPROOF ROTARY SWITCHES

Four new waterproof rotary switches are now available from ALCO Electronic Products. Identified as the MRCE Series, they feature a miniature 15 mm diameter cylindrical aluminum case. A neoprene "O" ring is provided to serve as a sealer between the bushing and panel. A second "O" ring is located inside the bushing for additional waterproofing protection. Miniaturisation permits high density applications.

Contacts and terminals are silver. Rating is 500 mA, 125 Vac or 28 Vdc.

Details from Namco Electronics, 239 Bay Street, North Brighton, Vic. 3186.



ADVERTISERS INDEX

news digest

PHOTON COUNTING

A new catalogue on Photon Counting is available from Tecnico Electronics.

A section of the catalogue entitled "Photon Counting — What is it? uses circuit diagrams, schematics, and graphs to explain the principle of photon counting which is a technique used to measure low level signals from photomultipliers or electron multipliers. Through the use of digital processing, significant advantages can be obtained over conventional analogue methods. Signal-to-noise ratios limited only by the statistical nature of the quanta being measured are readily achieved.

This catalogue also contains complete specifications on P.A.R.C.'s photon counting equipment, as well as a list of selected PMT tubes.

Tecnico Electronics, Premier St., Marrickville 2204, NSW, or Tecnico Electronics, 2 High St., Northcote, 3070, Vic.

PIEZOELECTRIC TOUCH SWITCH

A ceramic piezoelectric element forms the basis of a new pressure-sensitive push-button switch just introduced by Siemens.

Intended as a possible replacement for the proximity sensing or touch-sensitive devices often used on lifts and TV sets, the new Siemens B39910 device generates about 0.8 volt under a pressure of 150 grams (at which, deformation is a mere 0.5 μmetre). Cost is believed to be as low as 17–21 (US) cents per unit.

NEW TRACKING REGULATORS

Three new dual tracking voltage regulators are now available from National Semiconductor Corp. Called the LM125, LM126 and LM127, the regulators provide balanced positive and negative output voltages at currents up to 100 mA. Input voltage can be as high as + 30 volts, and there is provision for external adjustable current limiting.

The LM125 provides tracking outputs of ±15 volts making it ideal for op amp supplies. It features output voltages balanced to within 1% and line and load regulation of 0.06%. The LM126 provides ± 12 volt outputs balanced to within 1% and features line and load regulation of 0.08%, while the LM127 has +5 and −12 volt outputs which are specified to be compatible worst case with most MOS circuits.

Details from NS Electronics, Cnr Stud Road & Mountain Highway, Bayswater Vic, 3153.

ERRATA

SYNTHESIZER OSCILLATOR
November 1973

It has been found that IC6, a CMOS/IC type 4007 has a high failure rate. This may be prevented by performing the following modification.

Break the copper track leading away from pin 10 of IC6. Add a diode, type IN914, between pins 13 and 10 with the cathode (bar end) to pin 10. Also add a 4.7 k resistor from pin 10 to earth (pin 9).

If the 4007 has failed the symptoms are that the oscillator either does not work at all or, because the triangular waveform levels are no longer accurate, correct adjustment of RV12 is not possible.

RADAR ALARM ETI 702
MAY 1975

It has been found that some types of 555 IC from other manufacturers do not have the same characteristics as the Signetics NE555 used in our prototype. With these other ICs the alarm will close, or latch, during initial switch on. This may be cured by adding a IN914 diode between pin 6 and pin 2 (cathode bar to pin 2) and by changing R20 to one megohm.

AMPLIFIERS ETI 420, 422

Both amplifiers may suffer from interference from power mains transients when refrigerators, etc, switch on and off. The interference is picked up by the pre-amplifier and may be greatly reduced by adding 10 k resistors in the emitter leads of Q9 and Q10. This may be done by cutting the tracks between Q9 (Q10) and R53, C35 (R54, C36) and soldering a 10 k resistor across the break.

25 WATT AMPLIFIER, ETI 440
JULY 1975

A number of readers have asked us to publish a full-sized printed circuit board layout for this project. The layout is reproduced on page 102 of this issue.

NOW COMES THE POWER LINE. FROM SANSUI.

Good, solid Sansui quality in a line of receivers with more stereo power and performance for less than you'd expect.

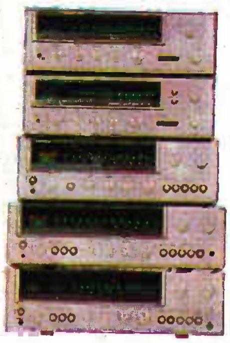
Top-of-the-line is Sansui 881: 63 watts per channel minimum RMS into 8 ohms from 20 to 20,000Hz with no more than 0.3% total harmonic distortion.

Inside, eleven computer-grade ICs and special Circuit Board Module construction eliminate a lot of the internal wiring to assure long-term stability.

Outside, rugged controls tailor the sound and direct 'signal traffic' throughout the 881 for 3 pairs of stereo loudspeakers, tuner section, turntables, decks, tape dubbing, microphone mixing, and much more.

But if the 881 is too much of a good thing, the Power Line offers other big-value receivers with similar cost/performance advantages.

Sansui



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RANK AUSTRALIA

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2 Bowen Street, Kensington, South Australia 5068. Phone: 332 4288

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