## INTERNATIONAL

## AUSTRALIA'S RADIO PIRATES 4-CHANNEL AMP TO BUILD WIN A

JANUARY, 1974 50c\*

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MULTIMETER -CONTEST

## You wouldn't buy the wrong pair of shoes for your feet.

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Attach TEAC's A-180 to the deck. It's our Dolby\* Noise Reduction Unit. You'll enjoy sound perfection because the Dolby

> eliminates unwanted tape hiss and other noise. Music never sounded so good. We invite you to take the step and bring this TEAC package of sound into your home. Notice how well it fits.

AN-180



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## electronics INTERNATIONAL

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COVER: Pirate radio hasn't quite come to this! Nevertheless illegal usage of the 27 MHz band continues. ETI's tame pirate is advertising-production man lan Ralston. (full story – page 34 onwards).









Published by MODERN MAGAZINES (HOLCINGS) LIMITED, 15 Bouncary Street, Rushcutters Bay 2011. Prome: 33 4282. Cables: MODMAGS SYENEY. Managing Director: Max Press. INTERSTATE advertising — Melbeurne: Clarrie Levy, Suite 23, 553 5t Ki da Rd. (51-9836). Adelaide: Ad Media Group of South Australia, 12-20 O'Connell Street, North Adelaide S.A. 5006. (67-1129). Brisbane: Eavid Wood, Anday Agemey, 11-14 Buchanan St., West End (44-2485) OVERSEAS — United Kingdom: A.C.P., 107 Fleet St., London, EC4. U.S.A.: A.C.P., Room 401, 1501 Broadway New York, Prinked in 1973 by Compless

A.C.P., Room 401, 1501 Broadway New York, Printed in 1973 by Conpless Frinting LtJ., 65 O'Riordan St., Alexandria N.S.W. Distributors: Australian Consolidated Press, (\* Recommended and maximum price cnly.) COPY RIGHT.

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Electronics Today International

**Ryrie House** 15 Boundary Street, Rushcutters Bay 2011 Tel: 33-4282

#### UK EDITION

Halvor Moorshead Editor

Robert Evans Advertising Manager

Electronics Today International 36 Ebury St., London SW1. Telephone: 01-730-2139

#### FRENCH EDITION

Denis Jacob Editeur

Christian Dartevelle Directeur de la Redaction

Edouard Pastor Directeur de la Publicite

**Electronique Pour Vous** International 17, rue de Buci, Paris. Telephone: 633-65-43

## **Electronic Revolution**

## A WELCOME-AND A WARNING

FOR the electronics industry, 1973 had very special significance. In that year, electronic technology proved conclusively that it could at last supplant a very large number of electromechanical functions, performing the tasks more accurately, more cheaply and more reliably.

In the space of twelve months, metal-oxide semi-conductors and solid-state readouts enabled the price of calculators to be slashed from hundreds of dollars to a current low of \$29. This new technology has driven their mechanical counterparts virtually off the market.

The same technology is beginning to make similar inroads into the mechanical clock and watch industries.

We have seen sixteen bit parallel processors, on a single printed circuit board, replace large and complex electro-mechanical control systems in applications from textile machinery to traffic light controllers.

With our current energy crisis it is perhaps fortunate that this has happened, for electronic equipment is, generally, more efficient than its electromechanical counterparts. In fact, less energy is required - not only to run them, but also to make them. Apart from which, the manufacturing processes generally cause little pollution.

Clearly this trend towards electronics will continue. Already automobiles are in production with electronic seat-belt interlocks of surprising complexity. Cameras are being built with all-electronic control. Even the ubiquitous poker machine is going solid-state.

For the alert, imaginative company, the new electronic revolution is an exciting challenge - but it will leave in its wake many organisations whose products have suddenly become technically obsolete.

The social implications of this changeover to an electronic technology could be considerable. Perhaps unemployment. Already there is concern in Switzerland, where the traditional timepiece industry is suddenly very seriously threatened.

Certainly it has happened before. The industrial revolution put many people out of work. But the electronic revolution that is now with us is on a much grander and wider scale.

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## LIGHT YEARS AHEAD

## introducing the ESS amt 1

Threadbare though the word "revolution" has become, the ESS amt 1 loudspeaker marks a revolution in high fidelity reproduction through its incorporation of the Heil Air Motion Transformer, developed and perfected by Dr. Oskar Heil, of Heil Scientific Laboratories, Inc., over the last four and one half years. This exciting new device gives the ESS amt 1 the first authentically new approach to sound generation in fifty years. As an achievement, the ESS amt 1 leaps far forward in the pursuit of acoustic perfection, and it is so clearly superior to all other loudspeaker systems that no previous experience in high fidelity reproduction will have been adequate preparation for this revelation in sound delineation.

Because it uses an entirely new and singular moving system, the Heil Air Motion Transformer produces sound free from even the most subtle forms of distortion distortion that robs music of its articulation and clarity, thereby creating listener fatigue, pain at high volumes, or coloration in the human voice All forms of distortion are gone; not only the clipping distortion of high level demands, but the less immediately recognized motional errors that rob brasses of their "sheen," strings of their "guttiness," solo instruments of a natural "ease" and turn an orchestra of individual instruments into a homogenized sonic blur. Every detail of the recorded performance is revealed with a degree of purity never before achieved and completely beyond the ability of all other sound generating devices

By utilizing the Heil Air Motion Transformer, the ESS amt 1 breaks completely with sound generating principles that stretch back, unchanged, to the earliest acoustic phonographs. From turn-of-the-century

"talking machines" through today's most sophisticated component systems, the air pressures you hear as sound have been created by the direct push of a diaphragm surface moving forward and backward to get air motion. As the diaphragm surface works directly against the air its movement must be as great, and as rapid, as the required air movement – and this holds true for cones, electrostatic panels, piezoelectric crystals, traveling wave transducers and even ionized air devices that have an ionized cloud moving "forward and backward" just like a paper cone.

The Heil Air Motion Transformer, used as the mid and high frequency reproducer in the ESS amt 1, departs dramatically from this traditional concept of sound reproduction. By squeezing air instead of pushing it, it effectively creates fives times more air movement than the direct push of an equivalent flat surface and accelerates transducer design light years ahead. The Heil Air Motion Transformer has no "piston" surface, no voice coil, no elastic suspension devices, no significant mass, no "forwardbackward" motion, no resonances, and is so light and simple that it carries a lifetime warranty. It surmounts all the motional and elastic restrictions inherent in conventional transducers and achieves a level of performance that finally approaches theoretical perfection.

#### the loudspeaker of the future – the ESS amt I

Utilizing the newly perfected Heil Air Motion Transformer, developed by noted physicist, Dr. Oskar Heil, and manufactured under exclusive license by ESS, the amt 1 is the most advanced loudspeaker system available today.

The Heil Air Motion Transformer, around which the ESS amt 1 was designed, is a revolutionary new transducer that does not generate sound waves by pushing air with a piston "plunger." As dramatically different from vibrating cones and panels as the rotary is from the reciprocating piston engine, the Heil Air Motion Transformer takes advantage of previously unutilized laws of physics to produce air movement with a technique that approaches the ideal massless generation of sound.

Instead of trying to displace air molecules with the forward-backward motion of a flat or cone surface, the Heil Air Motion Transformer harnesses the power-purchase of a pneumatic "lever" and by applying small squeezing forces over a large surface area produces air movements five times greater than an equivalent "pushing" piston surface. And whereas the energy applied to a piston driver is used to push a cone that pushes the air, the Heil Air Motion Transformer squeezes air directly. As a result of this greater, more direct and near massless transfer of energy, the Heil Air Motion Transformer approaches instantaneous acceleration for flawless transients, has no "cone breakup" to create coloration, and shows distortion figures as fine as modern electronics to recreate the sharpest of images, the cleanest of attacks and the highest harmonics with a clarity and immediacy never before experienced.

To form a picture of the completely new technique by which the Heil Air Motion Transformer generates sound, imagine trying to set a cherry pit, a low mass object (air), into motion with a high mass object, the flat of your hand (cone and voice coil).



This is obviously a technique of low effectiveness because the great mass of your arm and hand relative to the small

mass of the cherry pit prevents rapid movement and results in a poor transfer of kinetic energy from your arm to the cherry pit. Result: the pit can never move faster than your hand pushes it. Moreover, when trying to accelerate your hand rapidly and stop it suddenly, the great inertial force created by the mass of your arm results in sluggish starts and overhanging stops. All the dynamic drama of music is removed.

And yet for all its shortcomings, this is the way sound has been reproduced since the acoustic phonograph. Now imagine placing the cherry pit between your fingers and squeezing. The result: high effectiveness in the transfer of kinetic energy from your finger to the cherry pit, great movement of



the cherry pit with a small but powerfully effective lever-like movement of only the tips of your fingers.

This analogy describes the ESS Heil Air Motion Transformer's principle. Sound is squeezed into the air instead of pushed toward it. A light small surface only .5 mil thick and made of a recently perfected plastic having enormously high internal molecular damping is formed into multiple interfacing cavities. The volume of these cavities alters in response to electromagnetic forces generated by a uniformly distributed conduction cortex and projects sound outward with an almost perfect transfer of kinetic energy. The entire moving system is only two inches by five inches and its mass is effectively equivalent to only three-quarters of a linear inch of air across its surface - by contrast a conventional cone mechanism is effectively equivalent to one to three feet of air. This permits the moving system to react exactly with the imput signal and results in an incredibly accurate conversion to sound waves, a conversion realized by the listener as vastly superior definition, clarity and spatial proportionality. Music is reproduced to scale with a distinctiveness to each individual timbre that marks the difference between merely satisfactory reproduction and sound as clear as light.

The ESS amt 1 combines the amazing Heil Air Motion Transformer with a newly developed ten inch woofer which has an oversize, deep-drawn frame assembly and a powerful magnet to permit exceptional excursions at the highest possible acceleration. The woofer is critically designed for clean, impactful low frequency response and exciting transient capabilities that precisely complement the open articulation of the Heil Air Motion Transformer. The ESS amt 1 triumphs over time and space by recreating in all its past, distant grandeur, every nuance of the original performance. Nothing we say, or can say, will adequately prepare you for the ESS amt 1's incredible new aural freedom, clean, clear and airy as light.

#### the need for the ESS amt I

With the stunning improvements in recordings and electronics, the lack of significant improvement in loudspeaker drivers has become more and more apparent. Conventional cones and horn

speakers have been produced since the turn-of-the-century, and electrostatics, supposedly new, were produced and sold in Germany in 1923. Listeners felt, and were right in feeling, that there must be a better way to generate sound than to push against air with a conventional "plunger" type loudspeaker motor.

In the conventional paper cone "plunger" speaker, the mass of the moving system is so great that it constantly struggles against its own immense inertia. Just as when starting to push a wheelbarrow full of mushy cement or trying to stop it once it gets

rolling, the mass of these devices, at rest or once set in motion, makes precise starting or stopping impossible. As a result even the most compliant of these piston "plunger" speakers blur the sound to an extent now becoming fully realized. More importantly, because of their inability to recover rapidly once set in motion, they clip the tops off transients and thereby rob music of its dynamic range and hence its searing drama. Various attempts to overcome these deficiencies have led to cones at the end of "tubes," cones in sealed boxes, or multiple small cones. None of the "solutions" has had any significant effect in overcoming the inherent problem: too much mass and too little efficiency in transferring kinetic energy from the "plunger" to the air.

Electrostatic and ionic drivers have removed the mass of the moving system as a significant source of error, thus improving transient response through a more rapid recovery, but only at the price of releasing a Pandora's box of other limitations. The electrostatics are unreliable, have poor dispersion, cannot be played at high volumes, are costly, complex, inefficient and place difficult demands on an amplifier. The ionic tweeter has the added drawback of being able to produce only the extreme highs, while being inefficient and temperamental; moreover, it has this interesting feature: it consumes itself over a period of time.

Like the piston engine, the piston cone has endured because, until now, the alternatives have been complex, expensive, and even more inefficient and temperamental. Above all, no alternative has achieved sufficient sonic improvements to warrant the trouble. And yet the existence of these mechanisms even with all their problems and limitations, proves that the public wants greater fidelity in reproduced sound. Fidelity *surpassing* these devices and unhampered by limitations is now available with the revolutionary new ESS amt 1.





Stocks are now reaching the better sound shops. Recommended retail price \$628 per pair. For further information contact:

### ESS Inc., C/o 220 West St. Crows Nest. Ph. 43-3228

Heil Air Motion Transformer is the registered trademark for ESS loudspeaker systems incorporating design principles invented by Dr. Oskar Heil and licensed exclusively to ESS, Inc.



#### COLOUR TV FOR VICTORIAN RACEGOERS



Patrons at Sandown Park (Victoria) racecourse can now watch the races in colour on closed-circuit television.

This follows the recent successful introduction of colour closed-circuit television at Caulfield (Victoria) racecourse.

At Sandown Park colour will replace the black and white system installed by AWA in 1965.

The Victoria Amateur Turf Club has awarded a contract to AWA Rediffusion, Sydney, to provide the service at both courses.

Video Tape Corporation, of Sydney, is supplying the colour OB (outside broadcast) van and crew to operate the Marconi Mark VIII cameras and AWA Rediffusion has installed the

### SOLAR BATTERY A COMMERCIAL PROPOSITION

After eight years of research, a British company has developed a solar battery 125 mm square that provides an output of 300 mA at 2 V in full sunlight.

The firm, which has been working on thin-film solar cells for space applications, is adapting its know-how to monitors and distribution system.

The service will provide for colour coverage of racing events at the two V.A. TC racetracks for the next five years covering between them 33 meetings a year.

Twenty colour monitors are located at vantage points at both Sandown and Caulfield to enable racegoers to view the races and there is also a video-tape recording of the event immediately after the running of each race.

In addition, the signal will be of quality suitable for transmission to the broadcast television stations. For major events it is expected the Caulfield system could be linked with Sydney to provide direct colour telecasts of Sydney races.

other fields including remote marine lights, buoys and other navigational aids.

Among the various terrestial applications also envisaged for solar batteries are portable flashing beacons, portable power supplies, water pumping and irrigation control, and television and domestic lighting in developing countries.

#### **MICROWAVE WEEDING**

Microwave ovens have long been used for cooking and industrial heating. The same principle – of electromagnetic radiation – is now being used in an attempt to kill agricultural pests (i.e. insects, weeds, fungi) 'in situ'.

The method is attractive, to the agriculturist at least, in that no inorganic materials are left in the soil.

Power requirements are quite considerable, the energy source being a pair of 30 kW klystron tubes powered by a diesel generator. The whole equipment package is mounted on a 16 ton vehicle, the wheels of which are spaced to travel along rows between plants.

Early experiments have shown that plant yield is as much as 60 per cent greater compared with hand weeding.

The technique currently being researched (by the Agricultural Research Service of the Dept. of Agriculture, Texas A & M University) consists of exposing the soil to radiation at a frequency of 2450 MHz — the same frequency that is used in microwave ovens. If the radiation is absorbed by living tissue, the molecules are set into vibration and vital functions are disrupted.

#### **CHEAP CO-4 CHIP**

A single discrete four-channel decoder IC will shortly be available from the Signetics Corporation. The chip is unique in that it will enable both stereo and four-channel discs to be played on the same turntable without the need for level adjustment.

At its projected selling price of US\$1.54 (in large volume) the chip is sufficiently cheap to enable it to be used in low-priced equipment.

Existing systems could also be upgraded to reproduce discrete fourchannel sound by installing the chip – together with two additional channel amplifiers.

Whilst availability is currently not known it is probable that sales of the new IC will be limited to equipment manufacturers only.

The company is interested in receiving enquiries about licence to manufacture; it is still engaged in work on further improving the unit. Interested principals should write directly to International Research and Development Co. Ltd., Fossway, Newcastle-upon-Tyne, Northumberland, NE6 2YD, England.

#### **PORSCHE SHAKE-UP**



Rapid dynamic analysis of an entire racing sports car body has been achieved by engineers at Hewlett-Packard's plant in Santa Clara (USA).

In operation, a hydraulic exciter vibrates the car, and an H-P Model 5451A analyzer processes and stores information about the vibrations set

## SOLAR POWERED BATTERY CHARGERS

Solar powered battery charging equipment will soon be commercially available.

Aimed at the rapidly expanding boat and caravan market, the chargers are to be built by Britain's Joseph Lucas group under a licencing arrangement from the Solar Power Corporation of America.

First product to be marketed will be a 12 volt, 0.6 amp unit measuring 450 mm x 355 mm.

The charger uses silicon cells developed by the Exxon Corporation. These cells have an efficiency of approximately 10 per cent, thus, under ideal conditions, the cells could convert solar energy at a rate of about 100 watts a square metre. However, as the cells are circular, this comes down to about 60 watts a square metre.

Projected selling price is  $\pounds 200$ sterling, but the company hopes to be able to reduce this by a factor of ten within five to ten years.

#### TRUCK THIEF TAGGER

Truck hijackers and thieves may soon be foiled if a new 'electronic tag' system becomes commercially available.

The new system, developed in the USA by Californian company Hoffman Electronics, has just successfully completed field trials by the US Dept. of Transportation. up at selected points on the car's body. The firm's findings have been applied to modify a Porsche 914: by adding a roll cage that was positioned precisely to eliminate troublesome vibrations in the car's frame. So successful is their technique that H-P plans to offer automotive dynamic analysis capabilities as a commercial product.

Installed in the vehicle is a batterypowered receiver, transmitter, and a decoder whose function is to recognise a unique digital signal.

If the vehicle is reported as stolen, a police helicopter transmits a digital signal 'personally addressed' to the stolen vehicle.

The receiver and decoder in the stolen vehicle responds to the unique digital code and switches on the associated transmitter.

The transmitter now generates a signal indicating the vehicle's position and direction of travel.

It is also possible to arrange for ground-based stations to maintain selective calling procedures.

#### SOYUZ 11 -- WHAT REALLY HAPPENED

In June 1971, three Russian cosmonauts were found to be dead when their Soyuz spacecraft returned to earth.

USSR space authorities stated that the deaths were due to loss of cabin pressure on re-entry into the earth's atmosphere.

Academician Boris Petrov - in a Pravda article (July 4, 1971) hinted at mechanical failure, but USSR space authorities refused to give any further details.

Full details of the accident have now been revealed. Apparently the loss of cabin pressure was caused by

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#### **GERMANY TO USE MAG-LEV TRAINS?**

## news digest

excessively violent firing of the 12 explosive bolts used to join the re-entry capsule to the space vehicle. This accidently loosened a safety valve cap which in turn triggered an exhaust valve. Cabin pressure was totally lost in 45 seconds.

Subsequent ground tests showed that 27 seconds were required to close the valve by hand, but this was a full 17 seconds longer than the crew could have remained conscious.

The explanation of the accident was provided at American insistence during the second round of talks for the joint Soyuz-Apollo space mission held in Moscow on Oct 1 to Oct 17 1973.

#### PHOTOCOPYING LEGAL RULES US COURT

Photocopies can be made of research articles in scientific journals without infringing copyright and without paying royalties to publishers, the US Court of Claims in Washington, D.C., has ruled. The four to three decision came in a "groundbreaking" case involving the National Institutes of Health, National Library of Medicine, and Williams & Wilkins Co., publisher of medical journals. The American Chemical Society, in a friend-of-thecourt brief, has supported the publisher's position to restrict photocopying. The case will likely be appealed to the Supreme Court.

### MOTOROLA TO MAKE WATCH DISPLAYS

Motorola's Timepiece division in Phoenix will start to manufacture liquid crystal watch displays early in 1974.

Until recently the division had been manufacturing C/MOS, quartz crystals and other watch components, however the new development will now enable them to offer a complete watch module with digital display.

#### MINIATURE PROGRAMMABLE CALCULATOR

Hewlett-Packard are reliably believed to be developing a handheld calculator incorporating a programmable keyboard and 16 registers for memory.

Price is expected to be less than US\$700 and deliveries are believed to be planned for May/June 1974.

Latest report, just as we go to press, is that the unit may now be available as early as February.



A proposed rapid-transit system combining near 500 km/h magnetically levitated trains and an elevated highway or slower speed railway is being considered for Germany's 965 km Munich to Hanover route.

The concept, devised by MAN

UK AUDIO IMPORTS SURGE

Despite Britain's growing economic problems, spending on hi-fi equipment continues to rise.

A recent report from Finnresearch states that sales of audio equipment in Britain in 1973 (excluding aerials, decks, and loudspeakers) was £35 million. This is expected to grow to £70 million in 1978.

Imports accounted for over 70 per cent of sales of the more sophisticated equipment, however sales of the cheaper types of 'unit audio' systems are virtually dominated by British manufacturers.

Finnresearch believe that Britain's current fuel crisis will lead to an increase in audio sales – as expenditure is diverted away from spending on cars.

The report is obtainable from Ovum, 22 Group Inn Road, London, WC2. It costs £27 sterling.

#### **HIGH FLUX SOLAR CELL**

At the present time, the high cost of photovoltaic solar cells prohibits their use in the large scale generation of electricity from sunlight. However, R. Davis and J. R. Knight of the Plessey Company's Allen Clark Research (Munich) has side-suspended mag-lev vehicles located by upper and lower rails. Levitation and guidance magnets, together with the single-sided induction motor required for propulsion, are grouped around the upper rail.

Centre have now shown that suitably designed gallium arsenide/gallium aluminium arsenide heterostructure junction semiconductor solar cells can be operated at light intensities of 2000 times full sunlight, to produce specific outputs between 20 and 40 W per square centimetre, whereas with silicon cells the maximum usable sunlight concentration is about 10 times.

This high concentration is possible because the (Ga.A1) AS material is relatively transparent to sunlight so that the surface layer over the junction can be much thicker than is the case with silicon, giving a lower electrical resistance and allowing much higher power to be generated.

Cheap concentrators such as curved mirrors or Fresnel lenses can thus be used to focus the sun's rays onto small solar cells, thereby greatly reducing the unit cost of the electricity produced. The optimum working voltage and efficiency of gallium arsenide solar cells increases with light intensity, and at 2000 times full sunlight an efficiency of 24 per cent is forecast. Efficiencies approaching this value have already been achieved with nonbloomed and non-optimised cells of this type.

#### STOP PRESS PROF.BOSE-SYDNEY LECTURE

Technical development of Bose speakers will be discussed at a lecture 8.00 pm Friday 18 January (Science House, Gloucester St, Sydney 2000), under auspices of IREE Audio Group.

All interested engineers are invited to attend.

Organisers apologise for such short notice.

#### INFRARED BEAM LINKS COMPUTERS

The US Naval Weapons Laboratory in Dahlgren, Virginia has solved the problem of transmitting computer data across an intervening airstrip, by using an infrared data transmission system to send data directly over the airstrip which lies between two computer installations.

The airstrip barrier was one part of a data transmission problem that also included a requirement for a data link capable of moving 40.8 kilobits per second for effective high-speed, computer-to-computer communication.

Both problems were solved by roof-top installations of two Optran optical data-transmission links. These Optrans are now speeding a stream of data between a Control Data Corp. 6700 super-scale computer system and a CDC 1700 system, both housed in buildings flanking the airstrip.

#### FREE VALVE TESTING SERVICE

The first Mercury valve tester from the USA has recently been installed at the Dick Smith Electronics Centre in Gore Hill, Customers may use the tester completely free of charge. The tester can be used to test for emission, shorts and gas of over 1700 tube types including Nuvistors, 10 pin types and even car radio vibrators.

Easy to follow flip charts give the settings for the two controls needed to check any valve. A large panel meter gives an indication of the state of the valve on a pass/fail scale.

Replacement valves are also available for most types commonly used in Australia. Customers may purchase them at trade prices, thereby making considerable savings.

The free valve testing service will prove particularly useful with purchasers of the Telefix calculator. The Telefix, priced at \$2.00, enables TV owners to trace a large number of faults to an individual valve. The customer then simply has to check the valve on the Mercury tester to confirm his diagnosis.

Personal shoppers can take advantage of this free service at the Dick Smith Electronics Centre, 160-162 Pacific Highway, Gore Hill 2065.



#### **TEN-YEAR BATTERIES**

A chemically-powered battery lasting as long as a nuclear cell (approximately 10 years) has recently been developed by General Electric in the USA.

Intended primarily for heart pacemakers the new 3.6 volt unit consists of a bromine cathode, a sodium anode, and an aluminium ceramic electrolyte.

General Electric say that, because the electrolyte is a solid, reactive materials are kept apart. This, the company says, eliminates self-discharge and internal shorting.

The new chemically-powered battery should substantially reduce the cost of long-life pacemakers – from their present \$2400-\$3500 to less than \$360.

## US RADIO SHACK DEALERS SUE TANDY CORPORATION

America's Tandy Corporation have had anti-trust suits filed against them by six Radio Shack franchise holders.

The Corporation is charged with price fixing and restricting the ability of franchise holders to sell their businesses at fair value.

Amount of damages sought has not been revealed, however a reliable source estimates it to exceed US\$50 million.

The suit has been brought on behalf of all past and present Radio Shack dealers — including joint venturers, of which there are said to be about 500.

Dealers in the class action including Hew Corp., Keene, N.H.; Chip Corp., Claremont, N.H.; William H. Holt Assoc., Dover, N.H. (with stores in Portsmouth, N.H., Biddeford, Me. and CheImsford, Mass.); CSB Enterprises, Inc., Moorestown, N.J.; Neimar, Inc.,



ELECTRONICS TODAY INTERNATIONAL - JANUARY 1974

## news digest

Salem, N.H., and Millen, Inc., North Andover, Mass.

The suit charges that Tandy fixed prices in violation of antitrust laws by listing the prices of Radio Shack merchandise in advertisements and in promotional pieces mailed to customers; by setting the retail prices of merchandise in joint venture stores and by fixing identical retail selling prices for competing company-owned stores, joint venture stores and franchised stores.

Radio Shack dealers are alleged to have been "precluded from setting their own retail selling prices in a free and open competitive market," the suit charges.

On its second count, the suit asserts that "Each franchisee owns a substantial capital asset including his goodwill in his business," and charges the dealers "have been unable to sell, transfer or alienate their businesses because of the severe unattractiveness of a franchised business that can be terminated by the franchisor at any time on 30 days' notice, with or without cause," and "cannot obtain a fair and reasonable price for the capital sale of their businesses ..."

In its answer and counterclaim, Tandy admitted that it owns the merchandise in its joint venture stores and determines selling prices for that merchandise, but it otherwise denied charges of price fixing and denied that any alleged "combination and conspiracy" exists or has ever existed. Tany admitted that some Radio Shack dealers have become owners of "various amounts of valuable inventory, leasehold improvements and fixtures," but denied allegations that "goodwill in his business" can be included among a dealer's "substantial capital assets,"

Tandy denied all allegations concerning dealers' difficulties in selling or receiving fair prices for their businesses.

In its defense, Tandy said "Plaintiffs may not recover against the defendant on either count because, if defendant has violated the Sherman Act as alleged, plaintiffs are equally at fault in that they willingly participated in, assented to, and encouraged defendant to engage in the very acts and practices they are now attacking.

The Tandy counterclaim charged the Radio Shack dealers bringing suit with "engaging in an unlawful combination and conspiracy... in an effort to unreasonably restrain interstate trade and commerce..." and requested a preliminary injunction.

Tandy subsequently moved to strike class allegations from the suit so that it could proceed as an individual action.

#### H-P CALCULATORS IN US CHAIN STORES

Hewlett-Packard's somewhat unexpected move into chain-store sales of its products seems to be paying off.

Over US\$50 000 worth of H-P calculators were sold by 12 northern Californian branches of Macy's in one week alone last month.

Approximately 60 H-P35s and 45s were sold together with one each of desk-top printing models H-P46 and H-P81.

A Hewlett-Packard spokesman from the company's Advanced Products division said that Macy's are "receiving 15 to 20 per cent discount" on these units. This is much the same discount that Hewlett-Packard has been giving to their retail outlets in university bookstores.

#### NEW STANDARD FOR TRANSDUCERS FOR ELECTRICAL MEASUREMENTS

A new Australian standard for transducers for electrical measurements has been published by the Standards Association. It is issued as Australian Standard 1384 and applies to transducers which convert an electrical quantity such as voltage, power, frequency and impedance into a related electrical output. A main feature of the standard is the classification of transducers in terms of their permissible error.

It covers reference standards and definitions, classification, the influence of factors which may effect accuracy, mechanical and electrical requirements, marking and tests.

Appendices cover notes on test categories and test acceptance, and symbols for marking transducers.

Copies of AS 1384 may be obtained from the various offices of the Standards Association for S2.40 each. (Postage and handling extra).

We apologise for the late publication of this issue which has been caused by scheduling problems. Next month's issue is currently scheduled for February 13 and subsequent issues at four week intervals after that.



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## LASERS AT WORK

In theatrical performances and shows the stage laser is a new creative tool at the disposal of the producer. An acousto-electric deflection unit is used to project a dynamic background of light patterns synchronized with the accompanying music,

(Photograph courtese Siemens).

Once described as 'the ideal solution to yet unfound problems', the laser now finds innumerable applications throughout science, industry and commerce. Here, Dr. Sydenham discusses its use in measurement. A second article, will deal with power, communications and a whole host of other uses.

WAY back in 1637, Descartes laid the foundations of optical behaviour. leading up to the laws of diffraction. The concept of light as a wave of radiation was born. Newton, around 1670, suggested that light was corpuscular in nature, thus providing a second concept of light that also works in many cases. (Today we use either as is appropriate). It was another 130 years before the properties of interference were realised. This was the work of Young. In close succession various other laws of light were explained in terms of what we call classical optics.

But it was not until the 1920s, that the structure of the atom was understood, showing us that electrons can only exist in discrete states of energy level. This modern thought enabled the laser concept to be envisaged on paper. More years passed before a practical device was built, a microwave laser having been demonstrated first.

In 1960 Maimans prototype laser produced the first laser light.

The laser source was termed at the time "the ideal solution to yet unfound problems". There can be no doubt now that the problems have been found and that one type of laser or another provides a closely ideal solution to large and varied fields of need.

It took a year or two after 1960 before widespread application of lasers commenced. This was mainly due to their initially high cost. What now costs a hundred or so dollars (last month's ETI laser project, for example) then commanded several thousand dollars and many months' wait.

Today most of the mystery has gone out of laser manufacture. Technicians can assemble them, tune them and service them after a few hours' tuition. The reliability has steadily risen from days or months of operation to a point where manufacturers of CW lasers now offer 18 months' guarantee (and usually live up to it without a murmur). The robustness has been vastly improved. They are flown in vibrating aircraft, used in mines, in steel plants, in harbours: it is hard to find a place they haven't been used.

Expenditures on laser research and applications each year run to 80c a head in the USA, 18c in Britain and 1.2c in Australia. Military expenditure



high unit sits atop the Captain Cook Memorial on the East Coast of Australia.

is vast, especially in the search for the death-ray weapon.

#### **PROPERTIES OF LASER** RADIATION

Useful application of any phenomena is based on a working knowledge of the properties of the effect. The laser o ffers more than one unique characteristic over other radiation sources operating in the visible and infrared region.

Firstly, its radiation is extremely

chromatic, that is, it occurs as a specific very narrow band-width of frequencies - it is, therefore, a useful spectrally-pure source. This property enables laser radiation to be detected in the presence of considerable levels of background optical noise with little more than a good optical filter.

Secondly, the beam is coherent. This means that the majority of energy wave trains emitted are in phase, giving the radiation the ability to be used in interference modes of application. As yet technology has not delivered a

#### **Recent Optical Maser Experiments**

Recent physical experiments at Bell Laboratories have confirmed several predictions of the behavior of an optical maser. The theory of this device is discussed in the accompanying article.

In the experiments, Laboratories scientists used a synthetic ruby rod, 1/2 inch long and 1/5 inch in diameter. The ends of this rod were polished until extremely flat and parallel, and were covered with a reflecting, yet slightly transparent, layer of silver. This rod was held in the centre of a spiral photoflash lamp and illuminated with an intense flash of ordinary white light.

The investigators found that when the power applied to the flash lamps exceeded a certain value, a nearly parallel beam of light was emitted through the silvered ends. This light was red, like the ordinary fluorescent light from ruby, but differed from it in several important ways.

First, it was sixty times closer to being 'monochromatic'' (of a single frequency) than the ordinary ruby light. Second, the light is "coherent" as was demonstrated by arranging two fine, parallel slits in a thick silver coating on one end of a ruby rod. The pattern of emerging light showed the light from one slit to be interfering with the light from the other, indicating that the emitted light was in phase across the end of the Third, almost all of rod. this monochromatic light was emitted within

a cone angle of only one-tenth degree. Within this cone, the intensity of the light was far higher than could be obtained by the ordinary fluorescent process.

As a communications experiment, a ruby optical maser was set up at the Holmdel, N.J., location of the Laboratories and aimed at the Murray Hill Laboratories, 25 miles away. Red flashes, clearly visible to the naked eye, registered on photo multiplier tubes. The circle illuminated by the beam at Murray Hill was only about 200 feet in diameter. Another experiment involved transmitting pulses of light along a quarter mile of two-inch diameter circular waveguide, where the dust and

fog of the atmosphere could not attenuate the beam. Photomultiplier tubes at one end of the waveguide recorded clear pulses of high-intensity light. With further developments, a beam

from an optical maser might be used for a variety of scientific applications, including communications. At present, messages can be sent only in a code based on repeated flashes. However, since the coherent light is emitted in short bursts rather than as a smooth pulse, it may eventually be possible to modulate the signal, permitting many telephone conversations or television signals to be transmitted simultaneously over such a link.

"This short article released details of the first experiments testing the application of lasers – from Bell Laboratories Record – November 1960."

### LASERS AT WORK

detector that can respond to frequencies of  $10^{14}$  Hz, so interference must be carried out optically rather than electronically (as is done at lower frequencies). An infrared frequency detector was recently demonstrated at MIT so it should not be long before we have visible wavelength devices.

The third unique feature is that the laser beam emerges, not as a point source radiating in all directions, but as an already collimated ray diverging typically by only a part in a thousand (one milliradian). There is an exception to this generalisation, for the solid-state junction lasers do not possess this feature. Without modification the beam can act as a weightless line in space enabling a whole host of alignment measurements to be made. There is, however, much more to this feature than that, for it means that the radiation is already gathered into a narrow aperture and is, therefore, of high intensity. It also means that it can be further focussed in an efficient manner by collecting all of the radiation with a collimator (normally termed the telescope in laser technology). This can either provide tighter beam control or fine spots of extreme power density. As Brian Chapman outlined previously ("Lasers" ETI June 1973) powerful lasers can be focussed to provide temperatures of the order of millions of dearees.

There is no universal laser. They are offered with varying power outputs (milliwatts to megawatts), as pulse or continuous wave (CW) devices and can be at one of a number of discrete wavelengths ranging from infrared to near ultraviolet. Also now available is a tuneable laser system in which the output colour can be smoothly swept across the spectrum at the turn of a knob. There is even talk of an x-ray laser. It seems any substance can be made to lase – jelly has!

One type of laser that does not quite fit the above description of characteristics is the Ga-As junction laser. It produces spectrally-pure radiation but lacks both the collimation and long-term coherence features. Its virtue is that it is easy to modulate and, being pure in wavelength, is easy to detect in ambient light conditions.

Overall, the efficiency of lasers is poor. For instance, a 5 mW output CW He-Ne laser has an input of 40 W. This is still, however, by a long way, the most efficient method of producing radiation with the above properties. The characteristics of the smallest laser render it visible hundreds of metres LASER BEAM 10-30mm DIAMETER LASER BEAM EXPANDING TELESCOPE

Fig.2. Diagrammatic arrangement of laser used in conjunction with four segment photocell for precision alignment in the workshop.

away in daylight. The laser lighthouse (shown in Fig. 1) for instance, has a power input of 250 volt-amperes and can be seen twice as far as existing formulae for lighthouses predicted -a new code has been formulated to cover them.

Applications divide broadly. There are those concerned with measurement, as found in surveying, in the workshop, in the laboratory, at sea and in the air.

The main uses for the newly discovered lasers were at first in communications (see Bell Lab's Record account), but since then very many other applications have been found.

These include the cutting of materials ranging from ceramics, exotic and ordinary metals, wood, cloth and paper.

In the communications field, the bandwidth offered by coherent laser light is way beyond the requirements of most situations. This fact, and the cost of terminal equipment and transmission designed so far, does not make it an attractive proposition compared with waveguide alternatives. After these applications we are left with a whole host of other uses like those in art, teaching and computing.

4 - QUADRANT PHOTO CELL

#### THE LASER AND SURVEY WORK

The narrowness of the beam and its good penetration of the atmosphere immediately suggests the use of the CW laser to provide a reference line in space. By 1966 several firms were offering tooling lasers for use in precision workshop metrology. These used the normal CW He-Ne source encapsulated inside a precision-ground cylindrical tube, providing a beam that emerged from the centre of the tube. They were designed to provide a centre line through a system — such as a row of main-bearings in a large engine.

The centre of the beam, (see Fig.2), is detected using a four-segment photo-detector. In this, each pair of opposite cells are differentially connected and drive a meter. Thus the operator is provided with x and y deviation display, reading to fractions of millimetres. Devices such as these have been extensively adopted in



Fig.3. The Spectra Physics Dialgrade system has many accessories - here it is set up for alignment of pipes in the bottom of a manhole.



Fig.4. The scanning laser beam sweeps around providing a datum plane,

industry — their cost certainly exceeds that of a stretched wire but they are more precise and easier to use than their closer cost equivalent — the tooling telescope.

The major advance with these units over the last eight or so years has been the recognition that the normal laser cavity design is generally inadequate for alignment use. Quality systems now have special mirrors provided at the cavity ends, and a narrower bore, to ensure that the beam emerges always from the same place and maintains the same pointing angle in space.

Somewhat slower to gain acceptance, but now probably the biggest use of the laser in metrology, is the similar application to constructional and surveying alignment in the field, in tunnels and across harbours.

Basically, there is little difference between these systems and the tooling laser, the major addition needed being a telescope (collimator) to improve the collimation. This reduces the beam width at long ranges, giving improved precision in alignment. (The Laser Electronics range of survey lasers has a beam spread of 250 mm per kilometre.) It is also necessary to broaden the beam near the source, as the power density could be hazardous to the eyes — it is hard to ensure safety with unenclosed beams that stretch over distances of kilometres.

Survey alignment lasers need not be bore sighted to the same precision as a tooling laser. The mounting requirements also differ; usually they are fixed in the position of the telescope in a theodolite style frame. Most have self-contained supplies for use where mains power does not exist. Naturally, special alignment applications often call for a different type of mount. For instance, stands are available that point the laser vertically — for aligning lift shaft tracks and similar tall structures.

The first survey lasers were laboratory units mounted on theodolite frames. In the last two or three years there has been rapid development toward special-purpose, highly rugged, integrated systems that can confidently be used under the hardest of constructional situations.

The Dialgrade unit, marketed by Spectra-Physics and illustrated in Fig. 3, looks little like the normal run of CW laser package. It is a system developed mainly for pipe-laying under all conditions. Each unit is immersed in water to test for leaks; frozen in the inside of a block of ice and shock tested to 40 G. European companies, such as Wild and Siemens, also produce units for establishing grade — they have that continental appearance of being obviously workable in hard environments.

Applications abound for these units. Manual layout of pipes, foundations and trenches, and automatic applications such as tunnel boring 'mole' control and unmanned coal-face digging machines come to mind.

Another problem of construction surveying is the definition of a plane. Fewer companies have developed equipment for this - however both Spectra Physics and Laser Electronics market devices. In these, the CW laser beam is reflected from a rotating mirror providing a line that sweeps around in the horizontal (or, if need be, in the vertical) direction. Rotolite is Spectra Physics product name for their integrated system - it has been invaluable in the setting of raised floors, suspended ceilings and partitions - see Fig. 4. A special readout unit is also available to go with it - it provides an amplified

### LASERS AT WORK



Fig.5. Block schematic of WREMAPS II laser terrain profiler. All of the equipment shown is flown in the aircraft.

movement of beam meter displacement. With this unit, levelling operations become a one-man task. The user sets up the central scanner unit placing the defined plane where it is needed. He then moves out, as far as 150 m, with a measuring staff (that supports the detector) checking levels as the beam sweeps past repetitively. In the marine field, alignment needs are met by the Channel Light of Laser Electronics. This is a dual output, parallel-beam unit, in which each beam is switched for 0.5 s on and 1.5s off on one side, and 1.5 s on and 0.5 s off on the other. The beams overlap in the centre appearing steady when the observer is in the centre looking toward the source, whilst on either side they flash at 1.5 s or 0.5 s intervals indicating which way the ship has deviated. This guidance system can be used to guide ships and dredges along a straight line of lengths to 20 km.

Surveyors use lasers in various ways to measure range. A modulated beam of laser light (it may be pulsed carrier or continuous radiation) is transmitted out to a suitable target where it is reflected back to the sending terminal. Knowing the velocity of light (which we do to about 1 part in  $10^6$  in

distance to be determined. the (EM radiation travels about 300 mm in a nano-second). The main design task is to 'mark' the beam in some way in order that a sent pulse can be detected on return in order to time the flight. This can be achieved in one of two ways - firstly, by sending a single pulse and waiting for the return; or secondly, by transmitting a continuous modulated beam and then comparing the phase difference between the outgoing and returning signals. In the latter it is usually necessary to operate on a second frequency in order to Fig. 6. Schematic of interferometer layout and displacement sensing scheme used in the Hewlett Packard interferometer.

ambient air) the transit time taken for

the beam to go out and return enables

define distance more uniquely.

electro-magnetic distance These measuring devices (EMD for short), do not rely on laser light for their operation - they were in existence lasers. before years manv Incorporating a laser source has, however, increased the available daylight range and raised the ranging precision by a factor of two. Units, such as the laser Geodimeter, measure ranges of many kilometres this way, competing with the best microwave equivalent.

Problems of timing the rapidly travelling EM radiation limits the resolution of these units to a few centimetres, restricting their usefulness to long-range work. It is a pulsed laser system like this that is being used to measure the distance to the Moon to extreme precision. (The atmosphere error effects that normally limit EDM measurements to parts in 10<sup>6</sup> are not present for the majority of the flight path. Furthermore, longer distance relaxes the timing requirements).

Around 1969 the surveying instrument manufacturers of Europe each released (within months of each other) less expensive ranging units that made use of a Ga-As diode laser as the source. The diode current is varied directly to modulate the beam. These rangers were designed for shorter distances with the same centimetre precision (lower *relative* accuracy), and usually provide distance on a digital readout display.

Map making is a slow and somewhat for millions of tedious task, topographical data points must be measured to make a simple map. One recent device now helping to speed up the process is the laser-powered WREAAP terrain profiler. (Two models exist - Mkl and Mkll). These are used by the Australian Division of National Mapping and the Army. The latest design (see Fig. 5) uses a solid-state pulsed laser (Q-switched neodymium-doped YAG) to produce infra-red radiation. This is frequency doubled to produce pulses of green These pulses radiation. are





Fig.7. Calibrating machine-tool movements with the Rank Precision Industries laser interferometer.

transmitted, at 25 per second, through the belly of the aircraft to the ground below. They leave at 90 mm diameter, expanding to about three times this. 2000 m below, Reflected energy is detected back at the plane, and by using a fast timing counter it is possible to determine height to about a half-metre. Corrections are needed for aircraft roll, and for the changes in height of the aircraft as it flies. The profilers have been in active use for several seasons producing mapping data at a huge rate: in the 1971 season, 54 000 km were measured.

When the profilers were used over open sea or lakes, misleading answers were sometimes obtained. Careful analysis of the data revealed that the pulses were often penetrating the water giving, in fact, a profile of the bottom under the water. This led to the start of another programme (now in progress) to develop a mapping system for undersea work. The attenuation of even muddy water is not extreme - about 3 dB per metre so a return signal can confidently be expected. Combined with a sideways scanner, the flown profiler can become

a three-dimensional mapping tool for above and below water surveying.

Another large-scale measurement to which the laser has been put is the detection of the minute earth-strains that are induced in rock by the changing attraction of Moon and Sun, by earthquakes and by tectonic movements. Here the problem is not one of measuring absolute length to parts in 10<sup>6</sup> but one of detecting changes in length to parts in 1010 (an atom diameter in a 10 m distance).

One form of earth-strain meter uses a laser to power a long-path Michelson type of interferometer that is enclosed in evacuated pipes. As the far-end reflector moves relative to the near end, the fringes translate: these are monitored and the movements recorded for periods of months to years. The lengths of the nine or so interferometers built in Britain, USA, Italy, Japan and Australia range from 20 m to 1000 m. In this application it is necessary to stabilise the wavelength of the laser output to parts in  $10^{10}$ using a special technique that is explained later.

#### WORKSHOP METROLOGY

We have already mentioned the use of the laser as an alignment tool. It can also be used in the workshop to measure absolute lengths to great precision, (the best, in fact), by implementing the interferometer principle. Within two years of the realisation of the laser, several commercial enterprises had workshops interferometers on the market. By 1965 they were well accepted, but due their extremely high nrice to (\$40,000 then) few places could afford to have them. Today the price has been halved and the facility afforded by the basic equipment has been greatly expanded to include angle, alignment, velocity, flatness, pitch and vaw measurements.

The Hewlett-Packard model incorporates frequency stabilisation of the laser and detects frequency difference, avoiding the use of fringe counting, A block-diagram is given in Fig. 6 where it can be seen to be based upon a Michelson interferometer using corner-cube reflectors instead of plane mirrors. Corner cubes have the very useful property that they return a beam parallel to the incoming one regardless of small rotations of the cube - it is considerably easier to align an interferometer using these.

Being incremental by nature, a length can only be measured with an interferometer by translating the free corner cube over the total distance to be measured. If the beam is lost at any time whilst moving along the path the value will be incorrect. This means that the laser interferometer can only be used where a guideway straight to about 2 mm exists. Range capability varies from micrometres to decametres, the laser providing the coherence length needed for the greatly different path lengths between the references and the measuring arms. Figure 7 shows a machine-tool being checked with a commercial laser.

Interferometers have also been permanently incorporated into high accuracy inspection machines, into numerically-controlled machine tools and into scale calibrating machines.

Fig.8. Block diagram of the Machine Tool Industries Research PRINTED CIRCUIT PHOTOCELL Association in-process bar gauge. Fig.9. Simplified diagram of the stabilised laser that will soon become the new length MORK MPLIFIEF standard. STAR BEAM SPLITTER ABSORPTION 100 GAINCELL AVELENGTH STOP kHz STABILISED DIVIDE CROSECOND DIFFERENTIATOR PHASE-LOCK END MIRRORS FORMING OPTICAL AND PHASE SPLITTER WAVEFORM GAS TEMPERATURE DETECTOR ELECTRONIC CONTROL UNIT START INPUT CORRECTION STO

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1.5

PIEZO ELECTRIC MIRROR DISPLACEMENT GENERATOR

### LASERS AT WORK

The need to guide the corner cube is, however, a very real disadvantage. The use of hand-held corner-cubes as large as 150 mm across has been proposed for measurement in cases where no guides exist but does not seem to have been developed very far.

A less well-known application of the property of laser light is in the gauging of fine wire and filament diameters. This is achieved by simply placing the wire in the beam - diffraction effects around the wire cause the beam to break up, producing a line of dots on a screen placed beyond the wire. The various distances - screen to wire, spot separation and laser wavelength enable the wire diameter to be calculated. This method has been used for continuous sizing control by a position-sensitive placing photo-detector to view one of the diffraction spots formed. As the wire diameter varies, the spot moves, providing a correcting signal. It is interesting to note that the accuracy of diameter measurement increases as the wire-size decreases with this method.

Larger diameters can be measured by scanning the laser beam across the round stock, see Fig. 8, monitoring the angle during which it is vignetted on the other side. This is used in steel mills for gauging the size of red-hot bars as they are rolled.

#### HOLOGRAPHY

Several years before the first laser had been made, a revolutionary new concept for recording shape on a photographic plate had been proposed. It could not be demonstrated until the laser was developed, so its practical use had to wait. It is known as holography because it provides a kind of in which three photograph dimensional 'hollow' pictures are The basic technique of made.

PLANE MIRROR

holography is explained on page 24 of this article.

An extension of the procedure time resolved holography superimposes the hologram of an object at one time with that of another. If any differences exist between the two - shape changes or relative movement fringes are formed. Study of the fringe spacing and smoothness reveals much about distortion of the shape. As each fringe separation corresponds to fractional micrometre movements the method is verv sensitive.

Holography has numerous uses. In the workshop and research it has been used to study distortions in turbine blades, loudspeaker cones, vibrating disks, gas cylinders, car-type treads and cylinder bores. Although most examples we hear about are only in a once-off investigational stage of development, special purpose plants incorporating holography are slowly appearing. For example, a tyre testing machine is now available commercially. In operation, a hologram is made of the inflated tyre tread; the pressure is slightly changed and the before and after holograms interfered. If an area of abnormal stress exists (a piece of tread unvulcanised to the case, for instance) rings of fringes appear that visually stand out with respect to the broad-pitch fringes produced across the rest of the tyre.

#### SCIENTIFIC MEASUREMENT

The majority of industrially accepted devices have their genesis in the scientific laboratory. This is certainly true of the laser. There exists in various fields of research many more measurement applications that will, no doubt, gradually find their way into industry.

The first we will consider is the wavelength stabilisation method mentioned earlier, for this will shortly become the new improved

Fig. 10. The laser doppler TARGET velocimeter can be used to detect speeds ranging over many orders of magnitude.

international standard of length. A normally constructed He-Ne CW laser produces radiation that drifts in wavelength with time by parts in  $10^6$ . Any interferometric length measuring method using such a source cannot provide absolute measures of interval to better than this limit. Since the early sixties various means have been devised to stabilise the wavelength, the best (until recently) achieving parts in 10<sup>8</sup> control. This order, however, is not better than the already existing krypton wavelength standard produced with a gaseous discharge source.

Over the last three or four years several groups, at each of the Standards Laboratories in the USA, Germany Canada Britain, and Australia have been working on an advanced principle that will give parts in 10<sup>10</sup> reproducibility. Several units have been tested and it is now generally agreed that it is only a matter of time before the krypton source will be replaced by a laser stabilised with this new method --called molecular absorption stabilisation Its operation is as follows.

A normal CW laser has a gain cell (wherein energy levels of the atoms are pumped up) placed between two mirrors that form the cavity. As the cavity length is slowly altered, it is found that the power output from the laser varies, having a maximum at a certain length. Careful study of this peak reveals that there is, in fact, a slight drop of power in the middle we call this the Lamb dip. Early stabilisation schemes servo-controlled the length to keep the output at the bottom of this dip realising parts in 10<sup>8</sup> control of wave length.

Theoretical considerations suggested that this could be improved upon, and this is the case in practice. If a cell containing gas, as shown in Fig. 9, is also placed in the cavity and the length again varied it is found that there are, in the width of the Lamb-dip curve, a number of small narrow peaks. These are the result of absorption effects in the gas cell, and they occur at precisely defined wavelengths - far



the cavity length is varied with a piezo-electric microdisplacement device to hold the power output on top of one of these peaks. Now that the practical problems are virtually solved – the electronic detection is sophisticated – it should not be long before these units are available commercially.

A second laser measurement device. used mainly in research, is the laser velocimeter; it can measure the velocity of a moving medium, fluid or solid, looking at an extremely small portion of it. Laser light, (see Fig. 10) is shone onto the medium. Particles, such as surface defects on solids or in fluids, reflect some aerosols radiation back to the source where it is optically-mixed to produce an interference pattern. If there is no movement the pattern is stationary; if moving, the 'fringes' translate at a speed proportional to the velocity of the medium - it is a kind of doppler effect. The period of the detected fringes is therefore related to speed. The principle is easy to understand, there are several practical but problems, not the least being the short duration (one to five cycles only) of useful fringe signals that result because of the poor signal-to-noise ratio of the method. A description of the laser Doppler velocimeter was given in an earlier issue of ETI.

Other interesting scientific applications for the laser interferometer are worthy of note. For instance, diffraction gratings (ruled lines on a substrate - used to disperse infrared and visible radiation into the various wavelengths) are now ruled using laser control of the ruling carriage. The lines are placed only micrometres apart. Another use of the interferometer has been in the determination of the absolute value of gravity. The original scheme proposed by the staff at the Weslevan University in the USA is given in Fig. 11. A solenoid releases the top corner-cube allowing it to fall. Timing circuits (not shown) measure the time taken for the reflector to fall through a certain distance. The experiment is performed in vacuo to eliminate air friction effects

Laser radiation is spectrally pure and, therefore, very useful in spectroscopic studies. Initially, there was only a few specific wavelengths available, these being the characteristic colours of the various types of lasers. Today, we have the tuneable dye laser in which the colour can be swept across the spectrum at the turn of a knob. A high-intensity source — the argon ion laser, for instance — optically pumps an inorganic dye solution causing it to lase at wavelengths different from the pump radiation — refer to Fig. 12. The



Fig.12. Layout of Coherent Radiation's tuneable dye laser. The dye flows across the optically-pumping area being confined only by its inertia forces – no cell is used. The inset graph shows the range of wavelengths available with different dyes.

output of the cell does not occur at a discrete colour but as a broad band of wavelengths; a particular colour is filtered out using a tuneable Fabry-Perot etalon selector. In essence, changing the length of the etalon (a cavity formed between two parallel flat mirrors) alters its spectral transmission allowing only a very narrow band of colour through for a given spacing.

The short duration pulses available from some lasers have given a new dimension to high-speed photography. Picosecond pulse lengths of high intensity light enable extremely fast events to be effectively frozen.

#### **AN X-RAY LASER**

For many years there has been talk of ways to produce coherent x-rays. Now it seems an x-ray laser has been demonstrated, for reports are circulating of success by a London Theoretical considerations group. predict x-ray radiation will occur by laser action; the practical problem is to raise the energy levels sufficiently to move electrons into far-enough-out orbits. Energy levels to 20 000 electron volts are needed. Calculations show that a material raised in temperature to 20.10<sup>6</sup> degrees Celsius should suffice. It is rumoured that the London group used a glass laser (the most powerful) focussed onto graphite to produce x-ray emission.

When x-ray lasers become common practice they will greatly extend the capability of radiography. They will enable holograms to be made of the inside of optically opaque objects. Being coherent, such sources would also extend the fields of microscopy.

### THE LASER AND CRIME DETECTION

The potential of holographic methods is being investigated to see where it can help in the detection of crime. One case already demonstrated is the detection of footprints left in carpet – hours after they are made. A



hologram of the suspected area is made, followed by a second exposure a little time later. If anyone has been standing there, the indentation thus caused will still be creeping back giving small differences in distortion even hours later. The combined holograms appear as fringes that have the shape of the foot. They also indicate weight and distribution of load on the foot.

Another device that can be used in crime detection and espionage is the laser listening unit. Conversation in a room causes the window panes to sympathy with the vibrate in acoustical pressure changes. Δn infrared laser (one that cannot be visually detected) is aimed at the window from some distance away. Reflected radiation from the window is mixed with that sent, forming a doppler velocimeter in which velocity represents speech inside the room. These devices do exist - one was described in the November 1972 issue of ETL

#### **MEDICAL MEASUREMENTS**

In surgical transplants the problem of rejection is yet to be completely mastered. Kidney transplants, for instance, do not always take. If the degree of acceptance could be monitored daily it would be possible to remove a rejected organ before secondary effects set in. Current research aims to produce a pulsed holographic method that will enable viewable pictures to be produced of the organ showing the development of the all-important blood vessels.

Holography has also been suggested as a way to improve the fit of dental plates – the dual exposed hologram of

### LASERS AT WORK

palate and plate can show tiny difference.

We will see in the second part of this article that the laser has many more uses in medicine than for measurement alone.

### WHO KNOWS WHAT OTHER USES EXIST?

To round off this survey we finish with a quick list of other measurement uses of the laser.

#### HOLOGRAPHY – A 3-0 PICTURE FROM A 2-D PHOTO

In 1948, Gabor discovered a technique (in theory) called wave-front reconstruction — we now refer to it as holography. Leith and Upatnieieks demonstrated it in 1962.

A normal photograph contains amplitude information only about reflected light from a subject. If the subject is photographed in a special way with coherent light it is possible to produce a photographic negative having both amplitude and phase information. It looks nothing like a normal photo (Fig 1) - rings, speckles, dots are all there is to be seen - but when it looked through. using is coherent radiation shining from behind, the object appears to be reconstructed. Move the viewing angle and one sees around the object. Even more unexpected is that any fragment of the hologram will give the same reconstruction - all that suffers is brilliance level.

Although the mathematical explanation is complex the practice is quite straightforward provided stable supports exist. A typical setup is shown in Fig. 2. Incident coherent light falls on object and on the the photographic plate. Reflected light from the object also falls on the plate providing an interference pattern that is recorded photographically. To reconstruct the object (as an image) the set up is slightly altered as seen in Fig. 3.

By superimposing an object on a distorted replica of itself it is possible to detect changes in shape or position as differences. Time-lapse holography does just this – a hologram replica image is "placed" over the object forming fringes corresponding to differences – see Fig. 4. In missile tracking, a laser has been used to 'mark' the missile with a heat patch enabling a heat seeking missile to seek and destroy it. Bombs are guided down laser beams with unerring accuracy. Cloud heights and the extent of pollution in air are being measured using laser readers, (Lidar for short).

The Migros supermarket chain in Europe uses laser reading heads to scan the coded labels marked on goods. Not

only does the head supply figures for the till automatically to ring up the total charge, it also provides inventory and reordering data.

A meat tenderness meter has been reported – this measures the diameter of the fibres providing a more objective definition of meat quality.

No doubt there are numerous other measurement applications waiting to be tried!



ELECTRONICS TODAY INTERNATIONAL - JANUARY 1974

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## VIDEO PLAYER BREAKTHROUGH



Combining photographic and electronic techniques, latest video player may cost under \$300.

JUST as video disc players become a commercial reality, a small US based company has produced a working prototype video player that costs a mere fraction of competitive systems.

The unit, designed and developed by i/o Metrics (Sunnyvale, California), uses high density amplitude modulation techniques on 300 mm (12" approx) discs. Each disc carries up to one hour's colour or monochrome TV programmes — or an incredible 500 hours of audio.

The discs are made from conventional photographic film and may be manufactured by normal photographic contact-printing processes.

#### RECORDING

Master recordings are made on holographic film – chosen for its wide bandwidth (10 MHz) not its holographic properties.

The a-m input signal modulates a helium-neon laser. The resultant modulated beam 'prints' a train of dots on the film. Varying signal amplitudes appear as corresponding variations in the diameter and density of the dots.

The film disc is spun on a turntable at 30 revolutions per second. As the disc spins, the laser beam progressively exposes a spiral track — via a lens that moves slowly along the radius of the spinning disc.

Production discs are then made from the master by normal photographic processes.

#### REPLAY

For replay, the film disc is placed on a transparent turntable illuminated from below by a 25 watt incandescent globe. The globe projects an image of the record's track, via a simple optical system, onto a white card.

Tracking is accomplished by a simple servo-controlled optical system. The image projected onto the white card is viewed by three photodiodes, two of which control the position of a servo-driven mirror (Fig. 2).

The third diode reads the varying light intensity from the dot pattern on the film. The dot pattern is subsequently integrated to recreate the original a-m signal. This is converted to an rf signal at TV broadcast frequency, and fed directly into the receiving TV set's antenna.

#### **UNDER \$300**

Peter Wohlmut, president of i/o Metrics claims that the players can be manufactured for about US\$100 – implying a retail price of less than US\$300. Records, says Wohlmut, can be made for around 20 cents each and will be sold for about the same price as normal gramophone records.

A major advantage of the system is that it does not appear to be bothered by loose tolerance components – nor do the records appear to lose playback quality if they are misused.

The concept appears to be suitable for audio, analogue and digital recordings. According to Peter Wohlmut, about  $10^{11}$  bits of data can

be stored on one single 300 mm disc, and retrieved at the rate of six million bits a second.

The manufacturers have applied for patents covering the signal processing system and have plans to license suitable manufacturers to produce the devices commercially.



## CREATIVE AUDIO

A practical guide to creating and producing your own sound.

THE commentator acts as the eyes of his future audience, the location microphone as their ears.

At first it is not easy to be fluent when talking into a microphone – with the inevitable onlookers staring curiously. All one can do is to go out on the streets and try it a few times. This should help to conquer self-consciousness.

Obvious comments should be avoided, i.e. 'The brass band has just started to play'. The commentator should concentrate instead on the visual aspects, the colour of the bandsmen's uniforms, the route being taken and the size of the crowd. A second important duty that falls to the commentator is to cover the history and background of the situation in a digestible manner.

Before going on location, thorough research is necessary, short notes being made of relevant statistics and dates. It is also helpful to record 'mind-jogging' key phrases to be discussed. This homework not only allows the commentary to flow, but is also most beneficial when interviews are to be carried out. A subject will warm towards his interviewer if he feels that the latter has made an effort to find out about the topic being covered.

Sometimes complicated microphone placement is necessary on location, as when recording a brass band on the move. There is no reason in these circumstances why one should not over-dub the commentary later back at home, and often this gives a better balance.

#### INTERVIEWING

Inconspicuous equipment handling contributes a great deal to successful interviewing. The subject is liable to become microphone-shy if he keeps catching sight of the revolving spools, or has the microphone waved around inches from his face. It is also distracting if the interviewer gyrates around every few seconds to check the recorder is not over-modulating and the tape has not run out. The level should be appropriately set beforehand, so that a microphone



Recording the departure of a ship from Piraeus Harbour (Greece). Equipment used to make this stereo recording includes Neumann KM76 condensor microphones and windshields. Senheisser headphones are being used to monitor the output from the Stellavox SP7 recorder.

distance of at least 1/3 metre can be used. A directional microphone is a good choice for interviewing, its pick-up pattern operates well in poor acoustics and high ambient noise levels

The comments of the subject are of prime importance, and the choice the keeping between exists. microphone static, pointed at the subject (the interviewer will come out much softer on the recording), or re-directing it to pick up the interviewer's questions. The latter procedure may be adopted with a conventional question/answer situation, and here it is better to arrange seating positions to minimise microphone movement. This is aided by increasing the record gain control to permit a longer pickup distance.

#### ACTUALITY DOCUMENTARIES

An actuality documentary differs from the conventional form as the final programme contains only the interviewee without the accompanying questions.

The quintessence of an actuality documentary is facts about a situation.

The aim of the interviewer is to extract these facts from his subjects in an interesting manner. This invariably entails in-depth interviewing — an hour's raw interview may yield five minutes of useful material.

It is important when interviewing to utilize a close microphone position as this leads to a better acoustic match when cross-cutting tapes made in different environments. For the same continuity reasons a relatively dead acoustic with low ambient noise is helpful. If necessary blanket background effects can be added after the interview-editing stage.

PART FIVE

The style of interviewing differs from the normal question/answer format insofar as the interviewer tries to make the subject do most of the work.

The subject should be told before the interview is started, what the tapes will be used for, and why his help has been requested. He can be reassured that the question/answer routine will not be followed strictly, but will rather take the form of a chat, with the subject telling the interviewer in his own way what the topic is all about.

When putting on a fresh reel of tape, try to completely stall the conversation, or good material will be lost which will never sound quite the same if repeated.

Indirect questions prefaced by 'tell me' will provoke a greater response than direct questions. Instead of asking a cross-channel swimmer 'was it difficult?' which would probably lead to a monosyllabic answer, the question would get a better response if phrased, 'tell me, how was the crossing?'

More animated response still will be obtained if the interviewer assumes some naivety. Especially if he makes a statement he knows to be diametrically opposed to the beliefs of his subject. In the above example he may venture, 'I have been told that cross-channel swimming is quite easy'. Naturally this technique should not be taken too far!

The interviewer will have some preconception of the angle from which he wishes to tackle his subject matter. During the course of the interview he should be ready instantly to follow up the topics which provoke the liveliest reaction, relating them to his prior ideas of the final programme.

Subtle persuasion pays dividends. Encourage the interviewee, as he warms to his subject, with "Tell me more". In the early stages of an interview, the subject's speech is often stilted as he tries to say the grammatical 'right thing'. The interviewer must demonstrate that it is unnecessary to 'play up' to the microphone. The interviewer's voice will not be on the final tape in any case, so it is not so important for him to guard against what he says.

The art of the actuality interview is to get the subject to say what *he* wants to say, but in the way the *interviewer* wants to hear it.

Examine the following example -

Interviewer – "Was it easy swimming across the channel?"

Subject - "No, of course it wasn't." Interviewer - "But I understood that you had done it before."

Subject - "Yes, but it never gets much easier."

Interviewer - "What doesn't?"

Subject — "Swimming across the channel. It is just as difficult every time. There is no such thing as an easy swim."

The interviewer may appear to be stupid, but he has succeeded in making the swimmer more demonstrative. The swimmer's last responses, when cut from the tape, and without any further alteration, will form an ideal introduction.

It is quite likely that during an interview the subject may commence his answer before the interviewer has stopped speaking. The interviewer in this case can use the same re-cap technique as illustrated above; interjecting with "sorry, you were saying", he will get the answer repeated in a useful form.

It is essential that the interviewer remains quite silent during his subject's replies. The subject communicates with the interviewer, but the only response from the interviewer should be by way of facial expression. Nodding, smiling and frowning are preferable to ums, aahs and sniggers.

At the end of the interview, one should naturally thank the subject and ask if he or she would like to hear a replay.

#### LOCATION RECORDING

It is incidental sound effects and music that add flavour to a location documentary, the combination is more powerfully evocative than a commentary on its own.

Prior research will indicate possible characteristic sounds. At a carnival, for instance, there will be coin jingling collectors, motorcar horns and brass bands. Less obvious are the facinating results to be chanced upon if one can discreetly get into the middle of a crowd, and collect 'candid' comments with a hidden microphone. When collecting general background effects and repetitive sounds, one should tape at least two minutes of each. This would include such 'aural snapshots' as a busy street, the interior of a train. sea, restaurant and birdsong. With plenty of material, extended loops can be made of the useful sections, which at a later date can be over-dubbed onto the actuality interviews without repetition giving the game awav.

Microphone position is just as important when collecting sound effects as it is with the other sound sources discussed in this series. If one is not self-conscious, headphones simplify matters considerably, revealing the existence and whereabouts of background sounds to which one would normally be oblivious until the replay stage.

The biggest bugbear of location recording is the thundering noise caused by even quite gentle breezes impinging on the microphone diaphragm. Obviously the first line of attack is to try to record in areas sheltered from the wind and to use a windshield whenever outdoors. Many microphones are manufactured with a wire cage surrounding the pickup area, and for others a windshield is available as an optional accessory. Failing this, one may be constructed from foam-rubber or open-wave cloth such as hessian, which is fashioned into a 'hat' which slips onto the mike, and is secured with an elastic band. Even a handkerchief doubled over the microphone will allow an acceptable recording to be made in an emergency.

Another potential source of unwanted noise is the handling effects due to the microphone lead and casing. This is more bothersome with medium and high impedance microphones, and almost non-existent with low impedance versions. Advice here is rather negative – try to find a mike that is little affected; it should be held between the first finger and thumb, using another finger to retain a loop of cable, as the majority of the trouble is caused where the cable exits from the microphone body.

Location music balance is a rather

chance affair, even when headphones are used. Really the only way to record a brass band on the march, is to march along with them, holding an omnidirectional microphone on a boom-arm, the exact position being determined with headphones. A makeshift boom can be constructed with a chemistry clamp on a 'broom' handle. The difficulty, the same for any hand-held microphone music recording, is in keeping a static aural balance.

Stereo location recording demands the same care; a slight waver of a 'crossed pair' of microphones will cause the panorama to veer round alarmingly. Incidentally, it will considerably ease compilation at a later date if each tape is commenced at zero level, and faded down again before switching off the recorder.

#### EQUIPMENT COMPLEMENT

On location, spares are as important as the recorder itself. A stout, weatherproof shoulder-bag is best used to contain the following:-

A spare microphone and lead, terminated in a plug;

Enough batteries for the recording session ahead, with plenty to spare;

Mains power pack for the recorder (if available).

Extra tapes to cope with the unexpected;

Plugs and leads — soldered joints have a knack of coming adrift at awkward moments, so several ready-made connectors should be carried, including a plug to screened lead, with bared ends for taking feeds from PA equipment (check that it is not a 100 volt line!)

Microphone extension lead - not vital;

Razor-blade and editing tape to repair breaks in the tape should they occur.

A small screwdriver, pair of pliers,



Grampian DP4 microphone with polypropylene-strengthened foam rubber windshield.

#### **CREATIVE AUDIO**

wire strippers and cutters, box of matches, and packet of low melting point (match) solder.

A square of aluminium baking foil for quickly screening joints;

Insulating tape, and heavy duty carpet tape for fixing mike leads out of the way of clumsy feet.

A pocket torch may be needed for checking meter level in adverse lighting conditions;

A small pad for logging battery time and other notes, and finally, a pen.

#### PROGRAMME COMPILATION

Once all the material has been qathered, it will have to be knitted into a cohesive end product. The first stage is to find a quiet room and play all the tapes through at least once; an overall picture will begin to emerge of the type of presentation possible with the available material. The tapes are played through again, this time making careful notes of each item, its quality duration, and content. Interviews should be written out verbatim. It is helpful to log the items with reference to the tape position indicator.

Studying the logging sheets, one can now select the most apt pieces, which

are played yet again and reconsidered. In this way, a collection of a dozen or more top quality items will be selected.

Preconceived ideas will now have to be modified to fit in with the useable material, and a logical running order worked out for the items on the short list.

A factual documentary will need some type of commentary to make it flow; this may be derived in part from the location tapes, and a visit to the local reference library will provide a source of ideas for the remainder of the bridging commentary.

A start can now be made on a 'rough-cut'. It is advisable to dub the short list material onto a separate tape, editing only this copy, so as to guard the original tape against unfortunate accidents.

It will be evident at the rough-cut stage that the intended approach doesn't quite come off in some places, but elsewhere works better than expected. The recordist should be quite open to the 'feed back' from the tape; ruthless editing is difficult when one is aware of the effort that went into obtaining the material, but this pruning is the only way to a crisp, fast-moving result.

Variety sustains interest, as has been stated before. It is beneficial if the recordist can break the final bridging script down into a number of sub-sections, each to be read by a different person.

The final mix of location material/studio commentary may be carried out using the multi-track system described last month, i.e. re-playing the 'effects' tape (with leader tape between each item) on one recorder, and recording it on another together with the commentary fed in directly by a microphone.

If a stereo machine is being used for the record side of this operation. cross-mixes between effects tracks are possible. The (stereo) bottom track is prepared with one set of effects. complete with a fade-down at the end. The upper track is set to record, and the effects material dubbed from the lower track. Previously a second effects tape has been prepared, and is cued on the second machine, with the output level turned down, though also fed to the upper track of the stereo machine. As the lower effects track nears its end, the second machine is started, fading up its replay output as the signal fades from the lower effects track. Both machines can now be stopped, and the second tape spliced to the tape on the stereo recorder, just after the double fade, to preserve the quality of the second set of effects.

This series will be continued next month.





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ADC 550XE. Type: Induced Magnet; Output: 5 mV at 5.5 cms / sec. recorded velocity; Tracking Force: 3/4 to 2 grams; Frequency Response: 10 Hz to 20 kHz + 2 dB; Channel Separation: 20 dB from 50 Hz to 12 KHz; Compliance: 35 x 10 6 cms dyne; Elliptical Stylus Tip Radii: Contact radius .0003". Lateral radius .0007"; Vertical Tracking Angle:15°.

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This model measures  $51\%'' \times 14''$  (high) x 15%'' (deep) and is priced at \$57.00 (teak or walnut kits). Normally comes with base, but 4%'' legs optional.



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## **PIRATE RADIO** -an objective view



Mr Collyn Rivers, Editorial Director, Electronics Today International, 15-19 Boundary Street, Rushcutters Bay, NSW 2011.

Dear Sir,

I have read and collected every issue that you have ever published of Electronics Today International since its inception and therefore hope that you will publish this letter for the sake of freedom of opinion – even though it deals with an illegal activity.

I refer to radio pirating, and in particular a segment of a Four Corners programme that was broadcast last year.

As one of the 'dreaded pirates' I would like to strengthen and reveal a number of new points about pirating – on behalf of my colleagues.

The programme did a great injustice to us by saying that we will accept no rules and are not willing to pay six dollars for the right to transmit. This is entirely wrong. I and all my friends involved would be willing to pay up to \$20 for an annual licence for the right to operate legally.

The Radio Branch of the PMG seems totally against legalising our activities. They don't seem to me to have a very good argument. Whilst the majority of those who at present, use the band legally are working, we, who use the band This is a controversial article that will inevitably stimulate considerable discussion.

We would like to make it quite clear that the views expressed herein are those of our contributor, Roger Harrison.

Electronics Today International does not necessarily, agree nor disagree with our contributor's views — in whole or in part.

IN AUSTRALIA, a band of frequencies (27.23 MHz – 27.28 MHz) is set aside for 'communications with low-powered, short range, hand-held mobile radiotelephone transceivers by appropriately licenced persons (Document RB 191, June 1972, PMG Radio Branch).

Colloquially known as the 'Citizens' Band', this band is being increasingly used by unauthorised people known as 'pirates'.

Last year, a segment of the ABC programme 'Four Corners' was devoted to a report on these pirates. The programme occasioned little comment in the national press, but there was a subsequent wave of reaction that has gathered momentum amongst individuals and groups either

illegally are off the air. We rarely use the band before six o'clock in the evening, and so the most commonly heard condemnation of our activity – that we may confuse crane drivers, and thus endanger the lives of dogmen – is hardly valid. There is far greater chance that the driver of one crane may mistake the instructions from the dogman of another.

Probably the most important reason for our pirating on 27 MHz is that many of us just do not have the required knowledge to pass the amateur examination. In fact many of us do not have the time to.

I am in an important year in my education and I cannot devote enough time to learning the very specialised knowledge required to pass the exam. Yet my main interest is radio telephony and telecommunications and the particular electronics that goes with it. Why, therefore should I be deprived of the right to pursue that hobby which interests me greatly, what's more, when I first came onto Citizen's Band three and a half years ago I knew practically nothing of radios and antennae and propagation characteristics etc., yet just by practical experience and information picked up "along the line" I now know a fair amount about these subjects.

From this last point alone I feel that the legalisation of a Citizen's Band is justified, let alone the other points I have mentioned.

The writer of this letter included his name and address. This was verified as genuine but has obviously been withheld from publication. – Editorial Director.

directly or indirectly involved or affected by the activities of these pirates.

One such reaction was the letter reproduced on page 34.

In this article, I shall comment on the situation in several ways, giving the position of the PMG (as far as can be ascertained from the little literature that they have available, plus discrete ferreting) also that of the Wireless Institute of Australia (similar qualifications) - together with my general own views and comments. The main point raised by our correspondent is that the currently illegal activities of the 27 MHz pirates should somehow be 'regularized'.

There are, of course, plenty of precedents for allowing the 27 MHz band to be used for this purpose. In the USA for example, anyone, upon application and payment of a nominal fee, can obtain a permit to transmit on the 27 MHz Citizens Band. But this scheme is a big headache to the US Federal Communications Commission as the regulations covering the band are constantly and blatantly abused.

The problem that arises is rapid occupation and over-use, with subsequent chaos and abuse of regulations. In the US in particular, where five watts is the maximum permissible power, many CB stations run power from several hundred watts to over 1 kW SSB! And such equipment is readily available 'off the shelf'.

Even in Australia, where PMG regulations restrict 27 MHz transceivers to a power output of 700 mW, non-approved transceivers with far higher outputs can be bought quite easily. Apart from that, higher power outputs are permitted for services using frequencies close to 27 MHz, and equipment sold for these services is being exploited by pirates.

#### A NATURAL RESOURCE

It has to be remembered that, in one sense, the radio spectrum is a natural resource. Although not literally consumed, as are other resources, there is an obvious need for controls considering the multitude of claims made upon it.

We know only too well that if any resource is opened to use or exploitation with minimal or zero regulations, then chaotic exploitation will inevitably follow

The early usage of the radio spectrum was chaotic until international conferences were held, and committees/agencies established to regulate its use. I contend that a similar situation, on a macroscopic scale, could arise if a segment of the RF spectrum near 27 MHz were, to be

#### THE WIA'S POSITION

The view of the WIA -as abody - is that pirating (in any form) undermines the aims, objects, functions and traditions of amateur radio.

The WIA protested that amateurs were not given a fair go on the 'Four Corners' programme. A protest was made to the ABC, the producer of the programme, Senator McLelland, the Prime Minister's Dept., and the Leader of the Opposition.

A number of State divisions have made strong protests over the Four Corners programme, as has the Federal Executive of the WIA. It is interesting to note that the NSW division has been quiet on the matter.

The amateur allocation on 27 MHz (ie – the 11 metre band) has experienced an increase in a m a t e ur use, with encouragement from the WIA, (with the exception of the NSW Division), over the past year or so; probably with the object of reducing the pirate occupation. The proposed 'novice' amateur licence is to be allocated use of this band as well.

It is obvious that many amateurs have very strong, often quite emotional, and unsympathetic opinions of pirates. There are also a tolerant few who believe that many pirates can become good amateur radio operators given appropriate assistance.

## THE PMG's POSITION

Being a regulatory and licensing body, the PMG are naturally bound to enforce the regulations as they stand.

The Wireless Telegraphy Act makes it quite clear what unauthorized transmissions are - and spells out the penalties for contravention.

Currently the maximum penalties are \$1000 fine and/or five years imprisonment — with or without hard labour. So far as I can determine, this maximum penalty has not been imposed in at least the past five years. Nevertheless many prosecutions have been made for abuses of the Act since its introduction and varying penalties (fines of between \$200 and \$500) have been imposed. In all cases of pirating, the equipment is confiscated. So if you're caught you lose out all round.

This raises the 'rate-of-capture'. Accurate figures on this are hard to obtain without going through records of court all proceedings . . . a time consuming, and not necessarily accurate, task. One would also need to know the existing number of pirates and their growth rate over a given period. In spite of some quite ingenious, not to mention elaborate measures adhered to by most pirates, the PMG every now and again catches one in the act. The subsequent prosecution is almost invariably successful, but as it is almost impossible to gauge how many pirates there are, one does not know how successful the PMG are at catching them.

For obvious reasons, the PMG Radio Branch dislikes pirates and their activities but apart from that they do not wish the situations that prevail in the USA and New Zealand to occur here by opening up the 27 MHz band to all comers.

Inevitably some pirates on 27 MHz (as distinct from pirates on other amateur bands) turn to amateur radio to further their interest. A few amateurs admit to once being 27 MHz pirates before discovering the advantages of becoming legitimate. But it is quite obvious, from their ever-increasing numbers and activity, that a large proportion of these pirates are not turning to amateur radio.

There is a need for an outlet for an interest in communications and the view of the PMG (and obviously that of the WIA) is that it should be through the hobby of amateur radio and the regulations under which it now operates.

Both the PMG and the WIA are committed to opposing unrestricted or non-licensed (as distinct from unlicensed) radio communications by the very nature of their composition and functions. But they are to some extent coming to grips with the pirate problem as the long-researched and advocated novice amateur license will shortly become a reality.



### **PIRATE RADIO** -an objective view

Transceivers shown here are typical of those used by 'pirates'. Electronics Today emphasizes that sales - in Australia of this type of equipment are perfectly legal. There are many authorized, legitimate users.



allocated for use with the minimal regulations envisioned by the currently illegal operators on this band. Many countries have noted the USA's experience and have not allocated frequencies near 27 MHz for such use.

One of the prime arguments raised against the legalization of 27 MHz CB'ing is the possibility of interference to other legitimate users.

Our correspondent questions that this could happen - but here he is clearly wrong. He ignores the fact that essential services are allocated space in this section of the spectrum - rural ambulance services, bushfire brigades etc. Here, interference is without doubt, potentially hazardous to life I had personal and property. experience of this, when during the Victorian bushfires our 1965 communications system was disrupted by pirates' radios.

If 27 MHz CB was to be legalized, the problems would almost inevitably increase — as overseas experience has shown.

Another point raised by our correspondent is that many 'pirate' because they do not have time to study for an amateur licence.

May I suggest though that if the time spent pirating was otherwise engaged in studying for the amateur licence, pirates would be able to follow their alleged interests with far fewer restrictions than at present.

Many pirates have an erroneous idea of the level of technical knowledge required. It is only barely 'specialised', in fact some of the questions could be answered by high school students doing science as part of their curriculum. Assistance is readily available throughout most of Australia via clubs, the WIA etc. Most amateurs are only too willing to assist

This letter (regrettably unsigned) was received by Peter Cossins, VK3BFG. It appears to be a copy of a letter to the Postmaster General. It was originally published in the 'Victorian UHFer' and is reprinted by permission.

The Postmaster-General, Parliament House, Canberra, A.C.T. 2600.

Dear Sir,

In recent years many approaches have been made to the Australian Government for the establishment of a Citizens Radio Band and no doubt most of these approaches have urged the use of 11 metres for this sphere of operation,

Firstly, there is no doubt whetsoever that a definite need exists for licensing of this type in Australia. The millions of licensed Citizen operators throughout the World prove this, from Europe through Japan and New Zealand to the U.S.A. and Canada. The fascination of wireless communication has established Amateur, Commercial, Defence and developmental radio services from here to the Moon.

The great percentage of any population would like to have the use of wireless as a medium for communication, however in this it is restricted for the use of the Country emergency, technically qualified, emergency, and commercial interests. Those persons who are commercial interests. Hose persons who are not therefore engaged in the latter two activities find that the technical requirements needed for say, Amateur Licensing, are extremely difficult; for, to the majority it boggles the mind. The writer considers it an injustice to debar any

responsible person from communication, be it wireless or any other method.

Unfortunately, those Countries which have adopted the High Frequencies for Citizen Operation regret having done so. If one monitors any of the Citizen channels using 10 or 11 metres in either the U.S.A, or New Zealand the chaos is soon apparent. We can therefore take heed and consider the alternatives.

Before putting forward any proposal it is interesting to note that there is excellent radio operator material using our popular handphone channel and it is these people the writer is particularly concerned about, for to many of them the mathemetics of electronic theory and the music of Morse Code is more often than not seen as a Ceveat to Amateur Licensing. This is a statement borne out by the comments of many of the instructors of our youth clubs, so it follows that if we are prepared to act with imagination and understanding, if we are willing to give the problem some intelligent and sympathetic consideration, the answers will be found.

The following suggestions, I believe, will overcome the majority of the common objections — both from the Post Office and Radio Service in a segment of the Ultra High Frequency or VHF Bands for the use of radio hobbyists and novices. This service should be distinct from the existing Amateur Service, however the Amateur fraternity could be invited to comment on frequency allocations and general attitude as the proposed Service would be the obvious starting point for most potential Amateurs. The details are as follows:

- 1. The mode to be Frequency Modulation.
- 2. The Licensing of Base Stations only,
- except as hereinafter provided. A maximum of 10 watts aerial input.
- 4. P.M.G. type approved transceiver
- 5. At least two megacycles of the UHF or
- VHF spectrum. Antennae to be Vertically polarised and non-directional, however gain verticals should be provided for.
- 7. License should be on a permanent basis
- not by tenancy. 8. No theory or Code required but a rigid
- examination on station operation, regulations and safety procedures. 9 A
- Call-Book issued with every new license. 10. Crystal controlled channels,
- 11. License fees to be the same as for commercial base stations,
- The following comments are to expand the

eleven abovementioned intentions: -The use of FM would avoid the hash of heterodynes on occupied channels and would suit the electronic industry in it's development of the FM field. Any encouragement to design and manufacture this type of equipment in Australia is of tremendous importance to the industry and the economy.

The use of Base Stations only, means that the Service would be self policing as is the general case in most commercial operation. Coupled with the Call Book and the absence of Mobiles, direction finding would be very easy for the Monitor.

The only provision for mobile operation would be for Service Organisations such as the Country Fire Authority, The Volunteer Emergency Reserve, Civil Defence and St.
enthusiastic newcomers.

My belief is that many – but not all – pirates would have the necessary intelligence and aptitude to study for and pass the present amateur operators licence.

The writer of the letter raises an interesting point when he says 'Why should I be deprived of the right to pursue that hobby which interests me greatly'. I know that many pirates share this view. But really they are only depriving themselves. One exception to this comment of course is those under the qualifying age. But here, the forthcoming 'novice' licence will help.

In my view, those in favour of legalizing 27 MHz CB operation have not presented a well argued case. They seem to be trying to convince themselves that what they are doing is illegal but not damaging — and to express their feelings of being hampered by what they regard as silly or unnecessary legislation.

Ultimately they are at a disadvantage. Because their activities are illegal they cannot form a national association more effectively to put their case to the authorities. Nor, for the same reason, can they effectively assist each other. Apart from that they are severely limited in their range of activities and projects — with consequent limitations on any real learning gained from experience.

Of course the BIG question is how many of these people pirate for the thrill of illegality — rather than any genuine interest in communications as such.

#### A FURTHER LICENCE CLASSIFICATION

Surprisingly, our correspondent has not raised one very valid point that has been made by many people – both inside and outside the pirate radio controversy.

This is that many people (although not necessarily pirates), are interested in radio communications *per se, not the technology involved.* 

Such people may well have no interest whatever in radio technology - nor the aptitude to learn and understand the theory. And as is only too obvious when listening to many amateur operators - there is not necessarily a positive correlation between technical knowledge and good station operation.

There does seem to be a very good case for a 'minimal requirements' licence, — the forthcoming 'novice' licence not withstanding — and a spectrum allocation for these interests.

And so having in all probability alienated pirates and 27 MHz CB band protagonists alike – I might as well go on record as saying that, in general, I wholeheartedly support the proposals put forward by the writer of the letter reproduced on this page.

Overall, I think it is an intelligent approach and deserves wide and thorough discussion.

However I think that the interests of all concerned could best be served if the Citizens' Band users *shated a portion of one of the existing amateur* VHF or UHF bands. ("Daddy – who

Johns Ambulance, The maximum power allowable for these mobiles could be restricted to 5 watts, Of course the new Band would have to be subdivided into at least two sections to cater for these activities.

Suitable transceivers are readily available for use in the UHF spectrum, When a novice graduated to a higher class license the same equipment could still be used in the amateur UHF Bands.

The provision for gain vertical antennae would give an incentive to those interested in the study of UHF propogation, as little has been developed in this area.

If licenses were issued on a tenancy basis it would result in an ever increasing influx of stubborn pirates as each tenency lapsed, thus defeating one of the important objectives of the scheme.

To those of us who have monitored a cross section of the commercial FM channels, any programme to improve the standard of operation is welcome.

A Call-Book would give the Licensee a good measure of respectability and therefore prepare the way for mature and cordial operation. Despite the monetary fears of the Post

Despite the monetary fears of the Post Office for it's telephone and telegraph network, the New Zealand scheme hes shown that no decline in revenue can be attributed to their Citizen Band — to the contrery, their operators continually refer to the telephone for personal and reliable communication especially when the radio channels become busy. In any case the type of operator using the service would not be 'Landline Material'.

It is known and appreciated that the

Postmaster-General's Department has invited approaches from Amateur Radio groups for their thoughts on Novice Licensing, however we regretfully find that after much debate no unity exists for an approach to your Department on the subject. It now seems that the matter should be brought to your direct attention.

In conclusion, the creation of a service in the UHF or VHF Bands, as proposed, would eliminate 'skip' operation. Even in the well conducted New Zealand Citizens Radio Scheme, the 26 megacycle channels are chaotic when the 'skip comes in'. This is the prime reason for proposing the UHF/VHF spectrum. At the time of writing it appears inevitable that the FCC in Washington will approve an 80 channel Citizens Service in the 220 megacycle Band. The U.S.A. has learned the hard way and although their new Citizens Band will overcome the majority of the problems it will be many years before the 27 megacycle problems are phased out.

Our Hobby or Novice Band would provide e legitimate means for radio students to come on the air, instead of via the doubtful influence of 27 megacycles.

May I add, that although these suggestions are considered revolutionary by some acquaintances active in amateur circles, by radio technicians, relevant personnel in the Post Office and from the electronic industry, not one valid argument has been but against them — many of us consider that it is time these proposals were specifically put to the Government and in this regard I ask for your earnest consideration. are all those people outside our house shouting 'Traitor'???). Specifically, I would suggest 146 MHz to 148 MHz (or 147 MHz to 148 MHz), alternatively 439 MHz to 441 MHz.

The advantage, as I see it, would be that Citizen's Band users would be able to come into contact with amateurs 'on the air' and (hopefully) benefit from a technical resource that would be unavailable to them if they were allocated another frequency sement. Those who were capable of achieving the technical level required by the amateur examination, and pursued their initial interest on the VHF/UHF Citizen's Band, could be encouraged and aided to sit for their amateur licence. Both groups would benefit. I think that the Novice amateur licencees should be granted use of the same segment, in addition to those already proposed as set out elsewhere in this article.

I suggest the above segments of the 2 metre and 70 cm amateur bands for following reasons. the -The international 2 metre amateur band covers 144 MHz to 146 MHz. Australian amateurs are allocated 144 MHz to 148 MHz. Considering that Australian amateurs have an extra 2 MHz and that the predominant transmission mode between 146 MHz and 148 MHz is FM, I think that this segment is ideal for shared use between amateurs and CB. However, considering the increasing occupancy between 146 MHz and 147 MHz. (repeaters being used in this segment as well), I think that only a limited number of common channels should be allocated to CB for shared use and that the segment 147 MHz to 148 MHz should be 'open ground'. It also avoids adjacent channel interference between ground stations when amateur satellite operators are using the OSCAR satellite frequencies just below 146 MHz. In the 70 cm band I chose the segement 439 MHz to 441 MHz as this overlaps present FM operation (albeit limited) and again avoids the amateur satellite segment which covers 435 MHz to 438 MHz.

To sum up, it seems to me that a solution to pirating is best approached from several directions.

Firstly, the forthcoming novice licence notwithstanding, to introduce a further licence classification for the benefit of whose who are interested in communications but lack the technical expertize or interest in the associated technology.

Secondly, to introduce legislation prohibiting the sale of transceiving equipment to unlicenced people (in Britain a transmitter/transceiver may not be sold without the buyer producing evidence of his authority to use it).

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# PHILIPS 521 AMPLIFIER

Latest amplifier from Philips incorporates mid-range 'presence' control



DURING the past few years, Philips have produced a range of record players, amplifiers, loudspeakers and tape recorders under the trade name 'High Fidelity International'. The performance of this range has been specifically engineered to comply with (or exceed) the requirements of the West German high fidelity standard DIN 45 500.

The unit reviewed here is the Philips 521 amplifier. Of very modern design, perhaps its most striking feature is the frontal appearance which, surprisingly, is more typical of the best American design – rather than European.

The satin aluminium fascia is divided into three sections, the top a broad band of aluminium, recessed into which are two VU type meters one end, and a large circular volume control at the other.

Below this, on a central black band, are four horizontal slider controls. From left to right these provide, channel balance, bass cut and boost, presence cut and boost, and treble cut and boost.

At the extreme right hand end of this black band are two bezels, a red one to indicate power on and a green one to indicate stereo selection.

On the thin 20 mm wide fascia area, behind the High-Fidelity International label, are two DIN sockets, one for the microphone – the other for



**Recommended retail price \$295** 

headphones. To the right of these are a contour switch with three contours for the loudness control: a switch providing rumble plus scratch filter, a separate scratch filter position and a separate rumble filter position. Adjacent to these at the right hand end of the fascia are twelve miniature lever switches. These select microphone, tuner, tape recorder, auxiliary input, monitor, mono selection, speaker 1, speaker 2, or four speakers in parallel, headphones, and last but not least a power switch. The inputs are interlocked one with the other, and the four output switches are also interlocked so that only one may be selected from each group.

#### MECHANICAL CONSTRUCTION

The main frame and chassis of the amplifier are constructed from steel, aluminium, and plastic mouldings. These have been cleverly designed to provide not only high strength but a system for supporting the wiring harnesses within the main body of the amplifier.

The top cover of the unit is fabricated from veneered plywood suitably slotted to provide ventilation whilst at the rear Philips have designed some fancy but nonetheless effective heat sinks to provide good thermal ventilation for the large BD182 type silicon transistors.

Power Output 16 watts (rms 30 watts (rms	) in 8 + 8 Ω load ) in 4 + 4 Ω load	ds both channels driven ds both channels driven
Frequency Response at rated output at 1 watt output at 10 watt output		± ½ dB 35 - 20 000 Hz 25 - 20 000 Hz 30 - 20 000 Hz
Channel Separat on at	Rated Output	100 Hz = -30 dB 1 kHz = -31 dB
Hum and Noise with B	espect to Rated	Power
vo'ume Control at r		87 dB unweighted 97 dBA weighted
Input Sens tivities for F	Rated Output	
Input	mV	Impedance
Auxiliary	56	750 kΩ
Tuner	63	100 kΩ
Phone	2	50 kΩ
Tape Recorder	160	100 kΩ
Monitor	160	100 <Ω
Microphone	1	2 kΩ
Total Harmonic Distort (at rated output both c 100 Hz 0.1%.		6.3 kHz 0.1%
Intermodulation Distor	tion	1%
Tone Controls		
Bass		ost at 50 Hz ut at 50 Hz
Treble	and the second se	ost at 10 kHz out at 10 kHz
Position 2. + 6/	dB max. volun 8 dB at 50 Hz. 13 dB at 50 Hz.	
Presence Control	+7 to −5	cB at 2 kHz
Power Consumption at	Rated Output	125 Watts
Dimensions	470 x 11	7 x 280 mm

The inside of the amplifier is divided into four main sections. A large well shielded power transformer, with internal fuse connected to its main frame is on the right-hand side; the main preamplifier section of the printed circuit, with an array of printed circuit mounted switches (directly connected to the front mounted lever switches) is in the centre. Adjacent to this at the left hand end of the amplifier is a large and well constructed power supply complete with all silicon diodes for the rectifiers and large electrolytic capacitors. Behind this is the power

output stage complete with main heat sinks and minor heat sinks for the driver transistors, together with internal fuses mounted in spring clips.

Most of these unit inter-connections are terminated in printed-circuitboard-mounted miniature Philips plugs and sockets.

Five DIN input-sockets are provided at the rear of the amplifier. These cater for crystal or auxiliary input, tuner, tape recorder, monitor output and magnetic pick-up. Surprisingly there are no RCA type coaxial sockets. The connections for speakers are provided for also by four DIN sockets.

## MEASURED PERFORMANCE OF PHILIPS 521 AMPLIFIER -

### PHILIPS 521 AMPLIFIER

A screwdriver operated switch at the extreme left hand end of the amplifier provides for 110, 127, 220, and 240 volts mains input at either 50 or 60 Hz line frequency.

#### PERFORMANCE

In operation, the amplifier conforms exceedingly well with the manufacturer's specification. All of the main parameters, including power output (which in this case is 30 watts into four ohms both channels driven, and 16 watts into eight ohms) are achieved with a slightly lower harmonic distortion than indicated by the handbook.

The measured frequency response was within  $\pm \frac{1}{2}$  dB from 35 Hz to 20 kHz at rated output (with both channels driven) into four ohms. Good though that was, even better results were observed at lower output levels.

Channel separation — using an RCA to DIN conversion socket purchased specifically for the review — was not as good as would normally be expected, but the poor result was basically a fault of the adaptor rather than the amplifier itself.

In a system correctly wired as it should be, with shielded inputs to both channels, the manufacturer's claim of 45 dB separation should be easily achieved.

Input sensitivities are as they should be. In particular the two millivolts sensitivity for magnetic input is more than adequate for the majority of modern high guality cartridges.

The distortion characteristics of this amplifier are particularly good although the onset of high level distortion is particularly rapid once the threshold of clipping is reached. The true distortion level at one tenth and one half of the maximum output power lies between 0.01% and 0.1%. The circuitry utilised for the final output stage is particularly effective in providing very low levels of distortion.

The incorporation of a presence control (ie control of mid-frequencies) is a relatively new feature. It is of especial value when one is using a speaker system whose performance is non-linear in the critical mid-frequency region and for enhancing response in rooms that are excessively absorptive in the critical mid-frequency regions. This problem is one that has plagued European-style homes for years because the combination of thick drapes and large



stuffed furniture provides a substantial drop in effective reverberation time in the region between 1 and 10 kHz.

The loudness control is unusual in that there are three switch-selectable contours. Apart from this, the level of loudness compensation is set in two stages by the volume control setting. For example, on loudness contour position 1, the compensation is  $+4 \, dB$  at 50 Hz at a volume of  $-25 \, dB$ ,

increasing to +8 dB at 50 Hz at a volume of -43 dB, {maximum volume regarded as 0 dB). These two stages of loudness compensation are shown in the specification table accompanying this article.

We tried the amplifier out with a range of programme content using both Philips' and our own standard monitor speakers and could in no way fault its performance.





The Philips 521 amplifier is extremely good. Its performance is of the highest level and it is in our opinion one of the finest amplifiers that Philips have ever produced. Whilst its maximum output power is only 30 watts per channel, provided one does not use speakers of unduly low efficiency, the intending purchaser can be assured of his ability to rattle the windows to his heart's content.





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ETT FEBRUARY ISSUE

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#### FACSIMILE BROADCASTING

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## ELECTRONICS

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However, as a news magazine, Electronics Today International takes a pride in presenting outstanding news stories as they happen.

Because of this any of the articles described above may be replaced by other material.

## Our new 60-watt receiver. For people who want more power than a 100-watt receiver.

It isn't hard for some high fidelity companies to turn a 40-watt receiver into a 100-watt receiver. All they have to do is overestimate their own power.

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Fig. 1. Circuit diagram of Transient Generator 1. Envelope Control module also includes a modified VCA.

# **3600/4600 INTERNATIONAL MUSIC SYNTHESIZERS**



Fig. 2. Component overlay for Transient Generator 1.

This month's article commences the description of waveform shaping and control modules.

WE HAVE now described the main power supply, keyboard control and tone generator, and are now ready to build the circuitry used to shape the various generated waveforms as required.

It is advisable to re-read the first article in this series to gain a better appreciation of the purpose of the modules described this month.

#### CONSTRUCTION Transient Generator I

Assemble components to the printed circuit board, as shown with the component overlay (Fig. 2), paying particular attention to the orientation of integrated circuits, transistors, diodes and electrolytic capacitors. We recommend that sockets be used for the CMOS ICs at least. These CMOS ICs should also be the last components to be fitted to the board.

The mechanical assembly is similar to that for the oscillators (previously described). All rotary potentiometers and switches are mounted on a bracket as shown in Fig.6. The bracket, in turn, is mounted onto the component side of the printed circuit board. The wiring between the potentiometer and the switches is as shown in Fig.8.

#### VOLTAGE CONTROLLED AMPLIFIER

This is a very simple module and should not cause any difficulty. The component overlay is given in Fig. 4. and the potentiometer and switch wiring diagram in Fig.9. The MC1496 may be either a dual-in-line package or TO5. If the TO5 version is used it may be connected as shown in Fig. 3. The tag on the TO5 version is adjacent to pin 10 and this pin goes to what would otherwise be D1L pin 14 on the printed circuit board. Pin position 7, 9, 11 and 13 on the printed circuit board are not used with the T05 IC.

#### **ENVELOPE CONTROL**

The envelope control is constructed by assembling a transient 1 module and a voltage controlled amplifier (VCA) to the same bracket. The VCA module is modified by omitting the rectifier ICI (see 'How it Works' and overlay Fig.5) and the control input is taken from the transient 1 board output.

#### CALIBRATION Transient Generator 1

The only section of this circuit that needs calibration is the exponential generator. The procedure is as follows:--

With the module switched to the linear mode check that normal output is obtained. Now with the trigger input disconnected, and the output voltage at 0V, adjust RV5 such that the output of IC3 is also 0V. Set attack time to minimum and delay and hold level to maximum. If the module is now triggered the output voltage will go to +5V and stay there for about 10 seconds.

Whilst the output is at +5V, adjust RV4 so that +5V is also obtained at

Tra	nsient Ge	enerato	or 1	
R1.R2.16.	Resistor	12k	1/4W	5%
R3		680		
R4		15k		
R5		470	::	10.199.6
R6	000000	8.2k		
R7,19,22,24		1 M		
R8		1.8k 39k		
R9 R10	0.00	3.3k		
R11,12,13,2	0 "	1.2k		
R14		470k		
R15		27k		
R17.23	100 H	100k		
R17,23 R18,21,25		10k		
RV1,2,3 Pot	entiomete	r 2M lo	g rota	ry
RV4,5	Service Contraction	22k ti	rim po	1
RV6	6167 <b>*</b> 7-3	25k li	n rota	ry .
DPDT switch	(plain po	ot for er	nvelop	e gen)
	entiomete	r 2M lo	og rota	ry
DPDT switch			11 +	
	pacitor 4.	1µr 25	v tag	
tantalum C2,4,6	3	BoF cer	amic	
C3,7,9		00334		ester
C8,10,11				rolytic
(pc mounting			22010	
IC1,5 Integra	ted circui	t SCL4	1016A	E*
CMQS			3.200	
1C2,3,4 "	1200	LM3		A State
1C6,7 "	MES MAN	SCL	4001 A	AE **
CMOS.	-			1.
* The prefix	and suffic	K OT CIV	105 va	ries
from manufa ** should be	Solid Sta	ta Sciar	atific	via
(CEMA)	Sond Sta	te sciel	nunc i	July
01 2 Turne	istor Pl	N3638	or simi	ilar
Q2.4 Trans	istor Pl	N3643	or sim	ilar
Q2,4 Trans D1,2,3 Diod	e IN914 o	r simila	Ir	S. Strain
SW1,SW2, 5	witch SPD	T mini	at ure t	oggle
C& K7201 0	or similar			
SW3 Switch		V6 (not	used	on
envelope gen				
SW4 Switch		v/		
PC board ET				
Metal bracke Recommend				
1 8 pin sock	at Litility	type M	2139-	8
8 pins Utilux			-+05	Care Care 12
4 14 pin IC s				

PARTS LIST

#### PARTS LIST Envelope Control

All parts as for Transient Generator 1. Except that RV6 does not have a switch, delete R25. All parts for Voltage Controlled Amplifier Except Delete R3,R4,R5,R6,RV2,C3,C4,D1,IC1, metal work, socket and pins. SW1.

#### PARTS LIST Voltage Controlled Amplifier

· onugo oo				
R1	Resistor	8.2k 22k	1/4W	5%
R2,15,16 R3		4.7k		
		12k		
R4,7,8,10		3.3M		
R5 R6	,,	10k		
R9		39k		
		330		
R11,13 R12		470k		
		100k	**	**
R14,17,18,19,20 R21		3.3k		
RV1 Potentione	ator SOL to		entio	meter
RV2 Potention	ater 10k li	n rotar	V	motor
C1 Capacitor	33115	101/ /1	an	
tantalum)	5500	10 4 (1	ag	
C2,3,6 "	A 7115	= 25 V (	tag	
tantalum)	4.1 /201	20 4 1		
C4.5 "	330E	Ceram	ic	
C7.8 "		25V (e		0
pc mounting)	Tobe	(-		a de la com
IC1.3 Integrate	d circuit	LM301	A MI	NI
DIP	u circuit	LIN1301	~ mi	
102 "		MC 14	a6 (0	
similar D.I.P. pr	aforradi	NIC 14.	0010	1 2 2 2
D1 Diode IN914				
DI DIOGE IN91-	Miles Parts	54195-		
SW1 toggle swit	ch SPDT	CAK 72	01 (0	or
similar)				
PC board ETI 6	01			
Metal bracket to				
Recommended	extras			
18 pin socket L		e M213	9-8	
8 pin Utilux typ			100	
o pin oninan typ				

the output of IC3. Recheck the OV level and readjust if required. Repeat the procedure until both levels are correct.

When the module is returned to exponential mode check that the output of IC3 never goes negative.

#### Voltage Controlled Amplifier

The only adjustment required on this module is to null the output by adjusting RV1. With a signal applied to the input, and with OV on the control input, set the switch to *amp* and adjust RV1 for minimum output.



The Envelope Control module, The Transient Generator 1 module is similar except that the VCA board on the left is not fitted.

#### INTERNATIONAL MUSIC SYNTHESIZERS



Fig. 3. Full circuit diagram of Voltage Controlled Amplifier. For use with Envelope Control module, IC1 and its associated components are omitted. See overlay, parts lists and text.

#### HOW IT WORKS Envelope Control

This module is simply a combination of a Transient Generator Type I and a VCA, both of which have been described previously.

The only modification to the transient generator is the deletion of the hold-level switch and R25. (A hold level equal to the keyboard voltage is not required in envelope control).

The VCA is simplified by the omission of the rectifier (ICI) as the input is coupled directly from the output of the transient board and any zero error may be nulled out by the RV1. In addition the output potentiometer is not required and is therefore deleted.



Fig. 4. Component overlay for the Voltage Controlled Amplifier when used as a separate unit.

Fig. 5. Component overlay for the Voltage Controlled Amplifier as used in the Envelope Control module.

#### HOW IT WORKS

Voltage Controlled Amplifier The voltage controlled amplifier is constructed around the MC1496 integrated circuit. This is a balanced modulator – demodulator, the internal circuitry of which is shown in Fig.10.

The 1496 has differential outputs, i.e. two outputs in antiphase, which are not referred accurately to the 0V line. A buffer amplifier (IC3) having differential inputs, is therefore used

to provide a single ended output. In fact the 1496 has two sets of differential inputs, one set biased at about 0V, and another set biased at approximately -3V.

The input signal is injected into one of the -3V biassed inputs (pin 1) whereas the control signal is fed to the other input (pin 8).

When using the circuit as a VCA, the maximum possible attenuation is

required when the input is 0V. However, due to tolerance variations, the 0V from other modules may be up to 20mV in error. Hence a rectifier, ICI, is used so that any voltage less than +50mV is regarded as 0V. The maximum attenuation at 0V control, is adjustable by RVI.

When the module is used as a ring modulator the control signal is ac coupled and the output will be the product of the two inputs.

#### HOW IT WORKS Transient Generator I

The transient generator consists, basically, of two sections.

(a) the wave-shaping circuitry (analogue).

(b) Control circuitry (digital).

The analogue section consists of integrator (1C2), exponential converter (Q2, 1C3) and comparator (1C4). The comparator is a high gain differential amplifier whose output is normally either at +6 volts or at -6 volts. There is a small input region where the amplifier operates in the linear mode and the output voltage will then be somewhere between these two extremes. Negative feedback is applied by R14 so that this linear input region is approximately 30 mV wide.

Solid state switches select one of three voltage sources as input to the comparator. ICI/3 selects +5 volts, ICI/4 selects 0V and IC5/3 selects the output of level potentiometer RV6 or the output of the keyboard.

The switch potentiometer RV6, when in the off position, allows the keyboard voltage to be the third voltage.

The output of the comparator is connected back to the input of IC2 by R3 and a slope potentiometer as selected by ICI/1, IC5/2 and ICI/2. If the output of the comparator goes to -6 volts, the output of the integrator, IC2, will be a voltage, linearly increasing at a rate set by the selected potentiometer (RV1, 2 or 3). Conversely if the comparator output is at +6 volts the integrator will produce a linearly decreasing voltage.

When the two inputs are within 30 mV of each other the slope of the integrator will decrease, and when they are equal, (comparator output at zero) the system output will be stationary at the voltage selected by ICI/3, IC5/3 or ICI/4. This point will be stable as the comparator output is applied back to its input in a negative feedback loop, either directly, or via an exponential generator.

Generation of the exponential function is based on the collector – current to base-emitter-voltage relationship of a transistor, in this case Q2. The output of the integrator, after attenuation by R4, RV4 and R5, and level shifting by R6 and RV6, is applied to the base of Q2. Diode D1 biases the emitter of Q2 about 0.6 volts below zero and also provides temperature compensation for Q2. Resistor R7 applies a small bias and helps compensate different offset voltages in IC3. Integrated circuit IC3 produces an output voltage proportional to the collector current of Q2. Hence a linearly changing voltage, at the output of integrator IC2, will result in an exponential output from IC3. The range of the exponential generator is adjusted by RV4 and RV5.

When a key is pressed, the keyboard controller provides a -7 V to +7 V change. The positive edge of this transistion is differentiated by C7 and R19, (the negative edge pulse is clipped by D2) to provide an approximately 3 msec wide pulse which turns on IC5/4 and Q4 thus discharging C8. In addition this pulse sets the flip flop formed by IC6/3 and IC6/4 so that the output at B is +7 V, and turns on IC5/1 and Q1 thus clamping the output line at 0V.

At the end of the 3 msec pulse, C8 begins to charge from -7 volts at a rate determined by RV7. When it reaches 0V, approximately, the output of IC7 changes from +7 V to -7 V and thus an internal delay is generated which is adjustable by RV7. Also immediately following the 3 msec period, the output B is at +7 V and hence ICI/2 is turned on selecting the attack potentiometer RV1, and ICI/3 is turned on, selecting +5 V as an input to the comparator. Thus, as pin 2 of the comparator is higher than pin 3, the

output will be low (-6 V) and the integrator will start to rise. The voltage divider formed by R15 and R16 will apply -2 V to the input of IC6/2.

At this point we pause to briefly explain the operation of digital logic NOR gates. The digital ICs used in this circuit contain four, 2 input NOR gates. In a NOR gate, if either one or both of the inputs are high, the output will be low. Only when both inputs are low can the output be high. This is illustrated below.

lnput	Input	Output
Α	В	
0	0	1
0	1	0
1	0	0
1	1	0

Note for +7 V and -7 V supplies as used, 'O' means less than -1 V and '1' means greater than +1 V when applied to inputs, and 'O' means close to -7 V '1' means close to +7 V in the case of outputs.

Thus to return to our circuit the -2 V input at IC6/2 is a 'O' input and the output of IC6/2 will be high at +7 V.

When the output of the integrator (or exponential generator) reaches +5 V the comparator output will drop to zero volts causing an input of +2V to be applied to IC6/2. This is a '1' level and thus the output of IC6/2 will go to -7 volts. The output swing of IC6/2 is inverted by IC6/1 and differentiated by C9 and R24. The resulting positive pulse resets the flip flop (IC6/3 IC6/4) and the negative pulse is clipped by D3.

When the flip flop is reset its output goes to -7 V turning off ICI/2 and ICI/3 and a 'O' is presented to IC7/2 and IC7/3 (pins 6 & 9).

If at this time the delay period has not expired (that generated by C8 & RV7) a '1' will still exist at the output of IC7/I. Thus IC7/3 has a 'O' on pin 9 and '1' on pin 8 and its output will be a 'O'. Hence both inputs of IC7/2 are 'O' and its output will be a '1'. This turns on IC5/2 which selects DECAY 1 slope and IC5/3 which selects the output level set by RV6. The comparator now sees an error and drives the integrator to correct it. The output will stabilize again when the level set by RV6 has been reached. This output level will now be held until the "C" control is removed.

When the delay period is completed the pin 8 input to IC/3 goes to 'O', and since the other input is 'O', the output will be '1' and the output at 'C' will be turned off.

We now have the 'D' output at 'l' and this selects the DECAY 2 potentiometer and 0V reference to the comparator. Again the integrator drives to correct the error. Positive feedback is provided around IC7/3 by IC7/4 so that the input may change much quicker.

When the delay potentiometer is switched off (SW4/1 and 2) trigger input will now be direct to IC7/3 pin 8 and the delay will be determined by the key-hold time only, and not by the internal generator.

If the DELAY time setting (either internal or external) is shorter than the time to complete DECAY 1, DECAY 2 will be initiated, provided the attack time is completed, immediately the delay expires.

If the DELAY setting is less than the ATTACK time setting the ATTACK will be completed, DECAY 1 eliminated and DECAY 2 initiated.

The trigger input from the patchboard is buffered by Q3 to ensure correct operating levels for the logic. It also provides an inversion which means that the trigger will occur on the negative edge of the input trigger pulse.

controlled amplifier.



Fig. 6. Mounting bracket for Envelope control and Transient 1 modules.

#### INTERNATIONAL MUSIC SYNTHESIZERS



The voltage controlled amplifier

#### CORRECTION AND MODIFICATIONS Power Supply Board

Current overload protection is provided on all power supply outputs. However, if an output power transistor having a current gain at the specified minimum of 30 (normal range 30-200) is used, excessive current will be drawn from the LM301A and it may possibly be damaged.

To obviate this the following changes have been made. Resistors R16, 17, 18 and 19 are all increased to 1 k. Cut the PC board track leading away from pin 6 of each of the LM301As and add a 470 ohm resistor across each break.

These precautions will limit the power in the LM301A to a safe level should a low current gain power transistor be obtained.

The overlay diagram, Fig. 2 page 75 of the December issue, has incorrect pin designations for Q7 and Q8. The emitter (e) and base (b) markings should be reversed.



Fig. 8. Wiring to switches and potentiometer for Transient Generator 1.



Fig. 10. Circuit diagram of the MC1496 balanced modulator – demodulator IC.

# AUDIO NEWS

#### AWA WINS AWARD IN MILAN



A replica of the special loud-speaker column designed and made at the Company's North Ryde works for the Sydney Opera House concert hall has won AWA a Gold Medal Diploma at the Milano Triennale.

The AWA equipment was part of Australia's display at the Triennale which is one of Europe's major architectural exhibitions.

Organised by the Visual Arts Board of the Australian Council for the Arts, Australia's display, its first at the Milan exhibition, featured Sydney Opera House.

The Gold Medal Diploma was awarded for value of design and manufacture.

The jury which assigned the awards was made up of a committee of foreign exhibitors and a member of the Italian Ministry of Public Instruction.

The loud-speaker column is part of the Company's large scale electro-acoustic system which controls various aspects of programme reinforcement in the Opera House.

#### NEW HI-FI Exhibition for sydney

A new hi-fi exhibition – organised by the industry itself – will take place in Sydney 27-3 1st August this year.

To be called '75 Sounds Fantastic the show is promoted jointly by the High Fidelity Industry Association and IPC Exhibitions Pty Ltd.

The modern and highly active Centrepoint building in Sydney has been selected as the venue.

High Fidelity Industry Association President, Les Black said: "Increasing public interest in hi-fi made it an ideal time for the exhibition. Our Association and its members, and indeed the whole industry, should be behind this promotion. It is in all our interests to ensure the public is fully aware of the equipment we have available in Australia.

"A special sub-committee of the High Fidelity Industry Association has been formed to work closely with IPC Exhibitions Pty Limited. Already arrangements for a wide and exciting programme of advertising and promotion in mass circulation media is underway. The aim of the exhibition is to give the public the true story of hi-fi/audio "sound" under ideal conditions," Mr Black said.

"Visitors to the exhibition will be able to see, hear and compare the equipment from all over the world. We have magnificent products and the public should know about them," he said.

The main aims and objectives of this exhibition are to demonstrate to as many people as possible, the beauties, benefits and pricing of hi-fi/audio equipment.

The exhibition area has been designed to give excellent display space for 70 presentation areas. A demonstration sound theatre in which programmes encompassing the entire spectrum of musical experience from chamber music to pop will be conducted. It will illustrate the sound and versatility of the equipment available.

Participation in the exhibition is open to any company in the hi-fi business – not just to association members. Bill Martin, Secretary of the High Fidelity Industry Association, firm bookings for space are being made daily."

Members of the industry seeking forther information should contact:

Mr Bill Martin, Secretary, HIGH FIDELITY INDUSTRY ASSOCIATION, c/- Jervis Australia Pty Limited, 1/111 Old Pittwater Road, Brookvale, 2100. Phone 939-2922.

Mr. Tony Farrington, Director, IPC EXHIBITIONS PTY LIMITED, 3-13 Queen Street, Chippendale 2008. Phone 69-5651.

#### FOUR-CHANNEL SYSTEM FROM PIONEER

Following their enormously successful Prelude 500 stereo system, released last May, Pioneer are now marketing a four-channel bigger brother.

Priced very competitively at under \$500 the new Prelude 4000 consists of a complete six piece system claimed to provide true four-channel hi-fi performance at moderate cost.

The extremely versatile amplifier incorporates a tuner for both AM and FM bands, and has inbuilt capability for all forms of matrixed four-channel material. Inputs are also provided for discrete four-channel tape and for the future addition of discrete four-channel disc inputs. Like all Pioneer amplifiers this unit has input and output facilities to cater for all possible applications.

Amplifier power output is 7 watts rms to each of four speakers – i.e. 28 watts total with all channels driven.

Front speakers are two-way bass-reflex units incorporating a dome tweeter. Rear speakers are infinite baffle enclosures.

"Already, interest is enormous,' says

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Fig. 1. Foucault knife edge test.

# LASER EXPERIMENTS

THE EXPERIMENTS described last month required little additional equipment other than the ETI 524 laser itself, and hence, were of a very basic nature.

However, merely by adding a handful of cheap and readily available optical components, a number of surprisingly sophisticated and elegant experiments may be undertaken.

These advanced experiments will provide the student with considerable insight into the physical laws that so many of us merely learnt by rote.

#### FOUCAULT KNIFE EDGE TEST

The Foucault knife edge test is a standard technique employed by astronomers to determine the quality of lenses and curved mirrors, although this test has traditionally been performed with ordinary white light, a monochromatic laser gives better results and is therefore preferable.

When white light is used, chromatic aberration tends to mask the lens defects resulting from faulty grinding, or from the use of poor quality glass. When monochromatic laser light is used, the masking effect does not occur and defects are much more easily seen.

The experiment is set up as shown in Fig. 1. A diverging and converging lens system (-8 mm and + 167 mm our example, although focal lengths are not critical) is used to collimate the beam. A collimated beam has constant diameter with distance, this is obtained by adjusting the position of the long focus lens and checking beam diameter at various distances with a white card until negligible difference is

observed in the diameter at various distances.

The lens to be tested is now inserted into the collimated laser beam. This lens converges the laser light to a fine point, after which, it diverges again, as shown in Fig. 1.

If the edge of a new razor blade is gradually inserted into the beam at the cross-over point, the spot on the screen should darken uniformly as the razor blade cuts the beam. If the lens is imperfect however, instead of the beam darkening uniformly, irregularly shaped areas will be produced on the screen, some of which are brighter than others. These areas indicate the size and position of defects.

If you are interested in photography - try different camera lenses. The cost versus quality trade-off will be readily observed.



Fig.2a. Laser and simple optical bench set up as a Michelson interferometer.

Fig. 2b. Diagrammatic presentation of equipment shown in Fig. 2a.



#### MICHELSON INTERFEROMETER

The Michelson interferometer provides a means of making precise measurements of distance and movement, and has many applications in science and industry. Before the advent of lasers, the alignment of components in an interferometry experiment was extremely difficult even under laboratory conditions, and thus, expensive and very intricate alignment apparatus was required. Using a laser, however, alignment can be achieved in a few seconds.

We performed the experiment using a low cost optical bench setup as shown 2 and accompanying in Fig. photograph.

The beam from the laser is split into two components by the partially silvered mirror 'A'. One component travels directly to the mirror 'C' and is reflected back towards the laser. The second component is reflected by mirror 'B' back through the beam splitter, and then through the diverging lens onto a screen. A component of the beam reflected from mirror 'C' also passes through the diverging lens and the mixture of the two components thus creates an interference pattern on the screen.

Careful alignment of all components is necessary to achieve the interference pattern, but once obtained, it will be found to be affected by even the slightest vibration, change in path length, or change in refractive index of the air between the mirrors.

In many scientific and industrial applications, the diverging lens and screen are replaced by a highly sensitive detector. Such laser interferometers are used extensively for high-accuracy micro-positioning of



machine tools. Α typical interferometer (the Hewlett Packard model 552A) is able to measure position or displacement to within 1 x 10<sup>-8</sup> metre, ie, one hundred-millionth of a metre.

#### THE SPEED OF LIGHT

A special application of the interferometer is in the measurement of the speed of light. The set up for this is as illustrated in Fig. 3.

The experiment is conducted between two fixed points exactly 120 metres apart. This distance should be determined as accurately as possible. It is perfectly feasible to perform this

experiment outside in the open, but for optimum results it is best done in the early morning or evening when there is little wind and a minimum of thermal air currents.

The laser is modulated by an adjustable frequency source of around 625 kHz. Part of the direct output beam is deflected by a tiny mirror through a converging lens to a photo-detector. The output of the photo-detector is then displayed on an oscilloscope as a reference. The remainder of the direct beam passes to a mirror mounted precisely 120 metres away where it is reflected back to a third mirror and again to the



## LASER EXPERIMENTS



Fig.4. How holograms are produced.

photo-detector as shown in the diagram. Thus the longer path is 240 metres further than the reference beam. If the amplitudes of the two beams are equal and if the longer beam arrives at the photo-detector one half wavelength after the reference beam, (180° phase shift) complete destructive interference will occur and the waveform on the oscilloscope will disappear.

To create this interference, the beam path is made *exactly* 240 metres (two times 120) and the signal frequency adjusted accordingly.

The modulation frequency required to produce this null should be

624.5687kHz	_	corresponding	to	а
period of				

 $\overline{6.245687 \times 10^5}$  seconds Thus the time for light to travel a half wavelength is half this period – i.e.

> $\frac{1}{12.491375 \times 10^{5}}$  seconds The speed of light equals C.

$$C = 240 \div 1/12.491375 \times 10^5$$

= 240 × 12.491375 × 10<sup>5</sup>

2.99793 x 10<sup>8</sup> metres/sec.

In practice of course it will be



The Griffin and George optical experimenter's kit. Whilst not designed specifically for use with lasers, this is a very versatile kit.

impossible to measure either frequency or length sufficiently accurately to obtain precisely this answer. Because of this some error must be expected.

If a quick simple experiment is sufficient, an oscillator frequency of 600 kHz may be used. The corresponding half wavelength period is  $1/(12 \times 10^5)$  seconds, hence the result will be a measurement of 2.88 x  $10^8$  metres a second – an error of approximately 3%.

#### HOLOGRAPHY

One of the most interesting, and promising, applications of the laser is in its ability to make three dimensional photographs. These are known as holograms.

Considerable research is being conducted in this field, and the technique may one day lead to true, three-dimensional colour television.

A hologram is made by exposing a photographic negative to a scene that is wholly illuminated with laser light. The negative is simultaneously exposed to a reference beam that comes directly from the laser. Thus, as light from two separate sources is incident upon the negative, an interference pattern is recorded. The interference pattern is so fine that individual lines can only be seen with the aid of a high-power microscope.

The holograms thus made, are viewed by illuminating them with a diverged laser beam and looking at them, towards the laser beam.

It is perfectly safe, in this instance, to look towards the laser beam as when the beam is diverged, its intensity will be less than 1/1000 of the normal value. The method is shown in Fig. 4.

Whilst viewing the hologram move your head around and you will find that it is possible to see the sides, and maybe even the back of the object. Use your finger to try and pinpoint areas on the image. You will find considerable depth to the image. Holograms, and kits for making holograms, are available from laser and optical bench suppliers.

#### **OOPPLER EFFECT**

Doppler effect is a well known phenomenon by which the frequency of acoustic radiation (including frequencies above and below the audible range) and electromagnetic radiation is varied due to motion of the source, or of the receiver.



#### Fig.5. Constructing a simple laser galvanometer.

To demonstrate this effect at optical frequencies, set up the equipment as for the Michelson interferometer. Superimpose the two reflected beams on a photodetector instead of the diverging lens and screen.

Connect the of output the photodetector to an audio amplifier and then slowly move one of the mirrors backwards and forwards. The doppler effect causes an apparent change in the wavelength of the beam falling on the moving mirror. The intermodulation of the two beams at the detector will produce an audio output whilst the mirror is moving. Rapid movements of the mirror will cause the doppler frequency to be above the audible range (ultrasonic) and consequently a tone will not be heard.

#### **OPTICAL AMPLIFICATION**

The facts that the laser beam is very bright, and that the beam divergence is very small, make the laser a useful tool for amplifying very small, in fact almost imperceptible, mechanical movements.

Using the principle of optical amplification, many interesting devices may be constructed, two of which are discussed below.

#### LASER GALVANOMETER

Construct a small coil, from light gauge (around 26 gauge B&S) enamelled copper wire, by winding 20 turns on a cylindrical former such as a pencil or piece of dowel rod. Tape or glue the turns of the coil together and then attach two thin strands of wire to the ends of the coil. (Individual strands of wire from conventional three core flex are ideal). Cement a small mirror to the coil, and use the wires to suspend the coil between the poles of a horseshoe magnet as shown in Fig. 5. The longer the wires - the greater the sensitivity of the resulting instrument will be.

Now, being careful that neither the laser beam nor its reflection enters



anyone's eyes, aim the laser at the mirror and observe its reflection on the wall.

When a small current is allowed to flow through the coil, it will turn, thus deflecting the laser beam. We have constructed thus а mirror galvanometer and a long scale may be used on the wall to make quantitative measurements. Using appropriate shunts and multipliers, the optical galvanometer, thus constructed, may be calibrated to read volts and amps. or any other quantity that produces an electrical current in some way.

Using adhesive tape, fasten a small

mirror to your wrist directly over the point where the pulse beat is felt.

Again, taking the precaution mentioned above, aim the laser at the mirror. With your wrist held as steadily as possible on the table or some other support the amplitude and beat rate of your pulse will be observed by the deflection of the laser beam spot on the wall.

(The experiments, as described above, are based on data from the Metrologic Helium-Neon Laser Experiments Manual, by kind permission of Quentron Optics Pty. Ltd. Adelaide).



Low priced optical bench kit from H.B. Selby contains most of the components needed for a number of sophisticated experiments.



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## Bang&Olufsen



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# **INTERNATIONAL 420 4-CHANNEL AMPLIFIER**

By BARRY WILKINSON



Simple, yet effective unit has SQ plus ambience decoding - and produces 15 watts per channel.

TWO basic, non-compatible methods are used to obtain four-channel sound from gramophone records.

These are discrete, exemplified by JVC/RCA's CD-4 system; and the competing matrix systems, of which the Columbia SQ and the Sansui QS are best known.

Opinions differ as to which of the two main techniques has the most to offer.

Broadly, the discrete system has far better separation between channels – especially front-to-rear, but is more complex than the matrix systems. Furthermore a special cartridge and stylus is required.

All matrix systems are basically the same. Their only real differences lie in the proportions and phase relationships in which the original four channels of programme material are mixed down to two — and subsequently expanded out again to four during replay.





Fig. 2. Power wiring for the complete amplifier.

Channel separation of even very sophisticated matrix decoders is not as good as can be obtained from discrete units. Typically it is 10 dB left-to-right, and 3 dB or so front to rear - compared with the 20 dB - 40 dB and 20 dB respectively that is typically obtained from the CD-4 technique.

But against inferior channel separation, matrix systems are cheap, simple and relatively effective. So much so that over 100 makers of audio equipment worldwide now produce matrix four-channel systems, and of these, some 85 per cent use the so-called SQ coding/decoding technique.

The SQ system has also been chosen by the great majority of FM broadcasting stations. These stations transmit SQ matrixed programme material by conventional stereo broadcasting. The programmes are then decoded by the listeners' receiving equipment.

No special turntable, cartridge or stylus is required for use with SQ records.

Considering all the above, it is clear that the SQ system is by far the most commonly used today — hence our decision to use SQ decoding in the International 450 four-channel amplifier. We would however like to stress that this decision does not necessarily imply that we think that the SQ technique is the best

#### SPECIFICATION

OUTPUT POWER (a 2 channels driven 4 channels driven	15 W	) per cha per char	
DISTORTION At 0.1 W output At 1 W output At 10 W output 'SENSITIVITY Disc input	0.14%	1 kHz 0.13% 0.11 0.1% Hz	10 kHz 0.25% 0.18% 0.15%
All other inputs INPUT IMPEDANC All inputs	E	(Hz	
SIGNAL TO NOISE Disc re 10 mV in All other inputs	RATIO (Stere	o) 70 dB 79 dB	
DAMPING FACTO 100 Hz 1 kHz 10 kHz	R	5 30 30	
SQ DECODER PHA 100 Hz to 10 kH FREQUENCY RES Tone controls fla	z within ± 10° PONSE	+ 0 - 2 + 2	dB at 10 Hz dB at 50 kHz
Treble control Bass control		10 + 11 12 + 11	dB at 10 kHz dB at 100 Hz



Fig. 3. Circuit diagram of the power supply.



Fig. 4. Printed circuit board layout for the power supply.



Fig. 5. Component overlay for the power supply.

technically — merely that it is the most successful commercially, and the only one for which programme material is really freely available.

Unlike a number of other four-channel amplifier projects published recently, the International 450 has been designed specifically for home construction. The unit is simple yet rugged – above all it is relatively easy to construct.

Heart of the unit is of course the SQ decoder. Here we have used Motorola's very latest SQ decoder integrated circuit type MC 1312P. This chip is produced under а licencing arrangement from the holders of the world patents, CBS, Price of the chip includes a licence fee which is paid by the seller to CBS. (For those interested in the techniques of SQ decoders we will shortly be publishing full constructional details of an SQ decoder using discrete components. Our experience is that performance of this latter decoder is better than the IC version, but not by any really substantial amount. It is of course far more complex).

Apart from the inbuilt SQ decoder, our new four-channel amplifier incorporates 'ambience' circuitry. This enables 'synthesized' four-channel reproduction to be obtained from normal stereo records.

> HOW IT WORKS -POWER SUPPLY

Transformer T1 reduces the 240 Vac mains to 32 Vac which is then rectified by D1 - D4 and smoothed by capacitors C1 and C2. This provides a no-load voltage of about 48 V dc.

Since this is in excess of the maximum allowable for the power modules, a series regulator is used to provide a maximum of 35 V regardless of load. Transistor Q2 is the series regulator transistor, and as it dissipates a fair amount of heat it is mounted on the rear panel (but insulated from it) and has a plastic cover fitted to prevent damage to the transistor by accidental shorts. Zener diode ZD1 (18 V) provides the reference voltage for the menulator. Transistors O3 and O4

Zener diode ZD1 (18 V) provides the reference voltage for the regulator. Transistors Q3 and Q4 compare the zener voltage with the output voltage (divided by R4/R5) and hence provide a control voltage to Q1 which in turn controls Q2. The final output voltage is thus:-

 $V_0 = (V_z - 1.2) \times (R4 + R5)$ RS Fuses are incorporated in the

Internal layout of the four channel amplifier.

Further to simplify construction, the complete power amplifier stage is based on four hybrid amplifier modules. These modules are again, simple, cheap and effective.

#### CONSTRUCTION

The individual printed circuit boards should be assembled in accordance with the respective overlays. Care should be taken with regards to the polarities of all polarized components such as integrated circuits, diodes, capacitors and transistors etc.

Before soldering the power modules to the power amplifier boards, fit the boards and modules to the chassis and check alignment of the board and module since it is essential that the completed assembly aligns with the mounting holes later.

The mode selector switch is mounted directly onto the decoder printed circuit board. Press the switch fully home into the printed circuit board and solder all the pins to the board. ASSEMBLY AND INTERCONNECTION (Refer to Figs. 1 and 2)

1. Fit the power-cord grommet and the power cord and clamp.

2. Fit the power transformer to the rear panel using ¼ inch (6 mm) spacers (to allow room for the wires to come out). Orientate the transformer so that the red and black mains input leads are on the right-hand side.

3. Mount potentiometers and power switch to the support bracket, Fig. 19, and mount the bracket on the chassis on ½ inch (13 mm) spacers, retained by countersunk screws. Cut the potentiometer shafts to the correct length for the knobs being used.

4. Mount the external power socket, speaker outlets, fuses, input sockets and the power transistor to the rear panel. The power transistor must be mounted with insulating hardware. An insulating cover should be fitted to the transistor to prevent accidental shorts.

5. Fit a two-way terminal block, in the position shown in Fig. 2, in front and to the left of the power transformer. A screw should be fitted to the chassis just in front of the terminal block to which should be clamped the mains earth (green) and the transformer earth (also green). No other leads should be attached to this point.

6. The red and black wires from the power transformer should be terminated into the power outlet socket (one wire to each terminal) and two more wires should be taken from the power outlet socket to the mains power switch. Two further wires are then taken from the power switch to the mains terminal block as shown in Fig. 2.

Note that all wiring in the above section should be insulated for 240 Vac. All exposed 240 V connections, i.e. the power switch and output socket, should be well wrapped with insulating tape as a precaution against electrical shock whilst servicing the unit.

Di Desister 2.24	PARTS LIST POWER SUPPLY K 1/2W 5%
R1 Resistor 2.21 R2 '' 470	
R3 '' 430	
R4 " 2.41	
R5 " 2.21	k II II
C1,2 Capacitor C3 " C4 " C5 " Q1 Transistor Q2 " Q3 " Q4 " D1-D4 Diode ZD1 Zener diod T1 Transformer SW1 Switch McI PC Board ETI 4	2500/JF 63V electrolytic TYPE RT or similar 100pF ceramic 100/JF 25V electrolytic PC mounting 100/JF 50V electrolytic PC mounting TT800 or similar 8C108 " " BC178 " " BC178 " " BC178 " A14A e BZX70C18 240V/32V @ 2A A & R 6413 or equivalent Murdo Type 2904-1 20 use and panel mounting holders
insulator kit for	2N3055

outputs of the main amplifier modules to protect them from damage due to accidentally shorted speaker leads, and in addition, protect the regulator from overload. As current limit is not provided for the regulator itself, care should be taken not to cause any shorts on the regulator side of the fuses. Such shorts could damage the regulator.

The 18 volt zener also provides  $\varepsilon$ regulated supply for the preamplifier and decoder boards. The 18 volsupply to the decoder board goes viz a series LED indicator which thus provides a power-on indication.

Most of the power amplifier circuity is contained within the Sanken S1-1C10 amplifier modules and there is little point in describing the operation of these modules. The gain of the power amplifier is determined by the value of R3. The higher the value, the higher the gain. With 2.2 k the sensitivity is 650 mV P-P for 10 W and with 4.7 k the sensitivity is 350 mV P-P for 10W. The higher gain is used in the rear channel amplifiers to obtain a greater control range for the rear volume potentiometer.



Fig. 6. Circuit diagram of the preamplifier.



Fig. 7. Printed circuit board for the preamplifier (full size).



Fig. 9. Circuit diagram of one power amplifier module (two per assembly).

**t**]]

C5

C4

47uF

10V

10uF

16V

C6

10uF

25V

R2

10Ω

ξ

1

C2

INPUT OV

0

47uF

16V

**R1** 

10Ω

ELECTRONICS TODAY INTERNATIONAL - JANUARY 1974

0V

O

4.7k(REAR)





Fig. 10. Printed circuit board for the twin power amplifier assembly.



Fig. 11. Component overlay for the twin power amplifier assembly.

## HOW IT WORKS

The output level of a magnetic cartridge may be as low as 1 mV and this must be amplified and equalized before being applied to the tone controls.

Transistors Q1, 3 and 5 form this equalizing amplifier. The gain is controlled by R11, and the frequency response by R15, R17, C11 and C13. This complex network provides the correct RIAA equalization, the desired signal source and appropriate network being selected by SW1, 2, 3 and 4. The signal is then passed to Q7 which buffers the output of the volume control and drives the tone control network.

Transistor Q9 and Q11 form a high gain amplifier in which the gain is determined by the relative positions of the bass and treble controls. The 1 kHz gain is being approximately 2. When monophonic mode is selected the outputs are combined after the volume control.

7. On the power amplifier boards, connect leads for +35 V, 0 V and the speaker output. Allow plenty of length for these wires so that they may be loomed up later. The wire gauge used for these leads should preferably be 23/.0076. At this time also connect the input coaxial cables to these boards making sure that the shield is also connected to the board at this end.

8. Mount the two power amplifier boards into the chassis. The modules are bolted directly to the chassis and the boards are supported by  $\frac{1}{2}$ " (6 mm) spacers.

9. The power supply may now be installed. Wires may be soldered directly to the printed circuit board, or, to pins inserted in the appropriate places on the board. The power transistor (mounted on the rear of chassis) should be connected to the power supply board using 23/.0076 wire. Connect all the OV lines to the board at this time, plus the single +35 V line which goes directly to the fuse holders on the rear panel. If it is decided to solder wires direct to the underwise of the board, make sure the leads are left long enough to gain access to the bottom of the board later.

10. The speaker sockets, phone jacks and +35 V supply lines to the power amplifier (from the fuses) may now all be connected using 23/.0076 wire.

11. Terminate the power amplifier input cables onto the balance control (RV5). The wipers (centre contact) of these potentiometers are at 0 V and hence the shields of the cables should



all be connected to these points. Two resistors R29 and R30, are mounted between RV5 and RV4 (rear volume). Fit 6 inch (15 cm) lengths of coaxial cable to the inputs of these potentiometers. The other ends will be terminated later, on the decoder

12. The preamplifier board has a number of coaxial cables terminated on it (four per channel) these are:-

(a) Disc input (12" - 30 cm long)

(b) Disc output to selector switch (16" - 15 cm long)

(c) Preamplifier input (to volume

(d) Preamplifier output (10" - 25

The tone control connections are made by 10/.010 wire, the three wires to each pot being twisted together.

Continued on page 75

TO PREAM

FRONT

RIGHT



Fig. 13. Printed circuit board for the SQ decoder.

Fig. 14. Component overlay for the SQ decoder.

-O\*(

A9 0 4

0-0+

COS4IT1

6

BACK

RIGHT SACK

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Fig. 15. Artwork for front panel escutcheon of the ETI 420 four channel amplifier,



Fig. 16. Artwork for the rear panel.

HOW IT WORKS - DECODER

To properly decode SQ records it is necessary to phase shift the input signals and then selectively mix the phase shifted and original signals to synthesize the four outputs required. The Motorola IC, MC1312P, with the aid of a few external components, provides the four outputs very simply.

With conventional stereo records a mode of synthesizing four channel, known as 'Ambience Mode', has been used. This is quite effective and very simple. Normally in this method the two rear speakers are connected in

series, but in anti-phase, across the live outputs of the front speakers. In our case it is difficult to interface this system directly without complex switching. As we must use the rear-channel power amplifiers, we perform the same function by using a differential amplifier Q1, Q2 and Q3, the output of which is simply the difference of the two input signals with two outputs in antiphase. Switches SW1, 2, 3 and 4 select the appropriate output.

Allow about 6 inches (15 cm) for each lead. A further twisted pair is fitted between the preamplifier and decoder boards for 'mono' mode selection. Allow about 8 inches (20 cm) of wire, and an earth lead is connected to the rear panel earth lug.

Note that on the input RCA sockets all commons are tied to the rear panel earth lug with the exception of those for the disc input which are individually connected to the preamplifier board.

The preamplifier power rails can now be connected and the preamplifier board bolted into position using 1/4



Fig. 18. Drilling deteils for front panel escutcheon.





inch (6 mm) spacers. Check that these spacers do not short any of the copper tracks on the board, if so, use a small insulated washer between the spacer and the board.

13. Wire up the tone controls in accordance with Fig.1. Again using Fig.1 as a guide, wire the selector switch, volume control and all input wiring.

14. The +18 V power rail may now be connected to the decoder via the front panel LED power indicator. Make sure that the supply is connected to the thin lead of the LED and the thick lead is connected to the decoder board. This ensures correct polarity of the diode, which could be damaged under reversed supply conditions.

There is no direct earth connection to the decoder board, earthing is provided by the shields of the preamplifier output coaxial cables. Additionally, the earths to RV4 and RV5 are made via the shields on the coaxial cables from the decoder board. The decoder board may now be bolted onto the support bracket.



Fig.20. Details of chassis metal work and drilling.

ERRATA

LASER December 1973

The circuit drawing on page 43 shows C8 with incorrect polarity. This capacitor should be reversed.

#### DIGITAL STOP WATCH October 1973

There is a typographical error in the parts list on page 102 of this project. Capacitors C6, C7, C8 and C10 should be 4.7 mF not 4.7 pF and 1 pF as shown. The correct values are shown in the circuit diagram.

Integrated circuits IC3, 4, 5, 6 and 7 should be 7490's not 7493. The correct numbers are shown on the circuit drawing.



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Say farewell to the grand old DC300, and welcome to THE PROBLEM SOLVER, the amp that is going to make your job easier and your customers happier. The original model DC300 was a great amp - the first super-power low distortion amp in the world, when Amcron introduced it five years ago.

Meanwhile, top sound systems designers have used it successfully in hundreds of demanding situations, and made some excellent recommendations for improvements. The response of the Amcron design team was not an updated DC300, but a totally new and different amplifier, the DC300A. It is the only high power low distortion amp specifically designed for commercial sound applications. (CAUTION: There are some large consumer-type amps attempting to sell in the commerical sound field without providing adequate continuous power for all load impedances.)

#### Power You Can Count On

One of the DC300A's most outstanding features is that it had double the number of output transistors. This means effectively twice the muscle of the old DC300 - at the same price. Each channel has eight 150-watt devices for 1200 watts of power dissipation per channel. The DC300A is rated at 150 watts per channel continuous into 8 ohms with both channels driven, 300 w/ch into 4 ohms or 500 w/ch into 2.5 ohms.

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The DC300A output protection circuitry is a radically new design which completely eliminates DC fuses and mode switches and further reduces service problems to the negligible level. It is superior in every way to the old VIlimiting circuit pioneered by Amcron and now used by most other high power amplifiers, since it introduces no flyback pulses, spikes or thumps into the output signal, whether operating as a single or dual-channel amp.

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Also new is the DC300A's IC front end, which sets new world's records for low distortion and noise. At the 8-ohm rated output, IM and harmonic distortion is less than 0.05% full spectrum; hum and noise is 110db below. Servicing - if ever necessary - is a snap, since removing the front panel accesses the entire circuitry.

Although it is completely redesigned model, the DC300A has inherited some characteristics from its predecessor.

PRICE \$795.00 less than the DC300 sold for.

WARRANTY - three years, covering all costs of parts labor and round-trip shipping. COOLING - excellent heat dissipation provided by massive cooling fins and the entire chassis itself. DEPENDABILITY - stringent pre- and post inspection and testing proves every electronic component, every circuit module and every finished unit, to bring you one step closer to install-and-forget field dependability. PEOPLE - the same innovative design team and careful craftsmen who made the DC300 such a sound success. And the same knowledgeable customer-service men ready to discuss your special application and send you detailed technical data.



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# - it's easy This course, written in the mystery out of election of the mystery out of electio

This course, written in down-to-earth language, takes the mystery out of electronics — explaining it as the logical, fundamentally simple, yet far ranging subject it really is.

WE ARE unable to see electricity directly. But if electrical energy is converted to some other form, then a measurement of its magnitude can be made visible.

For example, the brightness of a light globe is a measure of size of one of the electrical quantities. Such a method is, however, not nearly accurate enough as the eye is a very poor judge of light levels.

A much better way is to use the electricity to drive a mechanical pointer across a scale. The extent of movement indicates the size of the quantity we are measuring. Devices using this principle are called 'meters'.

Meters come in numerous sizes, shapes and types (as shown in Fig. 1) but detailed differences need not concern us as yet for each one of them can be represented by our "black box" concept – an electrical parameter feeds into the box producing an observable pointer movement, proportional to the voltage, current, resistance or power (etc) being measured.

THIS MONTH



- five multimeters to be won!

The type of meter known as 'moving coil' is the most suitable (and hence most commonly used) meter for measurements in dc circuits.

A detailed description of the moving coil meter is given elsewhere in this article for those who wish to know more about its construction. However, such detailed knowledge is not necessary in order to make measurements with it, we can consider the meter purely as a black box device having two basic characteristics.

Firstly, it may be considered as having a fixed resistance between its two terminals. Secondly, it requires a certain amount of current to deflect the meter pointer to end-of-scale.

Meters of this type are described in terms of the amount of current required to deflect the meter pointer full scale. (This end-of-scale position is known as - full scale deflection - often abbreviated to 'fsd').

Thus a meter, described as being 0-1 mA, indicates current values between 0 and 1 mA, and requires one milliamp of dc current to deflect the pointer to the end-of-scale (fsd) position.

At this stage, we should point out that the term 'meter' is loosely applied both to the basic *meter movements* (as in Fig. 1) as well as to complete instruments that incorporate switching and other electronics. These additions to the basic meter movement are required to measure the different kinds and quantities of the basic variables in circuits, ie, voltage, current and resistance. Each can be measured, using exactly the same meter movements, with the aid of external resistors and appropriate connections.

How the same meter movement can be used to measure the different quantities is easily explained by using Ohms law and the rules of series and parallel connected resistors. We warned you that Ohm's law was basic! All electronic theory is built up logically piece-by-piece. So we reiterate – make sure you consolidate each piece of knowledge as we progress.

#### **MEASUREMENT OF VOLTAGE**

In our black-box representation of the meter, we stated that it could be

regarded as a resistor. Hence a voltage is required, dependant on the movement resistance, to drive a current through the meter. This may be calculated by our, by now, well known formula V=IR.

Generally, meter movements are sold with the full scale deflection current specified. Some are sold as ready-to-use, specific range units modified to read 0 - 1 A, or 0 - 10A, for example. These have built-in resistors to modify the basic movement characteristics but for the moment we will consider only basic unmodified units.

Unfortunately it is not common retail practice to quote the resistance of the meter movement. Manufacturers sometimes provide it on the actual unit itself – perhaps written on the meter face below the needle aperture, or in data sheets. (If not given, it can be measured, but as it requires a second accurate voltmeter this will be beyond the beginner).

If, as shown in Fig. 2 for example, the internal resistance of the meter movement is 1 k $\Omega$  (1000 ohms), and it requires a current of 100 uA to deflect it full scale (a common specification) it will be fully deflected by applying a voltage of

= IR .

V

- 100
- = 1000,000 x 1000

= 0.1 volts, or 100 mV.

So, although described as an amp-meter (we usually say ammeter) it may also be used as a voltmeter having 100 mV fsd.

Obviously the direct application of a voltage larger than 100 mV will cause the needle to deflect past the full-scale value. Excessive deflection can easily damage the movement. The excessive voltage may also cause more current to flow than the movement can handle – remember power is dissipated ( $P = 1^2 R$ ) so unless adequately cooled, the coil in the meter movement may become too hot and burn out.

So to make our basic movement read higher voltages we add a series resistor, as shown in Fig. 3a. This resistor is called the *multiplier*. Its purpose is to limit the current, at the chosen voltage, to the fsd value of the meter. For example, if when using the circuit of Fig. 3a, we require a 1 V fsd scale, we may calculate that the total

series resistance (from R = V/I must be







mA





From Ohms law (again!) we can see that when resistors are connected in parallel, the larger value carries less current than the lower value of resistance. As long as the resistances remain constant so does the ratio of currents.

For example, suppose we need the basic meter to read 300  $\mu$ A fsd instead of  $100\mu$ A. As the meter deflects full-scale with only  $100\mu$ A,  $200\mu$ A must be diverted by the shunt. Remember that the voltage across each resistor in a parallel arrangement is the same, so our shunt must be of such resistance that 200  $\mu$ A passes for 100 mV of applied voltage (remember the meter movement is also 100 mV fsd).

The shunt must be

 $R_{Shunt} = \frac{100 \times 10^{-3} \text{ V}}{200 \times 10^{-6} \text{ A}} = 500\Omega$ Another way to look at it (provided) the current range required is much higher than meter movement's normal





Fig. 3(a). Using a 'multiplier' resistor to provide a single voltage measurement range. (b) Adding a switch and extra multiplier provides more voltage ranges.

Fig. 1. Basic meter movements have many shapes, sizes and scales to suit different applications.

$$R_{\text{total}} = \frac{1 \text{ V}}{100 \text{ x } 10^{-6} \text{ A}} = 10^4 \Omega \text{ or } 10 \text{ k} \Omega$$

Remember the meter movement already contributes 1 k $\Omega$  so an additional multiplier resistance of 9  $k\Omega$  is needed. By a similar process the multiplier value for any voltage above 100 mV may be found. The upper limit is set by the insulation of the meter, but 1000 V full scale is usually possible.

Let us now see what happens if we require 100 V fsd. We would need a total resistance of  $10^6\Omega$  (1 M $\Omega$ ). But now it is pointless to subtract the meter movement's resistance value for it is insignificant compared with the multiplier value (0.1 per cent). Note also that for every volt of fsd range required, we need to add approximately 10 k in series (100 V-1000 k $\Omega$ ; 10V - 100 k $\Omega$ ; 1 V - 10  $k\Omega).$  We can, therefore, refer to the meter circuit in terms of this - saying it has a sensitivity of 10 k $\Omega/V$ . Meters are usually specified this way - not to help us design multiplier values but to enable the effective resistance of the modified meter to be quickly assessed. is most important when This connecting the meter into electrical circuits, as we shall see later.

Voltages up to 100 may now be read by connecting the leads of the meter and its series multiplier across the two points in the circuit between which we



Fig. 2. Regardless of shape or size every meter movement may be represented as a 'black box' having two terminals and an internal resistance. The current required to produce full scale deflection must also be given.

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require to know the voltage difference. There is no need to break any connections, so the procedure is very simple.

Make sure if you use such a meter in a permanent connection, that the metered voltage never exceeds the rating of the unit.

#### THE MULTIMETER

If we had a meter that was calibrated to read 1000 volts full scale, but were trying to read only three volts, the pointer deflection would be so small that we could not know with certainty whether the reading was two, three, or four volts. Obviously a more sensitive meter is required. Rather than unsolder our multiplier and instal a new one, it is much better to fit a switch that enables us to select a multiplier having a resistance appropriate to the magnitude of the voltage being measured. This arrangement is illustrated in Fig. 3. Such a modification produces a slightly more complex black box - the multi-range voltmeter. We will see below that various ranges of current and resistance may similarly be handled with switched ranges. When all these facilities are built into a multi-range, multi-function unit, it is commonly referred to as a multimeter.

#### MEASURING CURRENTS

Let us now examine how our 1 k $\Omega$ . 100  $\mu$ A fsd meter movement may be modified to measure larger values of current. Again it is done with resistors, but this time the resistor is placed across the meter and is thus in parallel with the resistance of the movement instead of in series as before. This parallel resistance is termed a 'shunt' as its purpose is to by-pass or shunt current around the meter, as illustrated in Fig. 4a.

## **ELECTRONICS** -it's easy!



Typical high quality multimeter, note the 'ohms' scale in which zero is at right hand end. Meters that indicate the measurement by a scale and moving pointer are known generically as 'analogue' instruments.

current) is to consider what value of resistance would develop 100 mV across it when the desired current flows. For example, 1 A fsd needs a shunt of

$$R_{\text{Shunt}} = \frac{V}{I} = \frac{100 \times 10^{-3}}{1} = 0.1\Omega$$

When designing shunts for large currents, thought must be given to the power dissipated in the shunt. In our previous example the power dissipated  $P = I^2R = 1.0^2 \times 0.1 = 100$  mW which is not significant. However if we were to require a shunt for 20 amps its resistance would be

 $R_{Shunt} = \frac{V}{I} = \frac{100 \text{ mV}}{10 \text{ amps}} = .01\Omega$ Power dissipated P = I2R  $= 10^2 \times 0.01 = 1 \text{ watt.}$ 

If our shunt is not to run too hot the resistor must be rated at two or three watts.

In practice the very low resistance required is usually obtained by using a short length of heavy-gauge wire and power dissipation is not usually a problem.

Shunts are usually made specially for meters, as there is little or no call for such low resistance values in the majority of electronic circuitry. Because of this they tend to be more expensive than normal resistors.

Measurement of current is made by breaking the circuit, in which it is required to find the current flow, and wiring the shunted meter in series with the lead and its original connection point so that the normal current passes through the meter and shunt.

We have seen how a shunt lowers the total effective meter resistance – especially as the current range rises. For this reason it is quite wrong to



Fig. 4(a). In order to measure currents greater than the meter movement fsd a 'shunt' must be used to divert part of the current around the meter. (b) A switch and extra shunts may be used to obtain more than one range.

(b)

connect a multimeter set to a current range across a component or section of a circuit. It will very effectively short the circuit out causing heavy currents to flow in components probably not able to support them. For example, our above mentioned 1 A meter (which has a 0.1 ohm shunt) placed across points in a circuit between which a voltage difference of 12 V exists, will cause a current to flow of

I flowing = 
$$\frac{12}{0.1}$$
 = 120A

This current, if the supply could provide it, would melt the leads and components instantly!

To create a multi-range ammeter we again use a switch (Fig. 4b) to select the required shunt across the meter. As the same current flows through the switch contacts, the upper current range is limited mainly by the size of



Fig. 5(a). The circuit required to measure ohms. (b). A typical multimeter scale – The Ohms scale is the centre one.



#### AC AND DC

In all our discussion so far, we have considered electrical current flow as being in one direction only. This kind of current flow (as from a battery) is known as "direct current" and we usually abbreviate this to "dc".

There is another kind of current flow which continually changes direction, flowing first one way and then the other. This is known as 'alternating current' or 'ac'. The mains supply used in your home is a 240 volt "ac" supply, and the direction of current flow reverses 50 times a second. We will study ac in more detail later on, for the moment, just keep in mind the distinction between ac and dc.

the contacts and to a lesser extent by the size of the shunts. For this reason multimeters rarely have a range higher than 10 A fsd.

#### MEASURING RESISTANCE

As well as having voltage and current ranges, multimeters are usually capable of measuring resistance.

As described above, the multiplier of the voltmeter arrangement alters the effective fsd value of the meter to suit various applied voltages. But if we provide a fixed voltage (from a battery) to the meter, and place the unknown resistor in series, we can work backwards from the indicated current to obtain the resistance value. This may be explained with the aid of Fig. 5a as follows:

If the meter leads are shorted together, there is virtually zero resistance between them. This method is in fact used to establish the zero ohms point on the scale.

In practice the leads are shorted together and an in-built variable resistance is adjusted to give full scale meter indication (i.e.  $100\mu$ A is flowing). Unlike the other meter ranges, on the resistance range full scale deflection represents zero.

At the other extreme, if the meter leads are not connected to anything at



Fig. 6. Circuit diagram of a typical multimeter (JM-20K). The shorting bar, shown by the broad arrow slides along to make three connections at each position.

all, the resistance between them is virtually infinite. Hence no current can flow and the meter pointer will not move from the left-hand end of the scale. This point thus represents infinite resistance and is marked  $\infty$  accordingly.

In between the 0 and  $\infty$  values the pointer will assume a position proportional to the external resistance added. By applying Ohms Law it is easy to work out the position on the scale for any other value. A typical ohmeter scale is illustrated in Fig. 5b. For example, if we use a 1.5 V torch-cell as the voltage source, the

adjustable multiplier needed with the 1 k $\Omega$ , 100  $\mu$ A fsd meter, must be:-

$$R$$
total =  $\frac{1.5 V}{100 \ 10^{-6} A} = 15 k\Omega$ 

from which the value of the meter (1  $k\Omega$ ) must be subtracted to get 14  $k\Omega$ With shorted leads the meter will go to fsd, now marked  $0\Omega$ . The multiplier is adjustable so that the zero point can be reset as the battery becomes discharged (lower voltage). If we now insert 10  $k\Omega$  externally we get a total resistance of 25  $k\Omega$ . The battery voltage will cause a current to flow in the series loop (remember in a series circuit all components pass the same current) that is

$$1 = \frac{1.5}{25 \times 10^3} = 60 \mu A$$

Hence, the meter, with 10 k $\Omega$  in series with its leads indicates its 60  $\mu$ A value but is now marked 10 k $\Omega$  on our scale. The process is repeated for decade values  $-100 \Omega$ , 1 k $\Omega$  100 k $\Omega$ , then for spaces in between until the scale is adequately filled. Note that the divisions are not evenly spaced and that this form of ohmeter has better resolution on some parts of the scale than on others. It is also clear that it measures 'back to front'. This is somewhat inconvenient but the simplicity of the arrangement more than compensates for this anomaly. More advanced (and therefore more expensive) multimeters usually read the conventional way.

It should be noticed that, in the example given, 10 k $\Omega$  gives approximately mid-scale deflection but, because of scale non-linearity, it is difficult to read values, around 100 k $\Omega$  at all, let alone with any accuracy.

To resolve this difficulty, various battery voltages and/or resistance multipliers may be used to obtain centre scale readings either larger or smaller than in the example given. Use ohms law to determine what multiplier and battery voltage is required to obtain a mid-scale reading of 100 k $\Omega$ .

When it is required to measure the resistance of a component in a circuit, it must be disconnected. (One side

Fig. 7. These diagrams illustrate the three basic measurement techniques for (a) voltage, (b) current and (c) resistance.



### **ELECTRONICS** -it's easy!



The multimeter, when measuring voltage, always loads the circuit. It is the <u>degree</u> of loading that matters.



When electricity flows through a wire, a magnetic field is produced in a plane perpendicular to the wire. This magnetic field may be concentrated by winding the wire to form a coil of many turns, and still further by winding the coil around a soft-iron core.

Such a device is termed an electro-magnet, when electricity flows through it, it will attract magnetic material — such as iron.

One example of the way such an electro-magnet may be used, is the relay in last month's practical exercise.

A further example is in the moving-coil meter.

If the electromagnetic coil is suspended in the field of a permanent magnet, (a permanent magnet is made of steel — steel once magnetized, remains magnetized, whereas soft iron loses its magnetism immediately the energising field is removed) it will be caused to rotate, when energized, by a force proportional to the energizing current,

In the moving-coil type of meter, as Fig. 9 shows, the field of the permanent magnet is arranged to pass across a cylinder in which hangs the coil of the meter. A fine spiral tension-spring restrains the rotation by providing a linearly increasing torque as the coil rotates. Attached to the coil is a pointer that moves across a scale, thus indicating current.

As the number of turns is increased, to improve sensitivity, the designer must use finer wire to keep the mass of the coil small. As a consequence of this requirement, sensitive meters usually have a higher resistance, and are more delicate. When using any meter with switched ranges, always start off by selecting a meter range much higher than your estimate of the quantity to be measured.

This precaution safeguards the meter should the quantity be much larger than expected.

only will do, but it is often easier to remove it completely).

To make a reading the meter leads are first shorted together and the zero ohms adjuster set to obtain zero ohms reading (this compensates for battery voltage variations). The unknown resistance is then connected between the meter leads and its value read from the meter.

The measurement functions, namely, voltage, current and resistance form the basis of the multimeter. Other ranges may be provided for ac (or alternating current) quantities. These will be discussed later in this series. Figure 6 shows the full circuit for a small meter — can you trace out the various circuits that we have described? Ignore the ac slider position for the moment.

#### LOADING THE CIRCUIT

As we have seen, connecting a resistor in parallel with another resistor reduces the effective value of both — to something lower than the value of either. Thus, as a voltmeter is in effect a resistor, connecting it across a circuit will inevitably change the resistance of that circuit. In effect one has paralleled one resistor with another, and the meter must shunt current away from the circuit.

Because of this, when a meter is connected across a circuit, the operation of that circuit may well be affected, thus causing the meter reading to be in error.

This brings us back to the reason for quoting the sensitivity of voltmeters in ohms per volt. Multiplying the sensitivity by the fsd range in use, gives the resistance of the meter circuit that will be shunting the component. Cheaper multimeters will have sensitivities ranging from as low as 1000  $\Omega/V$  volt to as high as 100 k $\Omega/V$ .



To illustrate loading effects, consider the circuit in Fig. 8. By Ohms law we

know that the voltage between points A and B is 0.75 volts – don't we?

Now let us see what happens when we use a 1000 ohms/volt meter on the 1 volt range to measure this voltage. The 1000 ohms of the meter in parallel with R2 will produce a combined value of 500 ohms. Thus the voltage read by the meter will be 0.5 volts instead of 0.75 volts – an error of 33 per cent!

Confirm these results for yourself and then try our competition. You may win yourself a multimeter.

It is the *degree* of this shunting effect that is important — in theory it can never be completely avoided, for some energy must flow into the measuring system from that being measured. In electronic measurements the rule of thumb is that for accuracy, the resistance of a voltmeter should be at least ten times that of the circuit — a hundredfold is better still.

This may not always be possible with an inexpensive meter, and some error will have to be tolerated. But remember — this error can be considerable if loading is severe. A check for loading is to make a reading on the next highest range. A much higher voltage reading will indicate that severe loading is occuring on the lower range. When this occurs we must take our reading on the lowest range that does not produce visible loading and put up with the lack of resolution. It should now be clear that the higher the sensitivity of the meter the better.

A similar thing happens when measuring currents, the series resistance of the meter may introduce undesirable voltage drops. In this case the combined resistance of the movement and shunt should be one-tenth, or preferably less, of the series circuit resistance.

This discussion of multimeters is restricted to those units that do not include electronic amplifiers — these will be discussed later when we have covered amplifier operation. Amplifier type multimeters are usually characterised by having a quoted fixed input resistance (called impedance in some data sheets) that is typically 1  $M\Omega$  or higher. With these there is seldom need to worry about connection loading.

Although we have discussed loading with reference to meter measurements, the same principles apply to the connection of any kinds of circuits – the black-box approach tells us this. Each circuit having input and output terminals will load those coupled to it – output is parallel with input of the next and so on. It is important to remember this, for all so often a circuit stage is developed that fails to operate into the following stage because of loading effects.

We have spent much time on actual multimeter circuits, for the

#### CHOOSING A MULTIMETER

Multimeters range in price from ten dollars, to several hundred dollars. The more expensive units incorporate an amplifier to increase the input resistance and/or very elaborate electronic circuitry to provide extremely high accuracy.

For the beginner, extremes of accuracy and input resistance are not necessary and a relatively cheap meter will be entirely adequate. Nevertheless – avoid the very lowest priced meters. These are rarely a bargain.

When purchasing a meter look for the following points:-

1) The sensitivity should be as high as possible, preferably 20 000 ohms/volt or better.

2) It should be capable of reading volts, amps (both ac and dc) and ohms.

3) Voltage ranges should be from one volt to at least 300 volts dc, and 10 to 300 volts ac.
4) Resistance should preferably have at least three ranges, times 1, 10 and 100.

5) Overload protection is highly desirable. This should disconnect, or protect, the meter if excessive voltage or current is accidentally applied.

6) Seek rugged construction. A meter is a valuable tool that should remain serviceable for many years.

# **UNDER 17's-win a multimeter!**





WE HAVE stressed that connecting a meter across an electrical circuit may alter the conditions previously existing in that circuit.

Bearing in mind the theory published in the current and previous articles in this series, calculate the conditions existing in Fig. 10. *before and after* the meter is connected.

Show all workings and provide a short comment (less than 200 words) on your results.

To encourage our younger readers, this contest is limited to boys and girls who are less than 17 years old on the closing date for entries – February 15th 1974.

Winners will be required to submit proof of age.

calculations involved illustrate the kind of thinking that is continually required when building circuits -especially of your own design. If you Five prizes will be awarded, each is a Jayem -20 K multimeter.

If more than five correct entries are received, judging will also be based on completeness and clarity of presentation.

Please be absolutely certain that your have included your name, address and age with your entry.

Entries must be addressed to 'Meter Contest' Electronics Today International, 15-19 Boundary St., Rushcutters Bay, NSW 2011.

#### CLOSING DATE IS FEBRUARY 15TH 1974

have stayed with us so far you are weil on the way to having the theoretical aspects of basic electronics under control.



#### Dick answers your *questions*

We get a lot of people writing in and asking us why we don't open stores in other parts of Australia. What's the reason Dick? Frankly I don't think it is necessary to have stores sprinkled around the country if and I basten to add there are stores sprinkled around the country # ... and I hasten to add there are some important ifs. The first is 'if you have a good catalogue.' The catalogue has to give very detailed descriptions so that the reader can be reasonably sure he's going to get what he wants. That's why we give as full a specification as we can in ours (in fact a lot of people use it as their 'Bible' because of all the in-

formation it contains). The second if is 'If you have an efficient Mail Order department'. spent a lot of time on my overseas trip kooking at Mail Order in the USA where it is used a tremendous amount. Our Mail Order department has been designed from their ex-perience. Users have a choice of 'fast' or 'slow' delivery - Comet overnight or Post. So that if a part is wanted really urgently a customer can phone us, telegraph the money, we can hand the goods to Comet and it will arrive the next day. I know that is a bit slower than going down to your local store but that brings us to the

third if - 'If it's in stock'. Everyone knows that the com ponent situation is getting worse and worse. So where's the point in having stock distributed all over the place? Surely it's better to keep it all in one central point so that everyone can draw on it? Having stock spread between several stores means that an A and collecting dust at Store B. Also there must be an inevitable overstocking if all stores are to provide the sort of service customers would expect. Holding extra large stocks costs money and I don't have to tell you who pays for that!!

So, as I see it, the only advantage of having a local store is that you can see the goods if they happen to be in stock which brings me to the last if: you have a proper money back quarantee.

Everything we stock is brand new and we give a money back guarantee in addition to any manufacturers guarantees. As we say in the catalogue, 'If you aren't satisfied with the goods, for any reason, return them within 14 days and we will exchange the goods or return your money.

If I can just recap, we don't have stores all over the place because we operate an efficient Mail Order system, have a detailed catalogue, goods can be in the customers hands rapidly with a money back guarantee And finally our catalogue has a dead easy mail order form - why don't you try it out?

#### Magnetic Stereo Pre-Amp Module

Complete ready-wired on a PCB measuring only 1%" x 2%". Two high gain transistors per channel. Frequency response from 30Hz to 20kHz within 1db of RIAA curve. 2mV sensitivity for 150mV output with input impedance of 50kohm. Typical noise figure is -68db with distortion below 0.04% \$11.25 (PEP distortion below 0.04% \$11.25 (P&P 30c).

#### Trio 9R-59DS Communications Receiver

An ideal set for Amateurs and Short Wave Listeners. 4 bands covered from 540kHz to 30MHz. Two mechanical filters to improve selectivity. Product detector for SSB Large dials for accurate tuning. Automatic noise limiter. Calibrated Bandspread. 'S' meter and BFO.2uV sensitivity for 10db S:N. Built-in speaker and 1.5W output. \$180 (P&P \$3.001

#### SPECIAL THIS MONTH

Get off to a good start with a FREE copy of World Radio and TV Guide (available separately also). This is a complete directory of every radio and TV transmitting station in the world. Over 400 pages of cramped print to give the listener all the facts and figures. Constant reference book for Amateurs and SWLs. Recommended by Radio Australia. We have fresh stock just in at \$5.75 or FREE with the Trio 9R –59DS.



#### **Educational kits**

#### **Crystal Radio Klt**

An all time favourite, brings in the local stations without a battery. Build your first radio in under 1 hour \$4.95 (P&P 30c).

#### 10 in 1

Includes a solar battery and enables several radios, signal generator and morse code oscillator to be built. 10 projects in all for \$8.95 (P&P 50c).

#### 50 in 1 Solar Energy

Kit gives 50 experiments using relay, meter, transistor, transformer etc. Uses two batteries. With 58 page manual \$21.95 (P&P \$1.00).

#### 150 in 1 The Ultimate

(See ET Nov 73) a magnificent kit in wooden case with enlarged visualised IC, radio tuner, CdS cell, transformer etc. No soldering to build 150 different circuits over and over again and some of your own. \$35.95 (P&P \$2.001



#### 30 Watt RF Klt

30 Watt RF Klt Unly available from us and specially produced for our many Amateur customers. Available in 3 stages which together give 30 Watt out from 300mV in at 144MHz from a 12.6V. supply. Uses the Solid State Scientific transistors. 7W stage complete \$11.50. 15W stage complete \$13.50. 30W stage complete \$13.50. Individual boards \$1.50 or the complete kit (saving \$5.00) for only \$3.750 (PEP 50c) \$5.00) for only \$37.50 (P&P 50c)

(See review on page 56.)



We've redesigned the layout of the popular ETI 505 strobe (circuit in 25 Top Projects or see our catalogue). Assembly is simpler and quicker. Our Assembly is simpler and guicker. Our kit also includes a very handsome spun aluminium reflector, Plessey capacitors — in fact everything ready to plug into 240V supply at only \$26.50 (P&P \$1.00).



#### **Digital Clock**

(E.A. Sept 73) We have only a few of these left at the special offer price so hurry. Based on the Special orer price so hurry. Based on the Sperry gas readout and National IC, this kit provides full 24 hour mains operation. Display is easily read from 40ft away. The National IC provides 4 or 6 digit operation. All parts, excluding case, cost only \$49.00 or Readout, IC and transistors for only \$28.75 (Both P&P 50c, but hurry!).



#### **Digital Counter**

**Kits** 

(E.A. Dec 73) We have the complete kit with a professional type case to make this useful instrument look like one costing much more. Kit also includes crystal, readout etc - in fact everything you need to make a really good job. 20MHz counter only \$116 (P&P \$2.00) or complete with prescaler to extend range to 200MHz \$135 (P&P \$2.00)



#### New 910-60 Digibezel

Imported from the USA for you digital enthusiasts. Handsome front escutcheon has 2" x %" window which fits chassis up to % th thick with simple clip. Beaut matt black finish for a really professional look to your clock, counter etc. Also included is a red polarising filter to improve legibility in high ambient (ighting conditions \$4.75 (P & P 50c).

#### Playmaster 136

The ever popular kit. Compares favourably with commercial units costing very much more. Has ex-pensive looking brushed panel. We also include Silicon Grease to improve thermal, appditions in output chem thermal conditions in output stage. This one is a Superkit complete with article reprints etc for \$65 or less Fairchild special offer transistors \$55.60 (Both P&P \$1.00).



#### Calculators 1200 Ruby

6 digit display with 12 digit capacity. Selectable decimal point, does all the usual calculations including chain multiplying etc. Bright easy to read magnified LED readout. Use 9V transistor battery. Worth at least \$10 more at only \$59 (P&P 75c).

#### 8012 Grantham

is a desk top model with floating decimal point. Operates from mains Constant key, overflow indication, leading zero suppression etc and 8 digit display. Ridiculous price of only \$79.00

#### 1211 Grantham

is the cheapest anywhere with a full memory. 12 digit display, constant key, percentage, clear entry etc. Truncate switch and 8 place selec-table decimal point. All this for only \$115 (there must be a mistake?) All these calculators have our money back guarantee plus AUSTRALIAN suppliers 3 month workmanship guarantee. You can't go wrong.

DICK SMITH WHOLESALE PTY LTD

160-162 Pacific Highway, Gore Hill NSW 2065. Tel 439 5311 or 02 4395344 (24 hour order answer phone).





#### MAG PRE-AMP

A complete magnetic pre-amp on a 13/16" x 2 1/2" printed circuit board, packaged in a transparent plastic bag with instruction sheet. The circuit contains 2 high gain transistors per channel to provide the excellent performance that potential users will want. Brief specifications: Frequency response within

Brief specifications: Frequency response within 1dB of RIAA curve from 30 Hz to 20 KHz. Sensitivity is 2mv for 150mV output at 1 KHz. Input impedance is a nominal 50 K. Noise Is typically -68dB. Distortion figure; less than 0.4% THD at 250mV and 1KHz output.



Ready to use \$12.50 (P&P 50c)

#### AM TUNER MODULE



Brief specifications: Tuning range 510-1625 KHZ. Output 750 mV into 100 K. Power supply 7 to 9V DC, 20 mA from battery etc. Module only (needs ferrite rod and capacitor) \$13.20 Rod aerial \$2.50 Tuning gang \$3.60 (P&P 50c)

Expo Amplifiers are very popular representing value in the medium price bracket. Come in and hear one

price pracker, come in and near one - you'll be pleasantly surprised and so will your bank balance. KA205 has 12Watt RMS output, handles radio, disc, tape inputs etc. Full range of controls and is housed in a deluxe walnut cabinet at only \$65 (P&P \$2,00). TA100 has an output of 25Watts.

b) IFSP \$2,001. TA3100 has an output of 25Watts RMS uses transformerless input and output stages, has 20 transistors. Scratch filter incorporated. Full 20-40000Hz response. Hand-rubbed walnut cabinet \$89,00. SCD77Y Cossette Derk II. Ideal for

walnut cabinet \$89,00. SCD77X Cassette Deck is ideal for adding to your stereo set-up. Beaut looking with slider controls. 2.5V output suits most Amps. Frequency response from 45-12000Hz \$119 (P&P Road freight extra).

Holiday time is ideal for knocking up a kit (they also make ideal presents). Here we list our most popular. First the Dick Smith "Superkits." These have been specially selected for the VIP treat-ment. Prototypes have been built and evaluated and we include comments and suggestions for improvement over original specs. You also receive reprints of articles and corrections. Most have flow-soldered P.C. Boards and extras that we think will help you to get a Super finish. Holiday time is ideal for knocking up Super finish

Playmaster 136 Amplifier, Without Playmaster 136 Amplifier. Without doubt the most popular amplifier kit we have ever handled. Compares favourably with commercial units. Has expensive brushed aluminium panel. We also include silicon grease to improve thermal conditions in output transistors, Less Fairchild Special offer transistors \$55.60 (including transistors \$65.00) Both P&P \$1.00.



ET1 100W Amplifier features full 100W RMS output. Prepunched heatsinks and silicon grease plus heat dissipating paint. Sturdy metal case. Ideal for gultar enthusiasts. Simplified instructions included \$65.00 complete (P&P \$1.50). 100W Pre-Amp Kit. Produced in response to numerous enquiries to complement the above amp. Two sensitivities for mics and guitars.

sensitivities for mics and guitars, yolume treble and bass controls. No case since most users build it into something else. Pretinned boards full circuits included for \$9.50 (P&P 50c).

TEST EQUIPMENT

A wide range of multimeters from beginner's models right through to the professional FET instrument, DSE-2 is an ideal first multitester having a sensitivity of 20,000 ohm per volt. 17 ranges cover AC and DC volts, amps. Resistance and useful capacitance ranges. Complete with test leads at \$12.50 (P&P \$1.00).

X-100W

# **Kits**

Varilight Dimmer. Handles up to 1000W gives professional light dimming at a fraction of the cost. Includes 8A triac and posh Clipsal flush mounting plate \$6,90 or elec-tronic components only in short-form kit at \$4.90 (Both P&P 50c).



Digital Logic Trainer. Learn all about digital with this beaut kit. Many sold to tech colleges, industry etc. Contains 6 JK flip flops, 2 and 3 input gates, inverters, buffers and 4-input Schmitt. These are supple-mented by a dual range clock, level setting switches and LED readout. Our kit uses best components avail-able including a handsome silk-screened panel \$82.00 (P&P \$1.00). Musicolour. Watch the coloured screened panel \$82,00 (P&P \$1.00). Musicolour. Watch the coloured lights dance to the sound of your favourite music. Filtered bands of audio are used to trigger the lights. Complete kit includes anodised front panel and explicit instructions \$52.00 (P&P \$1.00).

(P&P \$1.00). 30Watt R. F. Kit has proved popular with Amateurs. Available in 3 stages which together give 30 Watt out from 300mW in at 144MHz from a 12.6V supply. Get the complete kit (for advanced constructors) for \$37.50 saving you \$5.00 on stage prices. Dick's Decision Maker, Helps you make difficult decisions just by pushing a button, ingenious little circuit using transistor switching and LED lamps. Supplied with silver label and tough plastic case to fit your pocket. Only from us at \$8.75.



Car Burglar Alarm (E.A. Sept 73). Protects everything on your car except the driver. Yes even roof racks. Ideal for beginners, \$17.95.

Jayem 100K is a high sensitivity (100,0000hm / volt) instrument with S1 ranges and accurate to  $\frac{1}{2}$ 3%. 5' movement is easy to read and the carrying handle acts as a stand. Dide protection and built-in magnetic shield. Very popular at 39,50 (P&P \$1.00). Jayem L-55 FET VOM has a con-stant 10Meg input impedance. Has 7 ranges. Battery operated and supplied in handsome vinyl carrying case. 2x probe included to double d.c. voltage ranges and. Dedate the most tenacious test prod we know. Fast safe and trouble free two types — XL-1 is extra long old plated contacts recommended at 1.55. X.100W is a shorter version to general test use & cents. It's not just a price list. In fact you could hardly call it a catalogue, 64 pages jam-packed with information, 20 pages of data alone. Just check some of the contents: P25,26,27 Inside circuits and connections of 43 popular bit 25, 26, 27 Inside circuits and connections or 43 population of provide the provided and provided Dick please send me your Free catalogue. I enclose 30 cents towards post and packing. NAME ..... ADDRESS ..... Postcode ....

Electronics Australia and Elec-tronics Today Kits. These kits use the same high standard components as our Super-kits but are presented without added retinements. We use no reject or inferior parts, manufacturers seconds etc. We are too anxious to preserve our reputation!! Playmaster 131 Tuner (E.A. Feb 71) still very popular uses TAA840 IC and is supplied with handsome matt black scale card. \$23.50. Signal Generator (E.T. June 71) gives sine and square wave output in range 15Mz to 150kHz. Case Included

range 15Hz to 150kHz. Case included \$24.50.

range 15Hz to 150kHz. Case Included \$24.50. Transistor Tester is very easy to build with our 3" movement. Looks professional with de-luxe satIn panel, diecast case etc. \$14.50. Mic Pre-Amp. (E.A. March 72) suits all mics, has adjustable Bass response to improve performance. Another easy one at \$3.30. LED Indicator (E.A. March 72). Ideal for checking audio signals. Used by many groups to check out mixers, amps etc. \$3.10. 20W P.A. Amp (E.A. June 72) uses the TA20C module,has mixing inputs and gives 20W RMS supplied with engraved front panel and case. Ideal guitar practice amp \$57.00. Reverb Unit (E.T. 25 Top Projects) as featured in our catalogue. Im-proves sound of most instruments enhancing natural decay of sound. Complete with Plessey Spring Unit \$36.00.



Signal Injector (E.A. June 73). Almost as useful as a screwdriver, Uses 2 transistors and will do AF and RF work. Essential piece of basic test gear. Complete with hand-some probe case \$6.25. Stereo 2-4 Adaptor. The easiest way to sample 4-channel is this simple decoder from Nov 72 E.A. Knock one un for omit \$5.76

up for only \$5.75.

up for only \$5.75. Sperry Digital Clock Kit (E.A. Sept '73) Based on the Sperry Gas readout and National integrated circuit, this kit provides full 24 hour mains operation. All parts are included in the kit except the metalwork (we thought you'd prefer to make your own). Full kit \$49.00 Special Sperry/National offer of readout. IC and transistors only \$28.75 (Both P&P 50c). Headphone Adaptor (E.A. Aug '73) provides two sets of headphone outputs or speakers or both to be operated simultaneously. Separate left and right control from this very versatile unit. Full circuit details included from this very versa Full circuit details etc. \$18.95. included

24 hour STD orders 439 5344

Stereo and quadraphonic cartridges for automatic turntables

# ELAC product test PHONO-CARTRIDGES STS 555 & STS 655-D4





Recommended retail price STS 555 – \$74 STS 655-D4 – \$84

ELAC are one of the best known manufacturers of stereo cartridges in Europe and hold many of the original patents. They are innovators of high quality cartridges, in particular those specifically designed for automatic record changers.

The company's top of the line cartridge for many years has been the STS444 and our experience with this particular unit, both with elliptical and conical stylii, has shown it to be an excellent performer especially when used in Elac's 50H and 70H turntables.

But good though the STS444 has been, the advent of a new generation of cartridges — such as Shure's V15 Mk III — intended for non-automatic tumtables, has created a demand for comparable units for use with automatic turntables.

As we have stated before, the review of a cartridge is a surprisingly difficult task. To evaluate a conventional cartridge in the range 20 Hz to 20 kHz is already hard enough, for whilst some of the technical parameters are relatively easy to evaluate, others are extremely difficult and are rendered even more so as system quality advances to higher and higher levels. This is particularly true of the highest quality cartridges where small order differences between one cartridge and another are extremely difficult to determine.

The frequency response and dynamic characteristics at fixed signal levels are comparatively easy to evaluate, but, by and large, these are not the parameters that the purists care about. Dynamic performance on transients, and overall trackability in the presence of such transients, are the parameters that many people rate as being more significant.

Our evaluation of the STS 555 involved the use of a number of





Square wave response - 1 kHz at 7 cm/sec: left STS 555; right STS 655-D4

standard test records as well as several more conventional records chosen for their known excellence of quality.

A special Bruel and Kjæer swept tone record was used, in conjunction with our automatic recording equipment, to plot the frequency response from 20 Hz to 20 kHz. The same equipment also checks the separation between left and right hand channels.

Our second test checked the cartridge's (dynamic) response to a 1 kHz square wave recorded at an rms velocity of 7 cm/second.

This test provides a reasonable evaluation of transient response at medium velocity levels, but cannot evaluate the high tracking performance (25-30 cm/sec) that the best cartridges can now achieve.

It is for this reason that many manufacturers and testing authorities use special test records on variable speed turntables to measure trackability. Until better methods are devised we must continue to use this approach, together with records such as Shure's TTR 101 (An Audio Obstacle Course) and TTR 110 ("Audio Obstacle Course Era III") -which contain tracks with high, known, peak velocities.

We also use two other records. These are "The Missing Linc", Sheffield Records Volume II, and "Mandingo", E.M.I. Q4.TWO.400. These have recently become available and are particularly fine records for evaluating the dynamic characteristics of a cartridge.

"The Missing Linc" is a particularly interesting record. Sheffield have produced it as 'direct to disc' studio recording. This, the producers believe, results in the most faithful reproduction of sound presently available.

Their faith in this process certainly

ELECTRONICS TODAY INTERNATIONAL - JANUARY 1974

appears to be justified and the end result is a recording that is particularly suitable for the subjective appraisal of a high fidelity system — or its individual components.

"Mandingo" has more percussion instruments per centimetre of groove than almost any other record that we know. Whilst not specifically intended as a demonstration record it is excellent for evaluating transient performance.

#### STS 555

The first cartridge tested was the STS 555. This is a stereo cartridge specifically intended for use with automatic turntables — it is however, perfectly suitable for use with non-automatic turntables as well.

Listening tests showed that this cartridge had above average transient response, particularly low distortion and high trackability.

The measured frequency response



91



The D 555E was designed for decoding SO Advantet.

The STS 655 D4 will deliver top quarty from your CD channel discrete records.

Both are compatible with automatic or manual turntables.



SEE AND HEAR THEM AT YOUR ELAC DEALER

MAGNACORD INTERNATIONAL P/L 276 Castelreagh St., Sydney. 2000 was + 0.5 dB to -2.5 dB from 20 Hz to 20 kHz, the output extended beyond 25 kHz.

Channel separation was -20 dB falling to -18 dB at 18 kHz.

As our listening tests indicated, trackability and dynamic response was exemplary, the cartridge tracked very well indeed at one gram. Square wave response was also good.

#### STS 655-D4

The Elac STS 655-D4 cartridge is intended to be used for four-channel (quadraphonic) records using the discrete CD-4 system and is fitted with a German-made Shibata-type stylus.

In this particular field, Elac have very few competitors beyond the Nivico CD-4 cartridge developed by JVC some three years ago.

The frequency response of the STS 655-D4 cartridge is at least as good as its stereo counterpart, extending smoothly to at least 40 kHz, the present limit of our measuring capability Channel separation is one of the best we have seen, being better than 25 dB from 20 Hz to 20 kHz. The cartridge tracks well at one gram.

Currently there are no recognized methods of measuring the dynamic performance of discrete four-channel cartridges — nor are any test records yet available. Because of this we can only say that the cartridge performs eminently well on CD-4 records.

Elac have produced two very fine cartridges which, whilst intended specifically for the automatic record market, will perform equally well in manually operated tone arms. Whilst the Shure V15 Mark II and more specifically the V15 Mark III are not really compatible with automatic record players, the Elac STS555 and STS655-D4 cartridges are designed for such use and will provide a possible

alternative for those people who are looking for near V15 type performance in the lazy man's record player.

COMMENT

This review would seem to outline the difficulties experienced in producing visible test results from modern 'state of the art' type cartridges. Even the most well equipped laboratories, as possessed by the Testing Consultant who produced the review, must ultimately revert to ears.

We agree with the reviewer, that performance on transients, and overall trackability on these transients are the parameters many critics consider most. Tests for these qualities are only a way of trying to prove that a cartridge and its associated stylus assembly will convert mechanical energy with the highest degree of faithfulness to electrical energy.

Apart from this, Elac consider that a most important, often overlooked factor, is in the elimination of mechanical change being made to a recorded groove by a stylus whilst a record is actually being tracked. Elac have developed considerable expertise in measuring these mechanical changes and taking steps to minimise it in their cartridges. Unfortunately such measurement is beyond the convenient and economical means of most laboratories and is therefore unlikely to become a feature of comparative reviews.

The two critical parameters Elac consider most important then are - (a) what the stylus actually does in and to the record groove and (b) the degree of faithfulness with which the mechanical signal is converted to an electrical one, which of course, is finally reproduced by the speakers and becomes what you hear. Providing the listener can rest assured that his records are being treated with the utmost delicacy, the ultimate sound is then the best basis of judgement.

A.J. Muldoon, Sales-Manager, Acoustic Division, Magna-Techtronics (Aust) Pty Ltd.

MEASURED PERFORMANCE: Frequency Response 20 Hz to 20 kHz 20 Hz to 35 kHz Sensitivity at 1 kHz (4.5 cm/sec) Channel Separation at 1 kHz Channel Balance at 1 kHz Tracking weight

 ST \$555
 ST \$655-D4

 + 0.5 dB, - 2.5 dB
 + 2.0 dB, - 0.5 dB

 + 2.0 dB, - 0.5 dB
 + 2.0 dB, - 0.5 dB

 6 mV
 5 mV

 20 dB
 28 dB

 0.5 dB
 1.0 dB

 1.0 grm
 1.0 grm





# **MICROWAVE HEATING AND TESTING EQUIPMENT**

We manufacture the Swedish Husqvarna microwave ovens for domestic catering and industrial processes.

Agents for Holaday Industries microwave survey and monitoring equipment for the serviceman and research worker.

#### **FEATURES:**

- (1) Easy to use and read (2) Rugged, virtually immune to burnout. Maximum power density 1.5 w/cm<sup>2</sup>
- (3) Measurement independent of field polarization (4) Utilizes two easily replaceable 9V transistor radio batteries (5) Replaceable probe spacer cones (6) Attractive carrying case

#### Model HI 1500 \$275.00 Model HI 1700 \$975.00 **PROMPT** Delivery



#### Specifications:

- (1) Calibrated at 2450 MHz for use in the
- (1) Calibrated at 2450 MH2 for U I.S.M. Band,
   (2) Three ranges provided: 0-2, 0-10, and 0-100 mw/cm<sup>2</sup>, each calibrated at midpoint,
- Accuracy ± 1 db Time responses (0 to 90% of (4)
- final value for a step input) Fast — 1 second Slow — 3 seconds (5) Temperature compensated
- (6) Cardinal point calibration
- chart provided with each meter
- (7) Estimated battery life of 1 year
- (8) Instrument package dimensions: 2½ " x 3½ " x 6"
  (9) Probe length: 12"

Microwave Heating Pilot Plant for Industrial Plant and Development Work also available.

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# all shapes and sizes of sub miniature switches

Toggle, rocker, pushbutton, paddle, lever lock ... every practical alternative lever action combined with maximum performance, minimum weight and size and available in one, two, three and four pole models.

Subminiature switches manufactured by C & K Components Inc. U.S.A. are readily available in just about every shape, size and configuration imaginable and they are readily adaptable to a multitude of uses where space is at a premium. All switches feature rugged construction and simple mounting ... long-term, troublefree operation is ensured. **Toggle switch contacts** are rated 2 amps @ 240v. AC and 5 amps @ 28v. DC resistive load. The full C & K range is now available from the **Professional Components** Department, Villawood, **NSW or Plessey Ducon** Interstate agencies. **Catalogue containing** full specifications, options, information on hardware, panel layouts, mounting, etc. is available on request.



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5

ACRA

# 

#### DUAL IN-LINE I.C. PACKAGE HANDLING



A system to safely handle dual in-line integrated circuit packages has been designed amd made by an Australian company.

The DIL handling tools were developed by McMurdo (Aust.) Pty Ltd. of Clayton, Victoria.

The tools comprise a loading base to remove DIL's from manufacturers' packing tubes, a Dipinjector which assembles the DIL's to the printed circuit board and a Dipextractor for removing DIL's

Most manufacturers' tubes slot into the loading base to present one DIL at a time. The bases should be mounted on a base or bracket inclined at  $45^{\circ}$ . A bracket is available from McMurdo which takes three bases side by side to dispense different types of I.C.'s in use.

The Dipinjector device picks up the DIL's and compresses the leads to the correct pitch for insertion in the printed circuit board or sockets.

Manufacturers supply DIL's with the leads splayed 0.350 in whereas PCB sockets have a 0.300 in. pitch.

The use of the Dipinjector and loading base reduces assembly time by up to 75 per cent. Damage to the leads bonds and adjacent components is eliminated.

The Dipextractor is a spring-loaded device with thin blade-type legs which clip onto the body of the DIL even in the most crowded and inaccessible situations.

When a desoldering iron is applied to the solder at the base of the DIL on the reverse side of the printed circuit board, the Dipextractor instantly plucks it cleanly from the board as the solder wets.

Further details: McMurdo (Aust) Pty. Ltd., 19 Carinish Road, Clayton, Vic. 3168.

#### **MUSICAL CHIP**

American Micro-Systems, Inc., has introduced a single-package rhythm generator for electronic musical instruments.

According to the company, the MOS device designated the S8890 can simulate nine different percussion instruments and provides 10 different rhythm patterns for each instrument.

The S8890 has maximum instrument-voice-pattern length of 64 bits and operates on a single +12 V supply. It dissipates 400 mW and has an operating temperature range from 0 to  $+70^{\circ}$ C.

#### TECNICO TO HANDLE MICROSWITCHES

Tecnico Electronics have been appointed Australian Distributors for Pye Switches Limited of England. Pye Switches Limited have for many years made a range of microswitches, miniature toggle switches and joystick controllers.

Tecnico Electronics will be stocking the Zero Plus range (V3 series) and the subminiature Zero range (V4 series). These models are designed primarily for use in office machinery, instrumentation, vending and amusement machines, etc.

Further Details: Tecnico Electronics, Premier St., Marrickville, N.S.W.

## SOLID STATE DPERATING CONSIDERATIONS

Solid state devices are being designed into an increasing variety of electronic equipment owing to their high standards of reliability and performance. However, it is essential that equipment designers be mindful of good engineering practices in the use of these devices to achieve the desired performance.

This is covered in the RCA report "Operating considerations RCA Solid State Devices". ICE402. Available from Amalgamated Wireless Valve Co. Pty. Ltd. Box 24 P.O. Ashfield. NSW.

#### SCHOTTKY TTL

Fairchild in the U.S., have added 12 circuit types to their line of Schottky TTL integrated circuits. The company is also making all SSI Schottky products available in plastic as well as ceramic packages.

The newest additions to the Schottky line include two SSI gates available in both plastic and ceramic packages, and 10 new MSI devices available in a ceramic dual-in-line package. Fairchild now has 40 circuits in its Schottky TTL line, including 16 MSI devices.

The latest additions to the line include the 93S10 decade counter and the 93S16 4-bit binary counter, which provides counter functions at speeds up to 90 MHz and clock delays of less than 9 nanoseconds.

Another important addition to the Schottky TTL family is the 93S46 6-bit comparator, which compares two 6-bit words in less than 10 ns with one device; or compares two 12-bit words in less than 15 ns, using two devices.

Seven more Schottky TTL/MSI devices are scheduled for introduction by the end of 1973, according to Fairchild.

Further details: Fairchild Australia Pty Ltd, 420 Mt. Dandenong Rd., Croydon, Vic. 3136.

#### NEW SIGNETIC DUAL TIMER

Tecnico Electronics today announced the introduction of a dual timer – Model 556 – by Signetics Corporation. The dual monolithic timing circuit is a highly stable controller capable of producing accurate time delays or oscillation. Timing is provided by an external resistor and capacitor for each timing function.

Signetics have pioneered timers and they state that this new device brings in many new applications – amongst them are tone burst generators, speed warning devices and car burglar alarms. Circuits for these applications are available from Tecnico Electronics, Premier Street, Marrickville, N.S.W. or Tecnico Electronics, 2 High Street, Northcote, Vic.

#### TECNICO TO HANDLE CDC CONNECTORS

Tecnico Electronics have been appointed Australian Distributors for the connector range of Control Data Corporation. The range features a new and complete line of edgeboard connectors — wire wrap, flow solder, right angle, and even staggered contact terminations. These are offered in a wide range of sizes and include a variety of mounting configurations.

It also includes a two-piece connector – a perfect solution for interconnection between printed circuit cards, mother-daughter board designs, and various related non-edgeboard applications.

Further details from: Tecnico Electronics, P.O. Box 12, Marrickville, 2204 or Tecnico Electronics, P.O. Box 180, Northcote, 3070.

#### SECOND SOURCE LADDER NETWORKS



Production of the Series 811 Binary Ladder Networks, featuring precision tracking and high speed, has been announced by Allied Capacitors Pty. Limited on behalf of Data Device Corporation (DDC). Tracking rate is to 3 ppm/°C, and settling time is to 50 ns.

DDC's Series 811 Ladder Networks are miniature, 12-bit binary devices for use in digital to analog conversion applications requiring high accuracy and fast switching over a wide temperature range. These cermet thick film units are available in eight standard models, depending on accuracy and temperature range required, with standard resistance values of 5 k, 10 k or 20 k ohms. This "factory stock" choice of resistance values, accuracy levels and temperature ranges, makes what are normally considered custom units available at standard prices.

Principal reatures include: Maximum output voltage ratio errors as low as 122 ppm (0.012%), and specified output accuracies over  $-55^{\circ}$  to  $+125^{\circ}$ C or  $-20^{\circ}$  to  $+80^{\circ}$ C, operating temperature ranges.

The networks are less than 0.1 inch high and occupy only 1 square inch of board space. Their pin arrangement and low profile make them compatible with both flat pack and dual in-line integrated circuit package configurations. They are fully sealed and environmentally tested to meet stringent aerospace and military specifications.

Full technical Data Sheets are available from Allied Capacitors Pty. Limited, P.O. Box 198, Brookvale; N.S.W. 2100. PROTECT YOUR... INSTRUMENTS & EQUIPMENT





ALERT fuses are "on guard" against electrical overloads in Electronic, Industrial, P.M.G. Telecommunications, and D.C.A. installations. They are manufactured by Kenneth E. Beswick Ltd., U.K., and the ALERT range include British Military Standards, British P.O. Standards and many of the international specifications.

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TELEX: Melb. 31447, Sydney 21707 VIC.: 493-499 Victoria St., West Melbourne. Phone: 329-9633. N.S.W.: Sydney. Phone: 929-8066. W.A.: Perth. Phone: 49-4919. QLD.: L. E. BOUGHEN & CO., Auchenflower. Phone: 70-8097.

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Case to suit E.T.I. 100 watt guitar amp, and 419 4 input mixer/amp. Case \$9.00 Special 14g, heatsinks (not interchangeable with standard) \$3.20. Two p.C. boards \$2.30. Brushed aluminium front panel \$5.00. All Inputs and controls are on front panel only mains input and speaker outlets on the rear. Post and pack case \$1.00 others 15c. Complete kit as above \$20.00 post pald including layout drawings.

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Manufacturers of: Electrical/ electronic equipment, wound components and lighting control equipment.



# COMPONENT NEWS

#### PROTOTYPE PUSH BUTTON SWITCH KIT



Prototype push button switches can now be made cheaply and quickly with a switch kit produced for designers of electrical appliances and electronic equipment.

Each kit contains eighty switch modules with push on – push off action, interlock, where pressing a button cancels the previous button, and momentary functions.

Sixty mounting brackets for making one to 19 position switch banks are supplied. They have switch pitches of 10, 15, 17.5

#### MOS TO LED INTERFACE CIRCUITS

Motorola Semiconductors Ltd have just introduced two new dual-in-line integrated circuits which perform all the impedance and voltage transformations necessary to enable MOS integrated circuits to drive light-emitting diode numeric displays.

It is expected that the major application for the new 1C's will be in electronic calculators and display equipments.

Both device comprise arrays of Darlington transistors which provide the high input impedance necessary for the output of the MOS device and which can supply the necessary current for the display. They are intended for use with common-cathode LED displays operated in serially addressed,

98

and 20 mm. Matching latch bars are provided for the interlock function.

Switch buttons in five styles, both illuminated and plain, are supplied. There are 125 plain buttons in red, grey, black and white and 16 illuminated buttons in clear, red, pink and green.

Full assembly instructions, parts list and parts number are supplied with each kit.

Further details: McMurdo (Aust.) Pty. Ltd. 19 Carnish Road, Clayton, Vic. 3168.

#### time multiplexed format - as is normal with most MOS calculator chips.

Capable of sinking up to 50 mA, the first device – the MC75491 – contains four Darlington transistors and is intended for use as a segment driver. Two MC75491s are therefore necessary to drive a seven-segment plus decimal point display. The device features low standby current drain – important in battery-operated equipment.

The second device is the MC75492 hex digit driver comprising six Darlington transistors capable of sinking 250 mA.

Further details: Motorola Semiconductor Products, Suite 204, Regent House, 37-43 Alexander St, Crows Nest. NSW 2065.

#### 3 WATTS AT 3 GHz



Our electron microscope photograph shows Siemens' new UHF broadband power transistor capable of handling 3 W at 3 GHz. The device is mounted on a film-type circuit measuring  $0.6 \times 0.6$  mm. The two wires are connected to the emitter and base of the component. The transistor design, made visible in the photo, is typical for microwave technology: close spacing and strip widths in the um range ensure a favorable emitter edge-length to collector-base capacitance ratio.

The resistors, arranged on the left – front of each emitter strip, are used to keep the current load uniform and thus achieve a good overall HF quality factor.

Research has shown that operation up to 4 GHz is at present possible with drive currents up to 0.1 A. This is obtained because of the extremely shallow surface diffusion of boron and phosphorus ions and the use of multilayer metallization on a gold base, factors which also result in high device reliability. The resulting silicon planar system is protected against the effects of humidity by nitride passivation.

The new transistor was photographed by an "Autoscan" sampling electron microscope. This instrument has a greater depth of field and a resolution several powers of ten higher than an optical microscope. The use of an electron microscope provides an excellent method of assessing new semiconductor components, as conventional electrical measurements can be supplemented by an electron-optical check of the fine structural detail.

Further details from: Siemens Aktiengesellschaft, Zl/Presseabteilung Technik, Joachim Ullmann, Erlangen, Postfach 3240, Federal Republik of Germany.

#### LIGHT ACTIVATED THYRISTORS

Motorola Semiconductor Products Division has introduced a new line of annular, light-activated thyristors available in both plastic and metal packages. Applications include: solid state relays, sensing, detection, opto-logic control, card read ing/counting/sorting, and photo coupling in addition to more conventional control and driving circuits.

Part numbers MLS101 through MLS105 designate the plastic, TO-92 version and part numbers MLS201 through MLS205 are the metal case, TO-18 version. Both versions have peak reverse blocking voltages from 15 to 200 V. Forward rms current for the



MLS101 series is 250 mA and the MLS201 series is 400 mA. Peak forward surge current for both series is 5 amps. These devices can provide several kV of isolation between the controlling circuit and the controlled circuit. A standard gate lead is provided to allow conventional electrical control instead of, or in conjunction with the device lens.

The new light activated thyristors are completely wavelength compatible with the visible and infrared Motorola LED series.

Further details: Motorola Semiconductors Products, Suite 204, Regent House, 37-43 Alexander Street, Crows Nest NSW, 2065.

### MICROPOWER OPERATIONAL AMPLIFIER

Improved processing developments and rigid burst-noise criteria have enabled RCA to supply a micropower operational amplifier that is virtually free of popcom "burst" noise. The CA6078AT has a quiescent supply current of less than 25nA - very important when considering battery powered portable equipment. Further details: Amalgamated Wireless Valve Co. Pty. Ltd. Box 24 P.O. Ashfield. NSW.

#### IMMERSIBLE PROXIMITY SWITCHES

The RSM02 and RSM06 series magnetically actuated promixity switches from FR Electronics are now available as fully immersible items, meeting the stringent specification BS201 Test QF. These units, intended for use in limit-switching and position indication applications, are capable of switching any signal from milliwatts levels up to 1 amp at 240 Vac.

High standards of repeatability and reliability are claimed features of these devices and with careful system designs, life figures of up to 100 million operations are said to be easily achieved. Further details are available from NS Electronics Pty. Ltd., Cnr Stud Rd & Mountain Highway, Bayswater, Vic. 3153.



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# 

#### SCHLUMBERGER 7040 ACCESSORIES



Schlumberger have recently released four new accessories to increase the capability of their 7040 and 4444 digital multimeters. These are clip-on modules which then become an integral part of the instrument.

The modules comprise a 70401 battery pack making the unit capable of a full day's operation without recharging, active 7040 RF probe unit enabling measurement to 400 MHz, a 70403 current shunt to provide ac and dc current measurement to 10 A with a resolution of 1 mA, and a 70404 low level resistance unit, which extends the ohms measuring capability down to 100 micro ohms.

Further details: Schlumberger Instrumentation Australia Pty Ltd, 112 High St, South Kew, Vic. 3101.

#### VERSATILE NEW 60-MHz OSCILLOSCOPE NOW AVAILABLE FROM TEKTRONIX

Tektronix has introduced a new general-purpose oscilloscope line – the 5400-Series – designed for low cost, flexibility and ease of operation. A unique feature of the 60-MHz three-plug-in oscilloscope is the ability of its CRT readout to be externally programmed. Claimed to be unavailable on any other oscilloscope, this important feature can be used to identify tests, note conditions, data and dates, etc. It is also useful when pictures of displays are to be kept for documentation of measurement information.

With its 60-MHz bandwidth, the 5400-Series is said to meet all the needs of most oscilloscope users, especially those in engineering, production and education. Its three-plug-in mainframe also gives added flexibility for the user; 17 plug-ins are now

available offering a wide range of measurement capability to choose from.

Integrated circuits are used extensively to keep acquisition and maintenance costs low and to add to reliability. The package includes a detachable display module that can be connnected either to the top of the mainframe for a benchmount configuration, or to the side for a 133 mm high rackmount configuration.

A large (158 mm diagonal), bright CRT, push button function and colour-coded control panels contribute to the 5400's ease of operation.

The CRT readout of plug-in parameters (optional) greatly enhances the ease of operation of the 5400-Series. CRT readout previously was available only on Tektronix 7000-Series oscilloscope. Added operator speed, perception and convenience benefits are realised with the CRT readout as it actively displays measurement parameters. And, control settings are not overlooked as the control display has been brought together in one, highly visible area.

In addition the 5400-Series mainframe provides two amplifier compartments and one time-base compartment. The two amplifier compartments mean that up to four traces can be displayed using two dual trace amplifiers, and up to eight traces can be displayed using two four trace amplifiers.

Two plug-ins, the 5A48 Dual-Trace Amplifier and the 5B42 Delayed Sweep Time Base, are now available that make full use of the bandpass and CRT readout capability of the 5400-Series. The 5403/5A48/5B42 combination provides 5 mV sensitivity at 60 MHz and 1 mV sensitivity at 25 MHz. This 1 mV sensitivity is useful for observing signals at the heads of tape and disc drive units. Problems in these peripheral units are often causes of system malfunctions. Though not designed as a portable, the 5403/5A48/5B42 is light enough to be carried to remote locations.

The 15 plug-ins now available for use with the 2-MHz Tektronix 5100-Series oscilloscopes are also compatible with the 5400-Series mainframe. (They do not have readout capability, however). Thus. although the 5400-Series is new, it already has a wide range of available measurement capability. The plug-ins include multi-trace (up to four) amplifiers that are useful in medical, biophysical, or educational applications; differential amplifiers with 100 000: 1 CMRR; a differential comparator amplifier which can provide measurement accuracy to 0.25%; delayed sweep time-bases; a curve tracer for checking diodes, transistors, and FETs; and a dual trace sampling unit with DC to 1 GHz bandwidth at 2 mV sensitivity. More plug-ins that will utilize the additional bandwidth capability of the 5400-Series are planned to be announced.

With its present wide range of measurement capability, and the promise of more to come, the low cost 5400-Series should be an inviting oscilloscope line for the 60-MHz, general-purpose oscilloscope user.

Further details: Tektronix Australia Pty Ltd, 80 Waterloo Rd., North Ryde, NSW 2133.

#### LOW PRICE 'SCOPES FROM HEWLETT-PACKARO

New 15 MHz oscilloscopes, Models 1220A (dual-channel) and 1221A (single-channel) from Hewlett-Packard have features usually found only on laboratory models, yet they carry practical prices.

Deflection factors are 2 mV/cm to 10 V/cm, so they are suitable not only for the general run of audio, video, logic, and control measurements, but also for such low-level uses as measuring the performance



of IF strips. Special facilities are included to examine television circuitry.

The cathode-ray tube is of laboratory quality with an internal graticule for no-parallax measurements.

The new instruments are all-solid-state, excepting only the CRT. Sixteen integrated circuits are used. Construction is of extreme simplicity: a rugged one-piece frame firmly supports three circuit boards and the CRT, forming a sturdy, shock-resisting structure with a vinyl-clad aluminium cover. Power dissipation is low (40 watts), hence heat is low, favouring long, trouble-free life; no fan is needed, so the cabinet is unvented, resistant to dust, moisture, and most other adverse environmental effects.

Their performance and ruggedness, claim the manufacturers, make the new 'scopes useful around production lines, numerically-controlled machinery, process control equipment, automotive, aircraft, marine electronics, and communications equipment.

Built-in TV sync separation assures stable, automatic triggering on frame or line for convenient TV fault finding. With the instrument's times-ten expander, vertical interval test signals can be pulled out easily. Since sweep is calibrated, it is easy to identify timing problems in vertical or horizontal TV circuits and to calibrate colour circuits. With the do-coupled amplifiers, accurate voltage measurements may be made of waveforms with both ac and dc components.

Further details: Hewlett-Packard Australia Pty Ltd, 22-26 Weir Street, Glen Iris, Vic. 3146.

### DIGEST – A system for teaching digital computers

A new system available from Feedback Instruments is called DIGEST – Digital Equipment System Trainer. It teaches the basic operations of digital computers and provides a 'hands-on' training aid for easy simulation of computer hardware. The device teaches from the binary arithmetic stages of addition, subtraction, multiplication and division through to the process of information storage and retrieval, then on to step-by-step construction of



BRIGHT STAR CRYSTALS P/L. 35, EILEEN ROAD, CLAYTON, VICTORIA, 546-5076



### EQUIPMENT NEWS

elementary 'scratch-pad' programs. DIGEST simply comprises the interconnection of a new Core Memory Interface CM1258 with two units already existing in some colleges, namely the Digital Computer Trainer DCT352 and Core Memory Trainer CMT257, to provide an integrated 16-word, 4-bit digital computer system which is manually programmable. DIGEST is suitable for use in schools, colleges and industrial training establishments as a readily accessible, easy-to-use facility for the rapid assimilation of digital principles and elimination of the mystique which surrounds computers.

Further details: Ronald J. T. Payne Pty Ltd, 385 Bridge Road, Richmond, Vic. 3121.

#### STREAMLINING POWER TRANSFORMER DESIGN

Computer-aided design software for transformer design has been converted for use with the Hewlett-Packard Model 30 calculator system. How one customer is using the Model 30 for magnetics design work is detailed in a new 8-page booklet.

The system and software discussed provide the user with three basic transformer design modes: 1) Core size and wire size are automatically selected from specified build, temperature rise and regulation. 2) Wire size and build are selected to meet size requirements. 3) Size and conductor size are specified.

An actual recent power transformer design is described, including the costing program.

This AN 161-2, "Electrical Engineering" is available from Hewlett-Packard without charge.

Further details: Hewlett-Packard Australia Pty Ltd, 22-26 Weir Street, Glen Iris, Vic. 3146.

#### LABORATORY PHOTOMETER/RADIOMETER



A new laboratory photometer/radiometer has just been released by Alphametrics.

This is the first instrument of its type available for light measurement. Designed to simplify ultraviolet, visual and near-infrared radiation measurements, the solid state digital converter ultizes a variety of accessory probes available for most conceivable applications. Each probe automatically selects the desired measurement units and range limits which are displayed on an illuminated multicolour information panel.

The DC 1010 photometer/radiometer is claimed to offer two outstanding features: a new or integrated approach to light measurement whereby the entire measurement setup – from source, geometry, detector probe through indicator unit – is considered as a total system. This approach is claimed to eliminate many sources of inconvenience, confusion and error normally connected with light measurements.

The DC 1010 also has the ability to measure and display directly in several types of optical units, eliminating the need for secondary calculations. Alphametrics probe line is based on silicon photovoltaic detectors. Nominal sensitivity ranges from 10<sup>-11</sup> watts to 1 watt depending on probe type. Photometric sensitivity ranges from  $10^{-8}$  lumens to  $10^3$  lumens. Thermopile and photomultiplier detectors are also available. The converter unit provides a 31/2 digit readout of the parameter under measurement plus a power of 10 exponent arid the exact measurement units. The DC 1010 measures light intensities over a dynamic range of 7 decades, within the limits of  $10^{-19}$  to  $10^{19}$ , as dictated by the probe.

Additional operating features of the converter unit are: variable gain adjustment for simplifying filter transmission measurements; an offset control with full-scale offset capability; a display hold capability; a display intensity selector for varied lighting environments and band-width selector with a range of 0.1 Hz to 10 Hz. Optional features include: a digital I/O interface which permits remote range selection and provides a buffered BCD output; automatic ranging and a pulse measurement capability.

Further details: Alphametrics Ltd, 532 Berry St., Winnipeg, Canada.

#### **COLOUR TV PATTERN GENERATOR**



The Arlunya PG100 is an all solid state test pattern generator designed for alignment and fault finding in both PAL colour and black/white TV receivers.

Designed and manufactured in Australia in accordance with best international instrument practice it is said to meet the relevant CCIR standard and the requirements of the Australian Broadcasting Control Board Specifications.

In addition to the eleven basic patterns, i.e. colour bars, red, green, blue, white, chequerboard, crosshatch, dots, horizontal bars, vertical bars and staircase, the PG100 features continuous control of burst amplitude as well as the facility to select between PAL and NTSC encoding of the colour sub carrier. Where desired the U and V components of the chroma signal can be switched off independently.

This flexibility makes the PC100 an ideal instrument for factory production alignment and test, service workshops, customer house-call service and teaching applications.

Facilities have been incorporated which make the PG100 uniquely suitable for rapid fault diagnosis in TV receivers. Among these are swinging – swinging burst operation for testing colour killer circuits and modulated/unmodulated sound carrier for audio circuit testing.

Further details from: Arlunya Proprietary Limited, P.O. Box 113, Balwyn, Victoria, 3103.

#### CONTROLLED TEMPERATURE SOLDERING TOOLS



A new series of line voltage soldering tools featuring temperature control by 'electronic feedback' has been released by Adcola Products Pty. Limited.

Called the 'Thermatic' series, the new tools have a temperature range of  $200^{\circ}$ C to  $400^{\circ}$ C, steplessly variable. Tip-face temperature can be altered in seconds by a simple adjustment of the in-handle temperature selector. Since it is not necessary to change tips to alter temperature, tip costs are lower and tip inventories smaller and less critical. Neither is it necessary to wait for a substitute tip to heat up from cold – temperature variation is achieved within seconds.

The Thermatic tools operate on mains voltage – no transformers are required – and all solid state sensing and switching circuitry is contained within the handles. All electronics are sealed against moisture and dirt.

Since the element is switched off electronically when the tip reaches the selected temperature, much more powerful heating elements – three to four times the normal – are used. Heat up and heat recovery are therefore several times faster than with fixed temperature models, and the controlled temperature enables one tool to handle joints with widely differing "thermal appetites", whilst reducing the risk of damage to heat-sensitive components and insulation. Hybrid, multilayer, and high

# EQUIPMENT NEWS

density circuitry, previously requiring above average care and skill, can now be soldered with more confidence, according to Adcola. Long, fast sequences can also be performed without the penalties attached to high idling temperatures, so solder joint quality is improved, tip tinning retained, and tip life entended.

The temperature selector can be fixed, if required, to prevent unauthorised adjustment.

Further details: Adcola Products Pty Ltd, 22 Firth St., Doncaster, Vic. 3108.

#### DIGITAL PROCESSING OSCILLOSCOPE/31 CALCULATOR



The Digital Processing Oscilloscope/31 Calculator Test System is an integrated instrument system comprised of two recently introduced instruments from Tektronix, Inc. The Digital Processing Oscilloscope (DPO) introduced in March 1973 combined computer processing power with a signal acquisition power for a modern laboratory oscilloscope. A more recent introduction is the TEKTRONIX 31 Calculator which features English-like programming keys and a simple keyboard that does math exactly the way you write it down. Combining these new instruments results in an integrated instrument system which can perform complicated and difficult measurements and calculations with ease.

The unique programming ease of the TEKTRONIX 31 Calculator allows the user to begin programming the DPO/31 Calculator Test System at once. No computer software language is required and no special symbols are used. Finger-tip programming using the calculator keys permits anyone to write programs using the math language he has known for years.

Not only is the DPO/31 Calculator test System a great integrated team, but each unit is useable separately. Thus, when calculator aided waveform measurements are not required, both the oscilloscope and calculator may be used for independent applications. Because the Digital Processing Oscilloscope is part of the Tektronix 7000-Series of instruments a wide array of plug-ins are available. Such acquisition units include single and multi-trace amplifiers, differential amplifiers, spectrum analyzer, digital counters, digital voltmeters, sampling and time domain reflectometry.

Further details from: Tektronix Australia Pty. Limited, 80 Waterloo Road, North Ryde, 2113.

#### **CLOSED CIRCUIT TV**



Two Philips circuit television cameras are vital for the efficient operation of an automatic control system in the Ultimo (Sydney) plant of Dairy Farmers Co-operative Ltd. They are used to check valve settings and flow lines.

One camera, a Philips type LDH 0500 is equipped with remote control pan, tilt, zoom, focus and iris facilities so the control operator can view any section of the hall in fine detail.

The camera is used to check that flow lines and control valves are properly connected, and opened and closed at the right time.

The second camera, a Philips type LDH 0100 is a fixed installation. It is located in a weatherproof housing in the milk intake area, and is used to monitor unattended equipment where in-correct pipe assembly, pipework failure or plant maladjustment could cause product loss.

The cameras are connected to two monitors in the main control room.

#### **BWD SHORT FORM CATALOGUE**

BWD Electronics has now released its third short form catalogue – a quality publication covering the current product range.

The equipment described includes oscilloscopes with features such as plug-ins, single and dual trace, differential input etc., large screen displays and TV monitors. Accessories such as trolleys, cameras, cases, rack adaptors etc are also listed.

Stabilised power supplies, together with function generators and composite instruments, complete the range.

Copies of the 10 page catalogue are available free on request from B.W.D.

Further details: B.W.D. Electronics Pty Ltd, 331-333 Burke Road, Gardiner, Vic. 3146.



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# goes 1 better!

Since Rotel introduced its RA 210, RA 310, RA 610 to the Australian market, the acceptance has been remarkable and the praise lavish from those who really know a topline amplifier when they use one. Now Rotel launches its new range of even more sophisticated models, easily identi-

fied by simply adding a "1" to the numbers above! Read all about this fantastic new Rotel range with second to none value, more quality, lower distortion!





#### RA211

Frequency response 20-75,000 Hz. 12 watts RMS per channel. 50 watts total music power (IHF). All solid state electronics, all silicon output transistors. Pushbutton controls for power, speaker system 1, speaker system 2, loudness and tape monitor. Headphone jack, facilities for magnetic and ceramlc cartridges, tuner, tape recorder, auxiliary equipment. In handsome timber cabinet.

#### **RA311**

A solid state integrated amplifier that lets you enjoy a new world of genuine high fidelity sound! Advanced solid state electronics, low-noise silicon output transistors, 22 watts RMS per channel at 8 ohms, 90 watts total music power (IHF). Frequency response, 15-90,000 Hz distortion 0.1% at 1 kHz. Facilities for magnetic and ceramic cartridges, radio tuner, two tape recorders, and auxiliary input. Tape dubbing from tape 1 to tape 2, 4-channel matrix speaker switch for simulated 4-channel surround effect. High and low filter, loudness, and 1 and 2 speaker system switches. Housed in handsome timber cabinet.

#### **RA611**

140 watts total music power (IHF), 35 watts at 8 ohms, RMS. Frequency response 5-100,000 Hz, distortion 0.1%. Generates an amazingly transparent sound. Professional tape dubbing facilities from tape 1 to tape 2 or reverse, facilities for two turntables (magnetic), tuner, two tape recorders, and two auxillary Inputs. Three AC outlets, tone control defeat, muting, high and low filter switches. Individual bass and treble balance, bass and treble.

See also the potent RA 1210, 160 watt RMS (4 ohm) amplifier with twin power.





Proof indeed of the quality of the Luxman SQ 700X comes from F. C. Judd, writing in the authoritative British "Audio Magazine" March 1973:

66

The makers tend to under-rate the performance of this amplifier. Rated twenty watts (sine wave) power per channel, the tested amplifier yieded over 25 watts per channel BOTH DRIVEN. I estimate the SQ 700XG to be a top performance amplifier. (Complete review on request.)

Briefly: 27 transistors, 2 silicone varisters, 4 silicone diodes. Frequency response 10-50,000 Hz ±1dB. Distortion less than 0.1%. Other "ultimate fidelity" amplifiers built by Lux, the world's most experienced amplifier manufacturers: SQ 505X, SQ 507X, SQ 202.

Available from: N.S

.S.W.	M & G Hoskins Pty. Ltd., 37 Castle St., Blakehurst 2221
	lelephone: 546-1464
Q'LD	Stereo Supplies, 95 Turbot St., Brisbane 4000
	Telephone: 21 3623
S.A.	Challenge Hi-Fi Stereo, 96 Pirie St., Adelaide 5000
	Telephone: 23 3599
TAS	Audio Services, 44 Wilson St., Burnie 7320
	Telephone: 31 2390
VIC	Encel Electronics Pty. Ltd., 431 Bridge Rd., Richmond 3121
	lelephone: 42 3762
W.A.	Albert TV & Hi-Fi, 282 Hay St., Perth 6000
	Telephone: 21 5004

Sole Australian distributors:



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#### **REVIEWER:** Brian Chapman



POWER ELECTRONICS – Thyristor controlled power for electric motors by R.S. Ramshaw. Published by Chapman and Hall 1973. Hard covers, 213 pages 230 x 155 mm. Available from Hicks Smith and Sons Pty. Ltd. Price \$13.50.

The speed control of dc motors in industry has grown enormously in recent years largely due to the advent of the thyristor. This solid state device replaces the thyratron of bygone days and, in conjunction with other solid state circuitry, makes possible the implementation of control systems having a degree of accuracy previously unattainable.

Control of induction motors by means of thyristor inverters is also increasingly being used and hence a knowledge of the characteristics and use of thyristors in power control circuitry is essential for the power or control engineer.

This book provides a discussion of the characteristics of transistors and thyristors without getting involved in the physics of the devices, and then concentrates on the methods of their application to power and motor control.

Control systems are described in fairly general terms, providing information on the types of feedback loops used, but not of the detailed control circuitry.

The book is suitable for degree or diploma students or practising engineers wishing to extend their knowledge in this field. -B.C.



ELECTRICAL ENGINEERS REFERENCE BOOK 13th Edition. Edited by Professor M. G. Say. Published by Butterworths October 1973. Hard covers, approximately 1400 pages. 215 x 135 mm. Price approximately \$36, available early 1974.

Whatever the field of human technical endeavour, it generally has an associated text which may be considered the 'bible' for that particular discipline. For the electrical engineer, the Electrical Engineers' Reference Book must surely be considered in that category.

The very fact that the book is now in its 13th edition since its first appearance in 1945, says a great deal for its acceptance by the electrical fraternity.

This new edition has been extensively rewritten, the page size has been increased, and a new type style used. Although many of the chapter headings from previous editions have been retained, much new material has been added and the previous material extensively updated.

The list of contributors reads like a "Who's Who" of the British electrical and electronics industry, and hence one can be sure that each section is up to date and has been written by an expert in that field.

Typographic errors are found to happen in any text, but I can't resist mentioning one in this book that is of 'mammoth' proportions. On page 1-15 the mass of an electron is given as  $9 \times 10^{28}$ g. The error is only in the omission of a minus sign in front of the exponent – but what a difference, the figure given is about 100 times the weight of the entire earth!

If you are involved in electrical technology in any way you should have this book. – B.C.



CIRCUITS FOR DIGITAL EQUIPMENT by C.J. Daken and C.E.G. Cooke. Published 1967 by Butterworths, Hard covers 433 pages 250 x 155 mm. Price \$18.85.

Digital equipment, in particular computers and process control equipment, is now so widely used that there is a specific need for a text which provides a description of the circuitry in use in such equipment.

The present book is intended to fill this need and provides such theory commencing from the switching characteristics of diodes and transistors. It progresses through simple multivibrator and pulse circuitry to the various forms of logic circuitry, storage methods, analog-to-digital and digital-to-analog converters, digital indicators and finally examines the question of reliability.

Of particular interest is the coverage of ferrite logic and ferrite-core stores which are covered rather more thoroughly than usual.

The text is almost completely devoted to discrete component circuitry which has now largely given way to integrated circuitry in new designs. Hence the book must be considered out-of-date as reference material for design. However it would be of value to students of digital electronics because of the insight one would obtain into the basic theory of digital equipment.

The book is well written, uses relatively little mathematics and has extensive references at the end of each chapter. -B.C.



DICTIONARY OF ELECTRICAL ENGINEERING. By K.G. Jackson Published by Butterworths, September 1973. Hard covers. 375 pages 215 x 135 mm. Australian price \$6.00. Available early, 1974.

Whether student or experienced engineer, a comprehensive dictionary of terms in the field of interest, is not only useful, but almost essential.

This volume, although specifically designed for electrical engineers, has great breadth and scope. For it not only includes conventional terms, but also some of those used in allied fields. For example more and more thyristors and other semiconductor devices are being used in 'electrical' equipment. Additionally a good electrical dictionary should cover illumination and some mechanical engineering as these fields are becoming ever more involved in electrical engineering. This one does.

The dictionary contains many illustrations, (at least one every second page) and gives relevant formulae where necessary.

An appendix at the end of the dictionary gives Units; Abbreviations and Symbols commonly used – S1 units in particular. And a final section provides a glossary of common semiconductor terms.

A well prepared dictionary that covers electrical engineering to a reasonable depth. -B.C.

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#### LISZT - Dante Symphony, Boris Khaikin (cond.), Women's choir and orchestra of the Bolshoi EURODISC 86187 KK.

The Dante Symphony is rarely performed and in print it is often compared unfavourably with the Faust Symphony. The problems with this score are to my mind largely concerned with performance. A large orchestra is called for and in addition a female choir for the brief Magnificat which concludes the work. The stormy opening and conclusion of the first movement Inferno contains the sort of rhetoric which requires romantic tremendous verve and drive, with passages conductors tend to smooth over these days.

There is certainly much that is beautiful in the music, especially the Paolo and Francesco episode in the first movement and the Purgatorio; and I do not think the short Magnificat makes the whole work somewhat lopsided: it is an appropriate understatement which also comes straight to the point without that sickeningly sentimental tone which mars the ending of the Faust's choral finale.

There has been to date only one other recording of this work, that conducted by Gyorgy Lehel with the Budapest Philharmonic and Choir originally released as part of the Liszt sesquicentennial and still available in this country on Qualiton LPX 1070. The recording from Qualiton still sounds surprisingly good and if only on the basis of Purgatorio and Magnificat movements the Lehel performance would seem to have the edge over this newer recording. The Budapest strings have a more refined tonal quality which suits the very Parsifal-like second half of this work. Also, there is a greater feeling of calm in the Purgatorio while the female choir in the Magnificat sounds more celestial than the Russian choir here.

Predictably, however, Lehel does not sound quite at ease in the more stormy sections of the Inferno. Khaikin's first movement may sound rather wayward to many at first, and it often is. There are even moments particularly towards the end of the first movement when one wishes things

I thought at first that the Purgatorio movement seemed to have more forward movement than the music required but listening to it a few times has convinced me this approach seems to make more sense of the music and for once the Purgatorio does not sound like a different work altogether. The Fugato section of the Purgatorio, for instance, has a remarkable urgency about it which ultimately helps to place the concluding Magnificat in its proper place. Also the quick pace taken in the transition to the Magnificat is very much the way things should be done. The tonal quality of the female choir at this point in the work sounds very much like a Russian view of heaven, as I have suggested, but there is perhaps nothing wrong in that. It is a strong heaven we hear and we have at least less of the sentimentality which is about the more conventional sounds in Lehel's performance. The recording is, of course, more vivid than in the Oualiton record and pressing is excellent. Very highly recommended. - J.A.

#### JACOPO PERI-EURIDICE – Coro Polifonico di Milano, Solisti di Milano, conducted by Angelo Ephrikian TELEFUNKEN SAWT 9603/04.

Telefunken's new Musica Italiana series has come up with some strikingly important material and this is all to the good since the Italian Baroque is in fact sadly neglected on records. Performances, however, do not always have that careful interest in performance practice which we have come to associate with Telefunken. In addition translations of Italian texts have not been supplied in the recordings of vocal music so far issued. The present recording is one irritating case in point. The meaning of the words in this earliest of extant operas is all-important and we are not even given a synopsis of the Italian. Inasmuch as Rinuccini's text differs considerably from Striggio's in Monteverdi's Orfeo, and certainly not everyone outside Italy is sure to have command of Italian, the omission of translations is very unfortunate indeed.

This recording has been available for a number of years on Arcophon in Europe and Musical Heritage in America. The processing by Telefunken is superior to either format and the pressings are superb. In addition, this recording's availability on Telefunken should find more listeners than has been previously possible.

If one does not count Emilio Cavalieri's *Rappresentazione di Anima e di Corpo* as an opera, this work performed in 1600 and by the composer of the very first (now lost) opera, is the earliest work written in the new monodic style that heralded the Baroque period. By comparison to Cavalieri's more sumptuous style and all too-often tedious writing, the *Euridice* by Jacopo Peri is the true example of early

monodic style, very intellectual and almost stark in its avoidance of vocal display. At this distance in time it rains a monument to the humanists in Peri's circle who wanted to recreate Greek drama. Historians like to point to Monteverdi as the composer who rescued opera from the constricting style of early monody and very few seem to exempt Euridice from the general charge of tediousness to be found in early monody. At best, most writers on the period are surprisingly vague as to the quality of Peri's work. It is true that early monody was in fact a very restricting style but for all that Peri's Euridice is never dull; it is a very quiet style but the recitatives are highly varied and interesting. One can well understand why its first audience was deeply moved. There are few operas indeed in the Baroque period which show such striking originality and depth.

The performance here is mostly what one could wish for in this work. Angelo Ephrikian makes no attempt to realise this work a la Leppard and nothing is over-dramatised. One marvels at the restraint and respect with which everyone approaches the music. The singing is generally on a high level and only Adele Bonay's singing of La Tragedia and Proserpina leaves something to be desired. She does, however, sing her parts with intelligent attention to the meaning of the text and in this work this is perhaps a more important quality than any short-comings in the singing itself. Listen to the second side in this set and one will find singing and playing of intelligence and often exquisite restraint.

Not for the typical opera buff perhaps but urgently recommended for those interested in music. -J.A.

#### CHOPIN: Piano Concerto No. 1 in E minor, Op. 11. LISZT: Todtentanz. Alexander Brailowsky (piano); Philadelphia Orchestra/Ormandy. CBS Odyssey OD-2010 (\$2,75). Distributed by Avan-Guard.

An excellent record from all points of view. 1 have heard worse sound on full-price records; 1 have seen less generous offerings on full-price records (though the prize still goes to the long-deleted Parliament? recording of Babura-Skoda, with both concertos on the one record). There is minimal hiss, and only a trace of tinniness in the upper treble; and as well it is in the cheapest bracket for classical records.

Again, it is the soloist and not the orchestra who really makes a great Chopin performance. One could not have better from Ormandy here, as one would expect from his orchestra. He takes all three movements rather faster than usual, and adds a dash which is matched by Brailowsky. This is a performance which must be appreciated for its excitement, particularly the first movement, because it would be flattery to call it a great performance, like a Rubinstein performance. He does not try to imitate anyone's style, however, but is a Brailowsky original. Imitations of great styles rarely

(Continued on page 110)

# CLASSICAL

work, and imitations: of the Rubinstein shimmering, graceful *nubatoed* style very often produce mutations like the Schmalz Waltz and Murky Mazurka.

The other interpretation is the Arrau-type (on Philips 6500-255, Concerto No. 1 only), introspective and disciplined, with an orchestra to match. Particularly in the second movement, Brailowsky simply cannot match it. Arrau is no less exciting, but it is a distinguishing mark of a great pianst that he may be introspective and yet convey the excitement of the music at the same time. But this record is full-price, as is the Lewenthal edition of the Todtentanz of Liszt (coupled with the Henselt Piano Concerto, on CBS) which just has the edge Brailowsky's performance. Again, on Brailowsky is powerful and exciting, but Lewenthal not only has the advantage of full-price recording quality but has devoted himself to the resurrection of lost Romantic music and knows it inside out (he is also built somewhat like Liszt, an advantage in knuckle-crunching string-breakers like this).

The piece is a set of connected variations on a threatening, seven-note theme, designed to demonstrate the virtuosity of the pianist (Liszt himself, of course, to start with, and *his* performances caused the ladies to swoon quite away...). It has otherwise anything wirtuosic in stripping the skin from one's knuckles by dragging them from top octave to bottom and back again a few times. Nor in jack-hammering the bottom octaves with the apparent intent of breaking all the strings. But I suppose it had a social purpose. -T.R.B.

CHOPIN: Piano Concerto No. 2 in F minor, Op. 21; Krakowiak (Concert Rondo) Op. 14. Claudio Arrau (piano); London Philharmonic Orchestra/Eliahu Inabal. Philips 6500-309 (\$6.20).

This is the second record to be issued by Arrau in his recording of the complete (six) works of Chopin for piano and orchestra. Though the concerto is numbered the second, it is actually the first; the Rondo was written a year earlier, and both show very clearly that while Chopin's music for the piano is sheer genius, his music for orchestra is mediocre and even on occasions painfully weak.

In this recording, Inbal makes the orchestral part as interesting as is possible, producing the beautiful full-blooded Philips sound in excellent balance with the piano. It would be wise to listen to your copy before you buy it though, because mine was dogged by a persistent hiss and crackle (very unusual for Philips). Nevertheless, especially in these Chopin concertos as in no other concertos, it is for the soloist that one makes one's selection.

Perhaps the greatest recording to date of this concerto is the Rubinstein/Ormandy one, and a comparison between Rubinstein

and Arrau shows just how different interpretations can be. Rubinstein plays almost in a series of impressions with an unmistakable grace. Arrau is introspective, almost brooding; by no stretch of the imagination could one say that his style is graceful - in some ways it is almost blunt. While Rubinstein's Chopin is full of rubato, Arrau almost concedes it, on the relatively few occasions on which he uses it. For those used to Rubinstein's style, Arrau may sound very strange, but it should be remembered that it is really only the great interpreters who can succeed with a new interpretation, and Arrau is certainly great. Far too many copy Rubinstein's style without being great enough to get away with it; it sounds like post-Paderewski-ism. That means heavy rubato, persistent left-hand-before-rightism, and in the wrong hands (rather, from the wrong hands) sounds affected - at worst, musical dilettantism. Nowadays it is just plain dated. Arrau's introspection has brought a new light onto this concerto, and it is a great pity that there are not more Chopin performances which share his strongly imparted sense of discipline.

Of the 'Krakowiak' rondo, there is little I can say but that it is played with the same consistency of interpretation as the concerto. I find the piece rather tasteless, but for the poor quality of the orchestral part rather than the solo part. "Popular dance character of the themes" (cover notes) is understating it, however. I can hear large sections of it in the Moulin Rouge. But the parts which aren't dance hall are unmistakable Chopin, and well worth listen to. - T.R.B.



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Not Steeleye Span and not even Stealer's Wheel.

Dan Steele - outre Daniel - Steely Dan! And FRESH! Just what the world needs so very badly – another rock 'n' roll band. Another GREAT rock 'n' roll band: guaranteed high-octane third generation East Coast America - fully customized, fully versatile. New York/Boston rock 'n' roll the way it used to be back around '67 with groups like Orpheus, The Rascals and Left Banke - a little less plush, a whole lot more expansive, pungent, self-assured; but essentially in format, much the same.

Six years on the genre remains unchanged: the same sense of melody, rhythm and structure; the same lyric approach and persuasive control; the same insistency and joyfulness and enthusiasm - warm like a summer sunset, invigorating like a dawn skinny dip. Real tender and mellow and hypnotic.

Steely Dan play songs - angular, articulate, optimistic; solid and beefy accelerating firm, fluid through flight formation. verse/chorus/verse Infectious like instant V.D., and proportionately as epidemic: rock 'n' roll minus all those self-indulgent virtuoso doggedly solo instrumental noodlings; rock 'n' roll minus all the punk persona pyro-technics and thematic decadence.

Steely Dan play it natural - incisive, swift and thoughtful; easy to relate with; the note

- that's all all there is. Rock 'n' roll music elating in its intimacy, disarming in its tone: bitter/sweet and up-front-honest-innocent. Real open. Real romantic.

"How's my little girl?" Are you reelin' in the years? Stowin' away the time? Are you gatherin? up the tears? Have you had enough of mine?" It's all there, totally electric in influence: from Wes Montgomery and Charlie Byrd through to the Beatles, Byrds; from jazz through calypso to hard rock and latin back beat. Simply, Steely Dan is the finest and most capable new band America has come up with for YEARS.

Truly fine.



#### "PIN UPS" - David Bowie, R.C.A. Stereo, APL1-0291.

An interesting, unexpected album from England's multi-talented David Bowie: All twelve tracks have been drawn from the '64-'67 British rock archives and feature as David's favourite songs from that era. As an interpretive vocalist, Bowie commands most cuts easily, without effort; changing gears constantly from frantic blues through heavy rock 'n' roll to Mersey-side pop balladry and Pink Floyd psychedelia, retaining much of the original energy load yet subtly re-arranging, up-dating, affecting thoroughly with his own unique character.

A varied, well-defined set, not to be taken too seriously. Certainly, not to be compared with his own material i.e. "Hunky Dory", "Aladdin Sane" etc. Tracks include The Easybeats' "Friday On My Mind", "Roslyn"/"Don't Bring Me Down" by The Pretty Things, The Yardbirds' "I Wish You Would", "I Can't Explain"/Anyway, Anyhow, Anywhere" from The Who, and The Kings "Where Have All The Good Times Gone". Pick up on this.

#### HIS GREATEST PERFORMANCES" -Richard Harris. E.M.I. Stereo. SPBA. 1057.

A superlative 'hit' compilation from actor/singer Richard Harris - the man who brought back grandeur to the art of commercial balladeering. Though vocally restricted, limited somewhat severely in range, Harris projects passionately, eloquently, with much taste, much sensitivity, much control. "MacArthur Park", "Didn't We?", "My Boy", "The Yard Went On Forever", "One Of The Nicer Things" and "A Tramp Shining" are already accepted as contemporary standards. An immensely enjoyable album.

#### "TRES HOMBRES" - Z.Z. Top. E.M.I. Stereo, SAHA.8459.

A three-piece Texan blues-boogie band in the finest post Cream 12-bar gut muscle tradition - Z.Z. Top spew it up hard, pungent, unrelenting. "Tres Hombres", their third album, continues to let it bleed thick and ornery, pulsing electric with much enthusiasm, much dance appeal. Get it on.

#### "OORA" - Edgar Broughton Band. E.M.I. Stereo, SHVL.801.

One of England's original and last remaining 'underground' groups in the '68 socio-political consciousness vein, Edgar Broughton Band enjoyed initial success with mild hits such as "Out Demons Out" and "Apache Drop Out", yet somehow failed to consolidate their popularity due to a series of increasingly obscure thematic album releases, all of which, including the current "Oora", come across oppressive, undefined and emotionally inaccessible. Basically, it's hard rock bogged down in a sometimes pretentious, always erratic and obsessive mentality, more concerned with message than music. By far their best set in album number four, simply titled "Edgar Broughton Band" - Stereo. SHVL.791.



#### "RAZAMANAZ" – Nazareth. Stereo 6303.085. Phonogram. "RAZAMANZ"

Vintage '73 English boogie/rock, wholly electric in form - Nazareth dish it out dynamite dynamic, ravenous, totally commanding. A varied, exciting album loaded with punch and animation - an absolute rock 'n' roll treat with touches of Led Zeppelin, Slade, Status Quo and The Faces predominating. Heavy electric energy handled with taste, presented with much skill, much funk. Includes their two English hit singles, "Bad, Bad Boy" and "Broken Down Angel". Buy Some.

#### "MA" - Rare Earth. E.M.I. Stereo SREA. 5004.

Bland jazz-rock and diluted albino soul from Detroit's Rare Earth. A competent, efficient band with a sadly out-moded style blending touches of Chicago's brass, pallid attempts at accepella vocals similar to Tamla-Motown's Temptations, and odd psychedelic flashbacks in arrangement not unlike early Iron Butterfly circa "In-A-Gadda-Da-Vida". You've heard it all before. And better.



"Heart Food" – Judee Sill. E.M.I./Asylum. Stereo.SYL.9006; "Angel Clare" – Garfunkel. C.B.S. Stereo.SBP.234341; "If You're Lonely" – Eric Justin Kaz. W.E.A./Atlantic. Stereo.SD.7264; "A Little Touch of Schmilsson In the Night" – Harry Nilsson, R.C.A. Stereo.APLI.0097-G.

Four visionary helpings of heart balm, each based on essence – the capacity to love, be loved and love in return. At worst, as with Arthur Garfunkel's first solo set, sentimentality takes immediate strange hold and the result is little more than wallpaper muzak – decorous romantica cloying tacky, embarrassing in its conceptualized, the matically induced emotion.

"Angel Clare", despite superlative production, arrangements and musicianship, despite potentially dynamite material, comes across insipid, forced, totally insubstantial. In impact, Garfunkel's style is trite, narcissistic, engulfed in fairy floss vagueries, drowned out with castrated choir boy histrionics. His entire vocal stance remains rigidly unaltered, sustaining the "Bridge Over Troubled Water" effect endlessly.

Garfunkel's biggest problem is his breathlessly inhibited attitude, his lack of conviction. He doesn't sing; he merely exchanges petty pleasantries with each song, overloading each note with laboured man nerisms, excessive atmospherics, redundant feather-weight vocalese. The man's got no funk. No balls. No soul. Everything he does is calculated, choreographed to the tee.

Eric Justin Kaz, one-time leader of the now defunct Blues Magoos, though vocally slight, works through Gospel/Blues oriented, largely orchestral ballads with the same disarming intimacy and personable, natural easiness in tone as James Taylor. His style, his approach soars high, caressing, reassuring through sheer lack of assumption, gently and thoroughly commanding with its humble suppliance – loving real hard, openly, joyously.

"If You're Lonely" is an album for the soul sore, radiating warmth, exuding an unaffected, forth-right, masculine strength in lyric and melody as calm as it is convincing. Kaz sings of frustration, loneliness, Spiritual inconsistency; of Faith and Hope; of man's vulnerability and lack of insight. Just find a way to love – nothing more, nothing less. A beautiful album.

"Heart Food", Judee Sill's second Asylum release, is simply a *classic* – one of this or any other year's finest, most elating albums. Music for the Spirit: militantly reverential, passionately involving in devotion to the Sacred Heart. Sill is an amazing woman, openly documenting her ecstasies, inconsistencies, emotional self-doubts and, mostly, her unashamed struggle with the dark night of her Soul. She doesn't just write songs; Judee Sill raises hymns in the glorification of Jesus Christ, her perfect master.

Exultation/Exaltation. Again, it's love music. But with a difference: Judee Sill breaks free from Gospel/Church relgiosity and self-righteous preaching; she performs succintly in the colloquial, hitting hard with images alive, living, real – easy to assimilate, dead easy to relate with on any level. She's not a Bible-basher, Holy-roller or anything like that; Sill simply sings of love, pain, suffering, stating fully her beliefs free from the usual cliches and Jesus-freaking.

As a songwriter she rivals Joni Mitchell. Buy "Heart Food".

Derek Taylor (always one for the self-explanatory quotable quote) on Harry Nilsson's "A Little Touch of Schmilsson In The Night".

'There are twelve songs on this album and as you will hear, they are quite exceptionally distinguished pieces of art and as Art, they are timeless and very precious. Beyond price. It was important, therefore, to treat them with immense loving care and kindness...'

'Finally, something about why we did this album. We did it because these songs deserve, it, and because it is 1973 and times are tough and when times are tough, we need, all of us, whatever our age, whatever our lifestyle, whatever our pain ... we need a little touch of Schmilsson in the night.'

Absolute romance fodder, exquisitely conceptualized, centred thematically on Herbert Hupfeld's "As Time Goes By":

'You must remember this,

A kiss is still a kiss,

A sigh is just a sigh,

The fundamental things apply,

As time goes by.'

Twelve standards, ever-green love songs treated to a renewed lease of life by the world's best contemporary male vocalist, Harry Nilsson. Tracks include "It Had To Be You", "I Wonder Who's Kissing Her Now", "Always", "Lullaby In Ragtime", "Lazy Moon", "Makin' Whoopee!", "What'll I Do" and "For Me & My Gal".

Buy it, buy it, buy it – love it to death. A GREAT album.



#### "Frampton's Camel" – Frampton's Camel. Festival/A & M. Stereo. SAML. 34929.

As Humble Pie's lead guitarist through the first five albums, melody foil to Steve Marriot's fatally punkoid pseudo-Spade histrionics, Peter Frampton centred and balanced much of their early character, off-setting the basic gut raunch with a considerate, lucid delicacy in style - free from excess, intimately lyrical; always with the same positive, workmanlike bearing and control. As a songwriter, in both ballad and hard rock forms, much of Pie's most interesting cuts have been Frampton credits, ranging from the graciously reflective jazz-oriented "Only You Can See" and "Take Me Back" through to the mid-tempo bulldozer riff magnetics of "Shine On"/"Stone Gold Fever". Essentially, he's been far more than just underrated.

"Frampton's Camel", his second effort since the Humble Pie split, follows through in directions with his more subdued, acoustic ballad approach – largely introspective, low-key poignant in delivery, generous and unassuming in its impact. An album of beautiful songs roughed up 'round the edges' with a bit of cock-rock. Pick up on this set – Peter Frampton is one of England's most prolific young musicians. Real class thoroughly guaranteed.

#### "Rubber Bullets" - 10.C.C. E.M.I. Stereo. SKLA.7703.

Hailed as England's most potentially lethal straight pop/rock outfit in years (and rightfully so); 10.C.C. mix-match their style in an amorphous, wholly derivitive blend of fifties' highschool balladry, mid-sixties' British blues-oriented rock, Beach Boys/Four Seasons melody-accepella vocal structures and Zappa-styled Dada song forms circa "Reuben & The Jets". An intelligent, sophisticated band with so much to offer in the art of memorable, instantly and insistently appealing radio music. A fine album – quite superb in most every detail.

#### "New York Dolls" – New York Dolls (IMPORT) Mercury/Phonogram. Stereo. SRM.1.675.

Z

Third generation "Max's Kansas City" plasticon in the finest Reed/Bowie pop tart Decadent – New York Dolls: McLuhan-aged rock mutants specializing in post-Jagger electric energy orgasm of the sonic guitar rort variety; the front wave sniper squadron for such forth-coming acts as Teenage Lust, The Harlots Of 42nd Street, Wayne County & Queen. Musically, it's obsessive, frenzied, unrelenting – the full rock 'n' roll holocaust. Be warned, the Dolls mean business.





Borderline electronics perhaps, but this film was so unusual we sent Jan Vernon along to report.

SCIENCE fiction films get better all the time. Once the movie makers could get away with panels of flashing lights and a few shiny knobs and levers.

You can't even fool littie kids like that anymore. "Gosh dad, if he really had his thyristors wired to the solenoid like that he'd have a short in the l.C's."

This brings us to MGM's new movie 'Westworld', a science-fiction type movie which has some very believable technical equipment indeed.

It's set in the future, but only because the events in the story haven't happened yet.

What's 'Westworld'? Westworld is part of Delos, a thousand-dollar-a-day resort which allows guests to enjoy true-to-life replicas of either a frontier town – a medieval world or decadent Rome, all inhabited by robots. We mostly see Westworld in the film. It is the exact replica of an 1880's frontier town complete with gunslingers, primitive quarters and the full stresses of pioneer life. Like watching a western movie – except that the visitors participate in the action.

The film concentrates on Peter Martin and John Blane (played by Richard Benjamin and James Brolin). Blane has visited Delos before and is enthusiastically extolling its virtues to Martin. They change into western gear, strap on six-guns and board a stage for town.

Delos is controlled by technicians manning scores of computer consoles.

The only humans in the resort are the guests. The rest of the town's people are robots.

Blane and Martin head for the saloon. Martin is a bit embarrassed by it all, like someone who's been asked to play a silly game at a party. A robot gunslinger (played by Yul Brynner in all his usual black gear) provokes him to a gunfight. Martin shoots the gunslinger who dies realistically – with blood spurting – and finds he is starting to enjoy himself. Later he enjoys himself even more at Miss Carries' bordello where the 'girls' (more robots) are programmed to please.

Once the guests are asleep for the night the scene changes. Now we see the control centre. Robots are being programmed to meet any wishes expressed during the day by the guests. Electric vans glide around the silent streets picking up the robots who have been damaged during the day.

The robots are then lined up on operating tables, looking exactly like humans prepared for operations except that beneath the human-like skin are rows of gleaming electronic components.

Some of the robots are malfunctioning for no apparent reason and the chief engineer admits that they don't understand completely how they work. Some of the robots have been designed and built by other robots.

Next day Blane and Martin have another exciting day. The gunslinger has been repaired and programmed to hunt Martin who shoots him again. The sheriff arrests Martin and the two men stage a jail break and ride out of town.

A robot rattlesnake strikes and the metal teeth connect. This is not supposed to happen. The men are worried but forget their worries later back in town during a wild bar room brawl. The rattlesnake malfunction has been ' seen by the technicians on their monitors. They realise that something is seriously wrong. In Medieval World that day a pretty maid has refused a guest's attempt at seduction and slapped his face. They decide not to take any further guests until they sort out the trouble.

The following day Blane and Martin wake-up with hang-overs and stagger out into the street. There's the gunslinger who has been repaired overnight. This time he shoots at Blane, and to the shocked amazement of both men this time is for real. He shoots again. Blane dies — the scene looks incredibly realistic compared with the deaths of the robots.

Now the situation is out of control. The technicians shut down the power but realize the robots are running on their internal standby batteries. The technicians find they can't start up the power and are locked in the control room unable to open the power controlled doors. All over Delos the robots, who the guests have normally bested in combat, are out of control but behaving lethally according to their programmes.

In Westworld, Martin is trying to escape the gunslinger. He takes a horse (robot) and rides out of town. The gunslinger follows and now we start to see the world through the computer grid of the robot's eyes as he tracks Martin using all his programmed knowledge and skills.

Martin tries to hide in the under-ground control centre. But the gunslinger has switched to heat sensing and is tracking Martin by the heat pattern left by his foot prints. Martin attacks him with acid but the gunslinger douses himself with water and continues relentlessly to track Martin through all the worlds of Delos – which are now strewn with the dead bodies of guests.

Martin tries to destroy the gunslinger with fire but is only finally saved when the gunslinger's batteries run out.

End of movie — the message that playing at violence can get out of hand is pretty clear, but there's a few more implications.

Is this the sort of use we'll eventually make of technology. Could be... After all it's quite feasible that people might be so bored with daily life that they'd pay this sort of money to live out a fantasy.

One consolation. If you don't fancy being a guest in Delos at least there'll always be jobs there for good technicians and computer programmers to run the place.

The movie was directed by Michael Crichton who wrote the Andromeda Strain. It starts at Sydney's Liberty Theatre on Friday, December 28th.



#### **MUSIC SYNTHESIZER**

I have a number of questions concerning your current International Music Synthesizer..

a) Can the voltage controlled oscillators and other modules of the larger (4600) unit be used in the 3600 unit?

b) What is a rough estimate of cost of both units?

c) When will you publish circuit diagrams of the smaller unit?

d) Where can I purchase a case for the assembly — also a keyboard?

e) Are all circuit boards available - if so from whom?

f) Is it possible to start building the 4600 unit and use it before it is finally completed?

#### D.H. North Caulfield, Vic.

Nearly all modules are identical in both units – the 3600 merely has less of them Apart from that a few facilities have been omitted. The differences between the two units may readily be seen by comparing the specifications and front panel drawings shown on pages 28, 29 and 30 of our October 1973 issue.

Interconnections however are quite different. Full details of the smaller unit will be provided in approximately two months time.

It is possible to partially complete and use either unit. The 4600 model for instance may be used to generate quite complex sounds if work is

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completed on those sections described in our October, November and December issues.

Cost depends entirely upon the manner in which components are purchased – probably the best way is to purchase a complete kit from those companies who specialise in this type of business. Their advertisements will be found in most issues of this magazine.

The cases, printed circuit boards and all components will be available from several kit set suppliers in the near future. At least one is currently stating this in his advertising.

#### SUPERFLUOUS BITS?

The International 416 amplifier (June 1973) appears to have two resistors that do absolutely nothing at all! Resistors R3 and R4 are shorted out at all times by the earth connections – so why put them in? R.W. Broadview S.A. 5083

The function of these resistors is explained on page 78 of the issue concerned. Their purpose is to prevent damage to the input stage of the main amplifier if the input earth is disconnected – as it so easily is. They are sufficiently high value to prevent the generation of hum by earth loop currents flowing in these resistors.

#### CYCLONE DETECTOR

I refer to your project article 'Cyclone Detector' (ETI p. 143 Nov. 75) in which there appears to be some confusion in terms and capability which could be confusing.

Cyclones are of two types - tropical and extra-tropical. The tropical cyclone is a disturbance measuring a few hundred miles across, usually with extreme winds and rain near centre, and often with a calm cloudless 'eve' at centre; the extra-tropical cyclone or mid-latitude 'low' is a low pressure area also usually hundreds of miles in extent, and with which wet and windy, but usually not violent weather may be associated. On the other hand, a funnel cloud sometimes occurs as a particular manifestation of a tornado, which is linked with some severe thunderstorms. In common with a tropical cyclone there may be damaging winds, but a tornado and its parent storm is a relatively small scale phenomena, and is not meteorologically associated with tropical cyclones.

The TV adaption described might respond at short range to atmospherics originating in a thunderstorm, and with some sets, to mains dropouts – possibly storm induced. It could not be relied on to give warning of a cyclone or a 'vacuum funnel', and indeed, it could be exceedingly dangerous to pin any sort of faith in the device in preference to the excellent tropical cyclone warnings broadcast on radio.

R.L.B. Parkville, Vic. 2052

#### ELAC PUZZLE COMPETITION

PRIZE – AN ELAC STS.244-17 Cartridge Awarded to first correct entry opened on publishing date of next issue of Electronics Today International

	THE F			_	SB	_		.0.	. 0			we are extremely pleased to see a lady win an ELAC competition. So come on girls let's see more entries from you.
J parti S parti B part W part	ners			1 s j w b	2 3 b w w b j s s j	4 s b w j	5 s j b	6 b w s j	7 b j w s	w b	9 w j s b	PUZZLE NO. 10 The illustration shows how ten counters may be placed on the points of the diagram where the lines intersect, so that they form
Each evenin	of the fin ngs. Js	vs.	e pairin <sub>i</sub> Sj		oduce Bw	mat		es fo WE		hrei	8	five straight lines with four counters in every line, as indicated by the dotted lines, Can you find a second way of doing this? Of course a mere reversal,
23	Js Js	vs. vs.	Wb Bw		Bw Wb	VS. VS.		Sj. Sj				or, reflection of the given arrangement is not considered different — it must be a new scheme altogether, and of course, you cannot increase the dimensions of the digram, or, alter it's shape.
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**MR 611** 



Instrument evaluation laboratories - a step in the right direction

LAST month, after a blast about the poor quality and service that I have encountered with recorders I promised to discuss an approach that is just beginning to have impact on this problem.

For many years now Australia has had an organisation that provides a calibration and testing service to industry and science. This organisation is the National Association of Testing Authorities (NATA). Hundreds of laboratories are registered throughout Australia each to carry out specialised testing or calibration for their own products or for paying customers. (This magazine's equipment reviews are conducted by a NATA registered laboratory.) Britain also runs a similar scheme. In this way the standard of safety or accuracy of an instrument, a boiler, a carton, a concrete sample, etc. can be maintained.

I do not think I need stress the fact, however, that although an instrument might be the most *accurate* in the world this in no way guarantees that it will be the most *reliable*, or up to all of the specifications given. A NATA certificate only tells us that it has been calibrated to certain standards. To put it in everyday terms, your new Forden car might well do the hundred plus stated and return enough miles per gallon, but the roof could be leaking, the brakes grabbing.

Overall, with vehicles, it is not performance defects that send the cars back under warranty — it is the annoyances and non-specified features. This is exactly the case with instruments — accuracy is but a part of the story. In the recorders mentioned last month the defects were not in calibration but to do with inking, failure of the auxiliary indicator — and pieces falling off.

It has recently been estimated that a process plant nowadays includes some 3-15% of the total cost as instrumentation. Not a large proportion, so why bother about its quality when more cash can be saved in the purchase of the rest? But this is dull thinking for instrumentation is the controlling heart of the plant. A breakdown of a controller, the failure of a safety warning device, or the miscalculation of a computer may cost thousands of dollars. For instance, a ship not completed on time (due, perhaps, to incorrect instrument operation when first installed) costs someone \$1000/h; the closure of a chemical plant might need many man-days of labour to purge and restart the process - perhaps as much as \$50,000 will be needed. Have you ever thought what happens if a process like a blast furnace, or an aluminium smelter goes cold.

If my own (and, by the way, numerous other people write to me on the same theme) experience is anything to go by, Australian industry all over our continent must be losing (wasting would be a better term) thousands due to instrument failures that could have been avoided if the device had been tested for practical defects as well as accuracy before installation.

As far as I am aware, we have no advertised service that will take an instrument and evaluate it, so we look to Britain's attempts to see what has been done to alleviate defects before installation.

1961 the Scientific Back in Instrument Research Association (SIRA) pioneered a process-control instrument evaluation service in conjunction with the various power-generating authorities in Britain. Out of this grew the recently introduced SIRĂ independent evaluation laboratory - SIREP for short (Sira Instrument Research Evaluation Panel), This is paralleled by a similar group in Holland (WIB -Party on Instrument Working Behaviour). These two organisations provide service for Europe and the Americas. Australian organisations may, of course, use the service. It is not free, the fee ranging from \$300 to \$3000 depending on the tasks set. Members of the organisations receive reports automatically so a large user of instrumentation will be in possession of many of the reports needed. It is somewhat like subscribing to 'Choice' or 'Which' with the goods being tested being instruments instead of consumer products. There is a difference though, for the Evaluation Centres do not usually *compare* products; they report fairly on the defects and factors of an individual product. (ETI, in fact, operates a similar service on a smaller service scale with the regular product tests that are released each month).

The evaluation of all possible devices would need an enormous laboratory. So far at SLRA they have restricted capability to common variables such as flow, gas analysers, process instruments and optical components – WIB caters for others. It must be realised that adequate and worthwhile evaluation requires a miniature test plant with which to create the conditions needed.

Features tested or considered by the centre might include the quality of finish and manufacture; usefulness of the documentation; temperature coefficient of performance; tolerance to humidity; vibration characteristics; estimated reliability; general design features of the unit when tested as a subsystem in a larger system; safety in a flammable environment — the list of probables ends where the customer specifies.

That, in a nutshell, is what instrument evaluation is about. It seems industry in Europe is making more and more use of this. Perhaps manufacturers will one day give the customer an evaluation certificate as routine procedure. I suspect there are few companies game to do this at this time.

If the need does expand, let us hope it spreads to us. We certainly could do with it, but *who* will do it, for the initial creation of such a service is a costly matter. It is yet another facet of our need for indigenous instrumentation skills and facilities.

#### From Stereo Review Magazine:

"The Marantz 1200 proved to be the most powerful integrated amplifier we have ever tested. The power output at the signal-clipping level was 122 watts per channel into 8-ohm and a staggering 205 watts per channel into 4 ohms — all w i t h b o t h c h a n n e l s d r i v e n simultaneously.

The real worth of the Marantz 1200 was graphically illustrated by the distortion curve, which was between 0.05 and 0.07 per cent from 20 to 20,000 Hz at full power. At half power, it was about 0.03 per cent, and at one-tenth power (a very respectable 11 watts) it was about 0.015 per cent across the full 20 to 20,000 Hz audible frequency range.

The Marantz 1200 is a happy union of a truly "state-of-the-art" power amplifier with a highly flexible control preamplifier in a package no larger than many amplifiers with a fraction of its performance and power. Its sound is flawless, and we suspect few owners will ever use more than a small fraction of its power reserves."



#### From Electronics Australia Magazine:

"Though keenly priced, this handsome new Marantz amplifier (Model 1030) delivers 22 watts RMS per channel at the onset of clipping, and 15 watts RMS per channel at 0.5% distortion. Excellent specifications are complemented by attractive styling.

Frequency response measured at approximately one watt output, was  $\pm$  1.5 dB from 20Hz to 20kHz. The small deviation from the manufacturer's specification was due mainly to an extra decibel of response at 20Hz. We measured a signal-to-noise ratio of 73dB — a most impressive figure.

In general, it could be said that our test figures bettered or equalled the specifications given, which is recommendation in itself.

Access to the interior of the unit is obtained by undoing four screws. This allows one to remove the folded metal case revealing the "works" which are impressive in their finish and layout.

A listening test using known source

If you think our Reviews sound good wait till you hear our amplifiers.

### THE BEST PRODUCTS GET THE BEST REVIEWS

Marantz take pride in building the world's best amplifiers. And the best amplifiers have the best reviews. Here are some excerpts.

material and familiar loud speakers indicates that this unit justifies its specifications, and should satisfy those w h o c h o o s e e q u i p m e n t o n specification, as well as those with an eye for styling."

#### From Stereo Review Magazine:

"The Marantz 1060 stereo amplifier is a moderately priced, highly flexible integrated stereo amplifier whose performance does credit to the Marantz reputation.

At the clipping point, the Marantz 1060 delivered 38 watts per channel continuous into 8 ohms, 44 watts to 4 ohms, and 23 watts to 16 ohm loads, with both channels driven by a -1,000 Hz test signal. Harmonic distortion was very low between 0.017 and 0.055 per cent from 0.1 to 20 watts, reaching 0.067 per cent at the rated 30 watts and 0.3 per cent at 40 watts per channel.

The measured performance of the Marantz 1060 speaks for itself. Its distortion and noise levels were insignificantly low and the power output was adequate for the vast majority of home music installations.

The mid-range control has a strong effect on the warmth, or fullness, of the sound. We found it most useful for correcting the balance of recordings or radio broadcasts.

The compactness, flexibility, and superb performance of the Marantz 1060 add up to a truly fine product."



#### From Audio Magazine England:

"The Marantz model 1030 is one of a range of high quality stereo amplifiers made by the Marantz Company Inc of California USA. It is ruggedly built and housed in a steel case with a wood grain finish that matches nicely with the gold anodised front panel.

This is one of the few amplifiers I have ever tested with a performance not only better than that specified, but also one

We sound better.

well within the requirements for high fidelity. The Marantz 1030 is a little more expensive than most with about the same power rating and general facilities but I would say well worth it. The power output for example, although specified as 15W (sine-wave) per channel for 8 ohm loudspeakers; was no less than 20W with both channels driven.

The overall frequency response, the response of the loudness control and that from the magnetic pickup input are shown in the graphs and none can be faulted.

Moreover all Marantz amplifiers should have the same high standard of performance as the model 1030 which we can honestly recommend as a really worthwhile amplifier and as the foundation of a first class audio system."



#### From Australian Hi Fi Magazine:

"The Marantz 1030 amplifier is a two channel amplifier with input facilities for disc tuner, two tape machines, and microphone.

One of the appealing features of the 1030 is the very pleasant "feel" of the push buttons and rotary controls, all of which are light in operation yet with a positive firmness — evidence of a well engineered product.

A glance at the test results gives an indication of what to expect. The wide response is well maintained to the rated output, particularly at the extremes of the range.

This kind of performance is no accident, and we feel that Marantz have taken a great deal of care where it really matters.

Listening tests were carried out with the 1030 replacing the usual amplifier in a domestic system, and on all the material we tried the amplifier behaves as a true thoroughbred.

This Marantz model promises to deliver this performance with the reliability that only quality can assure, and we judge that the \$199 asked for the (uncased) model to be the best value for money that we have seen for a very longtime."

For complete Reviews, Brochures and Dealer list write: AURIEMA (A'asia) PTY. LTD P.O. Box 604, Brookvale. NSW 2100



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"It's no surprise!"



When people already think of one name as the best value for money, they naturally expect every new model to maintain the same high standards — or improve on them. So, Monarch's brilliant new Series 8 amplifiers will come as no great surprise.

No surprise — even though we've created a superb new amplifier, top-of-the-range Monarch 8000 to bring you continuous RMS power of 55 watts per channel at 8 ohms, with distortion of less than 0.1%; even though we've included tape dubbing and turnover controls; even though we've produced a frequency response of 50 Hz to 60,000 Hz; even though we're presenting three other new Monarch amplifiers — the 80, 88 and 800, which feature dramatic improvements in power and efficiency. It's no great surprise — because you *expect* Monarch to be the best... And it is, so all Monarch amplifiers remain "kings" on a power-to-performance-to-cost rating.

Try any of them. The prices are as undistorted as the sounds. All with the same beauty of design you expect of top performers. And all have the Monarch two-year guarantee on parts and labour. You know you're getting Monarch quality. Without paying more.

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Ionarch	800	80	watts	RMS
Ionarch	88	48	watts	RMS
lonarch	80	24	watts	RMS



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