ELECTRONICS Australia

HIFI NEWS

AUGUST, 1976
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MOS KEYING FOR ORGANS

EASY TO BUILD POWER SUPPLY

UHF SCALER FOR COUNTERS

SPECIAL FEATURE ON MICROPROCESSORS

TANDY CUTS PRICES! CATALOG INSIDE

From Sony research... a totally new turntable system

Sony PS-4750

Superb Fidelity from Today's Most Advanced Direct Drive

Audio experts the world over have been waiting for it . . . Sony's incredible PS 4750, the ultimate turntable system.

State of the art takes on a new meaning with the PS 4750, probably the quietest turntable ever made.

In one elegant design Sony has reduced rumble, feedback wow and flutter to minute levels far beyond hearing and virtually beyond measurement. Wow and flutter for instance is an amazing 0.03% (wrms.) Signal to noise is better than 70 dB (DIN-B).

Sony achieved this in a number of ways:
First, all the belts, pulleys, idler wheels and other paraphernalia used in conventional turntables to make the turntable spin at the record's speed, instead of the motor's, have been eliminated.

The Sony PS 4750 has no need for these trouble-some, noisy and fluttering parts, because its slow-revving D.C. motor is directly coupled to the platter.

Speed accuracy takes on new meaning with another Sony breakthrough, the "Magne-disc Servo Control."

Through a unique multi-gap head, this system automatically reads turntable speed through speed detective signals magnet-coated on to the turntable rim. Should there be any deviation induced by fluctuations in power supply, it immediately "instructs" the servo motor to make micro-accurate adjustments.

Another triumph of Sony research is the very material used to make the cabinet and turntable, B.M.C., developed specifically for audio use because its damping and resonance characteristics are 30 per cent better than the conventional aluminium diecast. B.M.C. is also virtually free of expansion or contraction, freeing the design of any problems arising from temperature changes.

Sony innovation didn't stop there. Look at the revolutionary rubber disc supports. These insulation mats are of a unique design which firmly grips the record, effectively insulating the disc from vibration when the turntable revolves. By preventing vibrations, these mats contribute to the stereo effect and significantly improve presence.

The precision tonearm is a universal type which accepts all quality shells and cartridges. Some of the Sony PS 4750's other advanced features are: stylus pressure adjustment (0-3 g), anti-skate compensator, viscous-damped (up and down) arm lifter, see-through stroboscope, independent pitch control (+ 4% on both 33⅓ and 45) and large insulator legs for effective prevention of audio feedback.

If you've been waiting for the ultimate turntable, you need wait no more. The superb Sony direct-drive PS 4750 is here.

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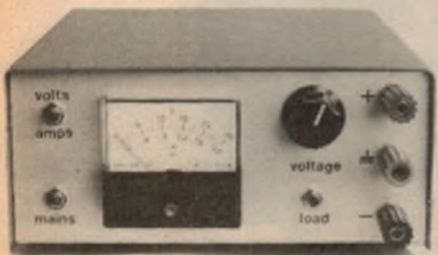
VOLUME 38 No 5



Designed with the hobbyist in mind, this easy-to-build power supply can provide voltages up to 30V and currents exceeding 2A. Features include current and thermal overload protection, and current and voltage metering. Details on page 42.

ORGAN CONSTRUCTORS: Our article on page 48 this month gives details of a MOS keyer module to add to your Playmaster 760 organ. The module may be used to provide as many pitches on the manuals as required, together with controlled attack and decay.

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world of electronics and hi-fi

projects and technical

SPECIAL SECTION ON MICROPROCESSORS ▸

regular features

On the cover

Commercial videotelephone networks may be only a few years away, and Philips of Eindhoven has developed a system likely to form the basis of such networks. The cover picture shows an experimental Philips videotelephone that is currently operating as part of a pilot network between 5 centres in Holland (see story page 34). The inset picture shows National Semiconductor's low cost development system using the SC/MP microprocessor. Picture courtesy Mr Edwin Schoell, NS Australia Pty Ltd.

Editorial Viewpoint

Behind the supplement in this issue:

During the past couple of decades, rapidly changing technology seems to have become the rule, rather than the exception. I wonder, however, whether any other area of endeavour has had to adapt to more than the one in which we are interested—not just to evolving technology but to complete changes in direction.

There was a memorable period, about twenty years ago, when virtually everyone involved in the technical side of electronics, from engineer to serviceman, had to face up to the challenge of the transistor. Fifty years of accumulated valve technology had to be re-thought, adapted or discarded altogether in as many months. But we managed somehow, with the "old hands" having to up-date and come to terms with a new breed of trainees who had studied little else but solid state. To repeat a phrase which I recall from somewhere: "it was an 'ard fight, but we made it!"

In fact, the next revolution was already just around the corner, requiring both "old hands" and "new hands" to adapt to integrated circuits—inscrutable little "black boxes" which rendered redundant a lot of the detailed stage-by-stage design which had hitherto been the forte of all electronics engineers. We coped with that, too, compensated by the fact that the black boxes could be strung together to perform tasks and achieve results which would have been out of the question with discrete components.

Then came the digital era, and the concept of bits and increments in place of the old and established linear approach. It wasn't a complete revolution but it produced a schizophrenic industry with some engineers still working with linear circuits while their opposite numbers, or their alter egos, operate in another world, where circuit symbols and logic symbols live cheek by jowl. Their technical exchanges have a certain Pidgin quality: some of the words are recognisable but, in reality, they're talking a whole new language!

Now, in mid '76, it's on again, with the entire engineering fraternity somewhat boggle eyed. Forget valves, forget discrete transistors, IC's, linear and digital. As Jim Rowe explains in his article introducing the supplement, what is being overturned now is the hitherto universal idea of designing an electronic circuit to perform a specific task. Instead, we are faced with "black box" microprocessors, which can do any number of different things—provided you can tell them exactly what and when. And that is the new task that many an engineer will have to face up to within the immediate future.

It's a long way from working out the bias for something to programming a microprocessor, but that's about where the road started, and where it's now reached!

Neville Williams

ON SALE THE FIRST MONDAY OF EACH MONTH

Printed by Dalley-Middleton-Moore Pty Ltd. of Wattle St, Sydney and Masterprint Pty Ltd of Dubbo, NSW, for Sungravure Pty Ltd, of Regent St, Sydney.
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Editorial Office
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Representative: Tom Duffy 267 4377.
Perth—454 Murray Street, Perth 6000.
Representative: Jack Hansen 21 8217.

Subscriptions
Subscription Dept, John Fairfax & Sons Ltd, GPO Box 506, Sydney 2001.

Circulation Office
21 Morley Ave, Rosebery, Sydney 2018
Phone 663 3911.

Distribution
Distributed in NSW by Sungravure Pty Ltd, 57-59 Regent St, Sydney; in Victoria by Sungravure Pty Ltd, 392 Little Collins Street, Melbourne; in South Australia by Sungravure Pty Ltd, 101-105 Weymouth St, Adelaide; in Western Australia by Sungravure Pty Ltd, 454 Murray Street, Perth; in Queensland by Gordon and Gotch (A'asia) Ltd; in Tasmania by Ingle Distributors, 93 Macquarie St, Hobart; in New Zealand by Gordon and Gotch (NZ) Ltd, Adelaide Rd, Wellington.

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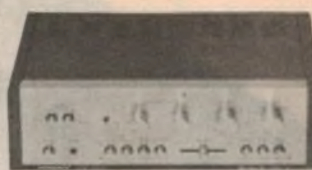

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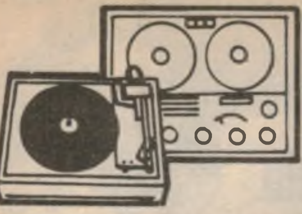


Hi Fi News

New cassettes: bigger, better, different

While the disc remains firmly entrenched as the main source of recorded sound for the domestic scene, the compact tape cassette has been widely accepted as the alternative system. But far too much is happening on the cassette front for the situation to be regarded as final and stable.

by NEVILLE WILLIAMS

When the compact cassette system was introduced by Philips, many years ago, it was seen largely as a handy format for voice recording, with a possible extension to medium quality music recording. Its humble role seemed almost to be sealed by the fact that the tape was narrower than standard reel-to-reel tape, while the speed of 1⅞ips was right at the low fidelity end of existing tape technology. Choice of that very low speed was seen as a brave, almost foolhardy move by Philips.

But the compact cassette format immediately grabbed the attention of the electronics industry. Marketing people saw its possibilities for home entertainment, particularly against the confused background of ordinary reel-to-reel tape, with its multiplicity of speeds, diameters and track configurations. Here was a single standard, backed by the stabilising pressure of the giant Philips group.

For the engineering fraternity, the format posed a tantalising challenge. Its potential as a medium fidelity program source was established very early; the problem was simply to refine the relevant tape technology to win an extra kilohertz of treble response here, a few odd dB of signal/noise ratio there, a further reduction in wow and flutter, and a point or two off the distortion percentage.

And it has been a continuing story, to the point where cassette performance has now overtaken the perceptive powers of the average hifi listener. Given optimum conditions, it is difficult, if not impossible, for the average hifi listener to pick the difference between a top quality disc and a copy of same made on cassette.

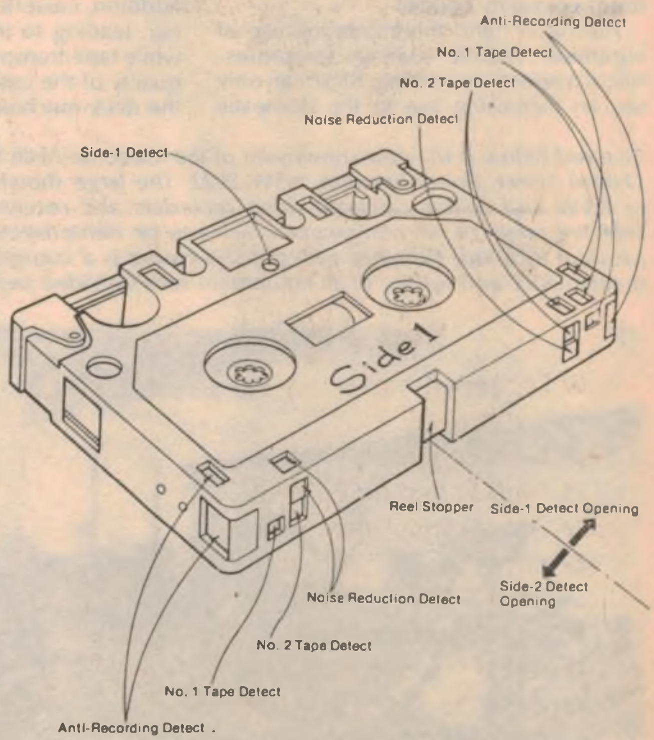
To reach this stage has required refinement of the basic mechanism to the point where wow and flutter, tape travel and head contact are so good as to introduce no obvious aberrations. The heads and the associated circuitry have been refined to a degree that makes the earlier generation of recorders—both open reel and cassette—look clumsy by comparison.

And, of course, there has been a continuous and highly competitive program of development of tape itself.

At one stage, it looked as though ferric formulations had reached a peak beyond which it would be difficult to go and attention turned towards the use of chromium dioxide tape. CRO2 offered an immediate increase in high frequency response, better signal/noise ratio and reduced distortion. Accordingly, most of the better quality cassette decks, which subsequenty appeared on the market, incorporated switching to accommodate the somewhat different bias and compensation required for optimum results from the new tape.

However, the matter has not rested there and the manufacturers of ferric oxide formulations have fought back with a whole series of refinements which have threatened the superiority of the chromium dioxide approach. The motivation flowed from existing commitments, from enterprise and initiative all the way through to the use—or

Below: The BASF Unisette was designed primarily for professional applications. According to reports, Japanese companies liked the basic idea but decided to develop their own version aimed at the consumer market. The result was the Elscaset (right), tantalisingly similar, but different!



From Technics literature, the above drawing shows the operate and sensing facilities provided in the Elscaset. The round holes adjacent to the front corners, and the rectangular holes adjacent to the capstan cutouts are for positioning. The hinged tape protectors on each front corner are shown closed.

avoidance—of patents!

As we have noted in earlier articles, ferric particles have been made progressively more uniform, laid down more evenly and packed more densely in the formulation, given better inherent magnetic qualities, doped with atoms of other material, and even used as part of a two-layer coating. The objective behind these exercises have been to achieve the required order of performance, hopefully without need for special bias and compensation, and hopefully to avoid the increased head wear allegedly caused by the use of chromium coating.

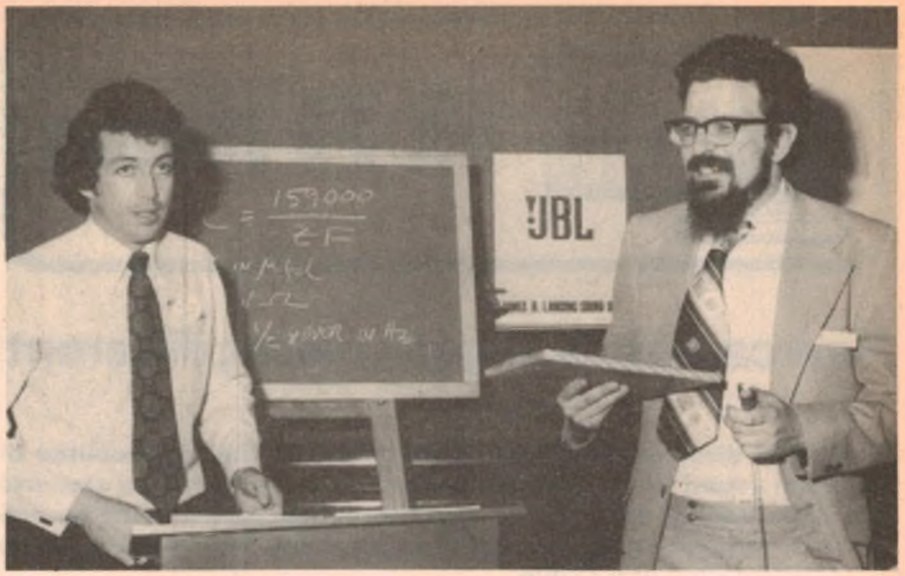
The effort—and the recent publicity—behind these ferric-based formulations has been such that the reader might be excused for thinking that chromium-dioxide has been rendered redundant, and that it will disappear from the domestic market, along with provision on decks for its use.

BASF, who substantially control the chromium dioxide patents, are adamant that nothing could be farther from the truth. They point out that chromium dioxide technology has not been standing still either, and that modern production methods, including in-reactor processing, have resulted in a much more refined, efficient—and cheaper—formulation. By contrast, some of the newer ferric oxide techniques are said to be more expensive and more difficult in terms of quality control.

Having in mind the increasing use of chromium dioxide coatings for professional magnetic recording, BASF can only see an increasing use in the domestic scene.

BASF are also beginning to make somewhat louder noises about their "Unisette" announced to the Audio Engineering Society about two years ago. The Unisette is a scaled-up version of the compact cassette, carrying standard ¼ inch tape and intended primarily for the professional audio market.

While the existing compact cassette has obvious advantages for storage and handling, it has to operate much closer to its performance limits than open reel tape, in order to satisfy professional standards; this, because of the decreased width and decreased lineal speed. In addition, cassette tape tends to be thinner, leading to increased print-through, while tape transport is dependent on the quality of the cassette housing as well as the deck mechanism.



A "first" for Harman Australia Pty Ltd, was a seminar on JBL products conducted in conjunction with BSP—Broadcast Services & Products Ltd, of 60 Airedale St, Auckland. It was attended by sound engineers from all over New Zealand. Chris Prouse, M.D. of BS&P (left) introduces to the audience Garry Margolis, applications engineer for James B. Lansing Sound Inc.

BASF engineers therefore, set out to develop something which would combine the convenience of the compact cassette with the potential for quality of the open reel format.

The resulting "Unisette" looks something like the familiar compact cassette but is much larger, measuring 148 mm wide, 94 mm deep and 19.5 mm thick. It accommodates standard 6.3 mm (¼ inch) tape and operates at 9.5 cm/sec (3¾ips)—twice the speed of a compact cassette. It will accommodate sufficient long play tape to give a playing time of 15 minutes per pass, or 30 minutes for the half-track configuration. With double

Pictured below is the new showroom of the Video and Hifi Centre, 2nd floor, 79-85 Oxford Street, Bondi Junction, NSW 2022. The large showroom has a large range of B&W and colour cameras, video recorders and receivers. As well, there is a selected range of hifi equipment which can be demonstrated to advantage at the pleasant location. Together with the showroom is a comprehensive laboratory for maintenance and service of all equipment sold by Video and Hifi Centre.

Does your system hunger for one?

Hi fi systems also need the right kind of nourishment. One of the most effective ways of providing it is featured above: the AKAI AA-1020 AM/FM Tuner Amplifier.

It puts out 20 effortless watts RMS per channel (both channels driven, from 20 to 20,000 hz, no more than 0.4% THD into 8 ohms load). It comes with the kind of facilities that produce the best kind of sound. And at $340†, the price isn't likely to turn you off.

But maybe your system hungers for a lot more power, in which case you should see our more powerful models.

Of course, like all AKAI hi fi equipment distributed by AKAI Australia, it comes with our Complete Protection Plan*. Which simply means 12 months full parts and labour warranty on all Tape Equipment, 2 years full parts and labour warranty on all Amplifiers, Turntables and Speakers and a lifetime warranty on all GX Tape Heads.

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The AKAI Hi-Fi Professionals are: **NEW SOUTH WALES — SYDNEY CITY AND METROPOLITAN. Sydney**: Douglas Hi-Fi, 338 George Street; Duty Free Travellers Supplies, 400 Kent Street; European Electronics, 187 Clarence Street; Instrol Hi Fi, Cnr Pitt & King Streets; Magnetic Sound Industries, 32 York Street; Jack Stein Audio, 275 Clarence Street. **Bankstown**: Selsound Hi Fi, Cnr North Terrace & Apian Way. **Burwood**: Electronic Enterprises, 11 Burwood Road; Edge Electrix, 31 Burwood Road. **Concord**: Sonarta Music Services, 24 Cabarita Road. **Cremorne**: Photo Art & Sound, 287 Military Road. **Crows Nest**: Allied Hi Fi, 330 Pacific Highway. **Hurstville**: Hi Fi House, 127 Forest Road. **Liverpool**: Miranda Stereo & Hi Fi Centre, 166 Macquarie Street. **Miranda Fair**: Miranda Hi Fi & Stereo Centre, Shop 67, Top Level. **Mona Vale**: Warringah Hi Fi, Shop 5, Mona Vale Court. **Parramatta**: Gramophone Shop, Shop 151, Westfield Shoppingtown; Selsound Hi Fi, 27 Darcey Street. **Roselands**: Roselands Hi Fi, Gallery Level. **South Hurstville**: Selsound Hi Fi, 803 King George's Road. **Summer Hill**: Fidela Sound Centre, 93B Liverpool Street. **Sutherland**: Sutherland Hi Fi, 5 Boyle Street. **Waitara**: Hornsby Hi Fi, 71 Pacific Highway. **Westleigh**: Sound Incorporated, 16 Westleigh Shopping Centre. **NEW SOUTH WALES COUNTRY. Albury**: Haberecht's Radio & TV, 610 Dean Street. **Bega**: Easdowns, 187-191 Carp Street. **Bowral**: Fred Hayes, 293 Bong Bong Street. **Broken Hill**: Pee Jay Sound Centre, 364 Argent Street. **Gosford**: Gosford Hi Fi, 163 Mann Street; Miranda Stereo & Hi Fi Centre, Cnr Donnison & Baker Streets. **Moss Vale**: Bourne's Merchandising, 1 White Street. **Newcastle**: Ron Chapman Hi Fi, 880 Hunter Street; Eastern Hi Fi, 519 Hunter Street. **Nowra**: Nowra Hi Fi, Shoalhaven Arcade. **Taree**: Taree Photographics, Graphic House, 105 Victoria Street. **Wagga Wagga**: Haberecht's Radio & TV, 128 Baylis Street. **Wollongong**: Hi Fi House, 268 Keira Street; Selsound Hi Fi, 2-6 Crown Lane. **A.C.T. Civic**: Allied Hi Fi, 122 Bunda Street. **Fyshwick**: Allied Hi Fi, 3 Paragon Mall, Gladstone Street. **QUEENSLAND. Brisbane**: Chandler's, 120 Edward Street; Chandler's, 399 Montague Road. **West End**: Stereo Supplies, 95 Turbot Street; Tel Air Electronics, 187 George Street. **Nambour**: Custom Sound, Currie Street. **Mt. Isa**: The Sound Centre, West Street. **Rockhampton**: Chandler's, 144 Alma Street. **Southport**: Stokes Electronics, Scarborough Street. **SOUTH AUSTRALIA. Adelaide**: Ernsmiths, 48-50 King William Street; Flinders Trading Co., 55 Flinders Street; J B Electronics, 115 Gouger Street. **Blackwood**: Blackwood Sound Centre, 4 Coromandel Parade. **Glenside**: Steiner Electronics, Conygham Street. **Moana**: Bob Carmen, 185 Commercial Road. **VICTORIA. Melbourne**: Douglas Hi Fi, 191 Bourke Street; **Warrnambool**: A. G. Smith, 159 Liebig Street. **WESTERN AUSTRALIA. Perth**: The Audio Centre, 883 Wellington Street. **Calista**: Hub Hi Fi, Kwinana Hub, Gilmore Avenue. **East Victoria Park**: Japan Hi Fi, 889 Albany Highway. **Nedlands**: Audio Distributors, Broadway Shopping Centre, Broadway. **Midland**: Midland Audio, 16B Great Northern Highway. **Mosman Park**: Audio Distributors, 14 Glyde Street. **W.A. COUNTRY. Bunbury**: Aabel Music, 130 Victoria Street. **Kalgoorlie**: Hambley's Hi Fi, Shop 13, Central Arcade, Hannan Street. **TASMANIA. Burnie**: James Loughran & Sons, 29-31 Wilmot Street. **Hobart**: Quantum Electronics, 181 Collins Street. **Launceston**: Wills & Co., 7 Quadrant. **NORTHERN TERRITORY. Darwin**: Pfitzners Music House, Smith Street.

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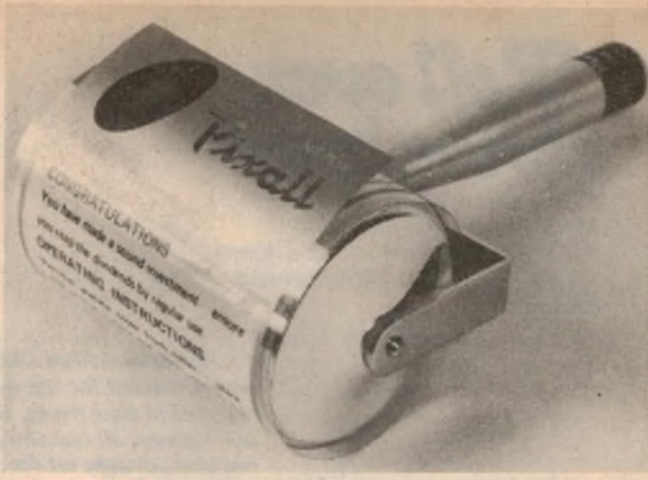


Dust comes to a sticky end!

Record brushes of one kind and another are fine for picking stray particles of dust and lint from the surface of otherwise clean discs; and, of course, brushes can be used while the disc is on the turntable. But what do you do when a disc needs more intensive treatment? The Crest Record Company suggests use of the Pixall record cleaner, as illustrated. Styled like a small paint roller, it is surfaced with a replaceable, slightly sticky layer of special tape. To clean a record, it is placed on a clean, flat surface and the Pixall rolled across it from the centre label outwards. Overseas testing indicates that the adhesive layer can pick up a large proportion of the foreign particles in the groove, together with surface grime, resulting in a generallly clean appearance, without any apparent deposit. In short, The Pixall is intended for deliberate, rather than casual use but is less tedious than some of the other "deliberate" alternatives. The Pixall sells for $9.95,with surface "refills" at $1.56 each. (For further details: Crest Record Co, 122 Chapel St, St Kilda Vic 3182. In NSW: 28 Albany St, Crows Nest 2065).

From a background of regional television and more recently, the Channel 9 network, Mr. Davis Evans has recently been appointed as Group National Advertising Manager for EMI.

play tape, the figures rise to 20 (or 40) mins, and with triple play tape to 30 (and 60) minutes.

While the Unisette has internal spools and guides, rather like the compact cassette, there are vital differences. The spools retain the tape inside the housing, to provide the necessary handling convenience, but they are normally locked in position by a couple of internal plates, so that the tape does not partially unwind when the Unisette is in storage.

When it is plugged into a deck, the plates are automatically disengaged and the spools are picked up and supported by the deck mechanism, substantially free of the casing. The same is true of the guides so that once in the playing position the entire tape transport is completely under the control of the deck, as on a normal open-reel machine. The cassette casing is merely a container, common to the two spools. BASF expect a wow and flutter figure of 0.04%, as a matter of course—similar to good quality open reel decks at the same traverse speed. Azimuth error should also be very low.

The Unisette is not designed to be turned over in the playing slot, as with a compact cassette. Since the spooling is under control of the deck and independent of the housing, and since the tape is a full 6.3mm wide, BASF have based their design on very high-speed rewind between playings initiated either manually or by recorded cues of one type or another.

Typically, a Unisette, when plugged in, would advance to its starting cue and wait for the "play" instruction. At the end of the playing cycle, it would encounter the rewind cue, would rewind automatically at high speed, and then stop, ready for manual or automatic eject. Provision is made to block accidental erasure, as with a compact cassette, and the makers envisage that standardised sensing cutouts will be provided to indicate particular characteristics of the cartridge, as for example, the noise reduction method, if any.

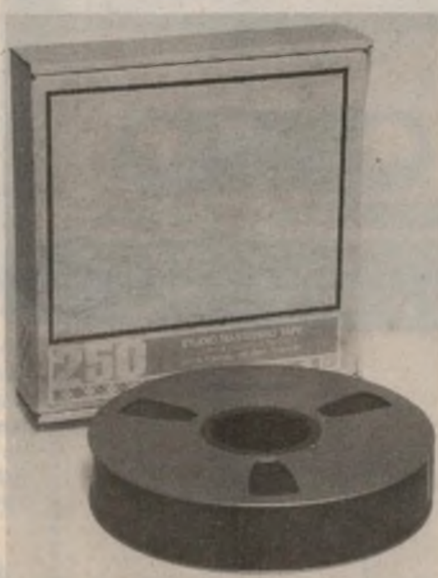
Chromium/ferric sensing is not envisaged, since BASF plans to standardise on chromium-dioxide for all Unisette tape—an indication of their faith in the future of this coating for a variety of possible applications. These include data logging functions, where high density recording would be accomplished by reducing the traverse speed and recording a greater number of narrow tracks.

BASF see the Unisette as an ultimate replacement for other professional cartridges and particularly for the endless loop variety. While these latter may also use 6.3 mm tape and operate at 9.5 cm/sec, their performance and life is strictly limited by their dependance on tape lubrication and by the tendency for the lubricant to transfer to the oxide layer.

As will be apparent from the photograph, the front of the Unisette is virtually an open framework providing access for a variety of head, tape tension and sensing provisions, together with space for twin capstans. When the Unisette is pushed into place, the capstans and heads engage the tape within this open area. The number of heads is a matter for the deck manufacturer and user, as also is the track configuration. Full-track mono is the simplest option, but twin-track and quarter-track configurations are possible with, possibly, a narrow cueing track down the centre of the tape.

As will be evident, the BASF Unisette is aimed primarily at the professional and commercial market, with spin-off into the quality domestic market seen only as a possibility. Broadcasting stations, music systems, language laboratories, sound libraries, talking books, etc, are all in the company's sights.

Their proposal for an automated stereo broadcast installation is particularly interesting. Racks in a basement would hold sufficient music for two years continuous programming. In the studio above, the operator would simply select by code Unisettes in the order required.



The new "Scotch" brand No. 250 studio mastering tape is said to offer a 4dB improvement in signal/noise ratio over current standards Nos. 206 and 207. Mechanical aspects have also been improved with greater wear resistance, less oxide shedding and fewer dropouts. (3M Australia Pty Ltd, P.O. Box 99, Pymble, NSW 2073).

Each would slide from its rack in response, transfer to a conveyor belt and be transported to the playing position. After use, a second conveyor belt would return it to the storage area, and sensing circuits, responding to a magnetic code on the Unisette spine, would return it to its allotted storage slot, ready for the next call.

FROM JAPAN: ELCASET

Against the background of the BASF initiative, it is intriguing to note a rather similar development from Japan, where a number of major manufacturers have got together to back their own jumbo cassette—the "Elcaset". Backers at the time of writing include Sony, Matsushita/National/Technics, Victor and Aiwa.

While this group alone is virtually sufficient to guarantee that the Elcaset will become a new standard—for better or for worse—the Elcaset is at the one time so similar to, but so different from, the BASF Unisette.

The Elcaset is similar in overall dimensions, but not the same: 152mm × 106mm × 18mm. It uses 6.3cm (¼ inch) tape at a speed of 9.5cm/sec (3¾ips) but the playing times are longer. The LC-60 Elcaset plays for 30 minutes per side, and the LC-90 for 45 minutes per side. Standard time constants are given as 3180usec + 70usec, suggesting that chromium or chromium compatible tape is being envisaged as normal. However, the diagrams show tape detect notches in the housing to allow decks to cope automatically with "Type I, Type II and Type III" magnetic tape material—probably equivalent to ferric, ferrichrome and chromium.

Other detect notches sense which side is being played, and tell the deck the type of noise reduction system, if any, in use. There is the anti-recording detect notch which operates like a slide switch; it can be set as desired for "protect" or re-record. On side 1, a special hollow allows the user, particularly an unsighted user, to select that side by feel.

The Elcaset also has an internal reel brake which prevents the tape becoming slack and spilling when not in use. The brake is accessible through a slot in the spine of the housing and is automatically disengaged when the Elcaset is inserted into the playing slot.

Track configuration on the Elcaset is similar to that on the normal compact cassette, except that the tracks can be somewhat wider. Each side of the tape can carry a single mono track or a parallel pair for compatible stereo. Down the centre of the tape there is room for two narrow control tracks. End-of-play cueing is provided by a hole in the leader, intended to operate in conjunction with optical sensing.

Whatever the climate in other areas of the world hifi industry, Superscope Inc, of Sun Valley, California, are not complaining. Board chairman Joseph S. Tushinsky states that sales for the first quarter of '76 are at a $40 million level—30% up on last year—and heading for the biggest total in the Company's history. Superscope is the manufacturer and distributor of Marantz and Superscope hifi components (some illustrated above) as well as having sole U.S. distribution rights for some Sony lines. Marantz and Superscope products are distributed in Australia by Auriema (Australia) Pty Ltd, Auriema House, 32 Cross St, Brookvale, NSW 2100, phone 939-1900).

The Elcaset is again similar to the compact cassette in that it can be turned over to play the second side, and play can commence at any point on the tape. It can also be fast wound in either direction, according to the facilities on the deck.

In an effort to ensure more consistent tape traverse, the Elcaset design also seeks to transfer responsibility from the container to the deck but the approach is quite different from that of the Unisette.

The front of the Elcaset is completely open, but hinged fingers at each end partially protect the tape during storage and handling. When the cartridge is pushed into the playing position, the fingers swing up to expose the open front. The tape is pulled out of the recess to rest against the heads (two or three as desired) and gripped, at the same time, by one or two drive capstans.

Don Fraser, Fellow of the Advertising Institute of Australia, has been appointed National Marketing Manager for Crest International, one of Australia's leading record companies. According to Managing Director, Marcus Herman, Crest is planning for a considerable increase in market penetration.

At the end of play, the tape is drawn back into the housing and the fingers close over it.

Unlike BASF, the companies backing the Elcaset are looking primarily at the top end of the domestic market, with commercial and professional applications no more than an attractive possibility. While there is no thought, at this stage, of unseating the compact cassette, the Japanese manufacturers see a world market for a medium that will offer the kind of performance which open reel devotees are seeking, with the convenience and versatility of the cassette.

Whether it will grab a significant share of a market that is so intimately identified with Philips daring—and successful—cassette concept, only time will tell.

AND THE MICROCASSETTE

In the meantime, there appears to be a new emphasis in Japan in the microcassette, a field largely pioneered by Philips for audio note-taking, personal messages, dictation of memos, etc. Now Japanese manufacturers are trying to produce a recorder/player with in-built 2-inch loudspeaker which is of true shirt-pocket proportions, both lighter and smaller than the earlier hardware.

While microcassettes are supposedly for speech only, the present talk about reduced wow and flutter, new style heads and tape, and a response edging up around 7kHz all has a familiar ring. Speed is 15/16ips, tape width as for the compact cassette and maximum playing time 30 + 30 minutes.

No matter how young or old the recording the Institute of the American Musical, Inc. relies on Stanton for playback.

Speaking of problems, how would you like to be faced with the need to accurately reproduce the sound from Edison Diamond Discs, Pathes and Aeolian-Vocalions? That's just what the Institute is faced with — and that's precisely why they turned to Stanton cartridges.

The Institute collection consists of approximately 35,000 discs, just about the sum total of American Musicals, from Berliners of the 1890's through the latest stereo and quadraphonic recordings. The collection (not counting thousands of cylinders) is roughly evenly divided between 78's and 33 rpm's. They have original, historic machines to play these accurately, but the arms are heavy and the old styli insensitive and somewhat worn. Furthermore, the acoustic playback does not permit them to filter the surface noise or tape these rare records.

Miles Kreuger, President of the Institute, discussed his problem with other famed and experienced archivists. They all agreed that the Stanton calibrated 681 Series was the answer. Naturally, it is the 681 Triple-E for critical listening and taping with more recent discs; the special 681 stylus for LP's; and, for the old ones, a 681 cartridge, especially wired for vertical response (with a 1 mil stylus).

Today, thanks to Stanton, the scholars, authors and researchers, who are dependent on the Institute's materials to pursue their projects, can get perfect to adequate reproduction of any of the material in the collection. The Institute, which is crowded into small quarters, is open by appointment only to qualified people. For the future, it looks forward to the day when it will have the space in its own building to make its collection more readily available.

The work of the Institute is important work . . . Stanton is proud to be an integral part of it.

Whether your usage involves archives, recording, broadcasting or home entertainment, your choice should be the choice of the professionals . . . the Stanton 681 Triple-E.

STANTON

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266 Hay Street Subiaco, Western, Australia 6008 Tel. 81.2930

FOUNTAIN MARKETING LIMITED
P.O. Box 5029 • Auckland, New Zealand • Phone 763-064

Philips System 14 Loudspeaker:

A CONCRETE EXAMPLE!

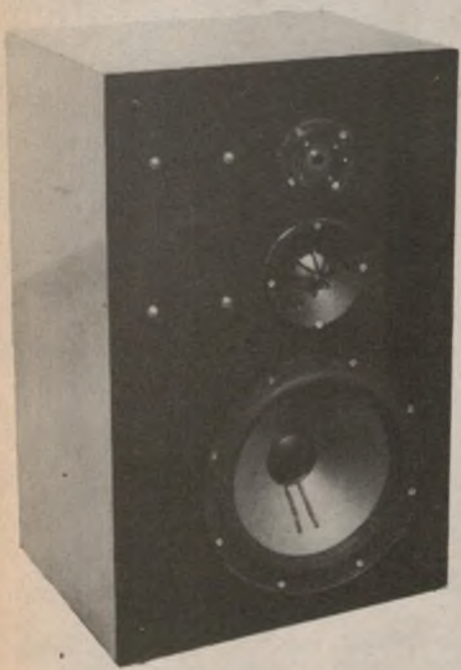
As a first reaction, one of the least welcome additions to the furnishings in your lounge room would be a pair of loudspeaker systems made from concrete. But you might think differently if we assured you that they were available in a demure teak finish, with conventional grille and quite indistinguishable from their wood panel counterparts.

But why concrete and what about the weight? Big wooden enclosures are heavy enough, but concrete . . .

Both are fair questions.

Ever since audio enthusiasts began to mount loudspeakers on baffles or in boxes, they have worried themselves about the problem of panel resonance; wood panels are resilient and, if energised by sound waves from a loudspeaker, they can vibrate and add their own quota to the radiated sound. To minimise the effect, they have to be thick and, in many cases, they have to be stiffened by internal cleats. Even then there may still be some apprehension, perhaps quite unwarranted: are the panels really dead, in the acoustic sense?

Many years ago, Gilbert Briggs of Wharfedale devised his own special answers to such problems. He built enclosures on the site from brick and he mounted loudspeakers on hollow frame baffles filled with dry sand. Such "panels" were acoustically inert, to be sure, but even in the days of single channel reproduction, not too many people seemed anxious to adopt such extreme measures.



Even with the front grille cloth removed, there is little to suggest that, behind the front felting, and underneath the laminate skin, the basic structure is poured concrete. Tweeter and mid-range levels controls are accessible through a hole in the front baffle but not in such a way as to encourage anything but semi-permanent adjustments. The enclosures are heavy but not unmanageable.

Concrete, too, had its adherents but they were no more numerous than the brick and sand exponents—for much the same reasons! So wood, in one form or another, has remained the almost universal choice.

We were very interested, therefore, when some months ago, Mr David White, Managing Director of George Hawthorn Electronics Pty Ltd, turned up in our laboratory with a pair of concrete loudspeaker systems, made in Melbourne. What's more, they were carried in without a forklift, and they looked as conventional as any other teak-finished rectangular enclosure. They were developmental prototypes for what was planned to be a complete range of concrete enclosures.

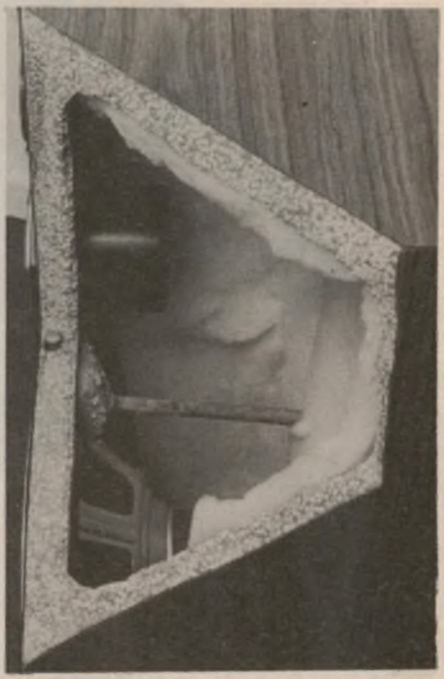
Here indeed was the promise of a non-resonant structure that was clearly manageable, both physically and in terms of manufacturing cost.

David White hastened to explain the background to the new systems.

They were made of concrete, but not to the traditional cement, sand and metal mix. Manufactured under a provisional patent taken out last year by the Melbourne Audio Clinic (M.A.C. Pty Ltd) they used an "aggregate" of polystyrene beads, making possible panels which are rigid and thick, without being impossibly heavy.

In fact, the enclosures are cast in one piece, obviating any chance of leaky joints. Just how this is managed is not clear but two or three methods suggest themselves, all rather fiddly. Once cast, the only access for fitting the divider network, leads and padding would be through the driver mounting holes.

By ensuring that the outer surface of the casting is smooth, it becomes a relatively simple task to coat it with adhesive and add whatever veneer or other such finish the market demands. Similarly, the grille frame and finish can take any convenient form, being held in place by pegs in each corner.



This cutaway section from one of the George Hawthorn enclosures clearly shows the polystyrene beads in the concrete mix from which the enclosure is cast. Note also the internal steel bracing rod and the lining on the inner surface. Synthetic woodgrain material on the outer surface gives a convincing timber finish, although plain black or white is also available on order.

The systems originally delivered to our laboratory were close in specifications to the Philips System 14 described in our 75/76 Year Book, but they differed in detail. We suggested that the design be slightly revised before being marketed to eliminate the awkward "ifs" and "buts", which the differences would raise. It could as easily conform to, and take advantage of, the work and publicity that had already gone into the System 14.

And this is what the new George Hawthorn system is: the System 14 in concrete. It is a fully sealed 80 litre enclosure using the Philips Ad 12100/W8 woofer, the very commendable AD 0210/SQ8 dome mid-range driver and the well known AD 0160/T8 tweeter. Associated with them is the ADF/600/4000/8 divider network, as designed by engineers of the Philips Elcoma group. Incorporated in the network are two miniature switches

FR-5080S

The True Hi-Fi Full-Automatic Direct-Drive Turntable.

Test drive it.

The FR-5080S is the one from Sansui that combines automatic convenience with direct-drive precision. Quite a combination.

It's the one with brushless DC servomotor to eliminate speed drift, keep wow/flutter to an amazing 0.03% WRMS or less and signal-to-noise ratio better than 62dB.

It's the one with strobo fine-adjust, with strobo light to ensure rotation speeds are absolutely perfect.

And the one with independent automatic mechanism, with 16-pole, 3-rpm gear motor that is completely disengaged during actual play from the tonearm linkage.

Almost everything is automatic, by the way. Lead-in, cut, return, repeat and shut-off. That's convenience.

But the performance specifications are something you'd probably only find in a manual. And that's precision.

You already know that a bargain turntable is better than nothing.

But if you want to involve yourself in music, you're going to have to get involved with true hi-fi.

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EASTERN AUSTRALIA: **RANK INDUSTRIES AUSTRALIA PTY. LTD. SYDNEY:** 12 Barcoo Street East Roseville, N.S.W. 2069 Phone: 406 5666 **MELBOURNE:** 68 Queensbridge Street South Melbourne, Vic. 3205 Phone: 62 0031 **ADELAIDE:** 234 Currie Street Adelaide, S.A. 5000 Phone: 212 2555 **BRISBANE:** 14 Proe Street, Fortitude Valley Brisbane, Qld. 4006 Phone: 52 7333 **CANBERRA:** 25 Molonglo Mall, Fyshwick Canberra, A.C.T. Phone: 95 2144 / WESTERN AUSTRALIA: **ATKINS CARLYLE LTD.** 44 Belmont Avenue, Belmont, Western Australia, 6104 Phone: 65 0511 / **SANSUI ELECTRIC CO., LTD.** 14-1, 2-chome, Izumi, Suginami-ku, Tokyo 168, Japan which provide three level settings for the mid-range driver and tweeter.

Impedance of the system is a nominal 8 ohms, falling to about 6.5 ohms at a couple of spots in the range, and rising to a peak of 22 at the woofer resonance.

George Hawthorn's type number for the system is 7A2C, the "C" signifying concrete. They are available with a matte teak or matte Spanish walnut laminate finish, in white or in black. A choice of grille cloth colours is also available.

As we said at the outset, the systems are strictly conventional in appearance: a purely rectangular enclosure, resting directly on the carpet, and with a push-on cloth grille. Removing the grille reveals the drivers mounted on the front surface of the panel, which has been felted in black to soften its appearance. The tweeter and mid-range level adjustments are accessable through the front panel with the aid of a small screwdriver; they are obviously intended to be preset to suit the room and the user, without thought of being constantly accessable.

Overall dimensions are 720mm high x 460mm wide x 370mm deep, and the weight about 40kg.

To be critical, we feel that the finish on the prototypes supplied to us did not do full justice to the concept. A peep inside, necessitating removal of the woofer, suggested that the divider network should be mounted more securely. When faced with replacing the woofer, we felt that it would be all too easy for the (admittedly special) mounting screws to fracture the inside edge of the concrete. The pegs which held the grille were bits of ordinary wooden dowel, which had not been dressed or finished in any way. We gather that the manufacturer is looking into all these matters to ensure a quality finish on the units finally offered for sale.

On the other hand, the actual performance was completely in line with what we remembered of the original System 14—very clean, very smooth, and untroubled by any power level that we could tolerate in the listening room. We can only say again that it is one of the most relaxed and uncoloured systems we have yet come across, and this without too many reservations about price, brand or mystique.

Philips suggest that the system be used with the mid-range driver at maximum level and the tweeter switch in the mid position. Our listening tests were at these settings and actual response plots, both near-field and at 2 metres on axis confirmed our evaluation. A near-field plot of the woofer showed it to be virtually ruler-flat from 49-600Hz with the -3dB points at 43 and 720Hz. A check over the rest of the range from 2m on axis indicated an excellent balance between all drivers with the tweeter leading slightly and carrying right on beyond the 16kHz test limit.

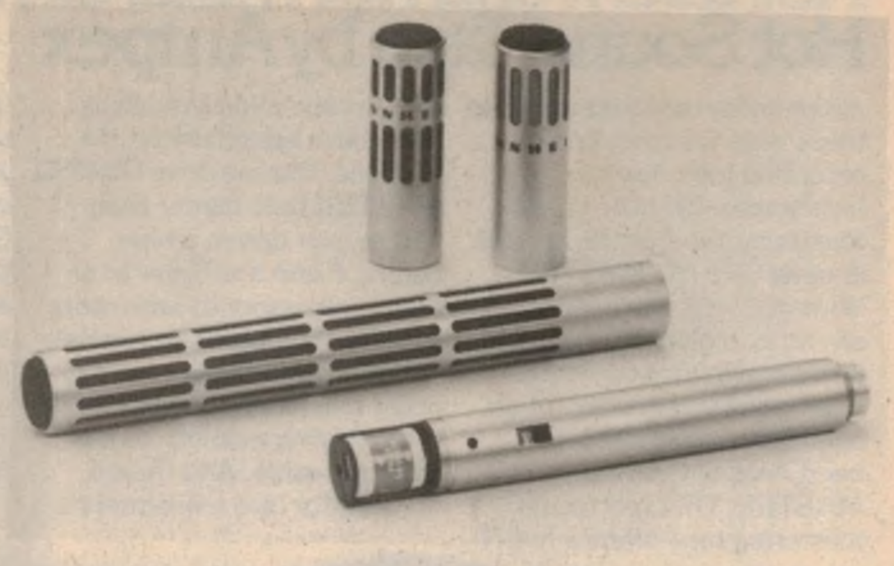
Does the concrete construction confer any significant advantage? Over a poorly constructed wood panel enclosure, it certainly would but a stout, well constructed panel enclosure would be a different thing. Both would have similar standing wave patterns inside and we could measure no significant difference in actual woofer output. If there was to be a difference, it would have to be in terms of panel movement and panel output and this could only be determined by very precise comparison of otherwise identical enclosures in an anechoic situation.

All we can say at this stage is that the concrete enclosures do appear to be acoustically highly neutral.

Maker's price for the 7A2C systems is $488 per pair, including tax. For those who might be attracted to the System 14 design without the cost penalty of concrete, heavy particle board systems are available carefully detailed and finished in a range of wood veneers and grille colours to customer requirements. The price is a very attractive $393 per pair, including tax.

For details of these and other enclosures available: George Hawthorn Electronics Pty Ltd, 966-968 High St, Armadale, Vic. (W.N.W.)

SENNHEISER 3-IN-1 ELECTRET MICS.



Sennheiser have come up with an attractive answer to the problem which faces many sound system operators—that of providing microphones with directional properties to suit different situations. The answer: an electret condenser microphone with three interchangeable head assemblies.

The Sennheiser release is the logical outcome of a new product announcement at the 1972 Hanover Fair. On that occasion, the company exhibited for the first time their MKE 201 and MKE 401 electret microphones, each comprising two screw-together modules—one containing the transducer head, the other the battery and output electronics to the line. Since the latter was the same in both cases, it was but a small step to market the type 2401 twin unit, containing one "grip" module and alternative heads for it.

This concept has now been expanded to include an extra head, designed to be much more directional and notably insensitive to vibration, wind and breath popping. The new 3-way option is pictured above.

The ME 20 head module (top right) has a substantially spherical characteristic, while the ME 40 (top left) offers a supercardioid pattern. The newer ME 80 head module (centre) operates as a pressure gradient transducer below about 1000Hz, giving a super-cardioid type of pattern. Above the 1000Hz, the pattern gradually changes into a pure frontal lobe at 4000Hz, becoming progressively narrower towards 8000Hz.

Intended for semi-professional applications, high quality public address and dedicated amateur use, the modules offer a frequency response of 50-15000Hz. The microphone, as a whole, operates from a 5.6V Mallory cell, with a battery life exceeding 600 hours, or from a phantom mains supply. Impedance is of the order of 300 ohms and weighted signal/noise ratio (DIN 45590) is 70dB.

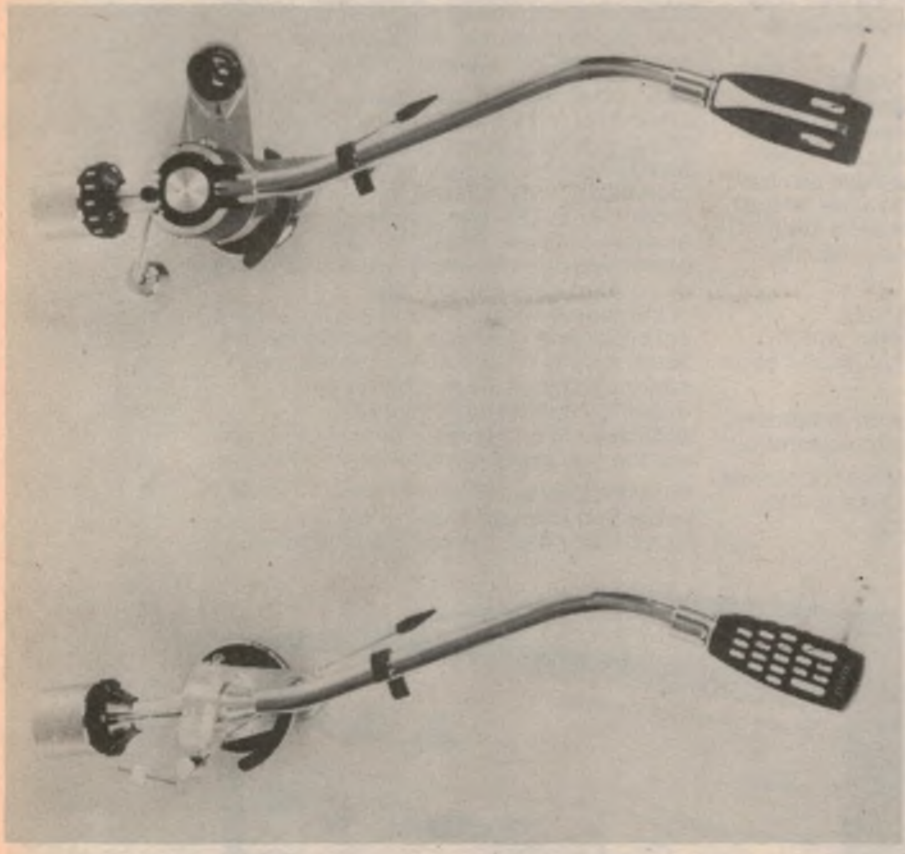
While the 3-in-1 combination is shown, Sennheiser can offer single microphone equivalents combining any one of the heads with any of 3 "grips" offering alternative output connections or unbalanced output suitable for use with tape recorders, etc.

For details: R. H. Cunningham Pty Ltd, 493-499 Victoria St, West Melbourne).

Jelco Tone Arms & Cartridges

Many hifi enthusiasts are interested in upgrading their turntable rather than replacing it. For these people, Jelco tone arms and magnetic cartridges will be of particular interest. Reviewed here are the SA-200 and SA-50 tone arms and the 4C-1X, MC-15D and MC-9 cartridges.

If you have a turntable which is becoming "long in the tooth" you may be unwilling to replace it because of the cost of a new unit, and the fact that the platter and motor are still in good condition. Possibly only the arm and cartridge need to be replaced, to update the performance to 1976 standards. A prime example of this would be the Labcraft turntable. Many thousands of these belt-driven units were sold up until a few years ago. Most are still in good condition and would be worthwhile updating.



At top is the Jelco SA-200 tone arm and below is the SA-50.

If you own a Labcraft or similar turntable then Jelco tone arms and cartridges represent an economical approach to updating. The two Jelco arms, designated SA-50 and SA-200, have differing appearance but identical specifications. Both are longitudinally and laterally balanced and have stylus tracking force set by adjusting the main counterweight slightly out of balance. Both have a removable headshell with the EIA locking collar. The headshells have standard lead colour-coding, 12.7mm cartridge-mounting centres and slots for stylus overhang adjustment. Both arms have the same hydraulically damped lowering device. The major difference in the two arms is in the anti-skating mechanisms. On the SA-50, anti-skating force is applied by a pulley and hanging weight. This has the advantage of simplicity, but is not continuously variable as is the spring mechanism on the SA-200.

One problem which may arise when adapting either arm to an existing turntable is that of rear overhang. For example, if the cartridge mass is under 7 grams the arm rear overhang (measured from the pivot) is less than 70mm. On the other hand, if the cartridge mass is in excess of 12 grams, the counterweight needs to be extended by a small subweight which increases the rear overhang to 83mm. Overhang to the right-hand side on the SA-200 is 55mm.

We fitted the SA-200 arm to a Labcraft 605L turntable and found no modifications necessary, apart from the drilling of three 3mm holes to secure the arm boss to the turntable baseplate. No problems were experienced in assembling or setting up the arm, apart from the adjustment for height of the lowering device. Here the screw fitted was a Philips head type which was not compatible with the supplied screwdriver.

We found the arm pleasant to use. Bearing friction appears to be very low and tracking force calibrations are accurate to within 5%.

One feature which would be appreciated would be to have two sets of calibrations on the anti-skating dial—one set would apply to cartridges with elliptical styli and the other set would apply to spherical styli. Either that or a printed table would be necessary to obtain exact anti-skating settings without having to resort to a test record and oscilloscope.

The hydraulically damped lowering device is most effective in its gentle lowering of the stylus onto the record surface, and its shows little tendency to let the arm drift outwards when being lowered due to the effect of the anti-skating force. However the lowering device is not damped on the upstroke so the lever should be used gently here to avoid a thump being produced by the loudspeakers when the stylus is lifted from the record groove.

Since both tone arms are inherently identical in performance the choice will tend to be a decision whether or not to pay the higher price for the continuously variable anti-skating facility and somewhat smarter appearance of the SA-200. Whatever the choice, satisfaction seems guaranteed.

Both arms are supplied with connecting cable fitted with phono sockets, mounting instructions and template and mounting hardware. The SA-200 was used to test the three cartridges reviewed here.

The three Jelco cartridges reviewed here are representative of the range. They are moving magnet cartridges with removeable stylus assemblies. All have standard colour-coded terminals and 12.7mm mounting centres.

Both the top-of-the-range 4C-1X and the lower-priced MC-15D cartridges are supplied in a plastic housing to which

SONY

JELCO MAGNETIC CARTRIDGES

they are secured with mounting screws and nuts. Accessories supplied with each of these two units comprise a small screwdriver, plastic clip-on stylus guard, stylus cleaning brush, miscellaneous mounting hardware and a specification sheet.

We found it tedious and unnecessarily fiddly to extract the cartridges from these plastic housings. You have to be careful not to damage the stylus assembly when removing the screws—the safest procedure is to remove the stylus assembly first. We much prefer the simpler packaging of the low-priced MC-9 cartridge. In this case the cartridge is firmly held in foam rubber and its stylus guard

tests we used a tracking force of 2 grams.

Square wave response at 1kHz was quite satisfactory and waveform on sinewave signals is good by comparison with most cartridges. Frequency response was tested with the CBS STR 100 test disc and a load of 56k. It was quite smooth, although not as flat as it might have been with an overall variation of ±3dB between 20Hz and 20kHz. Separation between channels was better than 28dB at 1kHz in both directions.

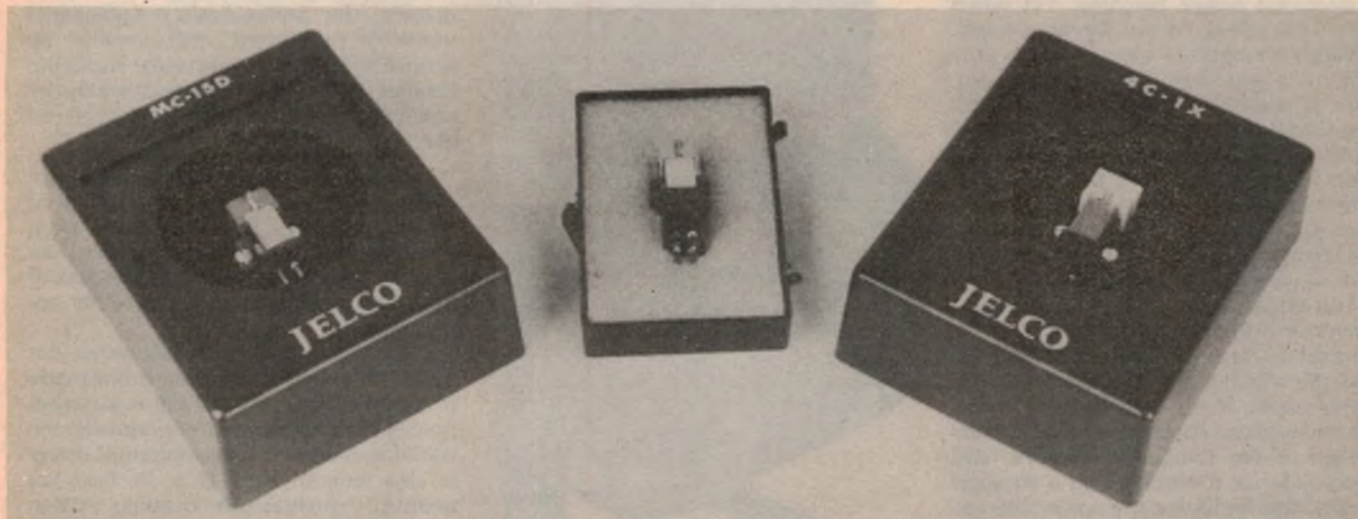
Subjectively, the sound quality is very good without any trace of stridency; although heavily modulated discs will show up its tracking shortcomings.

violins. Overall, this cartridge was disappointing and may possibly have been a poor example of the model.

Possibly the cheapest magnetic cartridge on the market, the MC-9 is only slightly behind the MC-15D in tracking capability. It gave a very good square response and waveform on sinewaves was very good considering its price. Frequency response was within ±2dB over the range from 20Hz to 20kHz and separation between channels was very good at 25dB at 1kHz in both directions.

Sound quality was clean and bright without any tendency to sound strident. It would thus seem a good choice for anyone upgrading to an economical magnetic cartridge.

Clearly the Jelco MC-9 is excellent



Jelco cartridges from left to right: MC-15D, MC-9 and 4C-1X. Each case has its plastic cover removed for the photograph.

MODEL	4C-1X	MC-15D	MC-9
Frequency response:	10 ~ 50,000Hz	10 ~ 25,000Hz	20 ~ 20,000Hz
Sensitivity:	2.5mV at 1,000Hz	5mV at 1,000Hz 50mm/sec	4mV at 1,000Hz 5cm/s
Channel balance:	±0.5dB at 1,000Hz	±0.7dB at 1,000Hz	±1dB at 1,000Hz
Channel separation:	better than 28dB at 1.000Hz 20dB at 30,000Hz	26dB at 1,000Hz	Better than 23dB at 1,000Hz
Impedance:	2,000 ohms	2K ohms at 1,000Hz	1,700 ohms at 1,000Hz
D.C. resistance:	350 ohms	350 ohms	350 ohms
Compliance:	17×10^{-6} cm/dyne	12×10^{-6} cm/dyne	20×10^{-6} cm/dyne
Load resistance:	47k ohms ~ 100k ohms	47K ohms ~ 100K ohms	50K ~ 100K ohms
Stylus:	"ICHIKAWA" stylus	0.5mil Diamond	0.7mil diamond
Needle pressure:	1.3 ~ 2 gr	1.5gr ~ 2.5gr	1.7g ~ 3gr
Empty weight:	6.4gr	5.7gr	6.3gr

is fitted. No problem is experienced in removing this cartridge from its packing—simply take it between thumb and forefinger.

Apart from the stylus guard and specification sheet, no accessories are included with the MC-9 cartridge.

First to be put through its paces was the 4C-1X. This cartridge is intended for use with CD-4 decoders and is fitted with an Ichikawa stylus (an alternative version to the Shibata stylus). Tracking performance was modest by today's standards. Even at its maximum recommended tracking force of 2.5 grams it would not track the +12dB drum test track of the W&G 25/2434 test disc. For the other

Much cheaper than the 4C-1X with its expensive Ichikawa stylus, the MC-15D had better tracking performance. It handled the +12dB test track (W&G 25/2434) at 2 grams and the +16dB track at 2.5 grams with slight mistracking. Square wave response was good, albeit with slight ringing superimposed. But waveform on sinewave signals between 4kHz and 10kHz was below par. Frequency response showed a fairly modest overall variation ±2dB between 20Hz and 20kHz. Separation between channels was 15dB at 1kHz in both directions.

Sound quality tended to be very bright with a tendency to sound strident on

value for money while the 4C-1X will be favoured in CD-4 systems because of its refined Ichikawa stylus.

Recommended retail prices for the Jelco cartridges are: 4C-1X, $50; MC-15D, $13.95 and MC-9, $9.50. The SA-200 arm is priced at $59.50 while the SA-50 sells for $32.50.

Jelco tone arms and cartridges are available from most stockists of electronic components and from high fidelity retailers. Trade enquiries should be directly to the Australian distributors for Jelco products, Ralmar Agencies Pty Ltd, 71-73 Chandoes Street, St Leonards, NSW 2065, or inter-state representatives. (L.D.S.)

HIFI REVIEWS

B & W DM6 Monitor Loudspeaker

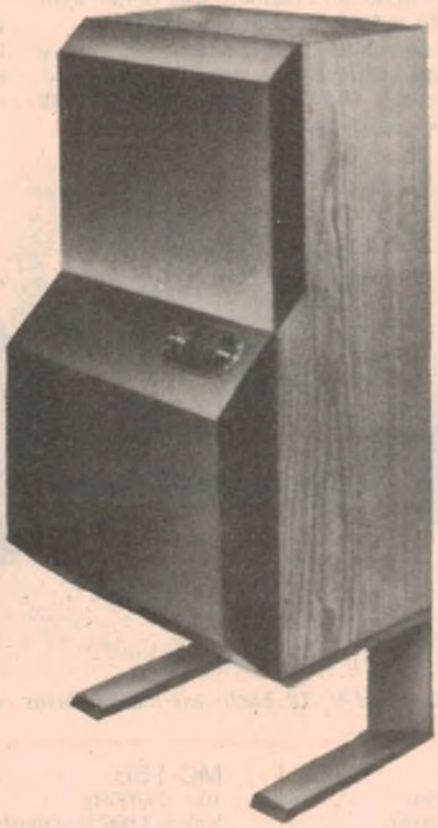
It is unusual to find a loudspeaker system which is greatly different from its competitors, either in looks or the technology employed. Here we review the acclaimed B & W DM6 monitor loudspeaker which certainly looks different—and incorporates quite a few interesting and innovative features.

Our initial visual impressions of the B & W DM6's when they arrived in our laboratory were not entirely flattering. There were a number of humorous remarks to the effect that they looked like a cross between a pregnant Dalek and a disarmed poker machine. Yet when they were set up in our listening room, which is arranged to be as close as possible to a typical domestic living room, their appearance looked far less stark and forbidding. In fact, after a few days' familiarity, they seemed no less suited to their surroundings and purpose than other loudspeaker systems of similar size. Some listeners were even beginning to like the appearance, but perhaps there were underlying reasons.

The major reason for the unusual appearance is that the stepped baffle is intended to provide "linear phase", a concept which was discussed in the Hifi News pages of our last issue. Basically, the linear phase concept involves careful design of the crossover network, and positioning of the drivers on a stepped or tilted baffle so that the voice coils are approximately all in the same vertical plane. The idea of this is to give the same propagation time from each driver to the listener's ears.

Apparently, the designers have optimised the baffle for the typical listening distance of 3 metres.

The idea behind the large mounting feet is to raise the whole system off the floor, to prevent undesirable reinforcement of the bass response—which can result in "boomy" sound and intermodulation of the lower midrange frequencies. This is a worthwhile addition to most loudspeaker systems, but one



which gives the most benefit with systems that already have good quality drivers.

Overall dimensions of the cabinet are 410mm x 750mm x 380mm (W x H x D), not including the feet which raise the DM6 off the floor by 178mm (seven inches). Mass is a solid but manageable 36.1kg. In fact it is quite easy to slide or "walk" the units over a hard or carpeted floor.

A neat feature of the recessed terminal panel on the rear of the cabinet is that connections may be made via DIN plugs or banana plugs. Certainly the banana plugs are the better proposition, especially when operation at high power is intended.

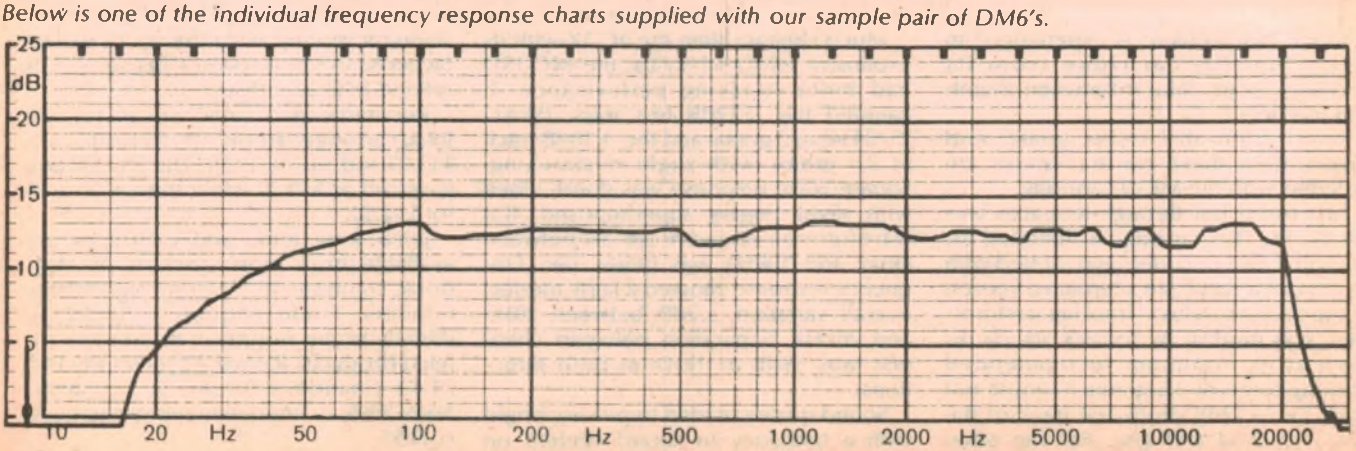
There are two grilles on the DM6 cabinet, one covering the woofer and the other covering the midrange and tweeter drivers. The grilles have a substantial frame of perforated steel covered by acoustically transparent cloth. Available cabinet finishes are white, teak, walnut or rosewood veneer while grilles can be black, brown or silver.

Complementing the odd appearance of the cabinet is the odd appearance of the three drivers. As can be seen from the photograph they each have an abbreviated chassis to enable the size of each stepped baffle section to be restricted.

Closer examination reveals more. For example, the tweeter dome is not made of the usual clear Mylar, but is a woven polyester fabric. Even more unusual, the curvilinear cone of the midrange driver is also woven—what B & W term an aromatic polyamide matrix. Put in simpler language, it's a synthetic fibre made by Dupont. It looks not unlike hessian. The resulting cone is very stiff and light and is apparently better than glass fibre and lighter than aluminium.

The woofer also has a curvilinear cone but of a more familiar material, Bextrene. The effective cone diameter is about 200mm and the cone resonance is 18Hz, which rises to 40Hz in the sealed cabinet. The midrange unit, by the way, occupies the entire upper section of the cabinet which has a volume of about 20 litres. As a result the midrange unit has the very low resonance of 65Hz. No chance of the

Below is one of the individual frequency response charts supplied with our sample pair of DM6's.



B&W DM6 Monitor Loudspeaker

midrange resonance being excited due to insufficient roll-off in the crossover network!

There are level controls for each of the drivers—the tweeter and midrange controls are on the front, while that for the woofer is at the rear. Each of these controls varies its associated driver level by plus or minus 2dB over most of the particular driver's range.

The well-written instruction manual gives comprehensive details of the loudspeaker's performance and shows, with the aid of one-third-octave response charts, the effect of the level controls. They even show response charts for the loudspeaker mounted in typical positions in a livingroom. Also there is a set of response curves for each matched pair enclosed in the manual. One of those curves, albeit without supporting data on the method of measurement, is reproduced here.

Crossover networks are first order (6dB/octave) to give optimum transient and phase response. The impedance curve shows the usual characteristic of a sealed system—there is the expected peak at the resonance of 40Hz, but otherwise the curve is reasonably flat with a minimum value of about 4 ohms.

One of the interesting points about the DM6 is that it uses an auto-transformer as part of the crossover network for the woofer. This allows the woofer output to be varied with the rear-mounted "LF Contour" control with minimum power loss while still maintaining a good damping factor for the woofer.

However, there is one problem which may arise, not mentioned by B & W. More than desirable DC may flow in the transformer if used with a DC coupled amplifier with a high offset voltage. This is because the resistance of the auto-transformer winding, as presented to the loudspeaker input terminals, is only of the order of 0.8 ohms. However, we assume that the problem has been thought of and the loudspeaker will operate quite satisfactorily with most DC coupled amplifiers which have a typical DC offset voltage of 30mV or less.

Sine wave testing of the DM6 revealed that its response was very smooth with a slight rolloff of the tweeter beyond 12kHz. Square wave response was remarkably good, especially since one normally gets such a poor result. Transient response also appears to be excellent.

However, it is subjective testing with music signals that reveals the character of the DM6. Its best characteristic is the midrange performance—far cleaner than any other speaker we have heard. It has no undue emphasis or harshness. The tweeter is also very clean and with the slight rolloff referred to above, it does not emphasise surface noise on discs or tape hiss. Again the bass is very clean and smooth down to almost 30Hz, though it is not quite as extended as some competitive systems.

We preferred the DM6 with tweeter and midrange controls set to the "flat" condition while the LF contour was set to "minus 1" which amounts to a 2dB cut at bass frequencies. Efficiency is on the modest side, but the loudspeakers can be driven to adequate loudness in most rooms with a 25 watt per channel amplifier. Alternatively, the DM6 will handle the full output of amplifiers with ratings in excess of 100 watts per channel. Fuses protect the loudspeakers in case they are overdriven.

The DM6 is a sealed three-way system.

We must rate the DM6 as one of the very best loudspeaker systems available, regardless of price. It is very carefully designed and engineered and is well finished. Having said that, the recommended retail price of $1200 per pair seems almost reasonable.

The B&W DM6 is available from selected high fidelity retailers. Alternatively, further information can be obtained from the Australian distributors for B&W loudspeakers, Convoy International Pty Ltd, 4 Dowling Street, Woolloomooloo, NSW, 2011. (L.D.S.)

News Highlights

Electronics will monitor Moomba gas pipeline

A system of 30 microwave repeaters has been installed by Telecom Australia along the Moomba to Sydney natural gas pipeline to transmit data from remote valve and scraper stations to The Pipeline Authority's control centre at Young, in central NSW.

The Young control centre will be staffed 24 hours a day by operators who will use the telemetry and data acquisition system to monitor the performance, status and general behaviour of all equipment associated with the pipeline. One of its prime functions is to obtain information from instrumentation at custody transfer stations at Moomba and Wilton, and use this information to calculate the instantaneous and accumulated flow of gas into and out of the pipeline.

Data is obtained from the 30 remote stations by polling the remote terminals via 1200 bps data lines. Each remote terminal is capable of providing for 22 status indications and 4 analog values, with the exception of those remote terminals installed at Wilton and Moomba which are capable of 32 status indications and 36 analog signals.

Because of the remoteness of the area through which the pipeline passes, 19 of the 30 Telecom Australia microwave repeater stations are powered by natural gas obtained from the pipeline.

Closed cycle vapour turbines are used to generate approximately 4kW of 24 volts DC power at each station. This power provides for the microwave repeater equipment, its supervisory system, cathodic protection, a mobile radio system and The Pipeline Authority's telemetry unit.

In addition to allowing the acquisition of data, the supervisory and communications system allows the operators at Young to control the closure of 30 mainline valves along the length of the pipeline. The operator can, in an emergency, isolate a section of line in which a problem may have occurred. The operator is also able to adjust flow conditions at Wilton to optimise measurement accuracy.

The communication system includes a mobile radio-telephone network which allows the operator to make contact with all personnel in vehicles within 20 miles of the pipeline, as well as the Authority's helicopter and chartered aircraft.

The control room of the Pipeline Authority's control centre at Young. Data is obtained from some 30 remote stations installed at intervals along the pipeline.

Ultrasonic images show diseased arteries

Some forms of atherosclerosis—popularly known as "hardening of the arteries"—can now be diagnosed without risk or discomfort to the patient, using a new ultrasonic instrument currently being developed at Stanford Research Institute (SRI), Menlo Park, California. The first model of the new instrument is now undergoing tests at the Mayo Clinic, Rochester, Minnesota.

According to Philip S. Green, Program Manager for Ultrasonics at SRI, the instrument produces television images of a small cross-section of tissue including arteries and surrounding muscles, veins, and organs. The only contact with the patient is a small water-filled bag resting lightly against the skin.

Previously, the only means available for visualizing the arteries was X-ray angiography, a process involving the use of an X-ray opaque dye injected into the patient's arteries either directly or through a catheter.

In the television image produced by the SRI artery imaging system, atherosclerotic "plaque" appears as a bright region in the normally dark blood-filled interior of the artery.

Plaque is a combination of fibrous and fatty deposits that accumulate on the interior walls of the blood vessels and tend to restrict the blood flow. These deposits may also break loose and block the flow of blood to part of the brain, causing a stroke.

Superimposed on the cross-sectional image of the artery is a graph showing the moment to moment velocity of the blood at each point across the vessel. This data is derived from ultrasonic waves scattered from the moving blood cells.

Preliminary results of the clinical investigation are very encouraging. The investigation has centred around the carotid arteries, which provide most of the blood supply to the brain.

In addition to the clinical studies, other researchers at the Mayo Clinic are investigating the differences in the ultrasonic properties of normal and diseased arteries and using this information to develop computer-aided methods of enhancing the quality and diagnostic usefulness of ultrasonic images.

RCA to develop hydrogen maser clock

RCA is one of two contractors selected by the US Navy to determine the feasibility of using hydrogen maser clocks—precise to one second in three million years—in Global Positioning System (GPS) satellites, it was announced recently.

RCA's Astro-Electronics Division, Princeton, NJ, received a $US835,000 contract from the Naval Research Laboratory to develop the clock, which derives its precision from energy level transitions in hydrogen atoms.

The hydrogen atoms for the clock are produced from hydrogen gas molecules by an electrical discharge, and beamed into a special container in a microwave cavity. There they undergo an energy state change, and emit a frequency that can be used to very accurately control the output frequency.

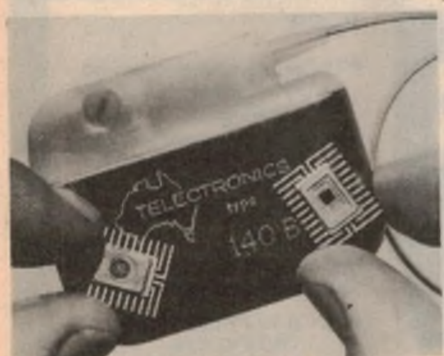
The satellite-based GPS system, scheduled to become operational in the 1980s, will provide precision fixes in three dimensions—longitude, latitude and altitude. Transit, the current operational system, is two dimensional, providing only longitude and latitude readings.

A planned constellation of 24 GPS satellites will continuously transmit time synchronised signals. A ship, airplane or land craft suitably equipped to receive the signals will be able to determine its exact position anywhere on the globe.

Voice controlled driverless vehicle

Neil Vickery, a salesman for Repco in Melbourne, demonstrated the electronic "works" of his voice-controlled, driverless vehicle during a recent Sydney demonstration. Simple voice commands transmitted over a UHF radio link are all that's required to control the car, a Holden Monaro. For example, the car starts on the command "start", engages drive on the command "go", and executes a right hand turn on the command "right".

Ultra-reliable ICs for cardiac pacemakers



A set of two Australian-made integrated circuits for cardiac pacemakers has operated for more than 15 million device hours without failure since their introduction a year ago.

The advanced pacemaker which uses these integrated circuits is now used by large numbers of patients in Australia and many other countries.

Telectronics Pty Ltd awarded a contract to AWA Microelectronics to develop and manufacture the circuits. The circuits, smaller than a match head, form the third generation of integrated circuits developed and manufactured by AWA Microelectronics for use in cardiac pacemakers.

New bar at the Dick Smith ranch

Dick Smith customers with a component data or substitution problem now have at their disposal a range of component data books—nearly $100 worth—on a new in-store data bar.

Dick has set up the data bar in his Gore Hill store on a trial basis and says that if it is successful, he will put data bars in all present and future Dick Smith branches. "Even enthusiastic and well-informed staff cannot possibly know all about the huge and rapidly expanding range of electronic components available today," Dick says. "Like our self-serve electronics supermarkets, the data bar is part of our continuing effort to help our customers to help themselves, enabling us to provide even faster service."

AWA to market Coursemaster autopilot for boats

Amalgamated Wireless (Australasia) Limited and Coursemaster Autopilots Pty Ltd have signed an agreement which gives AWA marketing rights for Coursemaster Automatic Pilots throughout Australia and Papua New Guinea (see EA Feb 1976).

The Coursemaster Automatic Pilot was designed by Mr Richard Chapman, a radio manufacturer of Lane Cove, who shared the 1974 John Lysaght Inventors' Award. The current Coursemaster Automatic Pilot is the result of 4 years of design refinement and product development undertaken after extensive tests in yachts and power boats.

The pilot has its own memory system and, when installed in a boat, will maintain a set course, allow for manual override, so that alteration of the course may be made to avoid collision etc., and then return to the course. It will always return to the set course by the smallest arc, ie less than 180°.

The Coursemaster Automatic Pilot will sell in Australia for under $1,000 excluding tax, compared with $1,500-$2,000 for imported pilots offering less facilities. The first pilots were delivered during May 1976 and are available from all AWA Marine Division sales and service outlets. Trade inquiries are invited.

Satellite will help monitor earth crustal movements

. . . and contains a message for the future

A satellite that looks like a giant golf ball has been launched by NASA into a 5,900-kilometre high orbit to serve as a tool for obtaining information on Earth's crustal movements, polar motion, solid Earth tides and precise locations of various spots on Earth.

The Laser Geodynamic Satellite (Lageos) was launched aboard a Delta rocket from the Western Test Range in California on May 4. Lageos will use and demonstrate the capability of laser satellite tracking techniques to make extremely accurate measurements of Earth's rotation and movement of the Earth's crust.

One important benefit of the pin point accuracy of such measurements could be a better understanding of the mechanisms which cause earthquakes. NASA expects the US Geological Survey, which is responsible for earthquake research and prediction, to use Lageos to make minute measurements of movements of large land masses, called tectonic plates, as well as specific measurements along critical faults, such as the San Andreas fault in California.

Lageos is a solid, heavy, passive satellite with no moving parts or electronic components. It consists of an aluminium sphere with a brass core, and carries an array of 426 prisms called cube-corner retroreflectors.

A laser pulse beamed from a ground tracking-receiving station to Lageos initiates a timing signal at the ground station that continues until the pulse is bounced back from the satellite and received at the station. By measuring this length of time, the distance between the station and the satellite can be calculated. This is known as laser ranging, and movements of the Earth's surface as small as 2cm can be determined.

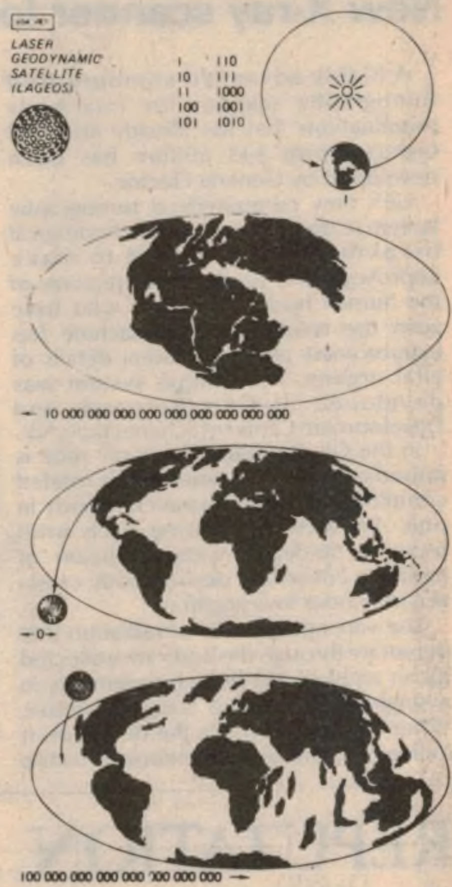
A message has been sealed inside Lageos in the event it should be retrieved from orbit or discovered after its return to Earth some 10 million years from now.

In its upper center the message displays the simplest counting scheme, binary arithmetic, which uses only zeros and ones. At upper right is a schematic drawing of the Earth in orbit around the Sun, and an arrow indicating the direction of motion. The arrowhead points to the right, the convention adopted for indicating the future. Under the Earth's orbit is the binary number one, denoting the period of time used on the plaque—one revolution of the Earth about the Sun, or one year.

The remainder of the Lageos plaque consists of three maps of the Earth's surface. Beneath the first map is an arrowhead pointing left, denoting the past, and connected to a large binary number. In decimal notation this number is equivalent to about 268 million years ago. The map shows the approximate configuration of the continents in the Permian period, about 225 million years ago.

The middle map displays the present configuration of the continents. Below it is a symbol indicating zero years, and arrows denoting simultaneously the past and the future; that is, the present. This map represents the zero point in time for the other two maps.

The final map is coded by an arrow pointing to the right and a binary number, again rounded off, denoting an epoch 8.4 million years from now—very roughly, the estimated lifetime of the Lageos spacecraft.



The solution to community antenna problems

Because of the shortage of good sites for 2-way radio systems and the advantages of sharing base stations, there is an increasing trend towards the "community", or "group" site, where maybe 10 or 20 base stations are installed and shared by users throughout the area.

The trouble with many so called community sites is that they have grown haphazardly. The result is often an unsightly cluster of aerials festooned on a mast.

Apart from the fact that some of these installations look untidy, they are also often inefficient because of lack of effective electrical isolation between the systems. Each base station affects the operation of each other base station, resulting in a deterioration of performance and shorter ranges.

An Australian company, Antenna Engineering Australia Pty Ltd, has overcome this problem by designing special antenna systems which, though electrically isolated from each other, are mounted on one tapered tubular support mast. The complete antenna system appears as a slender, aesthetically pleasing spire. Various heights are available —up to 24 metres overall—for either mountain top, or building roof sites.

The AEA TW series community antenna system offers a multiplicity of antenna combinations which, with AEA multicouplers, can provide up to 24 channels on a community site. The company also has a variety of isolated antenna systems.

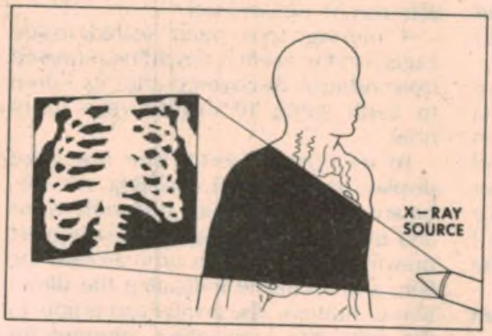
For further information contact Antenna Engineering Australia Pty Ltd, PO Box 191, Croydon, Vic 3136.

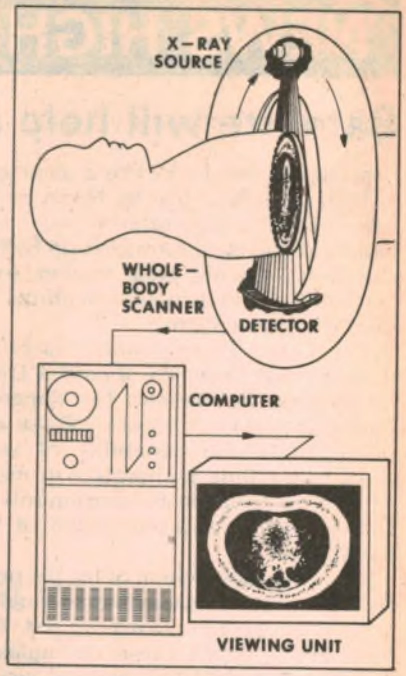
NEWS HIGHLIGHTS

New X-ray scanner for medical diagnosis

A highly advanced computerised tomography scanner for total-body examinations that has already attracted orders worth $33 million has been developed by General Electric.

GE's new computerised tomography system features a variety of technological breakthroughs required to make improved cross-section X-ray pictures of the human body. Physicians who have seen the results say the machine has extraordinary ability to reveal details of vital organs. The unique system was developed at GE's Research and Development Center of Schenectady, NY.





In the GE approach, the X-ray tube is pulsed a total of 288 times as it is rotated completely around the patient's body in only 4.8 seconds. During each brief pulse, a 30-degree-wide fan-beam of radiation covers the desired body cross-section under investigation.

The varying amounts of radiation that penetrate through the body are collected by an array of 320 detector elements in a single high-pressure xenon chamber. When the radiation hits the detectors, it ionises the xenon gas, producing electric charges. Some 90,000 detector readings per scan are collected and fed by special data-acquisition electronics to a high-speed minicomputer.

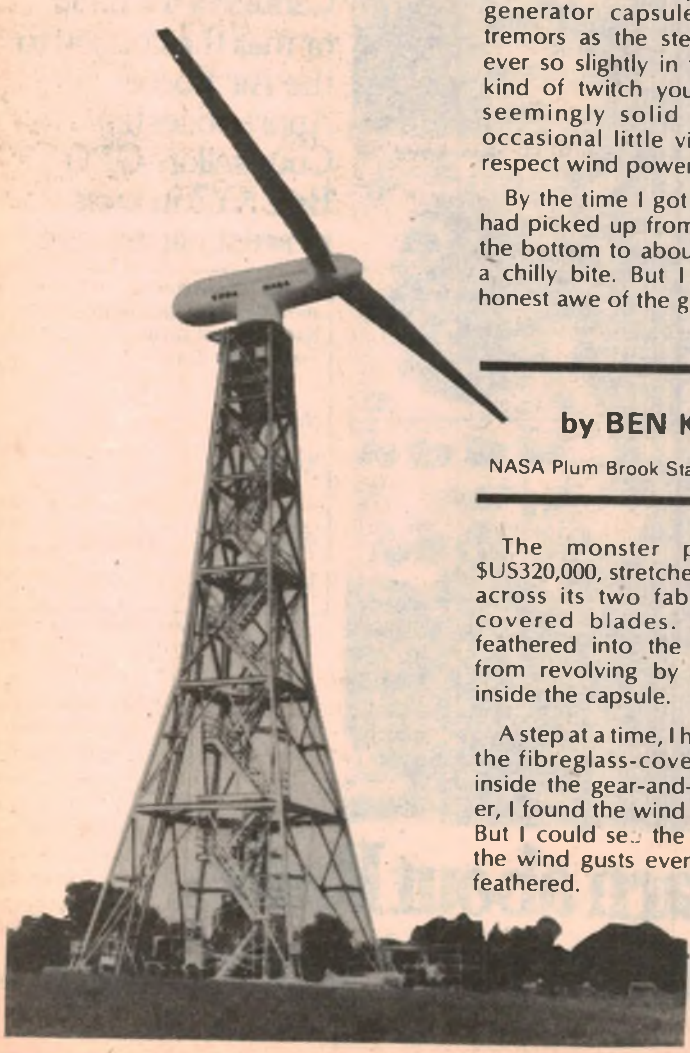
More than 54 million computing operations are performed within minutes to reconstruct the detector readings into cross-sectional images of body tissues and organs. The pulsed fan-beam approach in the GE system results in less X-ray exposure than the continuous multiple narrow beams of X-rays employed by other body scanners.

Short scan times also reduce the effects of involuntary patient motion and thus improve the sharpness of the computerised tomography pictures. And only minutes after the scan is taken, the radiologist has a clear picture before him on a TV-type cathode-ray screen. By fine tuning, he can emphasise detail in soft tissue, bone, the vascular system, or other desired areas in each picture. Electronic magnification of specific areas also is possible.

World's biggest windmill turns on the power

Within the next two decades, the world's industrial countries will face a common problem that promises to be one of major proportions—a shortage of energy. Among the various alternative energy schemes under consideration is wind power. NASA and the US Energy Research and Development Administration have designed and built an experimental wind turbine, applying space-age technology to the age-old search for power from the wind.

The biggest windmill prototype in the world stands in an open field at a site not far from NASA's Plum Brook Station in Sandusky, Ohio. It's the Energy Research and Development Administration's (ERDA) Model Zero 100kW wind generator, an experimental unit designed and built especially for ERDA by NASA.



I was visiting the site to check on the status of this giant wind generator, one of the testbeds for the US wind-power program. The rig's tapering tower, spidering its way up from the flat field, looked sturdy enough, much like high-tension towers all over the country. But as I climbed the open metal stairway leading 100 feet up to the streamlined generator capsule, I could feel the tremors as the steel structure wiggled ever so slightly in the wind. It was the kind of twitch you feel at the top of seemingly solid skyscrapers. That occasional little vibration makes you respect wind power.

By the time I got to the top the wind had picked up from the 10mph I felt at the bottom to about 25mph, and it had a chilly bite. But I soon forgot this in honest awe of the giant propeller.

by BEN KOCIVAR

NASA Plum Brook Station, Sandusky, Ohio.

The monster prop, which cost $US320,000, stretched a twisting 125 feet across its two fabricated aluminum-covered blades. The blades were feathered into the wind, locked tight from revolving by a hefty disc brake inside the capsule.

A step at a time, I hauled myself up into the fibreglass-covered capsule. Once inside the gear-and-shaft-filled container, I found the wind was suddenly gone. But I could se.. the giant blades flex in the wind gusts even though they were feathered.

When the blades rotate they make a soft but powerful swish as the wind pushes them around. The tower sways as the blades move from the high winds aloft to the low winds down closer to the ground. But even with the blades immobilized, I could feel the tower react every time a blade bent slightly to a wind puff.

Here are some of this unique rig's features and operating characteristics:

- The machine is designed to start generating power in an 8mph wind. It reaches its maximum 100kW output in an 18mph wind. Maximum blade rotation speed is 40rpm. This can be maintained in different wind speeds by changing the pitch angle of the propeller much as is done in prop planes. As wind speed builds to more than 18mph, the blades will spill excess power by approaching the feathered position. At wind speeds of less than 8mph and more than 60mph the blades will be placed in the full feathered position and will no longer revolve.
- Unlike most windmills I've seen, where the rotor blades face the wind in front of the tower and are kept pointing into the wind with a big tail fin, these blades are located downwind of the tower. There is no tail fin. Ron Thomas, who heads the Wind Research Project at NASA's Lewis Research Center in Cleveland, told me this keeps the wind from blowing the flexible blades into the tower. The tower, upwind of the blades, is less subject to dynamic interference from the blades. But as each blade comes down it is affected by the "wind shadow" of the tower.
- Instead of a tail fin there is a powered yaw control to keep the blades and the

ERDA's Model Zero mill produces 100kW—enough power to supply about 30 homes with the average assemblage of TVs, refrigerators, freezers, vacuum cleaners and washing machines. It's a prototype of wind generators that may feed large-scale power into existing utility networks.

fibreglass pod headed into the wind. The yaw control is designed to follow slow changes in general wind direction rather than sudden minor shifts in wind. Sudden shifts could overstress the shaft because of the precessional effects of the turning blade that acts like a giant gyroscope resisting change. Yaw rate is only 1/6rpm and operates even when the machine is not generating power. This could take care of a situation where the wind had stopped from one direction and started up again from a completely different angle.

- The blades are connected to a hub bolted rigidly to the main low-speed shaft. The hub houses the gears and linkages for changing pitch of the blades. Wind loads, both steady and gusting, and centrifugal loads are absorbed by the hub. The fixed hub has admitted disadvantages as well as advantages. The advantage is potential for low cost. The disadvantage is increased blade root forces that result from abrupt wind shifts or shears, and wind shadow from the tower itself.

- The pitch-change mechanism is the same hydraulic-pump type used in some early aircraft propellers. A rack-and-pinion torque actuator turns a master gear which, in turn, rotates the blades through a bevel gear on the blade roots. This system has the advantage of being self-contained and protected from the elements. Hydraulic fluid enters the shaft through rotating seals from a hydraulic pump mounted separately on the structure.

- The hub and low-speed shaft transmit high torque to the alternator through a 45:1 gearbox. From the gearbox the high-speed shaft drives the alternator at high rpm, through a belt system.

- The gearbox is a triple-reduction type set up to give a step-up ratio instead of a conventional step-down one. Gearbox is oversize, has a rated output of 176kw (236hp), about one-third higher than the maximum power of 133kW (178hp) the rotor should ever supply.

- The alternator is an 1800rpm synchronous two-bearing, self-cooled type with directly connected brushless exciter and regulator. The regulator includes power, potential, and current transformers. The 1425-pound alternator is a three-phase 60Hz, Y-connected machine rated at 125kVA, 0.8 power factor, 480 volts.

- The 100-foot tower is a steel pinned-truss design on a concrete foundation. It's not very good looking, but it is relatively low cost since it's the type already used by utility companies. The natural vibration frequency of this kind of tower is higher than that of a guyed tubular type—an advantage, as we'll see later. It is designed to withstand not only high winds but also big rotor thrust loads, both steady and cyclic. The design also makes it easily accessible for maintenance.

The rig's propeller is not just an ordinary one scaled up. Each carefully curved blade, made by Lockheed, is 62.5 feet long and weighs 2000 pounds. The pitch angle of both blades is controlled at the hub and the blade itself has a progressive twist of 26.5° (see drawing). Thus the thicker, slower-moving hub has a greater angle of attack than the thin tapered tip that cuts through the air at a much higher speed – 178.5mph, to be precise.

The rotor is the biggest single-cost item of this $US985,000 wind-energy research project. The wind may be free but, obviously, getting power from it is not.

Why has ERDA elected to take the large-scale approach to wind power? Why not go the small, onsite wind-generator route of suppying residential electric power, as many wind-power advocates propose? I threw these questions to Ron Thomas of NASA and others involved in the project.

Thomas told me his own typical mid-western home uses about 600kWH of electricity each month. If the average house in the Cleveland area were to have its own full-time generator it would take a machine like this:

- It would be a 4kW generator, have a rotor 30 feet in diameter, and be mounted on a 50-foot tower.
- Batteries would be required to store reserve power for windless periods when the generator was not delivering. These could not be simply a bunch of automobile batteries, because these are designed to provide big bursts of energy as opposed to delivering it over long periods of time.

A forest of such generators in a housing development is neither practical nor desirable from an aesthetic or from a safety viewpoint.

Big generators feeding power into an existing power grid is the design aproach taken by ERDA and NASA's Lewis Research Center. This saves money needed to distribute the new energy and also means it can be plugged in or out as needed and as it is available.

In Washington I had a long skull session with Louis Divone, chief of ERDA's Wind Energy Conversion Branch. I grilled him about the basic hows and whys of the Sandusky design.

Why not put a bunch of rotors on each high tower?

"For land-based systems it was determined that a single 200-foot rotor is more cost-effective to build than two 150-foot rotors on the same tower. The reason is that power from the wind goes up with the square of the rotor diameter. By doubling the diameter of a rotor we get four times the power. Thus it would take four 100-foot rotors to equal the power of one 200-foot one."

The cost?

"Depending on exact size it would probably cost 50 to 100 percent more for four rotors and the tower than for one big one."

Inside the gear-packed fibreglass capsule atop the 100ft tower author Kocivar gets a close look at the hefty disc brake that keeps the giant rotor stationary when adjustments are being made.

ERDA's wind energy chief Louis Divone shows the author a lightweight two-piece rib that's the same as one in the centre section of the rotor. The blades are made of aluminum, each weighing 2000 pounds.

Why not use more than two blades on a single rotor?

"More blades will give more torque at low speeds. This concept is used for water pumping. Fewer blades provide more energy for their cost. In small wind machines with blades 20 to 40 feet in diameter three blades are probably best in terms of cost and balance. In larger wind turbines two blades are better."

If the turbine blades are the expensive items and we think of producing them by the hundreds or thousands in a standardized way, how can they be fitted for different wind speeds?

"Variable-pitch blades are one answer. Another possibility is to use the same size blades, which would be cheaper to make in production, and have different generators or gearboxes for use in different sites.

"ERDA is also looking at variable-speed drives for small rotors. Also, some generators can, within limits, produce

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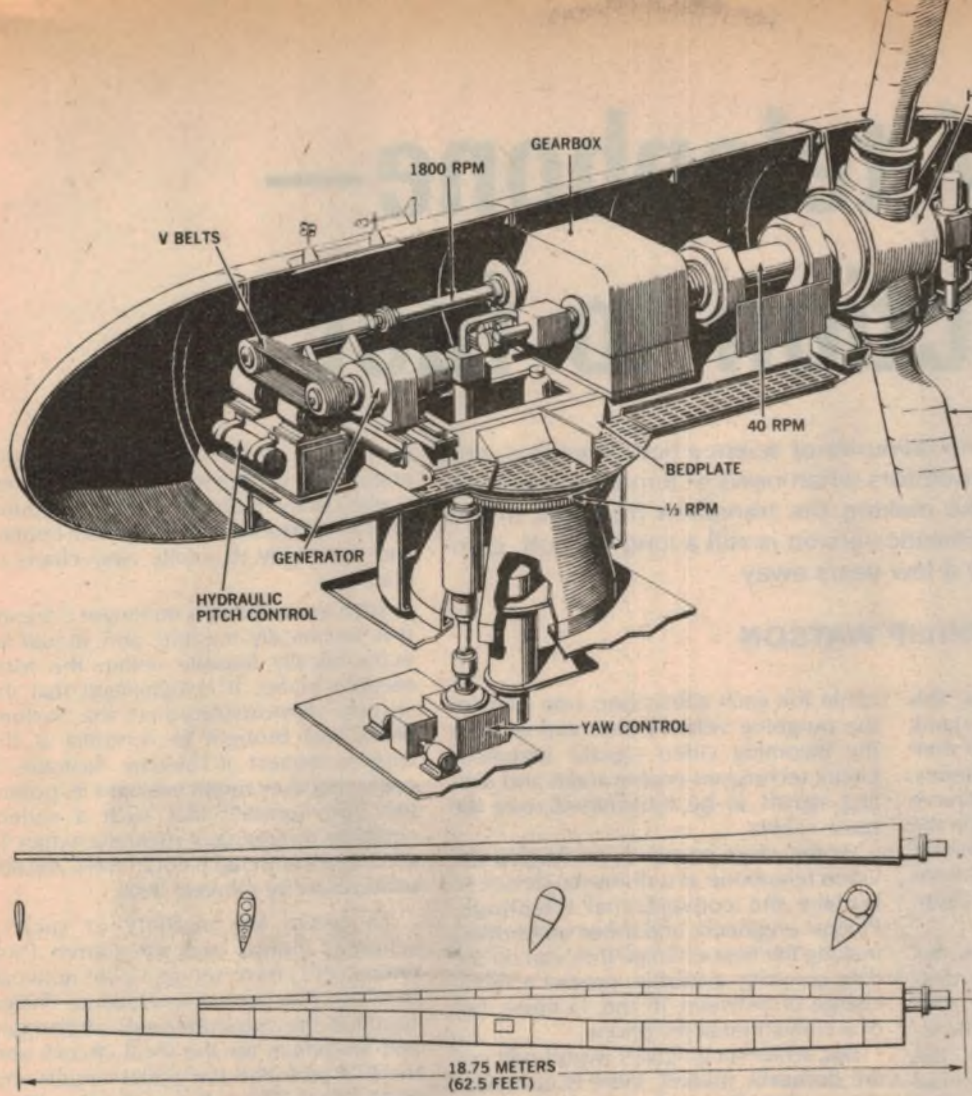
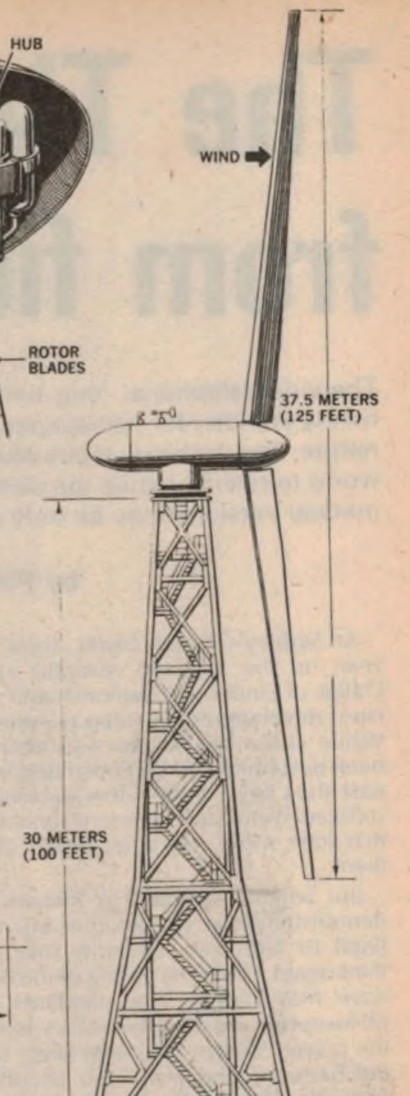




Drawing at top shows details of machinery inside capsule and how gearing steps up 40 rpm of giant rotor to generator's 1800 rpm. Cross-section of one blade shows varying angle from thick section near hub to thin lower angle of attack at tip. When the rotor's shaft is turning at 40 rpm, the blade tips are travelling at 178.5 mph. Right: operating position of blades downwind from tower.

constant-voltage power and constant frequency regardless of shaft speed. The 'within limits' would be a factor of three or four."

Why do we need constant speed on the rotors?

"There are problems of structural dynamics between the tower and the revolving blades. You want to keep the frequencies set up by the blades different from those of the tower. The big prop blades act like low-frequency tuning forks. If they set up a vibration frequency that is the same as the tower or even parts of it, the unit could tear itself apart with vibration."

How about the effects of ice on the blades?

"It could be a problem, yet we have not added any de-icing devices such as are used on airplane props. The big blades are flexible, and we think this will crack off any ice as it forms before it becomes heavy enough to unbalance them. If ice forms on the blades while they are parked we will have to work something out—perhaps glycol spray."

Tests with the first 100kW generator will go on for the next two or three years. But it's only one of several types of wind generators being investigated by ERDA.

Two new wind generators using the same size blades as the Plum Brook unit are under construction. By using bigger gearboxes and generators, these rigs will develop 200kW. The site locations are to be selected this spring.

The next step up is to develop a much more powerful machine. Ron Thomas told me:

"We're starting procurement of a 1½-megawatt machine. It will look much the same as the 100kW machine but will have a 180-foot to 200-foot rotor."

Design research on wind turbines at Lewis Labs is going in several directions. They are trying new composite materials for hubs to reduce weight, cost, and improve reliability of rotors; and are developing a new teetered hub for the rotor to replace the fixed hub, which should reduce the bending moments of the blade roots and make them less likely to break.

Cost for the next group of wind generators is expected to drop significantly. For example, the cost of the first 100kW machine is projected at $US5000 per kilowatt. Cost of similar follow-on machines is expected to be $US2000 per kilowatt. By the time industry-produced and operated wind rigs go into operation, cost is expected to go down to $US1000 to $US600 per kilowatt. This would make the windmills competitive with diesel generators using fuel that costs 30 cents a gallon.

The estimates of wind energy available on an annual basis are rather firm and predictable. This cannot be said about future world oil supplies. Add to this one major advantage of wind energy: it is non-polluting.

Reprinted from "Popular Science", by arrangement.

The TV telephone— from fiction to fact

The videotelephone, long time favourite of science fiction writers, and handy standby for newspaper editors when news of a more sensational nature was lacking, looks like making the transition from the dream world to reality. While the domestic version is still a long way off, commercial versions may be only a few years away.

by PHILIP WATSON

At Sydney's Royal Easter Show this year, on the Telecom Australia stand, Philips of Eindhoven demonstrated their latest development in video telephones. While video telephone systems have been described and demonstrated in the past they have, with a few exceptions, suffered from such inherent limitations that little more has been heard about them.

But anyone tempted to dismiss this demonstration as just another one destined to fade into obscurity may well think again. While the styling of the hardware may change, the standards, the philosophy, and the electronics behind the current design will most likely form the basis for practical video telephone networks throughout the world in the next few years. Already, standards have been agreed upon and engineers in Germany, France, USA and Japan are all working towards a similar goal.

A major problem, until recently, has been to provide acceptable picture quality within a bandwidth which could be handled by conventional telephone cables, as used between the subscriber and exchange. Rather ironically, the longer distance trunk links, between exchanges, have been less of a problem, since broadband bearers are normally available and almost any required bandwidth can be provided. But the need to provide special cables for individual videophone subscribers presents a serious economic barrier.

The present approach appears to be an excellent compromise. By reducing the size of the picture, while retaining the same definition (per unit area) as for broadcast TV images, the bandwidth can be reduced from 5MHz plus to about 1.3MHz. These signals can be transmitted over conventional telephone lines for distances of up to 2km without significant loss, or greater distances by the addition of amplifiers and equalisers at approximately 2km intervals.

The result is a system which requires only two pairs of ordinary telephone cable for each subscriber; one pair for the outgoing video signals and one for the incoming video signals. Ingenious circuit techniques enable audio and dialling signals to be transmitted over the same cables.

At this stage no one is envisaging the video telephone as a domestic device to replace the conventional telephone. Philips' engineers, and other authorities, making the best estimate they can on the data currently available, predict a rental charge of between 10 and 15 times that of a conventional telephone.

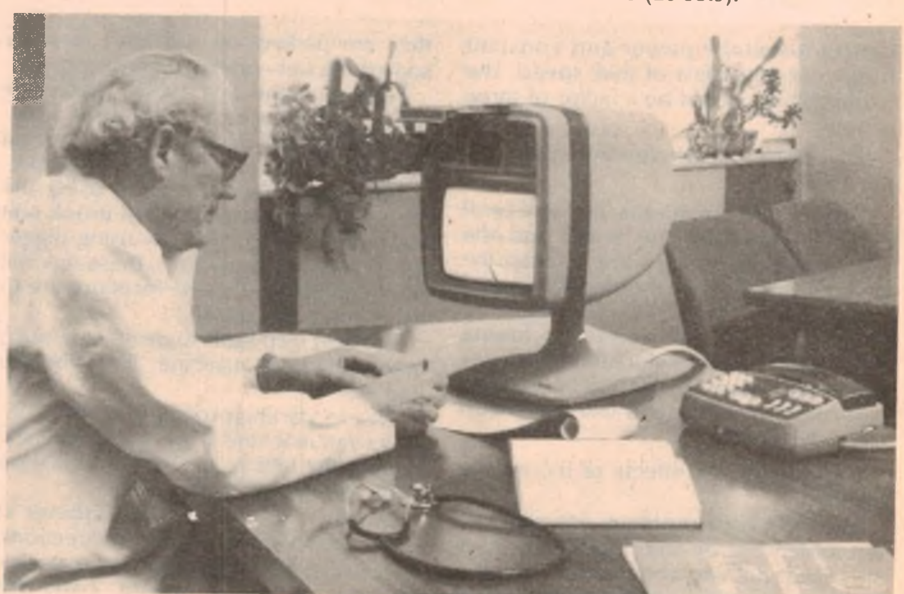
But, while such figures would rule out the domestic market, there is considerable scope for such a facility at the business, industrial, and medical level. It could well take its place alongside the telex, data transmission systems, facsimile systems and so on which are currently available as adjuncts to the normal telephone system.

It is not hard to imagine the time and money it could save if executives, engineers, or doctors in, say, Sydney could confer with their opposite numbers in Melbourne with full visual contact and the ability to jointly view charts or drawings.

Such a possibility is no longer a dream. It is technically feasible, and should be economically feasible within the foreseeable future. It is significant that the system demonstrated at the Sydney Show was brought to Australia at the express request of Telecom Australia, in order that they might evaluate its potential. They predict that such a system could be operating in Australia within 10 to 15 years and that it could have 200,000 subscribers by the year 2000.

To prove the viability of such a scheme, Philips and the Dutch Post Office (PTT) have set up a pilot network between five centres in Holland. Philips supplied the subscriber sets, exchanges and amplifiers for the local circuits and the PTT provided the actual circuits and trunk line facilities. The system has been in operation for the last three years.

The system operates between the PTT laboratories at Leidschendam (9 sets), the PTT at The Hague (15 sets), Philips at Hilversum (11 sets), Philips at Eindhoven (10 sets), and Philips laboratories at Waalre (20 sets).



Medical consultation is an obvious use for the TV telephone. Here a doctor uses the experimental Dutch network to discuss a chart with a colleague. The chart, on the desk, is reproduced on the screen. Note the angled mirror in front of the camera.

Four of the exchanges are of conventional design, extended with a video switching matrix of reed relays; the fifth at Waalre is an experimental one of the computer-controlled type.

The local network uses selected pairs of existing telephone cables. Some 300 amplifiers are used to make up for the losses which are frequency dependent; final equalisation takes place at the end of each transmission line. The trunk network is based on radio links between The Hague and Hilversum and between Hilversum and Eindhoven, each carrying two video telephone channels.

The purpose of this trial is to acquaint interested parties with this new means of communication, to get a better understanding of visual communication in practice and of the feasibility of such a service. Both organisations will evaluate its results as to technical and operational performance, and particularly as regards the participant's changes in communication and travel pattern. Within the two organisations the participants for this trial were selected from members who have an established communication pattern.

The units brought out for demonstration at the Sydney Show were accompanied by Mr van Loon, one of the engineers from Philips Telecommunication Industries (PTI) in Holland, who has been closely associated with the project since its inception. Mr van Loon was most helpful in demonstrating the equipment and answering this writer's technical queries.

The units, illustrated in this article, seemed to provide all the facilities one would require. A most useful feature is the "self view" facility, whereby the user can check his image as the other party will see it. Coupled with this is an electronic zoom facility to provide an optimum size image, and an electronic tilt control to take care of variations in subject height.

The "self view" can be a little disconcerting at first, particularly if one is tempted to work too close to the camera, with the lens at the "wide angle" end of its setting. The result is a nose which would compete with Jimmy "Schnozzle" Durante!

Equally disconcerting is the reversed image, at least if one attempts to straighten a tie or, for the ladies, attend to makeup.

Fortunately, there is a "test" position which produces a mirror image.

There is also a privacy button controlling either sound or picture.

Documents are transmitted by the simple expedient of pulling out a mirror above the camera lens. The mirror snaps down to a 45° angle and covers the desk area immediately in front of the screen.

Some measure of the effectiveness of the visual image can be gauged from the following story from Mr van Loon. As an experiment, PTI obtained the services of two groups of totally deaf people who had been taught to speak and were proficient at lip reading. They were located at two of the stations in the Dutch system and found that they could "talk" to one another as effectively as if they were face to face. To emphasise the situation to those observers with hearing the sound was turned off and one of the deaf participants translated the conversations for their benefit.

This must surely be the first time totally deaf people have been able to use a telephone!

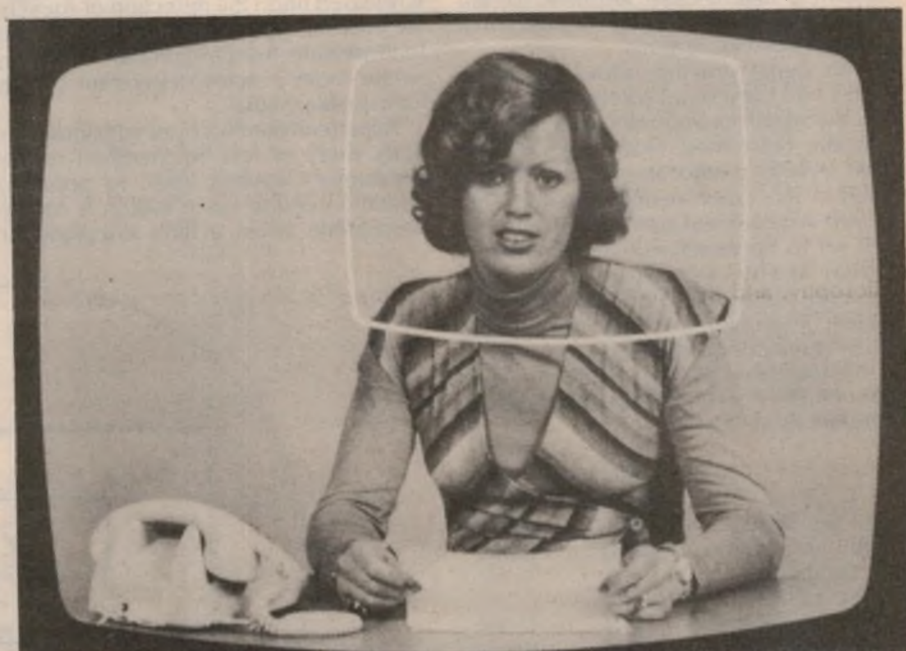
The finer technical details of the system, and some of the design philosophies behind them, are described in the following text. This information and diagrams are taken from a PTI paper by Mr van Loon and Mr van der Hoff of PTI, and Mr Knijnenburg of the Dutch PTT, plus notes made during discussion with Mr van Loon.

Map showing the extent of the Dutch experimental TV telephone system. It uses 65 sets in five centres.

The main aim in video telephony is the transmission of moving head and shoulder pictures. This permits a reduction in the information to be transmitted as compared to broadcast television.

If we consider the picture of a newsreader against a backdrop of maps etc., the essential part of the information occupies no more than 25% of the whole picture area. If we accept this part for video telephony, a bandwidth of 25% of the nominal value of broadcast TV (approx. 5MHz) seems reasonable; this can be obtained by reducing the number of picture lines to be scanned to 50%—which will reduce the vertical resolution by 50%—and accepting a reduction of 50% in horizontal resolution.

The resultant bandwidth of approx. 1.3MHz permits a reasonably efficient use of existing telephone cables in the local network. Unshielded pairs of a telephone cable allow for a length of 1.3 to 2km before amplification and equalisation of the signal is necessary. This distance decreases sharply with an increase of the bandwidth to be transmitted, owing to increased losses and crosstalk with frequency.



The narrow bandwidth for the TV telephone is achieved by scanning only one quarter of the area scanned in a normal TV picture. This is illustrated most effectively in the picture above, where the head and shoulder image is extracted from a much larger picture.

The synchronising and sound systems of the experimental network differ from the conventional TV systems. The sound is transmitted in digital form during the horizontal flyback period of each line. During the video line scan the sound is sampled into eight bits, stored in a register, then read out of the register at a much faster rate during the horizontal flyback period. At the receiver, these eight bits are again stored, then read out at the normal rate during the next line scan.

A basic requirement for such a system is a clock generator at the transmitting end and a similar clock, synchronised with it, at the receiving end. To synchronise the receiving clock a burst of 1uS pulses is transmitted during the horizontal flyback period, followed by the 8 bits of audio information as already explained.

Having established the synchronised clock to provide the audio link, it is logical to use the same reference to synchronise the horizontal and vertical deflection oscillators. The only additional information needed is the finish of one field and the commencement of the next. This is provided by a code pulse in the vertical blanking period.

A result of this approach is a four-wire audio transmission system. Together with the digitisation of the audio information, which permits lossless transmission, a very stable loudspeaker system is obtained that is less sensitive to the drawbacks inherent in the conventional analog two-wire systems.

This signal structure allows transmission to be carried out on two wire pairs, i.e., the signalling information can also be digitally transmitted. However, for practical reasons a separate pair of wires is used in the experimental network. This 6-wire arrangement permits the subscriber set to be switched over to conventional analog synchronisation and separate transmission of audio and signalling information in conformity with existing telephone systems.

A summary of the video system parameters, chosen for the experimental network, is as follows:

	Video telephone	European TV
lines per picture	313	625
field frequency	50Hz	50Hz
interlacing	2 : 1	2 : 1
aspect ratio (horizontal/vertical)	4 : 3	4 : 3
bandwidth	about 1.3MHz	about 5MHz

Early discussions on video telephone parameters aimed at one world standard, resulting in a preference for a 60Hz field frequency because of the reduced flickering in bright parts of the picture. ("Electronics Australia", January 1972, p15.)

However, the problem of unwanted modulation of the camera signal caused by fluorescent lamps working on 50Hz mains gave rise to some hesitation about the usefulness of such a world-wide 60Hz standard. (The modulation results in an objectionable 10Hz brightness pulsation which is almost impossible to eliminate.)

At the same time both the feasibility and desirability of simple conversion from video telephone standards to broadcast TV standards was demonstrated, and this requires that the field frequencies of the two standards be identical, ie 60Hz in the USA and 50Hz in most other countries. A second requirement for easy conversion is a number of lines per picture close to half that of TV standards (313 lines as against the standard 625 line TV systems).

These problems and influences have now been recognised internationally and it has been agreed that each area will proceed on the basis of existing standards; 60Hz in USA and Japan, 50Hz in most other areas. If and when international videotelephone circuits are established, it will be more practical to use standards converters similar to those currently used for broadcast TV. On this basis experiments in the USA are being conducted using a 263 line picture, at 30 frames.

Effective use of the video telephone necessitates "hands free" operation of the audio system. A voice switch is necessary to prevent acoustic feedback. The voice switch always blocks one of the audio channels; the blocked channel is released upon the detection of speech. To prevent the signal produced by the loudspeakers from tripping the detector, its threshold is made dependent on the loudspeaker signal.

This circuit readily copes with interruptions, more or less independent of the interrupter's speech level. In practice, operation of the voice switch is hardly perceptible when a little discipline of speech is observed. The handset may be used under conditions of high ambient noise. The audio transmission bandwidth extends to approx. 5000Hz, which ensures a reasonably good speech quality.

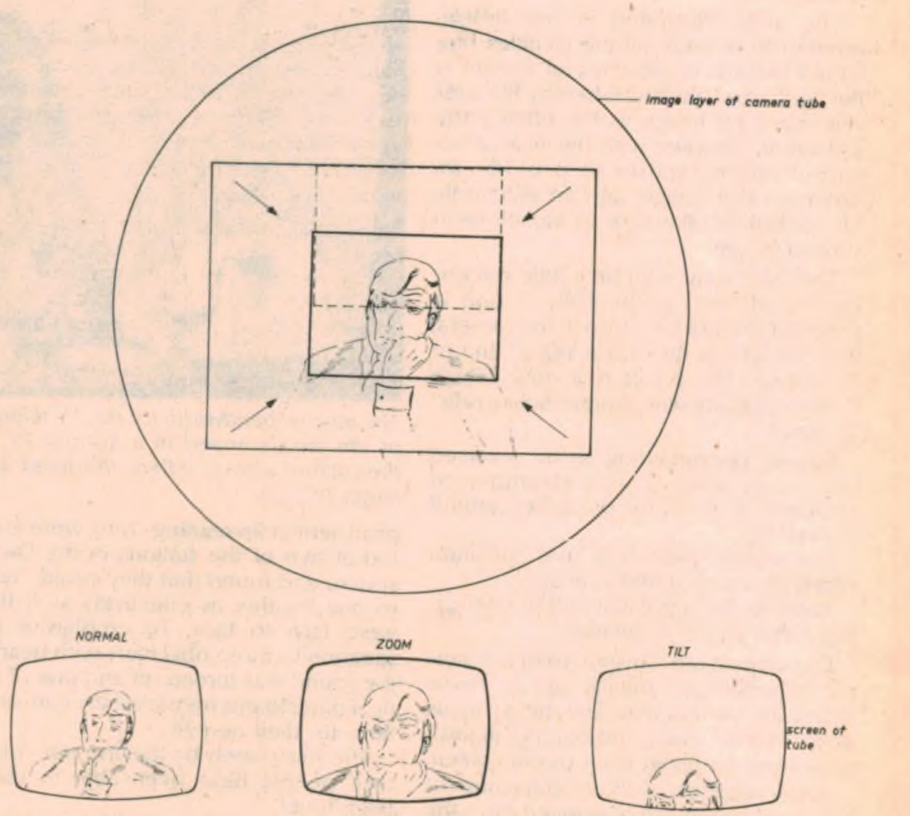
The picture unit contains the display tube, the loudspeakers, the camera tube and its small retractable deflection mirror used in the document mode. The elevation of the set can be adjusted manually and the set can be turned on its base. The control unit carries the push buttons for dialling subscribers, plus all the necessary controls.

The functions are:

'Self View', for monitoring the transmitted picture during conversation or document display; 'Privacy', inhibiting the transmission of video and/or audio; 'Testing', permitting performance testing of the set and preparation for a call (positioning of the subscriber and documents); brightness and contrast of the display tube; camera field of view (electronic zooming); camera tilt (electronic); camera focusing; volume of the loudspeakers.

The control unit also contains the microphone for the loudspeaking telephone system, and a handset for privacy during conversation; the loudspeakers are switched off when the handset is lifted. A secretary can assist in calling and answering, using a modified control unit with no picture facilities.

The human factors have been de-



Basis of the electronic zoom and tilt. The circle shows the image projected by the lens, the large rectangle is the area scanned in the "normal" position, the small rectangle is the area for the "zoom" position, and the dotted area shows the "tilt" function.

signed into the unit with the help of the Institute for Perception Research (IPO) at Eindhoven.

The main ergonomic parameters are: Viewing distance about 100cm; Height of camera over desk-top 40cm; Camera coverage at viewing distance nominal: 80 x 60cm^2; zoomed in: 40 x 30cm^2; picture size of display tube 19 x 14cm^2.

The viewing distance is a compromise. A short distance to the subject will introduce distortion, as is well known from photography. Besides, a short distance would limit the spatial freedom of the subscriber, because he moves more easily out of focus.

On the other hand, the dimensions of a desk and the requirement of having the instrument within reach for using the document facility put a limit to the viewing distance. Furthermore, a larger viewing distance would necessarily require a larger display screen, while a smaller set is more attractive from the aesthetic point of view.

For a nominal viewing distance of 100cm the camera will cover an area of 80 x 60cm^2, allowing sufficient freedom of movement. At 150cm this will be 120 x 90cm^2, which gives ample room for two persons sitting in front of the picture set, such as in a conference arrangement.

A rather high position of the camera above the desk top is an advantage, as it prevents ceiling light from coming into the scene. Additionally, a horizontal camera axis leaves more freedom for the user to move backwards and forwards, without undue movement in the picture, or even getting out of the picture. From the aesthetic point of view, however, a smaller picture unit height would be more attractive.

The optimum size of the screen is directly related to the resolution of which the human eye is capable. It is a well known fact that an observer tends to approach the display tube until the observed picture does not improve. Coming closer would render the line structure on the screen disturbingly visible. On the screen of the chosen 22cm tube the line structure will be visible but not disturbing at a viewing distance of 1m, while at 1.5m all the available picture details can still be observed.

The camera tube is a Plumbicon, which, together with some electronic circuits for contour sharpness and gamma, guarantees excellent picture quality. An advantage of a Plumbicon tube is the possibility of electronic zoom and tilt control. On the front of the image layer of the pick-up tube a circular image is projected by the optical system. The electron beam scans a rectangular part. Reduction of the beam scanning angles proportionally in the horizontal and the vertical senses results in a zoom effect when the picture is reproduced on the screen.

Tilt control is effected by a DC current through the vertical deflection coils, resulting in an up or down movement of the reduced scanning area. When the camera is zoomed in by a factor of 2, the resolution, which is determined by the line density on the image layer, is equal to standard TV conditions.

An Automatic Iris Control (AIC) compensates for the changes in scene illumination. At low lighting levels the iris control is extended by an Automatic Gain Control (AGC) which permits a total range of about 25-10 000 lux, varying from a dimly lit office at night to a sunny room in summer. At the lowest levels the picture becomes noisy. The control signal is the video signal itself, taken at the essential part of the picture, i.e., the centre. The iris reacts slowly to sudden illumination level changes such as persons passing by, doors opening, etc.

The signal level reduction which results from the reduced scanning area by zooming is compensated for by the automatic iris control. The largest iris aperture (f/2.8) gives a depth of field of 0.75-1.50m, allowing sufficient movement without undue blurring.

When the user pulls out the document mirror, a part of the desk in front of the picture unit is scanned. All necessary controls are automatically readjusted including the reversal of the horizontal deflection in the camera to compensate for the optical inversion introduced by the mirror. Focus is adjusted for an object distance of 50cm. The area covered is 20 x 15cm. As the display screen has about the same dimensions, image ratio is about 1 : 1.

For legible character transmission each character should be scanned by about 8 lines; this means a minimum character height of 4mm on the document. Typewritten text can only be read if the document is moved closer and the line length does not exceed 25 characters.

One of the most useful features of the video telephone is its potential as a conference device. This unit is designed to provide conference facilities by the simple expedient of adding extra units at each end.

In the conference mode an assembly of six persons seated in pairs before three picture units are linked through the video telephone network to a similar gathering elsewhere. The person speaking and his neighbour are seen at all three displays at the other terminal.

The choice of the picture transmitted is determined automatically by voice detection or manually by the chairman at either end. A wide angle camera may be added to take an overall view of participants at one end. However, the resolution of the system is not sufficient for a highly detailed picture.

The conference mode should be distinguished from 'Confravision' and other TV conference arrangements in which links are established between studios on a permanent basis using a 5MHz standard. As a rule these systems use only one camera at either end.

The focus is now on electronic camera control

Electronic circuitry is playing an increasingly important role in modern camera design and function. In this, the second of a two-part article, we examine further product examples of both still and cine cameras, and take a brief look at electronic shutters.

by BRIAN DANCE, M.Sc. Pt 2

Miniature camera: The Minox Company of Germany manufactures one of the smallest cameras available at present, their model 'C' being only 122 x 28 x 16mm in size. It weighs about 86 grams and produces negatives 11 x 8mm in size.

In this camera the lens is always fully open, as the depth of field in such a miniature camera is adequate to ensure that everything from 20cm to infinity is always in focus. Exposure times of 1/15 to 1/1000 second can be set manually, but the fully automatic electronic circuit of the Minox C provides a range of times from 7 seconds to 1/1000 second. A warning lamp is illuminated when the required exposure exceeds 1/30 second, and indicates that a tripod may be required.

An unusual feature of the Minox shutter is the use of two electromagnets, one to open the shutter and the other to close it. This was found to be necessary in order to obtain the relatively high speed of 1/1000 second, since the magnets take longer than this exposure time to operate. However, the two magnets are of similar design and the two operating delays are therefore almost exactly equal. It is remarkable to think that when the exposure time is very short, the pulse to close the shutter is produced by the trigger circuit even before the shutter has opened!

The basic circuit of the Minox C shutter is shown in Fig. 4. S1 closes when the shutter operating lever is pressed and the magnet M2 is energised. It opens the shutter at a definite instant and simultaneously opens the contacts S2 so that it de-energises itself. C1 charges through the photoconductive cell P at a rate determined by the intensity of the light falling on the latter. When the potential across C1 reaches a certain value, the trigger circuit is actuated. The magnet M2 then closes the shutter and opens the contacts S3. Four transistors and two diodes are employed in the trigger circuit.

Yashica products: The Yashica "Electro-X" employs a through-the-lens light measuring system with two cadmium sulphide photoconductive cells on each side of a pentaprism unit. An electronically timed metal focal plane shutter is employed to give exposures from 2 seconds to 1/1000 second.

Through - the - lens metering is employed by the Yashica TL Electro X single lens reflex camera. An integrated circuit controls the shutter speed, which can be varied from 2 seconds to 1/1000 second.

An integrated circuit is used for controlling the shutter speed in this type of camera. The circuit switches on a lamp in the view finder to indicate the direction in which the aperture should be adjusted to obtain the correct exposure.

Another Yashica camera, the Electro AX, includes two integrated circuits with a memory system. The latter is required because the through-the-lens light measuring circuit becomes inoperative immediately before the exposure when all of the light is falling on the film.

The Asahi Pentax ES: A 35mm single lens reflex, the Asahi Pentax employs a fairly complex integrated circuit containing the equivalent of some 50 transistors, diodes, etc. The exposure time is computed from the light intensity, the aperture and the film speed, this information being fed into the circuit from a photoconductive cell and two variable resistors.

The current passing through each of these resistors is fed into three separate logarithmic compression circuits which each generate output signals proportional to the logarithm of the input current. The exponential current voltage relationship across pn junctions is employed to generate the logarithmic functions.

The logarithmic signals are then suitably computed and the resulting signal is fed into an exponential expansion circuit (or anti-logarithmic generator) to produce an output current with a value proportional to the reciprocal of the required exposure time. This current is fed to a capacitor from the instant at which the shutter opens. When the capacitor voltage reaches a certain value, a trigger circuit switches off the current to an electromagnet and the shutter closes.

The information on the light intensity is available until the shutter release is pressed, but during the exposure the light no longer falls onto the photoconductive cell. The output from the logarithmic generator in the light intensity measuring circuit is therefore fed to a memory circuit. The latter provides an output voltage which is constant and which is proportional to the logarithm of the current passing through the photoconductive cell immediately before the

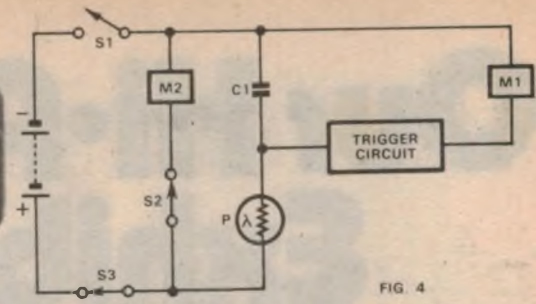


FIG. 4

The Yashica Atoron ultra-miniature camera features fully automatic exposure control.

shutter release is pressed. The high gate-source impedance of a field effect transistor is employed in the memory circuit to prevent the rapid leakage of charge from the memory capacitor.

The meter in the view finder of this camera obtains its current from a point before the exponential expansion circuit so that it can display a wide range of exposure times over a short logarithmic scale. If the indicated shutter speed is unsatisfactory, the aperture can be changed until one obtains an exposure in the desired range.

Electronic shutters: All of the shutters we have discussed up to this point have employed electronic circuits to control the timing of mechanical shutters. One may well ask, "What is the possibility of making a shutter which is completely electronic in operation?". Such a shutter would have to employ some form of electro-optical device to control the passage of the beam of light to the sensitive emulsion.

Completely electronic shutters have been made, but unfortunately present designs are suitable for use only in research laboratories and not in portable cameras. A Kerr cell with its associated power supply of some 50kV may be employed, but the equipment is heavy and expensive. In addition, only about 10% of the incident light can pass through such a shutter.

When a shutter of this type is closed, a small amount of light passes through it, so a mechanical shutter or a lens cap is also required to limit the time for which this unwanted light can pass to the film. One of the advantages of shutters employing a Kerr cell is that extremely short exposure times (down to a few thousand millionths of a second) can be obtained.

Light from a source or object to be photographed passes through a polariser which allows only light in one plane of polarization to pass through it. The plane polarised light is then passed through the Kerr cell which contains a liquid such as nitrobenzene.

If no voltage is applied between the two electrodes in the Kerr cell, the light passes through it unaffected. In this case, however, only a very small proportion of the light can pass through a second polarising prism (known as the 'analyzer'), since this second prism is rotated so that its axis is perpendicular to that of the first polariser.

This electronic shutter is opened by applying a short, high voltage pulse to the electrodes of the Kerr cell. During this time an intense electric field is applied to the liquid in the cell and this causes it to rotate the plane of polarization of the light passing through it. Much of the light coming out of the cell can therefore pass through the analyser to the film or plate.

For very high speed photography it is often much more convenient to illuminate the object to be photographed with a very short (but very intense) flash of light than to employ a shutter mechanism. The camera lens aperture is opened before the flash and is closed again after it.

Cine cameras: Electronic control is widely employed in cine cameras for automatic exposure control (normally by means of a through-the-lens system using a cadmium sulphide photoconductive cell). Control of the film running speed can also be effected more conveniently by electronic instrumentation than by the use of a mechanical system employing centrifugal contacts.

The electronic film speed control system used in the Leitz 'Super 8' will be discussed to show how electronics can be used in this application. The circuit used is shown in Fig. 5. The film driving motor, M, has a small tacho-generator attached to it; the latter produces an alternating voltage of a frequency equal to the motor speed. This alternating voltage is applied to the complementary transistor stage TR1 and TR2.

The signal at the junction of the two emitters consists of almost rectangular pulses whose total amplitude is equal to

Electronics in modern cameras

the battery voltage minus the sum of the saturation voltages of the two transistors. This amplitude is therefore almost constant.

The signal from the emitters is fed into the diode pump circuit of D1 and D2. It tends to charge C2 with such a polarity that it would cut off TR3. The greater the motor speed, the greater the current fed to C2 from D2.

However, a current flows through VR1 and S1 to C2 and tends to charge this capacitor with the opposite polarity. When this current makes the base of TR3 more than about 0.5V positive, this transistor conducts and reduces the base voltage of the pnp transistor TR4. The latter therefore passes a current to the motor.

The current to the motor (and therefore the speed of the motor) is thus controlled by the current fed into C2 from S1 minus the current from D2. The resistors R3 to R5 are used to select the operating speed which may be 18, 24 or 54 pictures per second. Both the current from S1 and that from D2 are approximately proportional to the battery voltage.

If the motor revolves too quickly, the current from R2 to C2 is increased in proportion. This reduces the current passing through TR3 and TR4 and therefore the power to the motor. Similarly, a decrease in the motor speed will result in an increase in the power being fed to the motor.

High speed cameras: More complicated equipment is involved in the really high speed cameras which are available for special purposes. For example, the Hitachi 16HM camera can take up to 20,000 pictures per second. It may be used to photograph crashing cars on a test rig, the burning of a photographic flash bulb, the explosion of gun powder, the cavitation in water surrounding a ship's propeller, the movement of the wings of birds or of insects, for research on the movements of athletes' limbs or for any high speed phenomena. If photographs are taken at 10,000 pictures per second and are subsequently projected at 16 pictures per second, the times are lengthened by a factor of 625; this is adequate to analyse the action of almost all high speed movements.

It is not possible to stop the movement of the film in such high speed cameras whilst each photograph is taken, since the film speed can be well in excess of 60 metres per second (216km per hour)! A rotating prism is therefore employed which provides an image which moves at the same speed as the film and in the same direction during the exposure. The film is accelerated to the full working speed in about 0.5 second, thus requiring a considerable amount of power.

In the "Cine 8" camera manufactured by the Visual Instrument Corporation of Burbank, California, the speed of the film is kept almost free from drift by an electronic servo system. The circuit employs a silicon controlled rectifier to determine the width of a constant frequency driving pulse which is applied to the permanent magnet DC motor. A tachometer driven by the film transport mechanism provides the servo reference. The shutter speed ranges from 1/20 to 1/9,000 second.

The Zeiss Ikon M808 electronic cine camera. Electronic circuitry is employed for automatic exposure control, and to control film running speed.

The Cine 8 can operate from 10 to 250 frames per second, the speed being set in one frame increments by a multi-turn knob placed at the rear of the camera body. Each turn of the knob represents a speed change of 10 frames per second. The camera speed is indicated by a three digit display immediately above the control knob. Mechanical stops are set at zero and 300 frames per second even though the design range is 10-250 frames per second.

This camera can also be operated with an optional pulse kit for pulse or time lapse operation. A single printed circuit board must be changed. Pulse rates are controlled by an external signal input or by an internal 'intervalometer'. The intervalometer rate is controlled by the same dial as that used for cine speeds, but the dial scale reading must be divided by a factor of ten.

Optional dual timing lights employing light emitting diodes are also available for use with this camera. These diodes print timing codes and/or event marks on the edges of the film. This can be a most important accessory when the film is moving at high speed for the photographing of rapidly occurring events which would not be easy to time in other ways.

Conclusion: Electronics has made a significant impact on photography only during the past few years. It seems certain that more and more cameras will employ electronics as manufacturers gain experience; this will include both the cheaper and more expensive cameras, since integrated circuits are now a very small fraction of the cost of any camera.

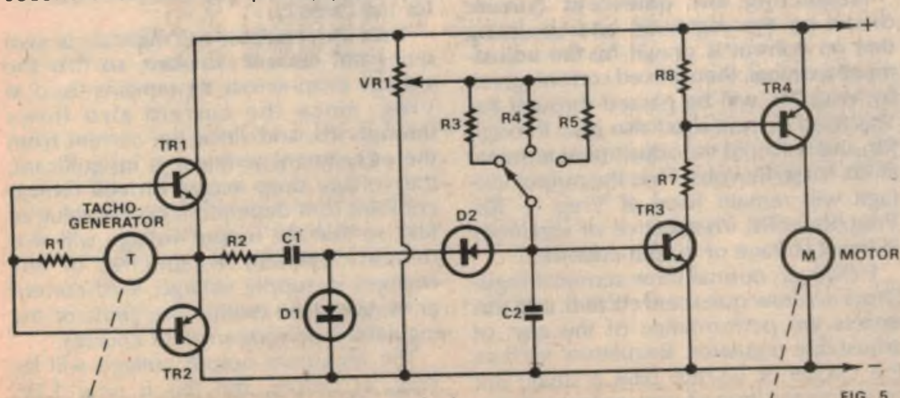


FIG. 5

New, fully protected IC design

Regulated Power Supply

Using only a single integrated circuit, this little power supply can provide voltages up to 30V, and currents exceeding 2A. It is completely protected against excessive currents and thermal overloads, and has current and voltage metering. Best of all though, it's simple to build!

by DAVID EDWARDS

One piece of test gear that never goes astray on any experimenter's bench is an adjustable power supply. It seems in fact that you can never have enough of them, especially if they are fully regulated and protected.

In this article we present a design for such a supply, which uses a single IC. The output voltage is adjustable from about 1.2V to 30V, and output currents in excess of 2A can be obtained.

Our prototype has less than 1mV of output ripple and noise, while the output voltage changed by only 130mV when the output current was increased from 0 to 2A. It is completely stable under all load conditions, both capacitive and inductive.

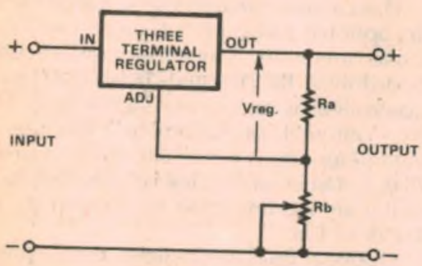


FIG. 1

This diagram shows how a three terminal regulator can be used as an adjustable power supply.

It also survived all manner of overloads. We short-circuited the output at full output voltage, and we connected fully charged electrolytic capacitors across it with the main supply electrolytic capacitors discharged, all without damage. It also withstood a fully charged capacitor connected similarly, but in the reverse mode. Attempting to draw full power with no heatsink also failed to damage it.

Refer to the accompanying graph for details of the load capabilities of the new supply. This is a graph of load voltage against maximum load current (at the onset of loss of regulation). As you can see, currents of up to 1A can be supplied at voltages between 3 and 25V. Higher currents can be supplied over a more limited range.

The limits of the curve are determined by the internal limits of the regulator IC and also by the regulation of the transformer. Note that this curve was measured using our prototype, and is only representative. Typical supplies may have slightly better (or worse) performances.

Heart of the design is a new National Semiconductor IC, the LM317 three terminal adjustable regulator. As well as being adjustable, the LM317 has better line and load regulation than standard three terminal regulators. Included on the chip are current limit, thermal overload and safe area protection circuitry.

Turning to Fig. 1, we can see how a three terminal regulator can be used as an adjustable supply, and why the LM317 is better at this job than a standard regulator. Any three terminal regulator acts to keep Vreg, the voltage between the output terminal and the common or adjustment terminal, constant.

Neglecting any quiescent current drawn by the regulator, and assuming that no current is drawn by the adjustment terminal, then a fixed current, given by Vreg/Ra, will be passed through Ra. This fixed current must also pass through Rb, and will hold the adjustment terminal at Rb. Vreg/Ra volts. Thus the output voltage will remain fixed at Vreg + Rb. Vreg/Ra volts, irrespective of variations in input voltage or output current.

However, normal three terminal regulators do draw quiescent current, and this upsets the performance of this sort of adjustable regulator. Regulators such as the LM309 or uA7805 pass a small, but by no means insignificant, quiescent current through the adjustment terminal. This current varies with input voltage and junction temperature.

This current is added to the fixed current passing through Rb, and any variations in it cause corresponding variations in the output voltage, thus spoiling the ripple and regulation performance. A second problem is that since these types are nominally 5V regulators, the lowest output voltage which can be obtained is 5V. The upper limit to the output voltage is set by the maximum allowable input voltage of the regulator.

The new regulator which we have used in this project also draws a quiescent current from the supply, but differs from previous types in that this quiescent current comes out of the output terminal, rather than the adjustment terminal. The current drawn by the adjustment terminal is very small, of the order of 50uA.

A second difference is that the output voltage of the regulator is 1.2V, rather than 5V. These differences make a significant change in the way the regulator works. In the absence of a load, the quiescent current must pass through Ra and Rb. Ra must be chosen so that the maximum quiescent current which is drawn by the regulator will not produce a voltage drop across it in excess of Vreg (1.2V for the LM317).

Thus the regulator will maintain ts own quiescent current constant, so that the voltage drop across Ra remains fixed at Vreg. Since the current also flows through Rb, and since the current from the adjustment terminal is insignificant, the voltage drop across Rb will remain constant (but dependent on the value of Rb), so that the output voltage will also remain constant, irrespective of any changes in supply voltage, load current or temperature (within the limits of the regulator's performance, of course).

The minimum output voltage will be Vreg, as before, but this is now 1.2V. Maximum output voltage is still set by the

PARTS LIST

1 LM317K adjustable three terminal regulator
2 2A 100PIV silicon diodes, 1N5408 or equivalent
2 1A 100PIV silicon diodes, EM401 or equivalent
1 transformer, 240V to 40V CT @ 2A, JT180, AR5502, PF3993 or equivalent
2 2500uF 35VW pigtail electrolytic capacitors
1 10uF tantalum electrolytic capacitor
1 1uF tantalum electrolytic capacitor
1 330k, 1 33k, 3.9k, 1 220 ohm ½W resistors
1 0.47 ohm 2W resistor
1 5k linear potentiometer
1 1k linear trimpot
3 DPDT miniature toggle switches
3 terminals, 1 red, 1 green, 1 black
1 case, 70 x 160 x 184mm; see text
1 heat-sink, see text
1 knob
1 1mA meter, 51 x 49 x 43mm
2 8-lug tagstrips, with 2 mounting lugs
1 4-lug tagstrip, with 1 mounting lug
1 mains plug, cord, grommet, cord clamp and terminal block
Solder lugs, solder, hook-up wire, tinned copper wire, machine screws and nuts, T03 insulated mounting kit, heat-sink compound

NOTE: Resistor wattage ratings and capacitor voltage ratings are those used for our prototype. Components with high ratings may generally be used provided they are physically compatible.

limits of the regulator. The minimum load current is still zero, as the quiescent current is passed by Ra and Rb.

Turning now to the main circuit diagram, Fig. 2, we can see how the complete supply has been implemented. The mains transformer is the same one as used in the new Twin Twenty-Five amplifier, and has a centre-tapped secondary rated at 44V and 2A. Two 2A 100PIV silicon diodes feeding 5000uF of capacitance are used to rectify and filter the output from the transformer.

The LM317 is connected as described earlier. Ra is formed by a parallel combination of two resistors, while Rb is a 5k linear potentiometer. With these values, the output voltage can be adjusted to above 30V. The 10uF capacitor connected across Rb improves the ripple rejection of the supply, while the diode connected between the OUT and ADJ terminals provides a discharge path for this capacitor when the supply is turned off.

The 1uF capacitor connected across the output ensures stability. The diode connected between IN and OUT terminals provides a discharge path for any external capacitors connected to the supply, and prevents damage to the IC itself. Output metering is provided by a 1mA meter, which can be switched to read either voltage or current.

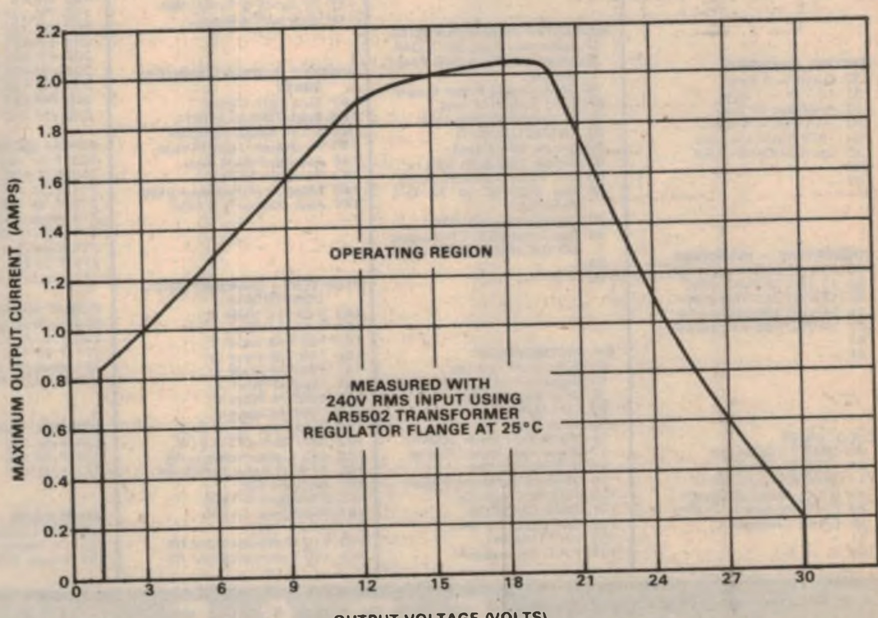
In the voltage mode a 30k resistor formed by a parallel combination of 330k and 33k resistors is placed in series with the meter across the supply. The meter then reads 30V full scale. In the current mode, the meter is connected across a 0.47 ohm resistor inserted in the return line to the filter capacitors. A 1k trimpot is used to adjust the meter so that it reads 2A full scale.

A double-pole double-throw switch is used to open the connections leading to the output terminal, so that the external load can be disconnected. This facility is required because the supply cannot be set to zero volts.

The output of the supply is fully floating, with neither terminal connected to the earthed case. A terminal connected directly to the case is provided, so that either of the output terminals can be earthed if desired.

A diode has been shown (dotted) connected between the output terminals. This is an optional extra which will prevent damage to the supply in the event that a reverse voltage is applied to the output terminals.

Construction of the supply should be quite simple, as there are very few components. We mounted our prototype in a case supplied by Dick Smith Electronics. This has an aluminium chassis with a painted steel cover, and measures



This graph shows the maximum voltage and current which can be obtained from the unit. The graph was derived from the prototype, and is only representative.

Power Supply

70 x 160 x 184mm. It is very reasonably priced at $3.60, and is supplied complete with rubber feet and cover attaching screws.

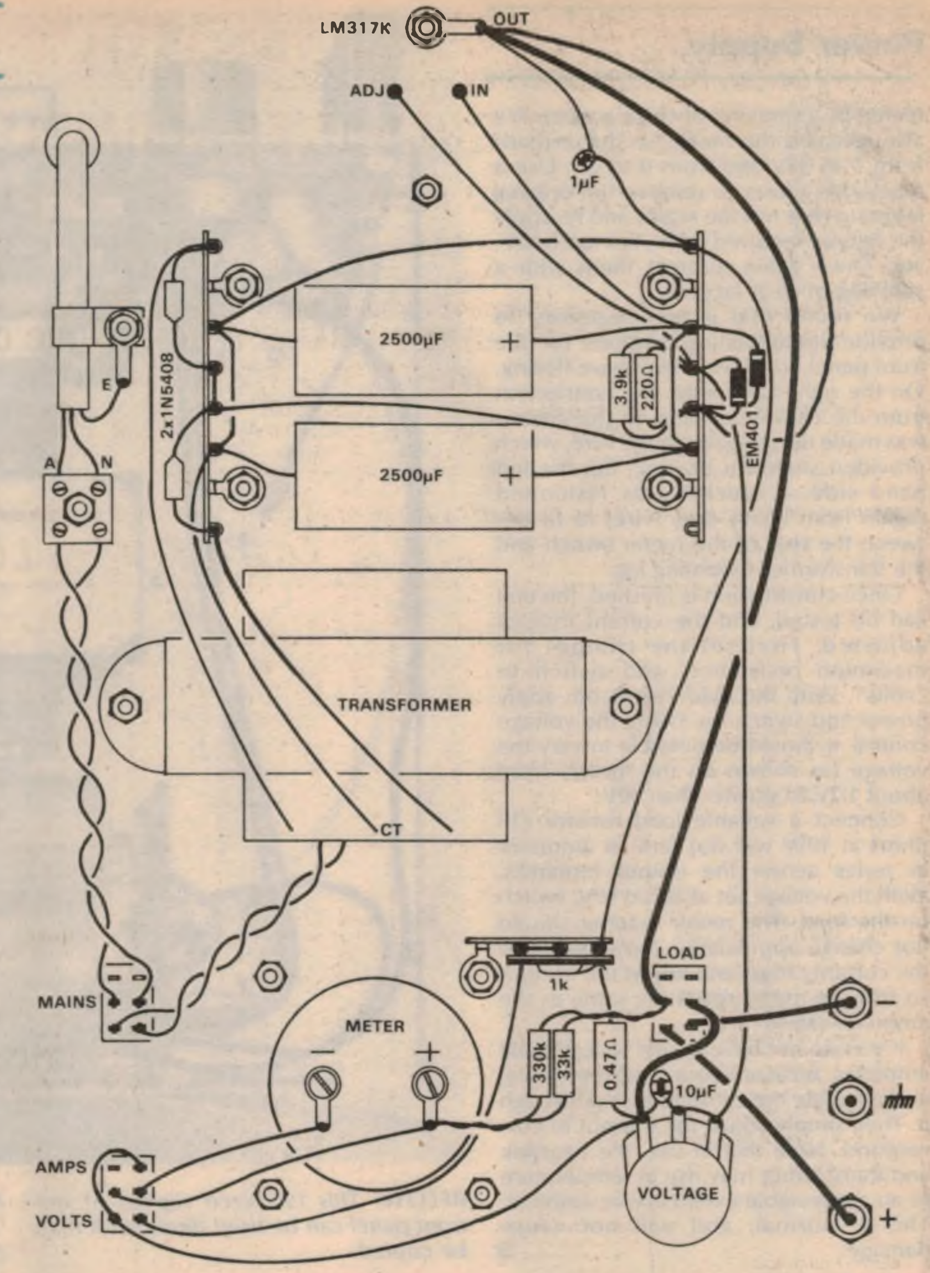
As can be seen in the photographs, the transformer is centrally mounted. Clearance must be left at the front for the panel meter and current adjusting trimpot, and at the rear for the electrolytic capacitors.

The mains cord enters through a grommetted hole in the rear left hand corner, and is clamped to the chassis. The earth lead is terminated in a solder lug, which is clamped to the chassis, while the active and neutral leads terminate in a 2-way terminal block. From there the mains is routed through the power switch to the primary of the transformer.

Mount the LM317 in the centre of the rear of the chassis. In order to gain maximum performance, a heatsink must be provided. We used a suitably bent piece of 18 gauge aluminium, thermally connected to the chassis and to the LM317 with heatsink compound. Remember that the LM317 must be insulated from the chassis. If desired, a commercial heatsink can be used.

The remainder of the components can be positioned, and the wiring completed, with the aid of the wiring diagram. Use heavy duty hookup wire for the marked connections, to ensure good regulation. The remaining connections need only be completed with ordinary hookup wire.

Suitable legends can be applied to the front panel using stick-on lettering, pro-



ABOVE RIGHT: Use this wiring diagram as an aid to the placement of components, and then to complete the wiring.

BELOW: The complete circuit diagram. The diode shown dotted gives full overload protection; see text for details.

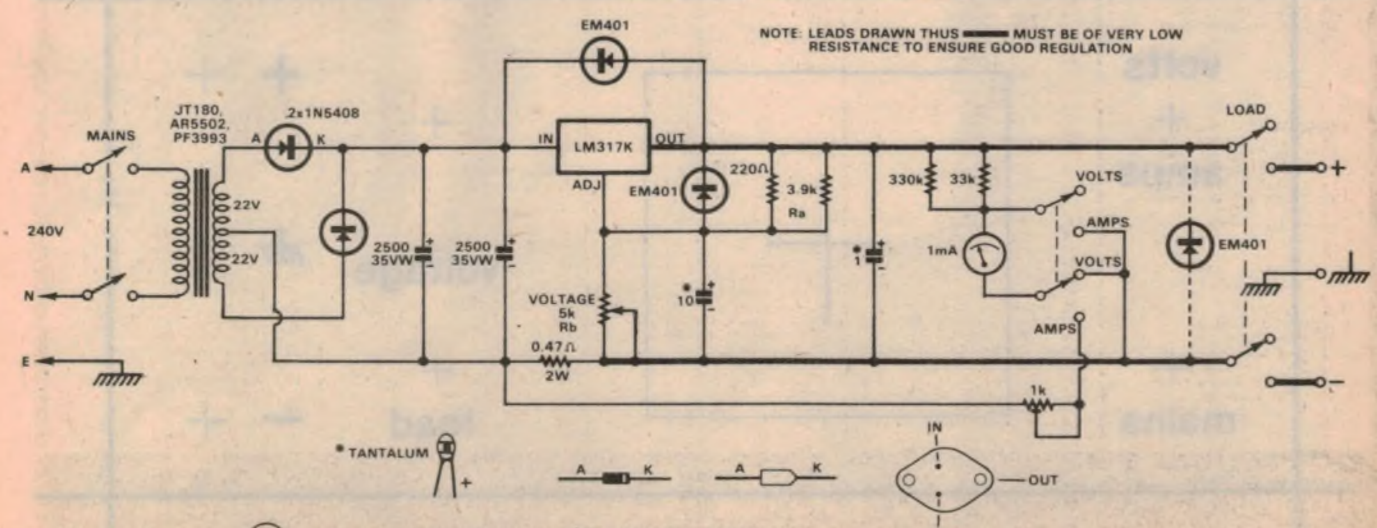


FIG. 2 FULLY PROTECTED 30V/2A POWER SUPPLY

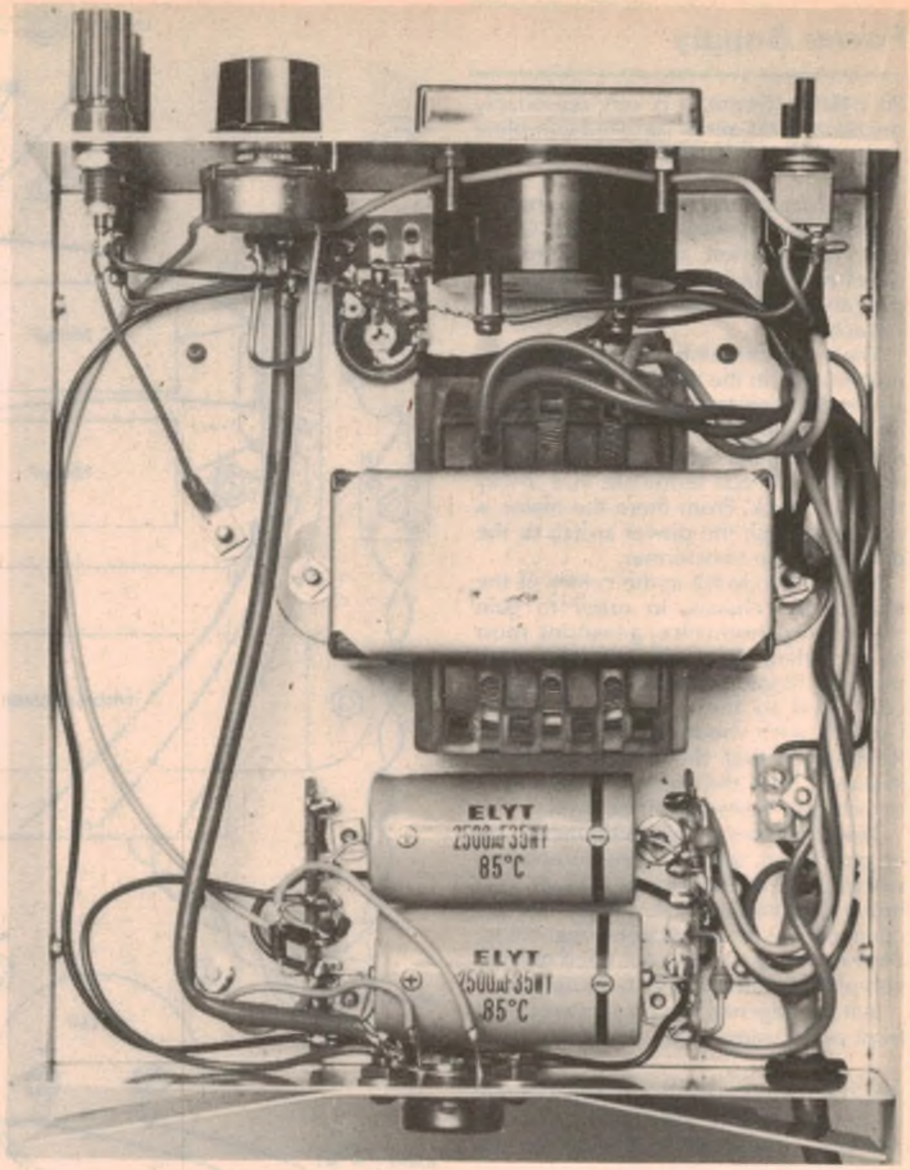
tected by a spraying of clear lacquer. We also rescaled the meter, so that it reads from 0 to 30V and from 0 to 2A. Use a typewriter eraser to remove the original lettering (but not the scale) and re-apply the figures required with stick-on lettering. Once again, protect them with a spraying of clear lacquer.

We found that it was necessary to provide strengthening brackets for the front panel, to prevent excessive flexing. On the right hand side, the connection from the chassis terminal to the chassis was made using heavy gauge wire, which provided sufficient bracing. On the left hand side, a bracket was fashioned (again from heavy duty wire) to fit between the rear of the meter switch and the transformer mounting lug.

Once construction is finished, the unit can be tested, and the current trimpot adjusted. First set the trimpot for maximum resistance, and switch to "volts". With the load switch off, apply power and switch on. Using the voltage control, it should be possible to vary the voltage (as shown on the meter) from about 1.2V to greater than 30V.

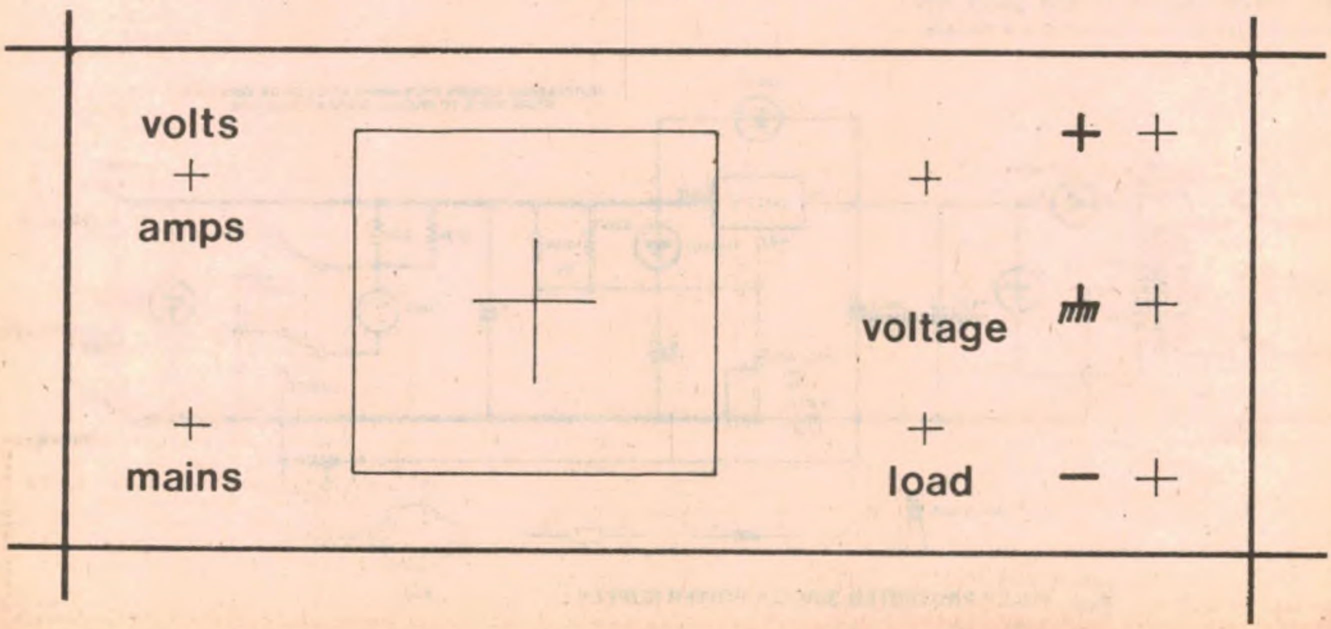
Connect a suitable load resistor (18 ohms at 10W will do) and an ammeter in series across the output terminals. With the voltage set at about 18V, switch on the load. The meter reading should not change appreciably. Now switch to the current range, and adjust the trimpot so that the meter reads the same as the ammeter (about 1A).

If you do not have access to a suitable ammeter, measure your load resistance, and calculate the current flowing through it. Then simply adjust the trimpot to correspond. Note that in use, the heatsink and transformer may rise in temperature to an appreciable extent above ambient. This is normal, and will not cause damage.



BELOW: This full sized replica of the front panel can be used direct, or it may be copied.

ABOVE: Note the two supporting "brackets", one at the left, and one at the right (partially obscured).



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CORVUS

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Wtih MOSTEK* single chip technology, the new Corvus 500 is the first non-Hewlett-Packard calculator with Reverse Polish Notation. 10 addressable memories, 4 level roll down stack to be introduced. If you compare the Corvus 500 feature by feature with the HP45, you will find striking similarities. There are also some important differences.

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	Corvus 500	HP-45
RPN (Reverse Polish Notation)	Yes	Yes
Memory Store and Recall 10 Registers	Yes	Yes
4 Level Stack. Rotate Stack	Yes	Yes
10 MEMORY EXCHANGE WITH X	Yes	No
Log. LN	Yes	Yes
Trig (Sine. Cosine. Tangent. INV)	Yes	Yes
HYPERBOLIC (SINH. COSINH. TANH. INV)	Yes	No
HYPERBOLIC RECTANGULAR ↔	Yes	No
y^x. e^x. 10^x. $\sqrt{x}$. 1/x. x!. x↔y. π. CHS	Yes	Yes
$\sqrt[x]{y}$ through INVERSE	Yes	No
GRADIANS	No	Yes
DEGREE-RADIAN CONVERSION	Yes	No
Degree Radian Mode Selection	Yes	Yes
DEC-DEG-MIN-SEC	No	Yes
Polar to Rectangular Conversion	Yes	Yes
Recall Last X	Yes	Yes
Scientific Notation. Fixed and Floating	Yes	Yes
Fixed Decimal Point Option (0-9)	Yes	Yes
DIGIT ACCURACY	12	10
DISPLAY OF DIGITS	12	10
%. Δ %	Yes	Yes
GROSS PROFIT MARGIN %	Yes	No
Mean and Standard Deviation	Yes	Yes
Σ +. Σ −	Yes	Yes
Product -- Memories	Yes	Yes
C.F. DIRECT CONVERSION	Yes	No
F.C. DIRECT CONVERSION	Yes	No
LIT-GAL. DIRECT CONVERSION	Yes	No
KG-LB. DIRECT CONVERSION	Yes	No
GAL-LIT. DIRECT CONVERSION	Yes	No
LB-KG. DIRECT CONVERSION	Yes	No
CM-INCH DIRECT CONVERSION	Yes	No
INCH-CM DIRECT CONVERSION	Yes	No

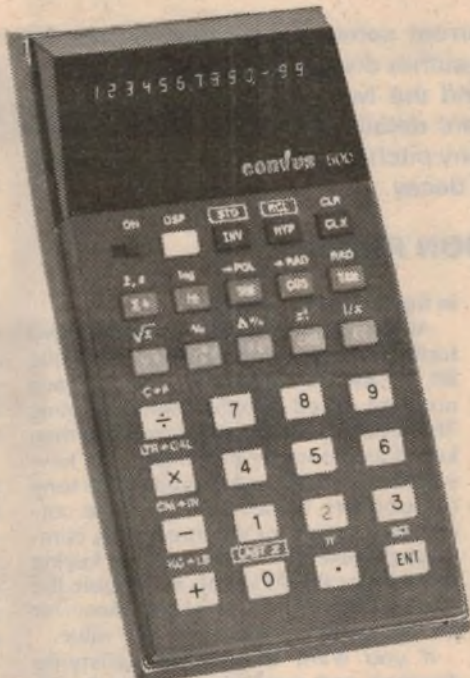
As you can see, the Corvus 500 is a lot more calculator for $95.

Price	**$95.00**
Mail charge	**$2.50**
Sales Tax exempt	**$85.00**

For sales tax exempt purchases, please supply number or certificate.

We have listed some of the many features, but let's amplify on some highlights:

1. RPN (Reverse Polish Notation) "COMPUTER LOGIC" and 4 LEVEL STACK.



Your problem is solved the way it is written, left to right sequence, eliminating restructuring, unnecessary keystrokes, and the handicap of having to write down intermediate solutions. And all information is at your disposal — just roll the stack (R) to any intermediate information desired. You arrive at your solution faster, more simply and, therefore, more accurately.

Perhaps at this point we should address ourselves to the controversy between algebraic entry and RPN. One question we must ask is why proponents of algebraic entry always use an example of sum of products and never an example of product of sums:

(2+3) × (4+5) =

Algebraic 2+3 = MS 5+4 = X MR =

TOTAL 12 keystrokes (SR51, add 2 more keystrokes)

RPN: 2 Enter 3+4 Enter 5+x

TOTAL 9 keystrokes

2. THE CORVUS 500 and HP-45 HAVE 10 ADDRESSABLE MEMORY REGISTERS, 4 LEVEL OPERATIONAL STACK, and a "LAST X" REGISTER (10th Mem. Reg.).

With 10 addressable memories, you have access to more entries, or intermediate solutions; less remembering, or writing down. YOU have to do. And less chance for error. The stack design also permits X and Y register exchange, and roll-down to any entry to the display for review or other operation.

The "last x" register permits error correction or multiple operations when a function is performed, the last input argument of the calculation is automatically stored in the "last x" register, which can be quickly recalled to correct an error, or to perform another operation using the same number.

3. DIRECT HYPERBOLIC and HYPERBOLIC RECTANGULAR to POLAR, and INVERSE. For those of you electronic and computer science engineers who require access to this specialised application, the Corvus 500 solves "your" problems.

4. A WORD ABOUT CORVUS 500 12-DIGIT DISPLAY AND ACCURACY. Finally you have displayed 12 digit accuracy in business format and 10 + 2 in scientific notation. LED is manufactured by Hewlett Packard.

FOR THE FIRST TIME you can raise the number 10 to 199th power or calculate Factorial (x!) of up to 120. Unbelievable!

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WHAT ABOUT CONSTRUCTION? With so many features, the next most obvious question must be in regard to the quality of the unit itself. We are proud to report the Corvus 500 to be double injected moulded, with "tactile" feedback keyboard. The compact, contoured case is 5½" long by 3" wide by 1¼" high and weighs just 8 oz.

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- Rechargeable and replaceable Nickel Cadmium batteries. Optional 3AA batteries.
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The Corvus 500 is warranted by the manufacturer against defects in materials and workmanship for one year from date of delivery.

For those of you who have the HP-21 or 45 or any other advanced calculator on order, aren't you glad you still have the opportunity to take advantage for the release of the Corvus 500 for $95.00? Hurry! Order yours today.

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Providing your organ with multiple pitches

This is a further article in our current series describing circuits for modern electronic organs. Here the author discusses multiple pitch keying. He explains its advantages, and the two approaches which may be used to achieve it. Also given are details of a MOS keyer module which may be used to provide as many pitches and manuals as required, together with controlled attack and decay.

by JAMIESON ROWE

Although a simple divider organ like the Playmaster 760 design described in earlier articles in this series can sound quite satisfying in the short term, particularly if fitted with reverb, it has a fairly basic limitation. Because the tone colours are all derived from square wave signals, they have no even harmonic components. This limits the range of tonal contrast available, as well as making it impossible to produce even reasonable approximations of diapason tone and other basic pipe organ tone colours.

The harmonic content of a basic square wave signal is shown in Fig. 1, and, as you can see, it contains only odd harmonics. These have amplitudes which decay from that of the fundamental in an exponential manner.

Broadly speaking, the way of solving this problem is by tonal synthesis: adding signals at the appropriate even harmonic frequencies, to fill in the gaps. Thus, by adding a 4ft signal (including its own odd harmonics) at twice the fundamental 8ft frequency, and with an amplitude of half the first signal, the missing 2nd, 6th, 10th, 14th and so on harmonics are inserted (Fig. 2). If we go further and add a 2ft signal at four times the fundamental, with a quarter its amplitude, we provide the missing 4th and 12th harmonics (Fig. 3).

Thus, with just the 4ft and 2ft signals added to the basic 8ft square waves, the harmonic content is vastly improved. In fact with the exception of the 8th and 16th harmonics, the harmonic series is now complete up to the 24th harmonic. From a practical point of view this gives very satisfying diapason, string and reed tone. (Even the addition of just the 4ft signal to the basic 8ft square wave gives a worthwhile improvement, incidentally.)

Of course the question is how to provide these additional signals. In simple instruments, they can be provided without increasing the number of effective keyboard switch poles, by using the technique of pre-mixing. This is shown in the diagram of Fig. 4.

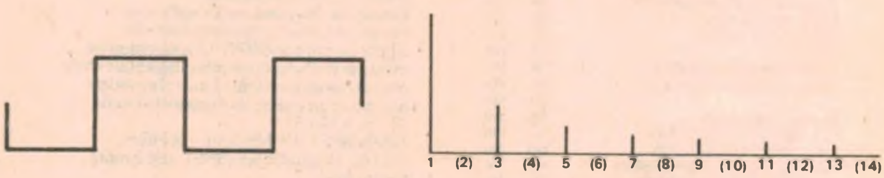
As you can see, it involves adding two further sets of keying resistors, so that the 8ft, 4ft and 2ft signals required for each note are mixed together before keying. The resultant "stairstep" signals are then keyed as before by the single pole keyswitches, and fed to the appropriate tone colour filters. Note that to give the correct proportions of the three pitch components mixed for each note, the keying resistors for the 4ft signals are double the value of the 8ft resistors, and those for the 2ft signals are four times the value.

If you want to provide satisfying diapason and reed tone colours to the basic Playmaster 760, but don't want to go to any more cost and trouble than is absolutely necessary, you could use this technique. All you will need to add is 98 extra keying resistors, the tagstrips needed to support them, and the appropriate wiring from the note generator board. As the original 8ft keying resistors are 100k, the 4ft resistors should be either 180k or 220k while the 2ft resistors should be 390k.

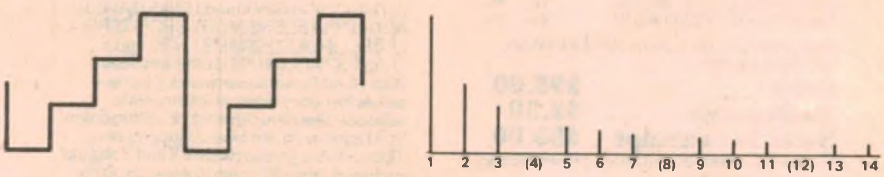
The problem with this simple approach is that once we've put in most of the even harmonics needed for some tone colours, we can't get them out again for tone colours which don't want them. We still have limited tone colour contrast, even though it is now in the opposite direction. For example it now becomes virtually impossible to get stopped diapason or "gedakt" tone, because this is based on only the odd harmonics!

The only real way around this problem is to use the same approach which must be used to provide the additional pitches required on more pretentious organs: multiple pitch keying. This involves the effective provision of additional poles on the keyswitches, to key the various signals separately.

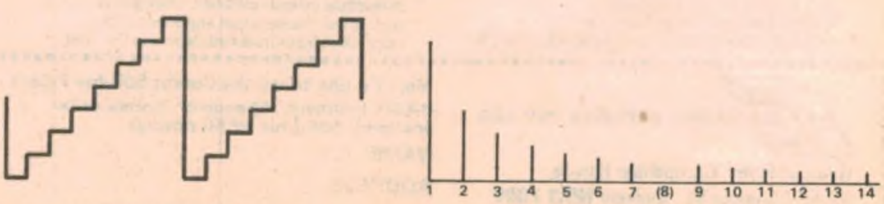
Once keyed separately, the signals may be used both separately or together as required. Thus the 8ft square wave signals may be used alone, to produce such tone colours as gedakt, but may also be mixed with the appropriate amounts of 4ft and 2ft signals to produce satisfying diapason, string and reed tone colours.



SQUARE WAVE AT BASIC 8FT PITCH — FIG. 1 — HARMONIC CONTENT



8FT SQUARE WAVE +50% 4FT SQUARE WAVE — FIG. 2 — HARMONIC CONTENT



100% 8FT +50% 4FT +25% 2FT — FIG. 3 — HARMONIC CONTENT

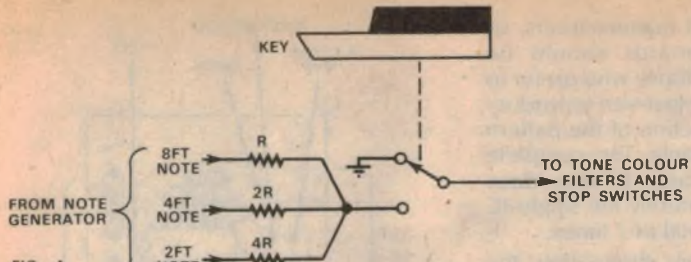


FIG. 4

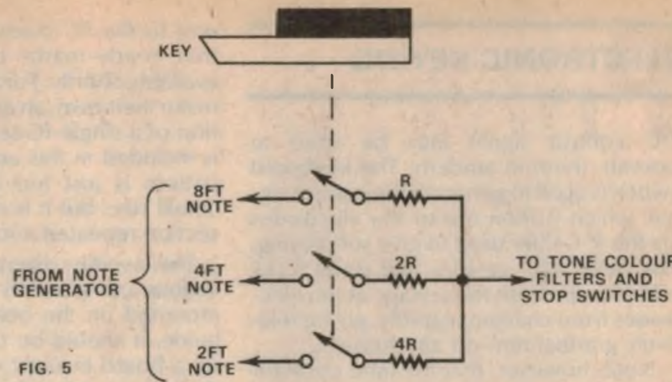


FIG. 5

Mixing pitches before keying can improve the sound from simple organs, as shown above, but multiple pitch keying as at right gives greater flexibility.

Not only this, of course, but the additional signals may be used to provide separate tone colours at the pitches concerned. Thus the 4ft square wave may be used alone to provide a 4ft Gedakt stop, for example, and also mixed with the appropriate amount of 2ft signal to produce a reasonably satisfying 4ft diapason or Octave stop. And the 2ft square wave may also be used alone, to provide a 2ft Stopped Flute or Piccolo stop.

Multiple pitch keying thus has two important advantages. It allows you to provide an instrument with a more satisfying tonal contrast range, and more satisfying tone colours themselves, at the basic 8ft pitch. And it also allows you to provide additional stops at other pitches, to further extend the tonal contrast range. Both of these advantages are particularly relevant when you are designing a more pretentious organ, with more than one manual.

Just how far one goes with multiple pitch keying depends upon the amount of trouble and cost you are prepared to expend, and the degree of musical satisfaction you require. In principle it is quite easy to add any pitches you want, including mutation pitches like 2-2/3 ft, 1-3/5 ft and so on. But bear in mind that each added pitch involves effectively adding another pole to every keyswitch of the manual concerned, even if the signals at the new pitch are used for only a single stop.

Broadly speaking there are two ways of adding the additional effective keyswitch poles required for multiple pitch keying. One is to use a keyboard with multiple-pole mechanical contacts, or to add further mechanical contacts to an existing keyboard. This is the approach shown in Fig. 5, and as you can see the circuitry is fairly straightforward. For simplicity the keyed signals are shown mixed together only, but they could also be used separately as required.

Adding further mechanical contacts to an existing keyboard may not be easy, although the cost is not forbidding. Multiple-pole contact assemblies made by Kimber-Allen are available from such firms as Jaycar Pty Ltd, of PO Box K39, Haymarket, NSW 2000. These use gold contact wires, and although primarily designed to be mounted on the Kimber-Allen keyboard may well lend themselves to others.

The second approach to multiple-pitch keying is to retain the single-pole keyboard switches, and use electronic keying circuits to provide the required number of effective poles. This tends to be more costly than the mechanical contact approach, although it may also be the only practical approach where an otherwise quite serviceable keyboard does not lend itself to adding further contacts.

Electronic keying also has another advantage, in that it becomes possible to control the attack and decay characteris-

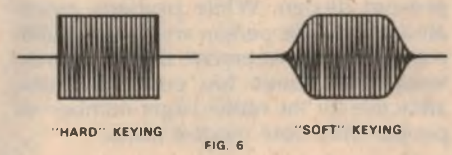


FIG. 6

tics of the keying. By slowing down the switching action, the keying becomes "soft" in comparison with the "hard" switching produced by mechanical contacts (Fig. 6.). This gives a considerable reduction in keying transients of the type usually described as "click" and "thump", and also gives a keying envelope rather closer to that of conventional organ pipes.

Various circuits have been used in the past for electronic keying, using such keying devices as diodes and transistors. However, the most attractive approach nowadays appears to be one using the CMOS 4016 quad switch IC, currently available at quite modest cost. As this device provides four independent voltage-controlled analog switches in the one package, it makes possible very simple and compact electronic keyer circuitry which also compares very favourably with other circuits from the cost angle.

Using the 4016 IC, I have developed a basic electronic keyer module which I believe should be suitable for most multiple-pitch keying purposes using the Playmaster 760, note generator and other circuits already described. The basic keyer stage circuitry is shown in Fig. 7.

As you can see, it involves two of the switches in a 4016 device, so that half a device is used per note per module. A basic keyer stage thus provides only two switch poles, to key two pitches. I will explain a little later why this has been done, also how to extend the basic keyers to add further pitches.

With the 4016 switch elements, the control electrode must be taken down to the negative supply rail (here earthed) for the switch to be turned "off", and taken up to the positive supply rail to turn the switch "on". The effective series resistance when the switch is on is typically about 300 ohms, while the signal feedthrough in the off state is typically about 65dB down.

Here the two switch control electrodes are connected together, so that a single

61-NOTE KEYBOARDS AVAILABLE

These 61-note keyboards should be of considerable interest to those intending to build a full console organ. They feature a solid steel frame, and steel key shanks with replaceable plastic caps. Fitted with gold SPST contacts, they are quite suitable for the MOS keyer circuitry described in this article. Quoted price is $110 including freight, from the Electronic Organ Company, 124 Livingstone Avenue, Pymble, NSW 2073 (mail order only).

ELECTRONIC KEYING

DC control signal may be used to operate them in tandem. The keyboard switch is used to generate the control signal, which is then fed to the electrodes via the R-C filter used to give soft keying. The series 470k resistor and shunt 0.1uF capacitor prevent the voltage at the electrodes from changing rapidly, giving relatively gradual turn-off and turn-on.

Note, however, that the time constant is still relatively short, at approximately 50 milliseconds. This is to ensure that the keyers are able to follow rapid keying, as required for various types of music.

As shown in the diagram, it is possible to use keyswitches having either single-pole off-on contacts, or changeover contacts. The only difference is that with simple off-on contacts, a 100k pulldown resistor must be connected from each keyswitch to earth, on the keyer side. This is to ensure that the keyer is turned off properly when the key is released.

With changeover contacts, this function is performed by the earthed "normally closed" contact, so the 100k resistors are not required.

The actual keying circuitry shown in Fig. 7 gives more of an idea of the way the individual keyed signals are likely to be used in a more elaborate organ. Assuming the basic keyers are used to key 8ft and 4ft signals, the individual MOS switch outputs are taken via 100k mixing resistors as shown, and combined to form keying buslines—one for the 8ft keyer outputs, and the other for the 4ft keyer outputs. Each busline is terminated in a 10k resistor to ensure that the output volume increases realistically as more and more keys are pressed.

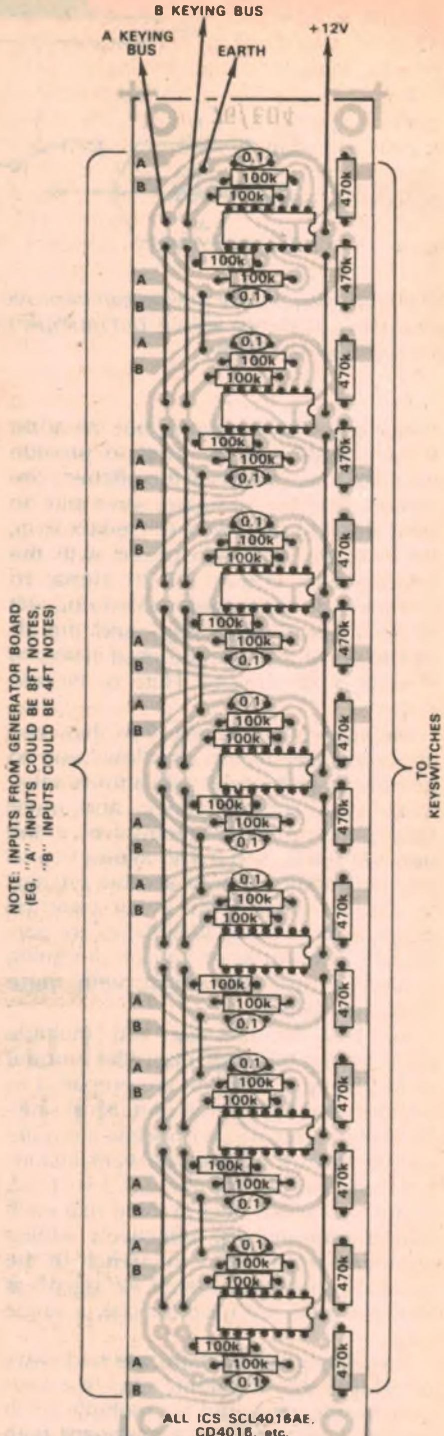
From the keyer buslines, the two signals may be used either individually, or mixed together as shown, depending upon the tone colours required.

The basic keyer module design provides 14 individual 2-pitch keyer stages, and involves 7 of the 4016 devices on a small PC board. The board measures 260x46mm, and is coded 76/EO4. Photographic copies of the pattern are being sent to the PC board manufacturers, so that ready-made boards should be available shortly. For those who prefer to make their own, an actual-size reproduction of a single-IC section of the pattern is included in this article. The complete pattern is just too large to reproduce actual size, but it is merely the single-IC section repeated a total of 7 times.

The overlay diagram shows how the various components and wire links are mounted on the board. Using this as a guide, it should be fairly simple to wire up a board in short order. Don't forget, though, to take the usual precautions when handling and soldering in the CMOS ICs—as explained in the March article.

At this stage you are no doubt still wondering why the basic keyer module happens to have 7 ICs, and is arranged to provide 14 two-pitch keyers rather than say 7 four-pitch keyers, or some other number like 12.

Actually this is the last of a number of keyer module designs we worked out, the earlier versions having been rejected mainly because they were designed with the needs of the large organ builder too much in mind. This tended to make the PC board quite complex, with many more holes to be drilled than with the present design. While perhaps more attractive to the person wishing to build a pretentious instrument, the PC boards would have been too costly and unattractive for the rather larger number of people with more modest plans.



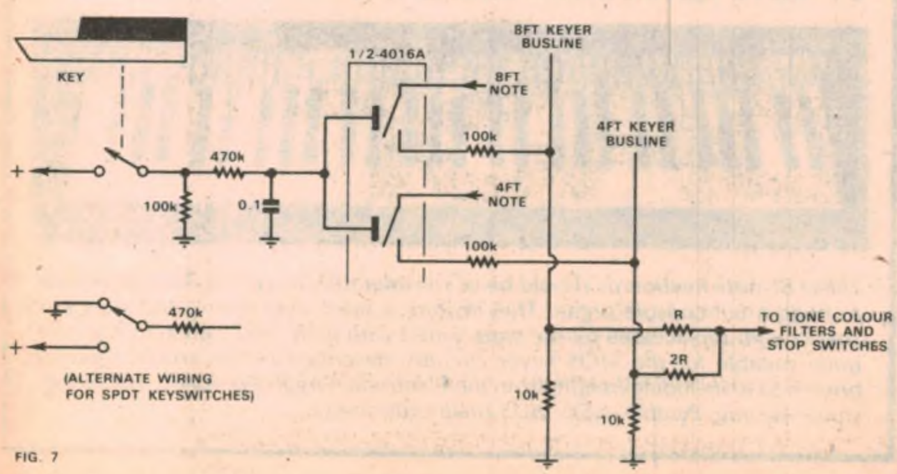


FIG. 7

Above is the wiring diagram for the MOS keyer module PCB, while at upper left is one PC pattern segment, actual size.

The final design provides for only two-pitch keying as that is the smallest practical number of pitches which one would want, apart from a single pitch (which doesn't need electronic keying). And there are 7 ICs on the module so that a single PC board will cope with the common 13-note pedalboard used on spinet-style organs.

For use on manuals, a number of boards will be required. To provide a 49-note manual with 2 pitches, you will need 3½ boards, while a full 61-note manual will require 4½ boards. A full 32-note pedalboard will require 2½ boards, again for 2 pitch keying.

For those wishing to add further pitches, this can still be done fairly easily. It calls for additional keyer boards, but these do not require the 470k resistors or 0.1uF capacitors used for keying signal filtering on the main keyer boards. The keyer control inputs of the additional boards are simply connected in parallel with those of the main boards, as "slaves" This is quite permissible as the control input leakage current of the 4016 switches is less than 10 pico amps.

I have designed the keyer module so that the main keyer boards may be mounted upside down, copper pattern upwards, on pillars. This allows the various control and note signal inputs to be wired easily to the copper pads along the edges of the PC board. It also allows additional slave boards to be mounted above the main boards, as desired, with vertical wires linking the control inputs of the slave boards with those on the main boards.

This way you can start with a single row of keyer boards, and then add rows of slave boards if and when you want to expand beyond the two initial pitches. With one row of slave boards, you will have a total of 4 pitches; two rows, and you will have a total of 6 pitches.

I suggest you use the main keyer boards on a manual to provide 8ft and 4ft pitches, as this will give you reasonably satisfying 8ft diapason, string and reed tone colour potential as well as gedakt tone colour in both 8ft and 4ft pitches. Similarly the suggestion would be to provide 16ft and 8ft pitches initially on the pedals, for the same reason.

When it comes to adding further pitches, this is largely a matter of the sort of organ you want to build, and how far you intend going. For example a popular-style two manual spinet organ might provide the following arrangement:
Upper Manual (Solo): 4 pitches—16, 8, 4, 2ft.
Lower Manual (Accompaniment): 2 pitches—8, 4ft
Pedals: 2 pitches—16, 8ft.

On the other hand a two-manual organ designed along classical lines might have a rather different scheme:
Upper Manual (Swell): 6 pitches—16, 8, 4, 2-2/3, 2, 1-3/5ft
Lower Manual (Great): 4 pitches—8, 4, 2-2/3, 2ft
Pedals: 4 pitches—16, 8, 4, 2ft.

In each case, you could start with a single row of keyer boards for each clavier, and add rows of slave boards as time and money permits. You don't have to pay for the extra keyers unless and until you actually need them, but if and when the time comes, they can be added relatively easily.

In the next article in this series I hope to give details of suitable tone colour filters for instruments using multiple pitch keying.

KEYER PARTS LIST

PARTS LIST FOR A MAIN KEYER MODULE

1 PC board, 260x46mm, coded 76/EO4
7 CMOS ICs, type CD4016 or similar
14 470k ¼W resistors
28 100k ¼W resistors
14 0.1uF metallised polyester capacitors
14 100k ¼W resistors (SPST key contacts only)
Hookup wire for power rail and keying bus links along boards

PARTS LIST FOR A SLAVE KEYER MODULE

1 PC board, 260x46mm, coded 76/EO4
7 CMOS ICs, type CD4016 or similar
28 100k ¼W resistors
Hookup wire for links, as for mair boards

A final note: Jaycar Pty Ltd, of PO Box K39, Haymarket, NSW 2000, advise that they now have stocks of Kimber-Allen stop tab switches, type STU. These have adjustable stops, SPDT switches, and cost $2.50 each. Matching ivorine tablets (unengraved) are available at 75c each. For those wishing to build a professional-looking instrument, they should be just the shot.

Extend your DFM to 650MHz with this

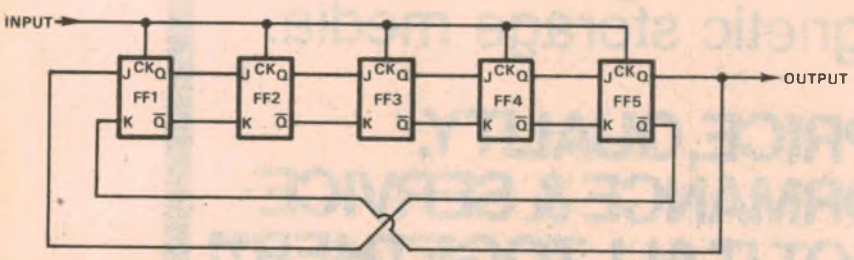
High Speed Prescaler

Using only five ICs (four of them low cost TTL types), our new prescaler can extend the range of your present counter or digital frequency meter to beyond 575MHz. It is simple to construct and should be of special interest to lab workers, mobile two-way radio technicians and VHF radio amateurs.

by DAVID EDWARDS

Our last prescaler was described in the October 1972 issue. This used the then-new 95H90 emitter coupled logic (ECL) decade counter. In the configuration used, this was capable of operating at frequencies up to 200MHz with an input sensitivity of about 800mV peak-to-peak.

A new type of ECL prescaler recently introduced by Fairchild Australia Pty Ltd has significant advantages over the earlier types. The 11C90 is a high speed prescaler designed specifically for communication and instrumentation applications. It will divide by either 10 or 11 over a frequency range from DC to 650MHz (typically).



This twisted ring counter is formed from a five-stage shift register, and has the advantage that all elements operate at the output frequency.

In addition to complementary ECL outputs, the 11C90 contains an ECL-to-TTL converter and a TTL output, operating from the same supply rails. Capacitive coupling of the input is facilitated by a provision for automatically centering the input signal about the switching threshold. Mode controls are provided to switch between the two available division ratios.

Thus, unlike the earlier prescaler, an input bias arrangement is not required, and the output can be connected directly to TTL logic, eliminating the need for a separate buffer stage.

The new prescaler circuit we have developed around the 11C90 consists of two cascaded decade dividers giving a total division ratio of 100, so that with an input of 650MHz the following counter is only required to handle a 6.5MHz signal. A divide-by-200 output is also available, giving half this frequency. Both outputs are buffered, to prevent loading effects from upsetting the operation of the prescaler. The outputs are TTL compatible.

Performance wise, the 11C90 is guaranteed to operate at frequencies up to 575MHz, with an AC coupled input signal requirement of 350mV peak-to-peak, over the range 0 to 70 degrees C. Typical devices will operate at 650MHz, with the maximum usable frequency being 800MHz. Minimum usable input signal is about 200mV peak-to-peak.

At higher input levels, the response drops off slightly, reaching 400MHz at 1200mV peak-to-peak. Higher inputs are clipped to this level by a pair of back-to-back silicon diodes. No coupling capacitor has been provided ahead of these diodes, as we have assumed that the prescaler will be used with a "sniffer loop". If required, a 0.1uF capacitor could be provided.

Our main design problem in using the 11C90 prescaler was in finding a suitable decade counter to follow it. In the interests of economy, and because the 11C90 is provided with a suitable output, we felt that a TTL counter would be most suitable. This counter has to work at frequencies exceeding 65MHz, and we felt that it should employ readily available devices, if possible.

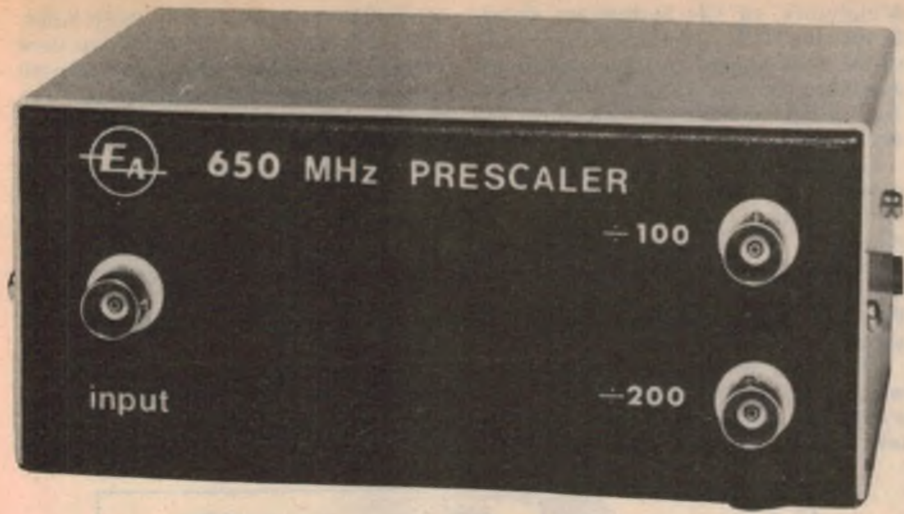
For this reason, we decided to use only standard TTL devices, rather than high speed ones, as these are somewhat harder to obtain. A quick check of the specifications of the standard TTL decade divider—the 7490—showed that this device was only capable of toggling at a guaranteed 10MHz, and was thus unsuitable.

Use of a 9001 JK flip-flop as a high speed input as was done in the previous counter was also ruled out because of speed limitations, this device having a guaranteed maximum speed of about 20MHz only. At this stage, an "angel" in the form of the Editor came good with a suggestion on how to use standard JK flip-flops at much higher than normal toggle rates.

His idea was to use five normal JK flip-flops as a twisted ring counter. In this type of counter, the flip-flops are connected in series as a shift register, with the last stage feeding back to the input in an inverting mode. Provided the correct initial conditions are set up in the register, the input signal, applied to all clock inputs in parallel, will be divided by ten, yet with each flip-flop toggling only at the output frequency.

To understand how this occurs, refer to the accompanying diagram and table. Each input pulse will cause the logic level stored in each flip-flop to be passed on to the next one on the right, with the output from flip-flop 5 being inverted before reaching flip-flop 1. If all flip-flops initially contain zeros (0), the successive contents of the register will be as shown in the table.

It can be seen that the resultant pattern repeats every tenth input pulse, and that each flip-flop only makes one 0 to 1 transition and one 1 to 0 transition in every ten input pulses. In other words, the input has been divided by ten, but each



PARTS LIST

1 11C90 high speed prescaler IC
3 7473 dual JK flip-flops
1 7400 quad gate
1 LM341P-5.0 5V/½A regulator IC, or similar
2 1N4148 or similar silicon diodes
4 EM401 or similar silicon diodes
2 1k resistors
1 33k resistor
1 2500uF 16VW electrolytic capacitor
1 100uF 10VW PCB mounting electrolytic capacitor
6 0.1uF ceramic capacitors
1 mains transformer, secondary 8.5V @ 1A, DSE 2155, PF2115, AR2155 or similar
1 printed circuit board, coded 76s7, 127 x 50mm
3 panel mounting BNC sockets (see text)
1 mains plug, cord, grommet, clamp and 2-way terminal block
1 metal case, 105 x 137 x 60mm (see text)
1 5-way tag strip
Hook-up wire, solder, solder lugs, machine screws and nuts, heat-sink compound

NOTE: Resistor wattage ratings and capacitor voltage ratings are those used for our prototype. Components with high ratings may generally be used provided they are physically compatible.

flip-flop is only toggling at one tenth of the input frequency.

Since standard JK flip-flops like the 7473 have a minimum specified toggle rate of 15MHz, we can expect that our twisted ring counter will operate at speeds of around 150MHz. This level of performance is quite adequate for our use, and means that the upper frequency limit of the prescaler will be set by the 11C90 device rather than any other components.

The remainder of the design presented no problems. We used three dual JK flip-flops (7473) as the twisted ring counter, with the spare flip-flop used to give a further division by two. The outputs are buffered by two 7400 gates, connected as inverters. The remaining two gates are used to ensure that on initial turn-on, the flip-flops are loaded with zeros.

On initial turn-on, the 100uF capacitor connected to the input of the first gate holds the input low and the output high, and hence via the second gate clears all the flip-flops. The capacitor charges up through the effective input resistance of the gate. After about 100msec, the gate threshold is exceeded, and the output goes low. This drives the clear line high, allowing the counter to operate.

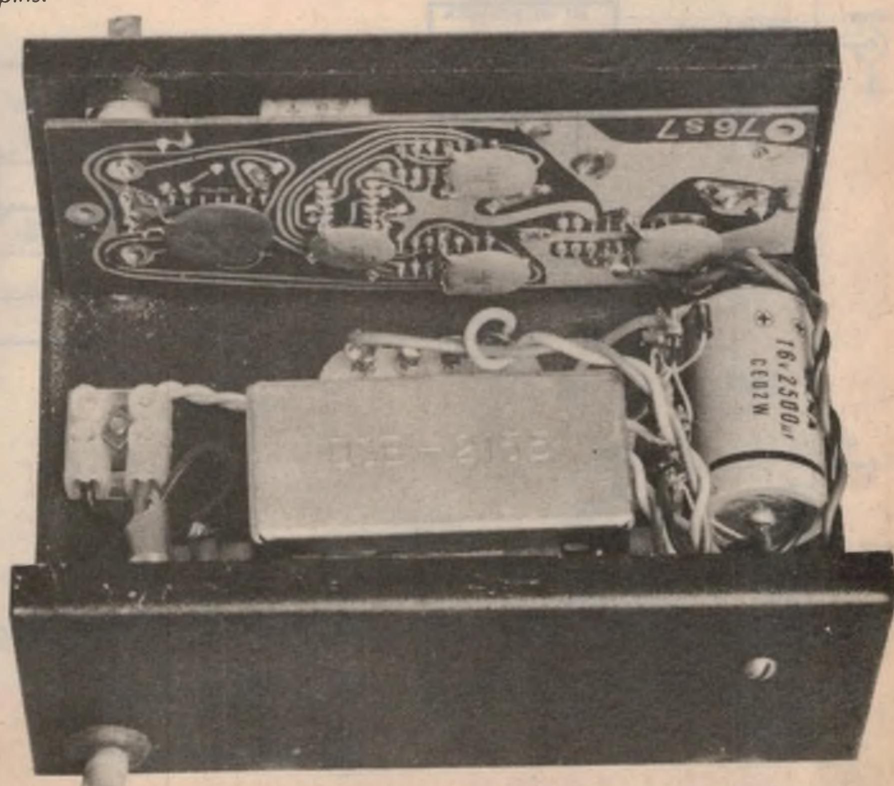
The 33k resistor ensures that the capacitor charges fully, and also provides a discharge path when the prescaler is turned off.

The prescaler requires a 5V power supply, with a current drain of about 300mA. We have used a bridge rectifier and filter capacitor combination to supply a three terminal regulator. We used a National Semiconductor LM341P-5.0 type, which is capable of supplying a fully regulated 5V at 0.5A. If desired, one of the 5V/1A three terminal regulators, such as the

INPUT PULSE	FF1	FF2	FF3	FF4	FF5
0	0	0	0	0	0
1	1	0	0	0	0
2	1	1	0	0	0
3	1	1	1	0	0
4	1	1	1	1	0
5	1	1	1	1	1
6	0	1	1	1	1
7	0	0	1	1	1
8	0	0	0	1	1
9	0	0	0	0	1
10	0	0	0	0	0
11	1	0	0	0	0
12	1	1	0	0	0

ABOVE: This table lists the ten different states of a twisted ring counter as used in the prescaler.

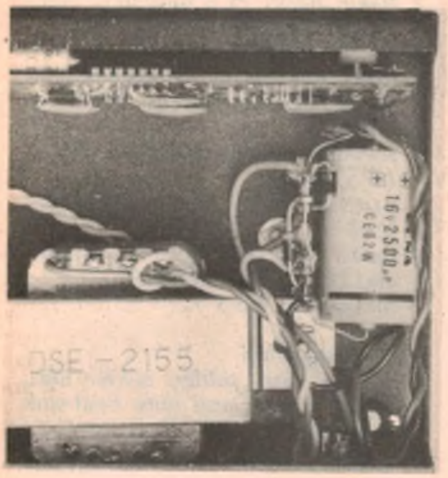
BELOW: This photograph shows the internal layout of the prescaler, looking from the rear. Note how the 0.1uF bypass capacitors are soldered directly to the IC supply pins.



650MHz Prescaler

LM309 or uA7805 could be substituted. Five 0.1uF bypass capacitors are provided across the supply. These are soldered directly to the supply pins of each IC.

We mounted the prescaler in a small aluminium and steel utility box, measuring 105 x 137 x 60mm. These come complete with rubber feet and assembly screws, and are available from Bespoke Metalwork, of 42c Sydenham Road, Brookvale, NSW. The transformer is one of the multi-tapped 1A types, which are available from a variety of sources. Typical type numbers are given on the circuit diagram.



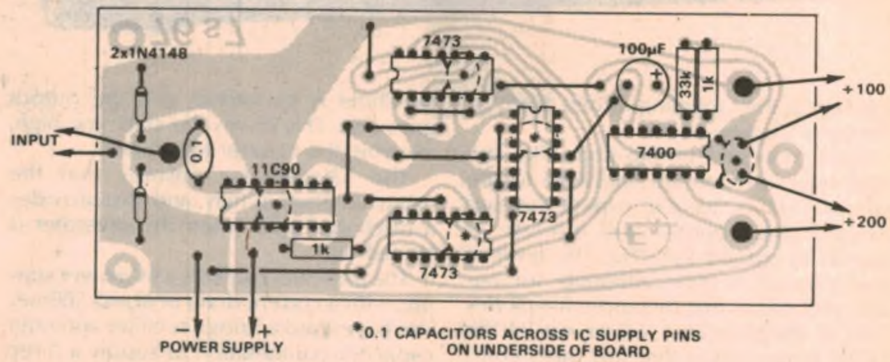
ABOVE: This photograph shows the layout of the power supply components. Note the regulator at the rear.

Construction of the prescaler should prove quite simple. A small printed circuit board (PCB) coded 76s7 and measuring 127 x 50mm is used to mount all components apart from those used in the power supply. This is supported by the three input and output terminals, as shown in the photographs.

These are BNC coaxial connectors, which are panel mounted by means of a large nut. It is only necessary to make one hole in the panel. Use the PCB as a template to mark out the three holes. The earth lugs of each socket are bent over at right angles, and a short length of tinned copper wire soldered to them to extend them through the PCB.

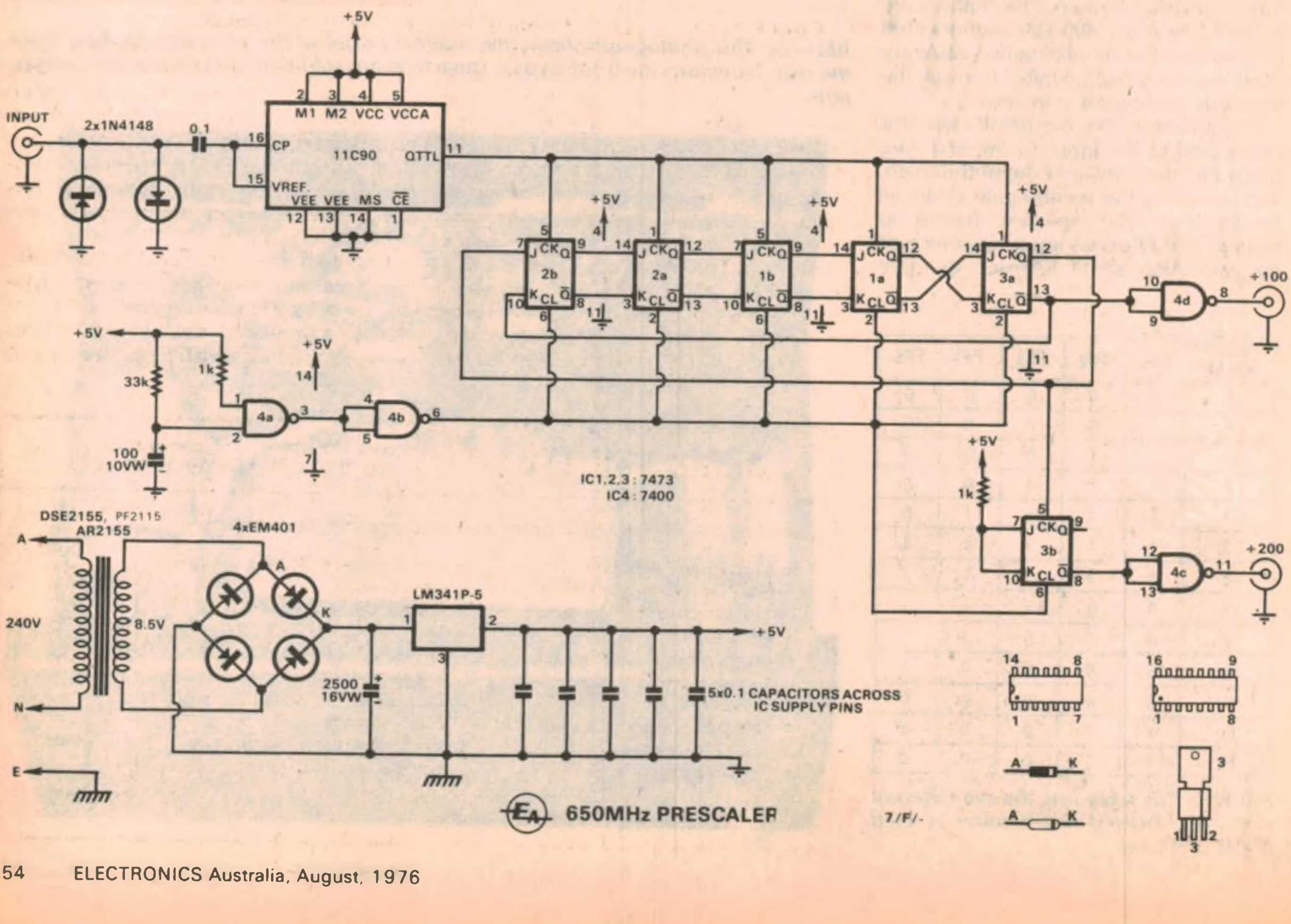
The PCB should then be a push fit onto the rear of the sockets, and there should be about 10mm clearance between the component side of the board and the rear of the front panel. We made a front panel from Scotchcal photosensitive aluminium, labelled as shown in the photographs. A similar panel could be made up using stick-on lettering and a small piece of aluminium.

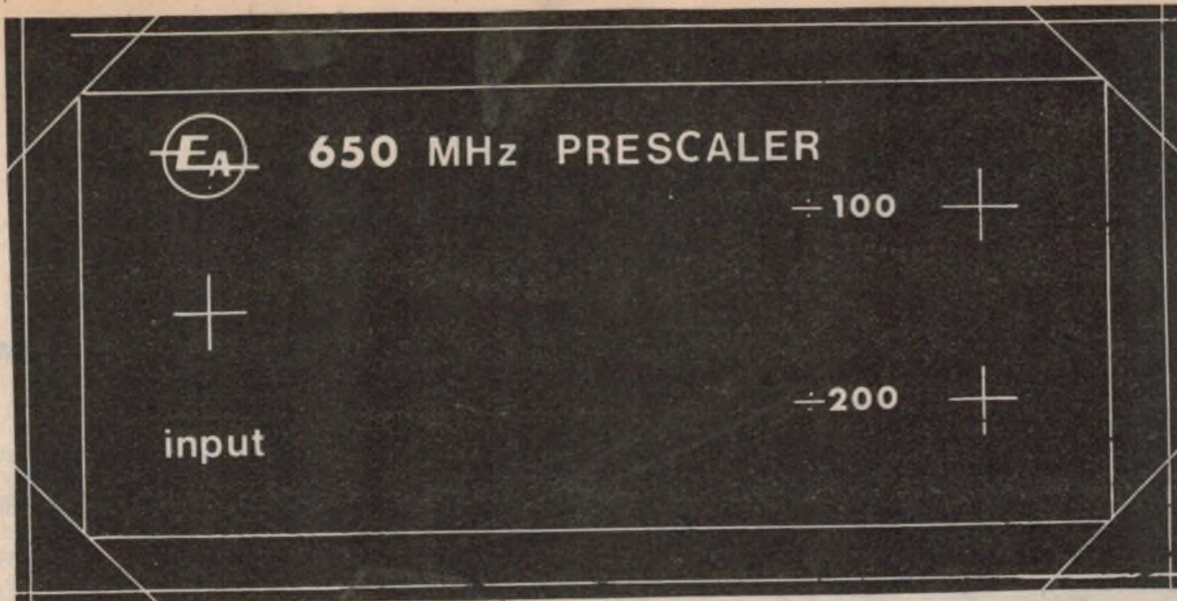
Before fitting the components to the PCB, a word of warning is appropriate. The 11C90 is made using the Isoplanar



BELOW: The complete circuit diagram. As detailed in the text, other regulators may be used instead of that specified.

ABOVE: This component overlay diagram will aid in fitting the components to the printed circuit board.





ABOVE: This actual sized reproduction of the front panel may be either copied or used directly.

BELOW: The printed circuit board pattern is shown actual size, and may be copied if desired.

II high-speed high-density bipolar process, and is susceptible to damage from voltage stresses. Although this type of chip is not as fragile in this respect as CMOS or other MOS chips, care should be exercised while handling them.

Fit all the links, TTL ICs, resistors and capacitors to the top of the board, but do not fit the five 0.1uF capacitors to the copper side of the board. Then earth the tip of your iron to the board, before fitting and soldering the 11C90 device. Then fit the 0.1uF capacitors to the bottom of the board.

Check the completed board for wrongly inserted components and solder bridges, and then put it to one side, while the power supply components are fitted to the case. The transformer is mounted at the centre of the rear of the case. The mains cord enters through a grommetted hole in the rear right hand corner, is securely clamped, and the active and neutral leads terminated at the 2-way connector. The earth lead is soldered to a solder lug, and clamped to the case.

A five-way tag strip is used to mount the diode bridge and filter capacitor, while the LM341P-5.0 is mounted on the rear of the case. Clean the paint from around the mounting hole, and thermally bond the heat-sink lug to the case with heat-sink compound. Do not insulate the regulator from the case, as this is the earth point for the circuit.

Complete the connections to the transformer, regulator and PCB with colour coded hook-up wire, and then fit the PCB to the sockets. The power supply leads from the regulator are simply soldered to the pattern near the holes provided. If desired, PCB pins can be used, to prevent the copper from being pulled off the laminate.

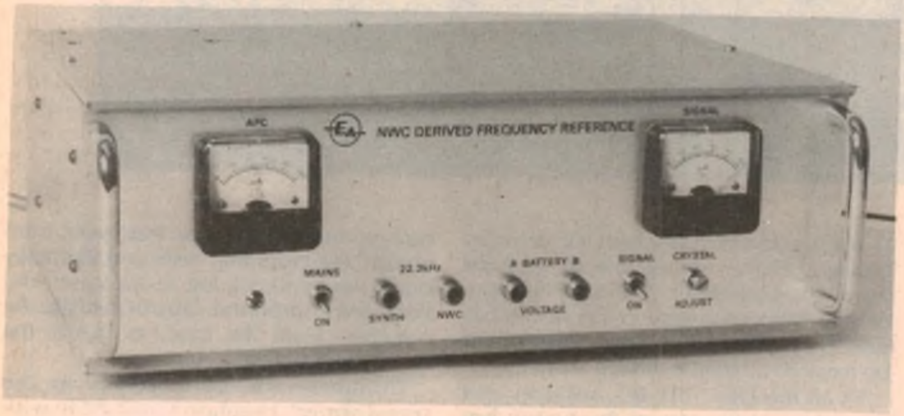
Construction is now complete, and your prescaler should be ready for use. To test it, simply apply a suitable input, and monitor the outputs. Both outputs should have unity mark/space ratios, and they should be the appropriate submultiples of the input frequency. Any frequency between about 10kHz and 650MHz is suitable.

Due to the lack of a suitable generator, we were only able to test the prototype at frequencies up to 300MHz. At 300MHz, a 300mV peak-to-peak signal was required for reliable operation.

Derived frequency reference from North West Cape

by IAN POGSON

PART 2



Here is the second half of our two-part article describing a frequency reference derived from the VLF signals radiated from North-West Cape on 22.3kHz. This month the author deals with the practical construction and setting-up procedure, and also gives some circuit improvements.

Some constructional pointers may be in order at this stage. From the outset, I imagine that only very interested and experienced personnel will be likely to attempt this project and as such, there seems to me to be no point in going into the finer details of construction. You will probably have your own ideas on how it should be put together anyway. However, a few comments may be useful.

While the prototype unit as described represents the way I did it, there are some areas where it could be improved upon, both from another's point of view and from the experience gained in making up any prototype. In addition, it must also be understood that the unit has been built up within the restrictions of what components are readily available and from an economy point of view.

The unit as mentioned earlier has been built into a case measuring 12in x 4in x 8in. As may be seen from the pictures, the case is pretty well occupied. If you wish to make up the complete unit as described and you are satisfied with the density, then the above size box is the one to use. However, if you feel that it would be better and easier to use perhaps the next size larger case, then it will make assembly and accessibility that much easier.

The location of the various sub-assemblies is as follows: Looking at the inside view and from the front, the receiver strip is fixed to the right end of the case. The synthesiser, consisting of two strips, is located at the other end of the case and stacked one above the other. The lower strip includes the diode ring mixer, together with the 22kHz and 300Hz tuned circuits. The upper strip includes the three 22.3kHz tuned circuits and the amplifier. On the rear edge are two short strips, each being one section of the power supply.

In the left hand corner is the power transformer, mains terminal strip and the ferrite toroid for the line filter. Also, on the back panel and behind the power transformer is the LM309 power supply IC. The smaller LM342-5.0 IC is mounted directly on its wiring board. Immediately in front of the power supply wiring boards is the box containing the two sets of six nickel-cadmium cells.

Between the battery box and the front panel are two Multi-Dip boards, back-to-back. The one nearest the camera includes the first three 7490 decade dividers, beginning with the one taking the output from the crystal oscillator. On the other side are the other two 7490 dividers, together with the LM1351 discriminator and the 7413 dual Schmitt trigger. Just to the left of these two boards are the two TRD223 transformers for the ring mixer. Finally, the crystal oscillator oven is located just behind the "signal" meter on the front panel.

The location of items of interest on the front panel may be seen from the picture and most are self-explanatory. The two 22.3kHz signals were brought out to sockets on the front panel so that they may be fed into a CRO for checking purposes from time to time. Also, as it would be a wise precaution to keep a check on the two battery voltages, these have also been brought out to the front panel. The "signal" switch was also brought to the front panel as a matter of operating convenience. Finally, the fine trimmer associated with the crystal oscillator frequency is readily available when required.

On the back panel we also have a row of sockets and a switch. The five sockets are for the aerial input, 100kHz out, 100Hz out, 50Hz out and 1Hz out. The switch either switches the two batteries in or out of circuit. Perhaps I should mention at this point what may be obvious to some, that some of the outlets and facilities offered both on the back and front panels may not be altogether in line with what you may need and so they may be altered accordingly.

Some of the items which require some details regarding construction are the coils. These are rather specialised in many cases and they have been made up accordingly.

The aerial loopstick should present no problems if the rod specified is used. However, if another rod is used, then it may be necessary to change the value of the 560pF capacitor to bring the assembly to resonance at 22.3kHz, within the adjustment available by sliding the coil up and down the rod.

The coils wound on Philips pot-cores can be a little tricky. These are L2, L3, L6, L7, L8 and L9. Due to spreads in component values and the quite small amount of adjustment available on the assembled coil, the number of turns is given as a starting point. The number of turns given should be slightly too many and it will be necessary during setting up and adjustment, to reduce the turns on each coil until proper adjustment is possible. The bobbins which I used were the double type and I wound about an equal number of turns on each section. The fact that this equality will be upset when the turns are reduced is of no consequence.

Wiring of the power supply is straightforward and no further comment is necessary. The six bypass capacitors associated with the power transformer were wired directly to the transformer tagboard, but if you use a different type of transformer then these capacitors may well be located at some other convenient points. The box to house the standby batteries is possibly better left to the individual to decide for himself. Suffice to say that I made up mine with some good quality cardboard and glue. The cells were covered with shrink plastic tubing which is available from Radio Despatch Service.

Incidentally, a hint may be helpful here regarding the use of the shrink plastic tubing. I cut lengths about 3/8in longer than the cells and slipped the tubing over the cell, with equal amounts overhanging each end. With a kettle on the boil, hold the cell in the steam and almost immediately the tubing will shrink and firmly grasp the cell. The cell should be rotated to get an even shrinkage. All this can be accomplished in seconds and without appreciably raising the temperature of the cell. All that remains is some condensed steam in the form of water drops, which are wiped off.

My crystal oscillator oven is a simple arrangement and some readers may wish to elaborate on it. I used some Formica sheet, about 1/16in thick. This is quite good as it has fairly good heat insulating properties and it is easy to work. The inside dimensions are 3in long x 1-7/8in wide x 1-11/16in high. The bottom piece of material was cut longer so that there was a protrusion of about 3/8in from each of the ends. A hole was drilled at each end for mounting purposes. The six pieces constituting the box were glued together, with the exception of the lid. In each of the four corners, I glued a piece of plastic "Rawlplug". These pieces took the lid fixing screws through a hole in each corner.

With the box dimensions given, I was able to line it on all sides with some ½in thick foam plastic. These pieces can be lightly glued into place and this leaves a small volume in the middle to take the crystal oscillator and heater assemblies. Perhaps it should be mentioned at this stage that when the two assemblies are finally put together and fitted into the space, the plastic foam is compressed where components protrude. This makes for a nice firm bed for the crystal and its circuits and reduces the possibility of shock to the components, with possible upsets in frequency stability.

The oven heater circuit is wired on a piece of miniature tag board, with four pairs of tags. The 82 ohm resistors are connected in two series pairs and run across the tags at each end of the board. The resistors are adjusted so that the crystal just nests in between them longitudinally. The OA91 sensing diode is wired on the back of the board and so that it comes in contact with the crystal holder at about its centre. The two transistors are located at what becomes the top end of the crystal holder. Using transistors in plastic cases, they may be located so that they touch the top of the holder. The other two resistors are located at any convenient place on the board. Care must be taken to ensure that the metal holder does not cause any short circuits. Tape can help where necessary.

The crystal oscillator is wired on another piece of miniature tag board with six pairs of tags. It is quite a tight squeeze to get all the components into such a small space, but it can be done. As the twelve tags are not sufficient to anchor all the components, I added five eyelets to the holes in the centre of the board. All components are fixed to one side of the board and tape is used on the reverse side to prevent any short circuits when this board is placed up against the side of the crystal holder, opposite to the heater board. A socket is fitted to the crystal to accept the leads. The coarse trimmer is fitted at one end of the oven box and the appropriate leads are run to it. The rest of the leads for outside are terminated on solder lugs under ⅛in Whitworth screws, with nuts on the outside to take external leads away.

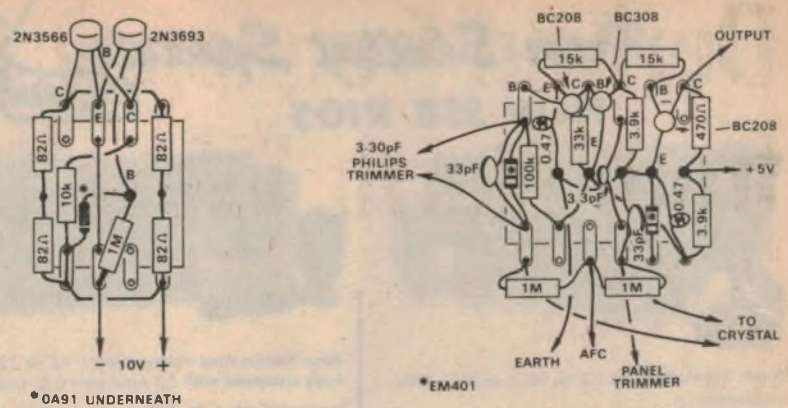
To hold the crystal, crystal oscillator board and the heater board together, I used some tape. This keeps the parts where they belong and helps in the rather awkward final assembly.

Before leaving the crystal oscillator and oven, it should be mentioned that it would be wise to test the oscillator and heater circuits before they are fitted into the oven box. With the two board assemblies taped together as mentioned earlier, they may be wrapped with a piece of ½in plastic foam sheet and given a trial run.

Construction of each of the other subassemblies will be undertaken in the usual way. One important point relates to the potcore coil assemblies. They are held together with ⅛in Whitworth screws, washers and nuts. In turn, they are also screwed to the centre hole of the tag board in each case. They should be screwed up firmly, with the two windows in line and such that the top half may be rotated by the width of the window. This reduces slightly the inductance and is the final method of adjustment to resonance.

As each assembly is finished, it may be tested as far as possible and left for final adjustment in the finished unit. The power supplies are probably the easiest in this regard and can be dispensed with quickly.

Possibly the next easy part of the project is wiring the divider and Schmitt trigger ICs. You will notice that I did not necessarily follow a straight sequence with the dividers. This was done so that I could get equal pulse width for the



Wiring diagrams for the oven heater circuit (left) and the crystal oscillator (right).


Rear view of the prototype. The five sockets (from left to right) are: aerial input, 100kHz out, 100Hz out, 50Hz out and 1Hz out. The switch is for battery on/off.

Peter Shalley Specials

CQ, CBERS

NEW SSB RIGS

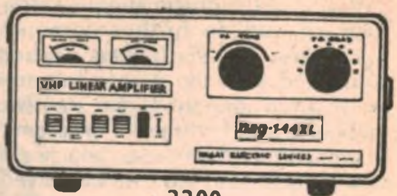
Mobile Transceiver for 12 to 16 Volts D.C. Fully synthesized on all 23 U.S. C.B. Channels
Output: A.M. 4 Watts / S.S.B. 12 Watts (not input to final)
Dual Conversion: P.E.P. Receiver: Power and S Meter. **Sensitivity:** less than .5 uv for 10db. **Transistors:** 36. Diodes & Thermistor 41 for use with Novice License.

$199 P&P$5

Base Station dual Voltage 240V. AC or 12V. DC Fully equipped with 23 American C.B. Channels.
Input to final: A.M. 8 Watts min. S.S.B. 25 Watts P.E.P.
Dual conversion: 7 I.F.Ts and 6 I.F. stages
Noise Blanker: Delta tune (Clarifier) +— 300 Hz. Meter for, Signal in, R.F. out, S.W.R.
Sensitivity: .5 uv @ 6db **Size:** 33 x 13.5 x 24.5 cm. Wt. 7¾ kg. For use with Novice License.

$249 P&P $5

LINEAR AMPLIFIER



2070

Frequency Range: 144MHz-146MHz (144MHz-148MHz) on special order. **Type of Emission:** SSB. CW. FM. **Tube Complement:** Model 2200 4CX350F. **Plate Power Input:** 500 watts PEP on SSB. 400 watts on CW and FM. **Drive Power:** 10-13 watts for full output. **(RX AMP) Receiving Amplifier:** 10 dB (nominal average). **Frequency Range:** 144MHz-146MHz. **Output Impedance:** 50 ohms unbalanced with SWR 2:1 or less. **Input Impedance:** 50 ohms. **Power Requirements:** 220/240 VAC 50/60 Hz single phase. **Power Consumption:** Approx 760VA. **Regulated DC Power Supply:** 13.5V 3A (maximum). Automatic protection against overload. **Size:** W 280. H 125. D 300 (mm). **Weight:** (approx) 15 Kg.

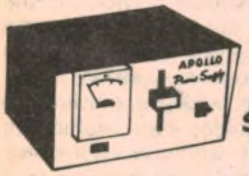
$425 P&P$10

2200

Frequency Range: 144MHz-146MHz (144MHz-148MHz) on special order. **Type of Emission:** SSB. CW. FM. **Tube Complement:** 829B. **Plate Power Input:** 200 watts PEP on SSB. 140 watts on CW and FM. **Drive Power:** 10 watts for full output. **(RX AMP). Receiving Amplifier:** 10dB (nominal average). **Frequency Range:** 144MHz-146MHz. **Output Impedance:** 50 ohms unbalanced with SWR 2:1 or less. **Input Impedance:** 50 ohms. **Power Requirements:** 220/240 VAC 50/60Hz single phase. **Power Consumption.** Approx 350VA. Regulated DC Power Supply: 13.5V 3A (maximum). Automatic protection against overload. **Size:** W 280. H 125. D: 300 (mm). **Weight:** (approx) 10.5Kg.

$678 P&P$10

REGULATED POWER SUPPLIES



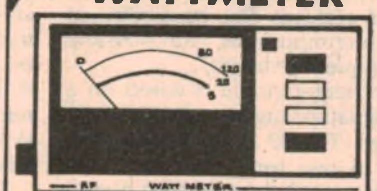
0–15 VOLT $42 P&P $2

New model Adjustable Regulated Power Supply Delivers 3 Amps from 0 to 15 Volts. Meter shows Voltage and Amps. On/off switch. Perfect where flexibility is required. Ready to wire in.

13·8 VOLT $29 P&P$2

Regulated power supply. Gives 12 Volts at 3 Amps. Electronic O/load protection. Bezel light. on/off switch. Ready to wire in.

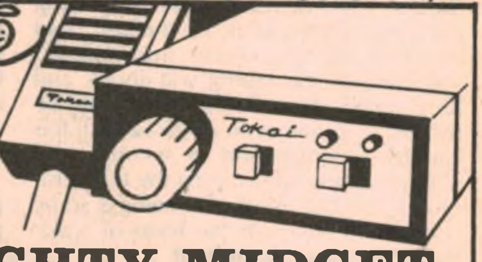
NEW SPECIAL WATTMETER



This is a must for the advanced Tec. Offers a very high degree of accuracy over its entire Range from 3 to 500 Mhz. Power Ranges: 5- 20- 120 Watts. Large meter O/all size: 19 x 10 x 10 cm. Accepts PL259 plug. Inbuilt Dummy Load, 50 Ohm Imp. V.S.W.R. less than 1.15 at 500 Mhz.

$119 P&P$3

POW!



MIGHTY MIDGET

TOKAI 5038B 5 WATT

Back at last the popular 3 channel Tokai 5 watt mobile. This tiny 27 Mc rig really punches out a strong signal. Only 28mm (1⅛") thick. With squelch, sturdy metal case, transmit and standby light, p/t/t remote mike, fused 12 volt lead. If you're after real power this one's for you. Fits into a tiny space.

$99 P&P$3

End of Line Sale

TV MONITOR AND DOOR PHONE

SAVE $200!

ON THIS C.C.T.V. MONITOR AND INTERCOM COMPLETE OUTFIT CONSISTING OF

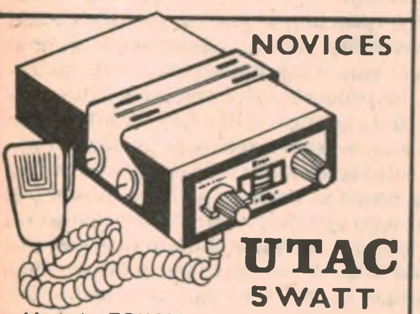
1. Camera on flexible mount with f1.6 lens and 10 meter cable.

2. Monitor with 5" screen. 3 Pix adjustments. Good for low light conditions. Down to 20 lux. Ideal for shop, pool or front door.

3. Intercom and doorphone switches screen on from front door—speech with pic.

HALF ORIGINAL PRICE! $199 P&P$7

NOVICES



UTAC 5 WATT

Made by TOKAI branded by UTAC

This is a handsome chunky 5 watt made for the American CB market with the full compliment of 23 American channels. You couldn't buy the bits for this sort of money. So get one while stocks last.

- 31 Semiconductors
- All metal case
- Fully synthesised
- P/T/T mike
- Cradle mounting
- 12 Volt DC
- PUB ADD FAC

$99 P&P $3.00

CONTACT 1 WATT

$39.95

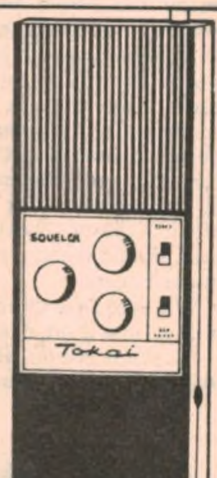
· 14 Semiconductors · Squelch · Tone call · 2 Channel · Earphone · Strap · Batteries · Post & Pack $2.00

This must be the bargain of all time. No price increases yet but it can't last. We managed to get a special price on a huge quantity and we're passing the saving on to you. A full 1 watt in an all metal case.

TOKAI 1607 1 WATT

This is possibly the most superb 1 watt phone available to day. Used by many government departments incl. Maritime Services, Fisheries, C.S.I.R.O., Police etc. 3 channel facility, bat meter, rugged metal case, tone call, vinyl carry case.

$97



TOKAI TC506 5 WATT

This is a superb hand held unit for the boating man. It's ready to use just as it is – nothing extra is needed to put a good powerful signal in the air. If you wish an external 12V supply can be used or rechargeables can be fitted but wherever you go your 5 Watter can go with you. Great value at

- 22 Semiconductors
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- All metal case
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HAND PHONES

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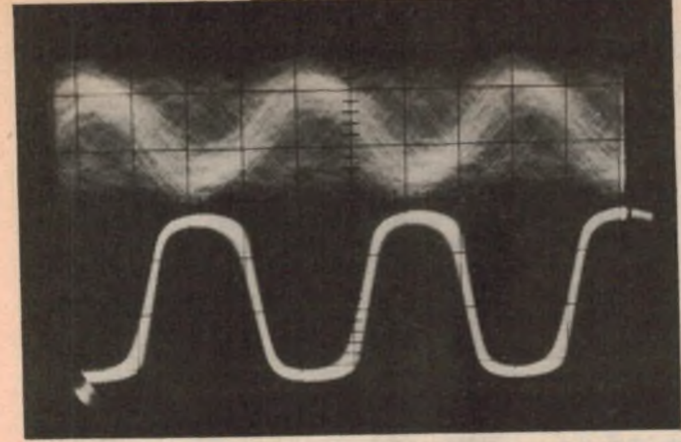
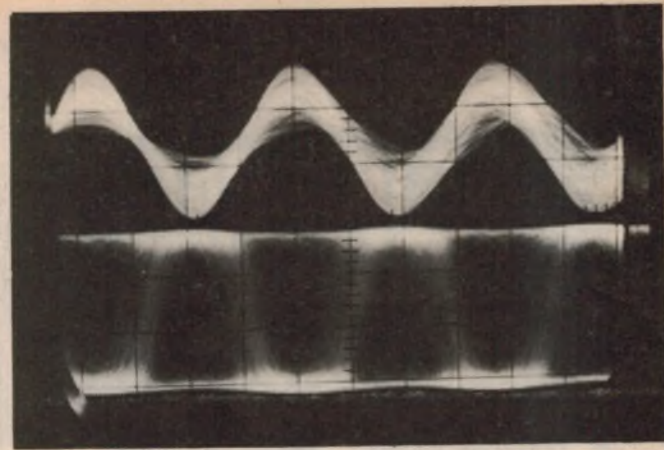


This photograph shows the clipped North West Cape signal synchronised with the CRO time base.



Here the synthesised signal has been synchronised with the CRO time base. This is the display preferred by the author.

50Hz outlet to drive a clock movement and, contrariwise, so that I would get a short positive going pulse for the 1Hz output. If you have other requirements in this regard, then you should alter the sequence accordingly.

The receiver is wired on to a miniature tag board with 24 pairs of tags. The wiring follows a fairly logical sequence from left to right. The major components can be seen in the photograph. The frequency synthesizer is wired up on two boards, each with 20 pairs of tags. Again, most of the major components can be seen in the photograph. It should be noted that the LM1351 discriminator is not included here but it is mounted on one of the two IC DIP boards. Looking from the front, it is located on the left end and on the board facing the rear.

With all the subassemblies done and with preliminary tests completed, it is a good idea to interconnect the various parts on the bench and get it all working, albeit roughly, before finally putting it all together in its case. Then the serious business of getting it running smoothly can be undertaken.

To get the device going, set up and properly adjusted, you will need an accurately calibrated audio generator and preferably a frequency counter, together with a double-beam CRO.

Let us start with the receiver. Set the 1M pre-set pot to maximum resistance and the other three to about mid-travel. Assuming that the power supply is working and available, apply 10V to the receiver. Adjust the 100k pot for 9.2V at the collector of the last transistor. Adjust the 2.2k pot for zero reading on the signal strength meter. With the aerial loopstick omitted at this stage, feed in 22.3kHz via a blocking capacitor, into the base of the third transistor. The generator level should be adjusted to suit in the usual way. A reading should be obtained on the signal meter.

Now rock the frequency of the generator to determine whether the tuned circuit is higher or lower than required. It should normally be lower, assuming that you are not particularly lucky enough to have it right on frequency. More than likely, the frequency will be low and the rather tedious job of removing the coil must be done, and one turn removed. This process should be repeated until the frequency is just slightly low, such that it can be brought right to resonance at 22.3kHz, by slightly rotating the top half of the potcore, as mentioned earlier. With this tuned circuit adjusted, the generator output is then applied to the base of the first transistor and the process repeated.

The aerial loopstick with at least 3m of coax cable, may now be fitted and it may be adjusted in the first instance by radiation from a piece of wire about 1m long, connected to the output of the generator. The generator level will have to be increased quite a bit and the coil should be moved along the ferrite rod for maximum response. Switch off the generator. It should now be possible to receive the signal from North West Cape. The rod should be rotated in the usual way for maximum response. A better way is to look for the null and then turn the rod through 90°.

It should be mentioned at this vital stage, that Murphy's Law may come into the picture. If you are unable to receive the North West Cape signal, more than likely it will be somewhere between 9.55 on Wednesday morning and about mid-afternoon. Or, it may be between about 5 minutes to an even hour (EAST) and the hour. On Wednesdays, the station is off the air for weekly maintenance, and at the other times, the signal goes off for a few minutes.

Having received the signal, it may now be viewed on one of the CRO traces, by taking the signal output from the junction of the 10k resistor and the .047uF capacitor. The 47k trimpot should be adjusted for 6.6V at the rotor. When the signal goes off the air, the diode gate should close and no noise should be evident at the output and the trimpot may be adjusted accordingly. However, the gain control trimpot (1k) will ultimately be adjusted to give the maximum gain, consistent with overall stability and with the aerial loopstick in its final location. It will be appreciated that many of these preset pot adjustments are interdependent and will need to be adjusted for best overall performance of the various functions.

Before leaving the receiver, there is still one adjustment to make. Lift the two 1N914A clipper diodes. Still viewing the signal on the CRO, reduce the effective resistance of the 1M pot in the noise limiter, until it just starts to bite into the signal envelope. Replace the clipper diodes and the receiver is adjusted.

The frequency synthesiser should be adjusted next. The passive multiplier which multiplies the 100Hz square wave to 300Hz is not likely to require any adjustment at all. However, it may be well to check on it and if the tuned circuit

Coil Winding Details

L1 500 turns 30B&S enamel (5 layers each of 100 turns with paper insulation between layers) close wound on ferrite aerial rod 12mm diameter x 200mm long. (See text.)

L2 & L3 60 turns 30B&S enamel wound on Philips 4322 021 30280 P18 2-section formers and assembled into two Philips 4322 020 21510 P18 3H1 halves and held together with 1/8in Whitworth RH brass screw, nut and two washers. Approximately 10mH. (See text.)

L4 500mH coil in potcore. (R.C.S. Radio.) May be wound similar to L2 and L3 but with more turns of finer gauge wire.

L5 10mH single pie RF choke.

L6, L7 & L9 Same as for L2 & L3 but with only 50 turns. Approximately 5mH. (See text.)

L11 8 turns insulated hookup wire (red, black, green) trifilar wound on a toroidal former, approximately 1¼in OD x ⅝in ID x 5/16in thick. Winding covered with electrical insulation tape.

is off the wanted 300Hz by enough to cause a serious drop in output, then it would be desirable to "fiddle" with the 0.15uF shunt capacitor, making the effective value smaller or larger as required. Incidentally, to adjust the synthesiser, the best way is to have the crystal oscillator and dividers working so that the required square waves are readily available.

Now the 11 times multiplier should be adjusted. This will be done by varying the number of turns on the potcore until resonance at 22kHz is achieved.

Now we have the two frequencies, which when added together, will give us a nominal 22.3kHz. These components are fed into a ring mixer which now has to be adjusted. Again looking at the signal on the CRO, connected across L7, set the 2.2k balancing pot for the maximum and cleanest output. The CRO is now shifted to across the emitter-follower output and then L7, L8 and L9 are adjusted for maximum output at 22.3kHz. It will be seen that the amplitude of the 22.3kHz synthesised signal varies somewhat and the tuned circuits should be adjusted for a minimum variation between maximum and minimum amplitudes. As before, each coil will be adjusted by altering the number of turns in the first place and then the fine adjustment will be done by rotating the top cup as before.

At this stage, you are in a position to make some preliminary checks of your synthesised frequency (and so your 100kHz crystal oscillator output) against that received from NWC. To avoid instability, make sure that the receiver input circuits and the high level synthesiser circuits are as far apart as possible. Also, the aerial loop stick should be kept well away from the receiver and synthesiser.

The two signals should be applied one to each beam of the CRO. Set the amplitudes and time base so that a display resembling one of the photographs is obtained. Two photographs are shown, one with the clipped NWC signal synchronised with the time base and the other one has the synthesised signal synchronised. I prefer the latter.

If you get a similar display to ours, with the synchronised signal clear but the other one blurred and obviously not phase locked with the other one, then this is good enough and the setup should be dismantled and fitted permanently into the box.

With the parts all fitted to the box, the unit should be set up as before so as to make further adjustments. After switching on, it should be left for about half an hour to allow the oscillator to get up to temperature and settle down. Actually, after all adjustments have been done, the crystal will come into phase lock with the incoming signal after about ten minutes.

It should be remembered that we are going for a high degree of accuracy and this calls for considerable care and patience to achieve this goal. First of all, we have to get the crystal oscillator onto a frequency close enough to come into lock with the incoming signal. This may be done in a number of ways. A clock may be fitted to say the 50Hz output and its timekeeping adjusted to within about one second per day. This will be done by adjusting the coarse trimmer on the crystal oscillator. This done, the crystal oscillator should come into phase lock with NWC.

The above method is probably the easiest but it takes time. Another method is to simply take pains to slowly adjust the coarse trimmer until the oscillator is brought into locking range. This method can "drive you up the wall" and calls for considerable patience, unless you happen to be lucky. In pursuing this method, watch the unlocked signal on the CRO until it becomes less blurred and finally you can see which way it is drifting. Careful further adjustment will bring it into phase lock.

The third method, and one which is somewhat of a paradox, is to adjust the crystal oscillator output by means of an accurate frequency counter. The chances are that if you have such a counter, you may not want to build this device anyway!

Regardless of the method whereby you have achieved phase lock, this is a big step in the right direction but there is more to do to ensure the maximum performance from this device.

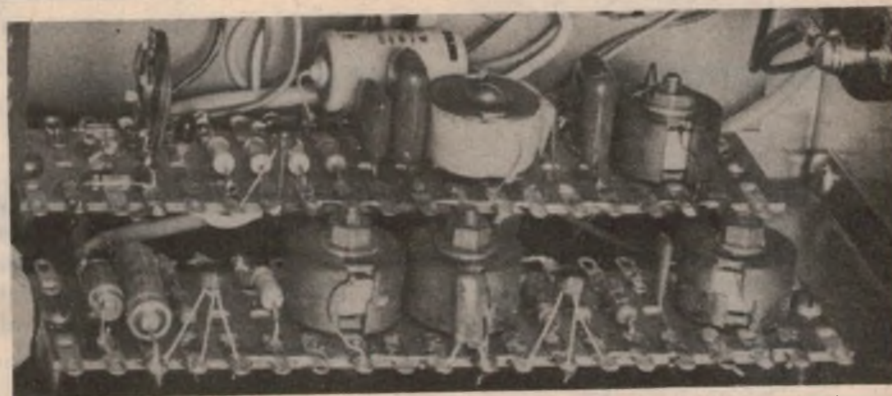
To this end, it is largely a matter of getting to know the device of your creating. Fairly obviously, a main objective is to get the crystal adjusted as close as possible to the correct frequency. Standing in the way of this endeavour are quite a number of small but important factors. I will not attempt to go through them all but setting down of each of the functions which directly or indirectly affect the crystal frequency is most important and this is a factor which cannot be hurried.

Provided that the crystal stays in phase lock, it is a good idea to leave the unit running for a few days, or even a week or two to settle down. Then all adjustments previously made may be reviewed. The gain of the receiver should be checked to make sure that it is stable under all conditions. Use as much gain as this will allow. By this time, the position of the aerial should have been established. Make sure that the 47k gate threshold pot is adjusted so that the gate closes when the transmitter goes off the air. On the other hand, do not set it back so far as to unduly clip the signal when it is weak. In conjunction with this adjustment is the bias pot for the associated transistor, as well as signal strength meter adjustments.

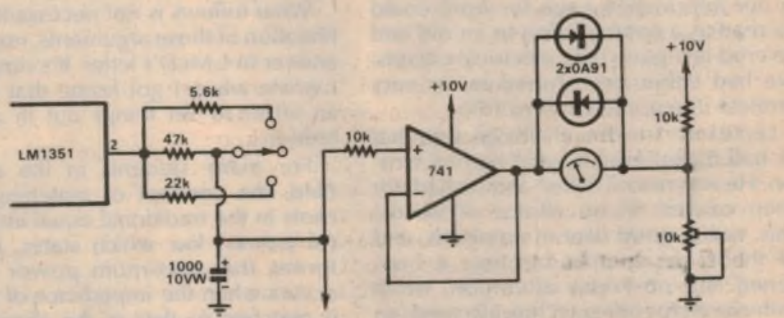
Possibly the most difficult adjustment, as mentioned before, is to get the crystal as close as possible to frequency. Readers may find their own method of doing this but one way which I have found to be satisfactory is to wait until the transmitter goes off the air (preferably for maintenance on Wednesdays). Wait for a few minutes and determine the reading of the AFC meter. When the transmitter comes back on the air, adjust the crystal very carefully so that you get the same AFC meter reading.

Another method, which also involves waiting for the transmitter to go off the air, is to make use of the one second pulses from the dividers and compare the time difference between them and the seconds pulses from VNG. This can be done by putting the respective pulses up on a double beam CRO and by means of the time base calibrations, measure the time difference between the pulses. This must be recorded initially and then subsequently watched over two to four hours, still with the transmitter off. The difference can be determined on a good CRO to within one millisecond. Any drift should be compensated for by adjusting the trimmer on the front panel.

Since the circuit was drawn, a number of changes have been made and these may be made quite readily in most cases. Change the 10uF 12VW electrolytic at the junction of the 10k resistor and 47k pot, to 100uF. Increase the resistor in series with the signal strength meter from 47k



At top is a close-up view of the receiver circuitry, while above are the synthesiser sub-assemblies. The nearest strip includes the three 22.3kHz tuned circuits.



AFC metering circuit modification. A 741 op amp is used as a voltage follower.

to 82k. At the junction of this resistor and the meter, add a 220uF 16VW electrolytic to earth.

Another change not quite as easy as the others, involves a modification to the AFC metering circuit. This has been found wanting in that it is not centre reading and it is not really sensitive enough. This has been overcome by adding a 741 op amp as shown in the circuit diagram. The 741 is used as a current amplifier with unity voltage gain. The 10k pot is for adjusting the meter for centre zero and the two OA91 diodes are added to give some measure of protection for the meter. The extra components were mounted on a piece of miniature tag board and mounted on the back of the meter with the two meter terminal screws.

One other point which needs some further attention is the time constant as shown in the same circuit. The original circuit showed a time constant of only one second. This is not long enough for good short term stability and it should be increased accordingly. Just how much is a difficult one to answer and the final figure will largely be up to individual determination.

I have tried values up to about 100 seconds but this calls for very accurate adjustment of the crystal frequency and it does not allow for much deviation. I have settled for a compromise, in that I have arranged for switching between three values. The capacitor is a 1000uF 10VW electrolytic and a 47k resistor, giving about 50 seconds. A second resistor of 5.6k is connected to pin 2 of the IC and switched in parallel with the 47k to give a time constant of about 5 seconds. A third resistor of 22k, instead of the 5.6k, is switched across the 47k resistor to give about 15 seconds. I mounted a 3-position toggle switch on the back panel.

So there it is. With this device, you should be able to determine frequency to a high order of accuracy. It is not easy to quote firm figures but it should be possible to obtain readings to a few parts in 10^9, given the right conditions and with proper procedure.

Forum

Conducted by Neville Williams

Impedance matching: Get a load of this!

'Whether or not he intended to, a reader from Yeppoon (Qld) recently triggered quite an argument in our office by questioning an item that had been written, in the first instance, by Leo Simpson. Not that Leo believes himself to be incapable of error; it's just that he offers such a spirited defence against anyone who seems to be suggesting that he has made a mistake somewhere along the line!

As you will note from the accompanying letter, L.McD. contends that an item in our information page for April could be read as a contradiction to an old and revered law governing electrical circuits. We had either been mistaken, or very careless in our choice of words!

Leo's retort to the challenge was that he had meant exactly what he had written. He was not mistaken and he had not been careless in his choice of words! This, with a good deal of emphasis, and all the more notable because it happened late on Friday afternoon, when enthusiasm for office technicalia tends to be at its lowest ebb.

My own immediate reaction was to defend the critic and suggest that he might have a point.

Perhaps we had over-reacted to the original question. Instead of merely suggesting that it was a question of signal voltage rather than signal power, we had tended to "preach" a bit about matching in practical electrical circuits, as distinct from hypothetical situations.

As a result, our critic had over-reacted and now Leo was matching his effort. Could there be some common ground that we had all missed?

I began to speculate whether the impedance of an output stage as a "source" could be accepted on face value as its published output impedance—a parameter classically measured from the output end looking back, and so drastically affected by feedback.

It was then that Jim Rowe made his entry, pointing out that amplifier stages might *not* qualify at all as "sources" in the strict (and simple) sense, since they were really converters, changing DC input to AC output—with a whole lot of parameters of their own needing to be taken into account.

So the discussion continued, beyond "knock-off" time, down in the lift, out the front door and along the street—until we had to go our separate ways.

What follows is not necessarily a continuation of those arguments, nor a direct answer to L.McD's letter. It's simply what I wrote when I got home that night, in an effort to set things out in a logical fashion.

For many students in the electrical field, the concept of matching has its roots in the traditional equal impedance (or power) law which states, in broad terms, that maximum power transfer occurs when the impedance of the load is matched to that of the generator, or power source. Students are encouraged to do sums or plot curves which confirm that power transfer falls away to either side of this "ideal" condition.

In his letter, which we have abbreviated somewhat, L.McD does just this, plotting power to loads between 2 and 10 ohms from a 5-ohm source; the power curve peaks at 5 ohms, right on the button.

So far, so good.

Unfortunately, L.McD, along with many others, has failed to realise that the equal power law is predominantly a mathematical exercise, having surprisingly little relevance in the real world of electronics. As an everyday requirement, maximum power transfer tends to be the exception rather than the rule, a point which many texts fail to make sufficiently clear.

Where L.McD has gone completely off the rails is in his assumption that maximum power transfer corresponds with maximum efficiency and therefore minimum wastage. Further, that about 50% efficiency is the "norm" with which other figures should be compared.

In fact, the expression for efficiency (i.e. load power/total power) is quite different to that for equal power. Efficiency passes through 50% for the equal power condition and then climbs on towards 100% as the load impedance rises above that of the generator. The normal objective for a designer concerned with power transfer is to strike an acceptable compromise between power in the load and system efficiency.

To quote M. G. Scroggie in his "Foundations of Wireless and Electronics": ". . . it may be considered better to deliver 320W with a loss of 80W than the maximum (500W) with a loss of 500W".

Elsewhere, he uses the illustration of a power station: attempting to match the load resistance to the generator resistance "would cause so much power to flow that it would be disastrous!"

Imagine any one of our state power houses feeding 500 megawatts into the grid—and dissipating 500 megawatts on the site!

Equally there is no way that the ordinary consumer will want to match the impedance of his domestic equipment load to that of the incoming supply mains; he couldn't afford the power bill!

Dear Sir,

With reference to E.A., April 1976 page 115, Information Centre, Playmaster 132: you quote in your answer with reference to matched power in source and load that "this wastes half the power and amounts to gross inefficiency".

This statement contains some very poorly chosen words and, to a person seeking information, could very easily lead to a false impression.

Maximum power can only be transferred from source to load when Zs=Zl, i.e. when they are matched. This condition does not waste half the power as it is a necessity for the remaining half power to be able to be absorbed by the load.

Zs=Zl for maximum efficiency can be proven by Ohm's Law quite simply.

If matching is inefficient and wasteful of power, how much more so is mismatching! Indeed, if we are to take your statement at its face value, then it is better to throw away our SWR bridges, etc. Those technicians, radio and otherwise, who have concerned themselves with critical matching in the past can now forget it, as it would appear that more power can be absorbed by the load, and more efficiency obtained if the load and source remain unmatched.

Getting back to our original statement, I've no doubt that you didn't intend it to sound the way it was written. However, a better choice of terminology is really required to clarify your answer.

L.FMcD (Yeppoon Qld).

The consumer must accommodate to the available voltage but will logically select the current rating (therefore the impedance) of the domestic equipment to provide just the required amount of lighting, heating or motor effort. In short, the consumer relies on a deliberate mismatch to achieve efficiency and economy and to avoid waste.

Now let's have a look at the question in the April issue, and our reply which prompted the letter from our correspondent. I.M. (Essendon, Vic) said that he had a preamplifier with an output impedance of 3.9k, and wondered whether it could be used with a main amplifier having an input impedance of 150k. Would we please advise?

In framing a necessarily brief answer, we were aware of the likely background to the question but we simply stated that: "It is rare in audio situations for output impedances to be matched to input impedances or, more briefly, to match source to load".

This statement is fair and true. It was the next sentence that stirred the spirited retort:

"This is because the (matched) condition is one of equal power dissipation in the load and source. This wastes half the power and amounts to gross inefficiency".

In making this statement, we were not trying to ridicule the piece of mathematical dogma mentioned at the outset. We were simply continuing the theme expressed in the preceding sentence: "in audio situations..." It is continued in the next sentence: "In practice (audio situations) source impedances are very much lower than load impedances".

The final sentence was intended further to illustrate this point and is worthy of closer examination. But let's stay, for the moment, with the original preamplifier/amplifier proposition.

As with most amplifiers, the Playmaster 132 requires an input signal, normally specified in volts (or millivolts). To be sure, one could re-express this as a certain amount of power in a particular input resistance but it would be out of step with normal thinking. The main concern of the electronics designer is that the source be able to apply to the input the requisite maximum signal voltage at minimal distortion.

Where the source is a preamplifier, the corresponding requirement is that it must be capable of delivering at least the maximum required signal voltage to the amplifier, with minimal distortion. The requirement could well be prejudiced if the preamplifier output circuit was heavily loaded by the input impedance of the main amplifier—hence the general desirability of seeing that the load impedance is much higher than the source impedance, in order to minimise such loading.

One does read occasionally in hifi literature that a certain amplifier "matches" a certain preamplifier. It does not necessarily mean that the impedance levels are the same; more commonly it signifies that the impedance levels are compatible, with the amplifier input impedance comfortably above the preamplifier output impedance, for the reasons just stated. More importantly, "matches" indicates that the preamplifier can comfortably drive the amplifier, with low distortion and a convenient overall gain.

In the case in point, the Playmaster 132, with an input impedance of 150k, would have negligible shunting effect on the 3.9k output impedance of the preamplifier. Virtually the whole available (i.e. unloaded) voltage would be applied to the main amplifier, representing a very efficient transfer, and virtually no loss.

However, any attempt to artificially match the two impedances could damage this comfortable situation. Increasing the apparent impedance of the source by adding a 146k series resistor would effectively halve the gain of the system and double the signal level through the preamplifier with, almost certainly, a rise in distortion level. Conversely, shunting the main amplifier input impedance down to 3.9k would pose more difficult operating conditions on the preamplifier, the additional drive power being used purely to raise the temperature of the shunt resistor!

Hence our statement which we stick by, in the context in which it was made: the matched condition would waste power and amount to gross inefficiency.

Just before moving on, it may be worthwhile to refer to the loading which would most probably be presented by the preamplifier to the input transducer. Conventionally, the input impedance to a "magnetic" phono channel is kept to 47k, and most cartridges will have been designed to work into this value. Again, the 47k does not "match" the cartridge in the traditional sense, even though the term may be used. 47k provides that amount of loading which will most nearly ensure a flat frequency response after RIAA compensation.

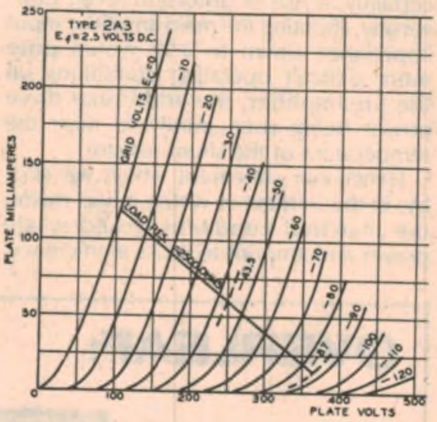
While one could dwell further on the front end of amplifiers, even more fascinating aspects emerge when one takes up the final sentence in our answer, relating to amplifier output impedance and optimum load. In the very place where one is undeniably talking about power transfer and impedance, the conventional matching concept still doesn't get a look in. Hence our remarks in the April issue.

Let's see why:

Consider that classic power triode, the 2A3, for which the curves are shown overleaf. Its plate resistance, or effective output impedance is listed as 800 ohms and, in terms of the equal power theorem, one would logically expect the recommended output load resistance to be of the same order. Instead, it turns out to be 2500 ohms. How come?

The first vital point is that the 2A3, like any other output device has certain limit ratings such as maximum applied voltage, maximum average and/or peak current, maximum plate (or collector) voltage, etc. The so-called operating point, or the no-signal quiescent point, must be selected within these limits and, for a single-ended class-A operation, the point suggested is: grid bias −43.5V; plate 250V; plate current 60mA.

If, with this operating point, one considers an 800-ohm load, the load line would be much steeper than the one shown, having much the same slope (but leaning to the left) as the characteristic curves themselves. Towards the low-current high-bias end, it would run into a zone where gross non-linearity is evident and where the plate (or output) resistance is far higher than the nominal 800 ohms. To avoid the non-linearity, and to minimise distortion, a much higher value of load has to be selected. Thus, for maximum "undistorted" power output, a device with a nominal output impedance of 800 ohms ends up having to operate into a load of 2500 ohms.



With tetrode and pentode valves, the discrepancy is even greater. The nominal plate (or output) resistance may lie between 20k and 100k for different valve types but the actual value over the working range may peak to something much higher again or, at some instants, be as low as a triode.

The application of voltage negative feedback around an output stage may lower the effective output impedance but, curiously, does not have much effect on the value of the optimum load. This much was made clear by F. Langford Smith and others, who laboriously constructed a family of pentode—with feedback curves—an exercise that should be much simpler in these days of computers and plotters.

It was appreciation of this that sent me off on a rambling journey of speculation, as mentioned at the outset. What kind of generator of "source" is an output valve (or transistor) which not only fails to obey the equal impedance law but which requires a load seemingly so unrelated to its rated output impedance?

With solid-state output stages, there is a shift in emphasis on the various device and circuit parameters but, as with valves, output impedance does not figure in the determination of load, except in a highly inferential way. And, once voltage negative feedback is applied—as it always is in solid-state amplifiers—we are left with a stage or a "black box" system, with a source impedance of a fraction of an ohm, working into a load of, typically, 4 to 15 ohms.

In terms of amplifier design, a solid-state class-B system, as per the above, would have an efficiency of well over 60%, being typical of present-day hi-fi amplifier practice.

The majority of such amplifiers are designed to operate into 8-ohm loads. If operated into, say, 15 ohms, efficiency rises, the output transistors run cooler, but the maximum available power falls.

If operated into less than 8 ohms (or other rated load) the available power may increase, but so also does the potential power dissipation in the source—output stage and power supply. Things may start to get hot, fuses to blow, or devices simply fail due to stress.

It may be appropriate to comment on just one more aspect:

In his letter, L. McD suggests that, if our comments are to be taken seriously, a whole generation of amateur station operators and others may just as well discard all their impedance measuring and matching gear. I could suggest that a fair amount of equipment and associated ideas could justly suffer that fate but that is one of Jim Rowe's pet subjects!

The one "chestnut" that, above all others, warrants a mention here relates to the "necessity" of matching transmitter to feedline, and feedline to antenna.

Yes, when the antenna is the load, it should match the impedance at the load end of the feedline, both to ensure optimum transfer of power and to eliminate reflections back down the feedline and consequent standing waves.

But the coupling between feedline and transmitter is not required to be an equal impedance match. The size and position of the link, or the effective position of the tapping on the output circuit, is dictated by the amount of loading which we choose to impose on the transmitter output stage. In short, the objective is an accurate impedance match at the antenna, and a selected MISMATCH at the transmitter!

In a receiving situation—and TV sets are the classic example—the receiver, as the load, should match the bottom end of the feedline, for maximum energy transfer and minimum standing waves. If the antenna also matches the feedline, that's fine but it's not nearly critical as the load (or receiver) end.

And that's about where I propose to leave it. What a crazy situation when one gets so involved in a problem that you spend several hours over the weekend writing about it. I'll have to see whether I can get my own back on L. McD!

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6DX8	1.52	1.38
6EA8	1.53	1.39
6EB8	1.87	1.71
6EJ7	1.30	1.18
6EH7	1.30	1.18
6ES8	1.76	1.60
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Getting into Microprocessors

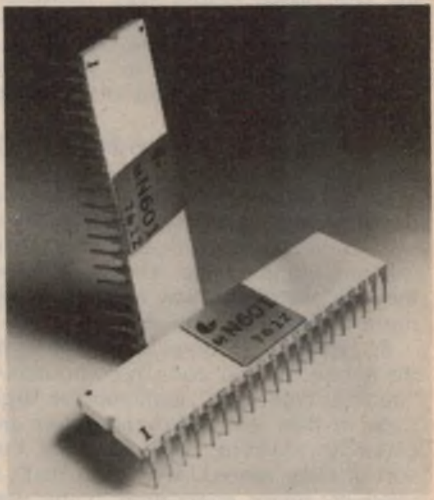
Five years ago, microprocessors and microcomputers were little more than dreams in the minds of research engineers and science fiction writers. Now they are a reality, and they seem set to change the whole face of electronics.

The change is happening already, and it is happening fast. So fast that overseas it is being described as an explosion, a revolution.

Many engineers and technicians in industry have been caught on the hop, and have found it difficult to adjust to the new devices. On the other hand many hobbyists have accepted the new devices with gusto, and some are pioneering all sorts of new applications. A healthy new market area has sprung up, to cater for the growing army of computer hobbyists.

Well, what are these new devices? Why are they having such a dramatic impact? Why are they having such an appeal for hobbyists? Why will most of us, whether professional or hobbyist, need to come to terms with them? How do you get started?

This supplement is the first of a number of features we are planning on this important subject, to answer questions like those above, and help you to "get into microprocessors". Editor Jim Rowe starts the ball rolling in the introduction which begins below, written to give you most of the background information you should know.



Most microprocessors come in 40-pin dual in-line packages, like the two shown here. These are samples of the Data General mN601 "microNOVA" chip, a 16-bit device which is software compatible with the same firm's minicomputers.

What exactly is a microprocessor?

Broadly speaking, a microprocessor is an integrated circuit (IC) which contains virtually all of the circuitry required to form the "heart" of a digital computer. Made using large-scale integration (LSI) techniques, it combines on a single IC chip the control, timing, data manipulation and arithmetic sections.

There are many different microprocessor ICs being made, and they vary quite widely in terms of potential computing capability. At the low end of the spectrum are relatively simple devices with a modest repertoire of different functions, and designed to deal with data in the form of 4-bit words. Rather more elaborate are the devices at the top end, generally with a much more powerful repertoire of functions, and designed to deal with 16-bit data words. In between these two extremes are many medium-level devices, most of them designed to deal with 8-bit data words or "bytes".

What is a microcomputer?

In general terms, as the name suggests, a microcomputer is simply a small computer—small in terms of physical size and cost, that is, not necessarily in terms of computing power. Nowadays there is also the broad implication that it uses a microprocessor IC as its functional heart.

Along with the microprocessor there is at the very least a memory of some sort, in which the "program" is stored. This is a sequence of binary numbers which the microprocessor interprets as "instructions", telling it how to perform the required tasks.

More specifically, there are two broad types of microcomputer. One type is similar to minicomputers and larger computers, in that it is designed to operate as a general-purpose computing system. The main memory is read-write or "random access" memory (RAM), and the computer may be made to perform virtually any required task simply by storing the appropriate program in the RAM. A series of different tasks may be performed one after the other, by feeding in and running a number of different programs in turn. This type of microcomputer therefore conforms quite closely to the conventional concept of a digital computer.

Microcomputers of this type are already tending to compete with established minicomputers, being capable of offering similar computing power at a fraction of the cost. It seems likely that in time, microcomputers will gradually eclipse both minicomputers and conventional large computers. Or putting it another way, all digital computers are likely to become microcomputers in the sense that they will be based on microprocessors and other LSI devices.

The other type of microcomputer still has a microprocessor controlled by a program stored in memory. But in this case the memory is a read-only memory or "ROM", and the program is therefore substantially permanent. The microprocessor and the ROM thus form a system which is designed to perform a single task, rather like a conventional custom-designed logic circuit.

This type of microcomputer is

described as being "dedicated", to emphasise the difference between its single-task behaviour and that of the general-purpose type. The task performed by a dedicated microcomputer may be quite complex, but it can only be changed by replacing the program in the ROM.

Just how this is done depends upon the type of ROM device being used. With mask-programmed ROMs, programmed by the manufacturer, it means replacing the ROM device as a whole with another. This must also be done with programmable ROMs (PROMs) of the type using fusible links. However, there are other PROMs which permit the stored program to be erased, either electrically or by exposure to ultra-violet light, and a new program stored in its place.

Why are these new devices having such a dramatic impact?

Basically there is a very simple and down-to-earth reason why microprocessors, in microcomputers, are forcing their way into our lives: cost. More and more, they are providing a way of doing things more cheaply than conventional ways.

By "things" we don't just mean here the traditional tasks done by computers—"number crunching", manipulating large slabs of data, etc. Microcomputers are certainly providing ways of doing this sort of thing more cheaply, but that's a relatively minor application. If this was the only application of microcomputers, they would scarcely be making a ripple.

In fact the horizon is very much wider than this. Microcomputers are capable of doing much more mundane tasks—the type of thing previously done by custom-designed logic circuits, relays, mechanical timers and sequencers, and so on. And they are fast becoming not only a more reliable way of doing these things, but far and away the cheapest way of doing them.

For example the latest automatic sewing machine to be released on the US market has a dedicated microcomputer inside, replacing the usual cams and other complex mechanics used to produce the various fancy stitches. Similarly the latest automatic washing machine to be released has a dedicated microcomputer replacing the traditional timing motor and sequence switches. And microcomputers have already started to appear in petrol pumps, traffic light controllers, process controllers, elevator systems, cash registers and other point-of-sale terminals.

In fact it is the dedicated type of microcomputer which seems to have the largest and most dramatic potential. We've probably only started to scratch the surface of its applications, because as yet we are still talking about existing jobs. Once we all get used to the idea of really low-cost "programmable black boxes", all sorts of applications are bound to open up—doing things which until now we wouldn't have even tried doing because they seemed too hard.

Why are microcomputers becoming the cheapest way of doing even quite mundane jobs?

There are two basic reasons why microcomputers are fast becoming the cheapest and most practical way of doing even mundane tasks. One is that IC manufacturing costs are lowered. Instead of having to produce many different types of specialised IC, the manufacturer is able to concentrate on only a few types: a microprocessor chip, RAM and ROM memory chips, and a few associated devices. These can be produced in really large quantities, giving economy of scale.

The other reason is that once a piece of equipment is designed using a microcomputer system, changes and modifications may be made far more cheaply. There are no costly changes to mechanical hardware, just changes to the "software": the program in the microcomputer memory. With dedicated systems, this is merely a matter of plugging in a new ROM with a modified program.

Why are engineers and technicians working in electronics finding it hard to adapt to microprocessors and microcomputers?

Microprocessors are providing problems for engineers and technicians because they are changing the whole approach to electronic equipment design. Traditionally, you designed a piece of equipment using conventional circuit design techniques—first developed in the days of thermionic valves, then adapted to transistors and ICs.

This involved selecting various specialised-function devices, and working out how they could be connected together to perform the specific job to be required.

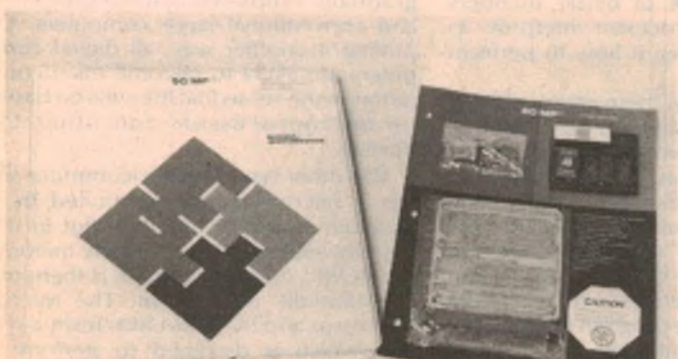
With microprocessors, this whole approach is becoming redundant. More and more, circuit design is becoming a matter of taking one "general-purpose black box" containing a microprocessor and a memory, and "telling it what to do". In other words, writing a program to put in the memory, so that the microprocessor is able to do the job.

In short, circuit design is changing into computer programming, and circuit designers are finding that they must change into programmers. Much of their existing electronic design experience is becoming redundant, and they are having to learn a different set of skills.

How do you learn the skills required to work with microprocessors?

This depends to a certain extent on whether you are coming in at the professional level or at the hobby level, although the two are closer together than

Here are two of the evaluation kits currently available. Below is the National SC/MP kit, at right the Fairchild F8 kit.



one might perhaps think.

Not surprisingly, the firms making microprocessor ICs and the other devices involved have been motivated to help professional users adapt to the new devices. They have a vested interest in selling the devices, and this won't happen until engineers and technicians have learned what they are, what they can do and how to drive them.

Virtually all of the firms concerned have brought out great piles of literature supporting their chips: technical data, applications material, programming courses and so on. And many of them run intensive-course seminars designed to give the engineer or technician a fast down-to-earth introduction to their particular devices.

This is all very well, but there is a limit to what one can pick up from literature or from an intensive training seminar. To get real insight into microprocessors and microcomputers, there is no substitute for "hands-on" experience—actually sitting down and playing with one, writing and running small programs, and so on.

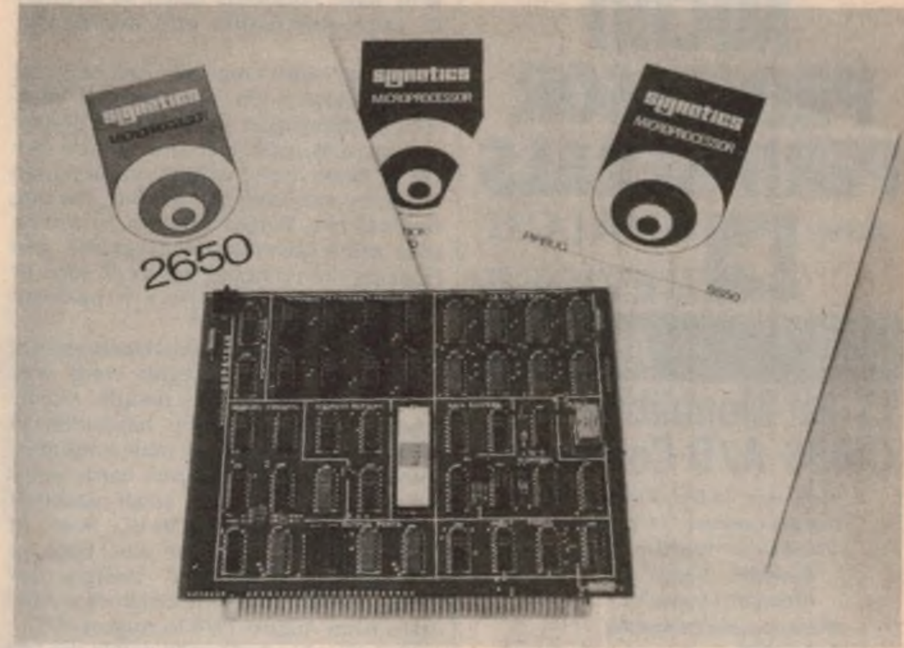
The companies soon realised this, and in an effort to meet the need they first came up with two rather different answers. One answer was to develop equipment to which they gave names like "prototyping development system". These were generally built around a microprocessor, but were basically a full-scale minicomputer designed to provide complete user support for writing, debugging and running programs intended for simpler systems. The cost was up in the many thousands of dollars.

The other answer was to make the same sort of facility available via the big computer time-sharing services, so that any firm with access to a time sharing terminal could do the same things.

In both cases, the user was presented with high-powered computing machinery "pretending" to be the sort of simple systems he was actually trying to design. And while this approach was fine for the very big user, who knew exactly where he was going and could afford to get there fast, it didn't really help those who weren't too sure what it was all about.

Happily in the last year or so, the manufacturers have been able to come up with a different answer, of much greater value to the small user and the person who still doesn't know if they are going to be a user or not. The exact format varies a bit, but broadly speaking this answer consists of a very basic microcomputer system built on a single PC board. It is usually called an "evaluation kit", and it is designed to provide the simplest, cheapest way of doing three things:

1. Getting "hands-on" experience with the microprocessor concerned.
2. Learning to write programs for it.
3. Developing programs for practical applications.



Here is the Signetics PC1001, larger of the two evaluation kits available based on that firm's 2650 8-bit microprocessor chip.

Most of the kits are designed to communicate with the user via an ASCII-code 110-baud teleprinter, such as the Teletype model ASR-33. However others include simple interfacing via a calculator-type keyboard and a set of 7-segment LED displays.

Exactly what do these kits provide?

Generally they provide a set of technical literature and user manuals, including a guide to programming. On the PC board, either already or when you have assembled it, there is the microprocessor chip, a ROM chip or chips, a RAM chip or chips, and a few other chips to provide a clock oscillator, a teleprinter interface and so on. More elaborate kits may have, or have provision for additional input-output interfacing, and perhaps provision for easy memory expansion, etc.

In the ROM already is a utility program described broadly as a "debug" program. Each firm tends to give their debug program a distinctive name, like "KITBUG", "PIPBUG", "FAIRBUG" and so on.

Debug programs differ a little, but generally what they do is allow the user to do the following things:

1. Feed a program into the RAM, either via the teleprinter keyboard, or via the punched paper tape reader if the teleprinter has one.
2. Examine any of the stored instructions, and modify them if required.
3. Run the user's RAM program, either all in one slab or in sections (the latter can help in finding why a program isn't working in the way you expected).
4. Examine any of the microprocessor's registers after the program has run, to see if all has gone as expected.
5. Punch out a paper tape version of the program via the teleprinter tape punch, if it has one.

These are just about all of the basic functions one needs to learn how to drive a microprocessor, and to develop small programs for practical applications.

The various functions listed above are provided by the debug program in response to simple commands typed in via the teleprinter. Each command has a code letter like "M" for examine memory, "P" for punch out the program, and so on, with the letter followed as required by numbers giving relevant address information—usually in hexadecimal code.

What do these evaluation kits cost?

It varies from firm to firm, and depends upon whether the kit concerned comes as an actual assemble-it-yourself assembly kit, or as a wired and tested board that only needs connection to a power supply and a teleprinter. Also some are more elaborate than others, to cater for those coming in at differnt levels of sophistication.

Currently prices vary between about $80 for a very simple kit, up to about $400 for a fairly pretentious one. These prices include full technical literature and user manuals, but don't include power supply or teleprinter, etc. ▶

Why have hobbyists taken so strongly to microprocessors and microcomputers?

Playing with computers can be great fun, as there is the same sort of intellectual stimulation provided by cryptic crosswords, puzzles, and games like chess. Once you've written even a simple program and finally got it going, the bug tends to bite. Before long, you're writing ever more adventurous programs, and hooking the computer up to all sorts of other equipment to have it perform ingenious tricks.

Of course before microprocessors came along, these delights were only available to a few lucky people. Mainly these were people who happened to work with computers or minicomputers, although there were a few hardy souls who built up their own small machines the hard way, using earlier ICs. Some of these people were those who built up the author's "EDUC-8" design, described in the issues of Electronics Australia from August 1974 to August 1975.

But what has happened within the last six months or so is that in coming up with the low-cost "evaluation kits" to help engineers and technicians get started with microprocessors, the manufacturers have at the same time produced what are in fact very tiny minicomputers. And this is the development which has triggered the dramatic increase in computer hobby activity.

To be sure, most of the evaluation kits are designed to go with ASCII-type teleprinters, and these are neither cheap nor readily available as far as the hobbyist is concerned. But there are ways around this problem. One way is to use an old Baudot-type teleprinter, and hook it up via a bidirectional code translator. Another is to build up a video terminal unit, based on an old TV receiver.

Here's where a magazine like Electronics Australia can help, by solving some of these practical interfacing problems. At E-A we are in fact already working along these lines, and we hope to publish details of interfacing units in the near future.

The main point to realise is that microprocessors and microcomputers are

Rockwell International make a large family of microprocessors and other associated chips, three of which are shown here.

here, and that it is now possible for both professional and hobbyist to "get into them" with surprisingly little pain and financial strain.

To conclude this introductory look at microprocessors and microcomputers, here is a short and by no means complete survey of the evaluation kits currently available in Australia. Only brief details are given, and we hope to deal with many of the kits in more detail in forthcoming issues. For the present, however, the following may give you an idea of the type of system currently available. The kits are listed roughly in order of price.

1. **National SC/MP:** This is currently the lowest cost evaluation kit on the market, at $79.95 plus tax. It is based on the National Semiconductor SC/MP ("scamp") microprocessor chip, an 8-bit device designed primarily for low cost dedicated applications. The evaluation kit provides a complete basic system, with the KITBUG debug program in a 512-byte ROM together with a 256-byte RAM, a simple teleprinter interface and a crystal clock. It comes as an assemble-it-yourself kit, complete with full assembly instructions, user manual and programming manual. (NS Electronics Pty Ltd, cnr Stud Rd and Mountain Highway, Bayswater, Vic. Kits are available from all franchised distributors.)
2. **Fairchild F8 Kit:** This is based on Fairchild Semiconductor's F8 microprocessor, which is a two-chip 8-bit design. The kit comes as a wired and tested PC board, complete with an edge-connector socket already wired to a power supply/teleprinter cable; also a set of user, programming and applications manuals. The ROM has a capacity of 1024 bytes ("1k"), and comes with the FAIRBUG debug program in situ. The RAM also has a capacity of 1k, to allow development of quite elaborate user programs. Cost of the kit is quoted at $166.50 plus tax. (Fairchild Australia Pty Ltd, 37 Alexander St., Crows Nest, NSW 2065.)
3. **Mostek F8 Survival Kit :** Based on the F8 microprocessor which Mostek second-source from Fairchild, this kit comes in either assemble-it-yourself or fully assembled versions. The fully assembled kit provides 1k bytes of RAM, and 1k bytes of ROM with "DDT-1" debug program in situ. It also provides three 8-bit input/output ports, in addition to the teleprinter interface. The clock uses a quartz crystal. With the kit come a detailed application note, a programming guide and a listing of the DDT-1 debug program. Also an F8/ANSI Fortran Cross Assembler on punch cards,

to allow program development on large machines if desired. Approximate price of the D-I-Y kit is $158, with the assembled kit $200. (Namco Electronics, 239 Bay St., North Brighton, Victoria 3186. Also Total Electronics.)

4. **Signetics PC1500/KT9500 ABC prototyping system:** This is based on the Signetics 2650 microprocessor, an 8-bit device. The system comes either as an assemble-it-yourself kit (KT9500), or as an assembled PC board (PC1500). The system includes a 1k ROM with resident "PIPBUG" debug program, together with 512 bytes of RAM, two 8-bit latched input/output bidirectional ports, a crystal clock and a teleprinter interface. It also provides buffered data and address lines for subsequent memory expansion. The system comes with a 2650 technical manual, PC1500 applications booklet, PIPBUG listing and various technical notes. Price of the KT9500 kit is $165, with the PC1500 assembled system $245. (Philips Electronic Components and Materials, 67 Mars Road, Lane Cove, NSW 2066.)

5. **INTEL SDK80 System Design Kit:** Based on the Intel 8080 8-bit microprocessor chip, this comes as an assemble-it-yourself kit. On the PC board mount a 1k eraseable PROM with resident debug and monitor program, 256 bytes of RAM, a crystal clock, and three bidirectional 8-bit input/output ports as well as a teleprinter interface. There is also a second 1k eraseable PROM, for user program storage in addition to the RAM. The kit comes complete with assembly instruction manual, 8080 technical manual, and programming manuals. Price of the kit is $320 plus tax. (A. J. Ferguson Pty Ltd, 29 Devlin St, Ryde, NSW.)

6. **Signetics PC1001 Prototyping card:** This is based on the Signetics 2650 microprocessor, like the PC1500. The kit comes as an assembled PC board, with 1k of RAM and 1k of ROM containing the "PIPBUG" debug program. It has a crystal clock, and provides two 8-bit input ports and two 8-bit output ports as well as a teleprinter interface. The PC board also provides status indicator LEDs, and buffered address and data lines to simplify subsequent memory expansion. The kit comes with a 2650 technical manual, PC1001 applications booklet, PIPBUG listing, and various technical notes. Price of the PC1001 kit is currently $395. (Philips Electronic Components and Materials, 67 Mars Road, Lane Cove, NSW 2066.)

7. **National PACER System:** Developed by Hamilton/Avnet in the US, this is a packaged microcomputer system based on the National Semiconductor 16-bit PACE microprocessor chip. It comes as both a kit and an assembled unit, and has a case, complete with 8-character LED alphanumeric display panel, calculator-style keyboard and power supply. It has a 1k ROM with debug program, and 256 words of RAM. Further details are given in an article on PACER which appears later in this supplement. Price of the PACER kit is $595, with the assembled unit $695. (NS Electronics Pty Ltd, cnr Stud Rd and Mountain Highway, Bayswater, Victoria.)

8. **MICRONOVA 8562 microcomputer board:** This is a system produced by Data General, the minicomputer company. It uses the Data General mN601 16-bit microprocessor chip, with a powerful instruction set including hardware multiply and divide. The board includes 2k words of RAM, but a version of the system is available with 4k words (model 8563). The board includes buffering and timing circuitry for memory expansion to 32k words of dynamic RAM. Price of the 8562 board is quoted as $784. (Data General Australia Pty Ltd., 98 Camberwell Rd, Hawthorn East, Victoria.)

9. **OTHER MICROPROCESSOR CHIPS, ETC: A number of other microprocessor chips and associated devices are available from various firms, apart from those above. Some of these are listed briefly below.**

Motorola 6800 microprocessor family: From Motorola Semiconductor Products, Total Electronics, Cema Distributors.

General Instrument CP1600: From R & D Electronics.

MOS Technology 6502: From Digital Electronics (Marketing) Pty Ltd.

RCA COSMAC system: From Amalgamated Wireless Valve Co.

Rockwell PPS-4, PPS-8: From ANK Transmissions, Box A723 Sydney South, NSW 2000.

10. **OTHER MICROCOMPUTERS AND SYSTEMS: A variety of other microcomputer systems are available, apart from single-board evaluation kits as described above. Some of these are listed briefly below.**

MITS Altair 8800: Based on the Intel 8080 microprocessor, and designed for expansion to large minicomputer level. From WHK Electronic and Scientific Instrumentation, 2 Gum Rd, St. Albans, Victoria.

MITS Altair 680: Based on the Motorola 6800 microprocessor, with similar design approach to the 8800. From WHK Electronic and Scientific Instrumentation.

Intel 8080A Cramerkit: Based on the Intel 8080A microprocessor. From Ampec Engineering, P.O. Box 18, Strathfield, NSW.

Microprocessors: the basic concepts

If you've not had any experience to date with computers, a major problem in understanding and using microprocessors is likely to be the unfamiliar concepts involved. There is also a language problem, due to the use of many terms from computer technology. This introductory article has been written to help overcome both problems.

by FRED HORNE and BERNIE KUTE
National Semiconductor, Texas

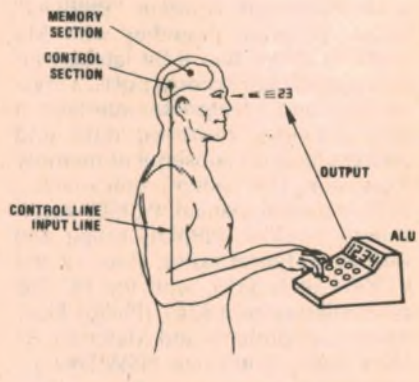


FIGURE 2. Man + Calculator = Computer

Today, a computer connotes a machine that, once it is set up for a specific problem, performs a computation automatically and without human intervention. The present use of the term "computer" has a second connotation–it usually refers to an electronic machine, although mechanical and electromechanical computers do exist.

Two important factors dictate the intimate association between computers and electronics: no known principle other than electronics allows a machine to attain the speeds now commonplace in both large- and small-scale computers; and, no other principle permits comparable design convenience. In particular, digital computers use numbers that are respresented by the presence or absence of a voltage level or pulse on a given signal line. A single pulse defines one "bit" (short for binary digit, a base-2 number); a group of pulses considered as a unit is called a "word", where a word may represent a computational quantity or a machine directive.

For purposes of illustration, we shall compare two systems for solving simple mathematical expressions, both of which are comprised of the classical elements of a computer: an input/output device, a memory, a control section, and an arithmetic and logic unit or ALU (the computational element). The control section, together with the ALU, is considered to be the central processing unit (CPU). (See Fig. 1.)

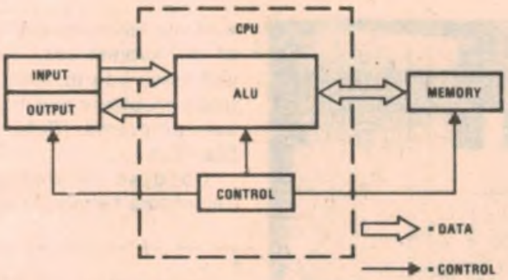


FIGURE 1. Basic Elements of a Digital Computer

The first system (Fig. 2) is comprised of a man and a calculator. The man's fingers represent the input, his eyes coupled with the calculator's output represent the system output, the calculator electronics function as the ALU, and his brain serves as the memory as well as the control section. Here is the sequence of events that occurs when our man-calculator solves the problem 6 + 2 = ?

1. Brain accesses first number to be added, a "6";
2. Brain orders hand to depress "6" key;
3. Brain identifies addition operation;
4. Brain orders hand to depress "+" key;
5. Brain accesses second number to be added, a "2";
6. Brain determines that all necessary information has been provided and signals the ALU to complete computation by ordering hand to depress "=" key;
7. ALU (calculator) makes computation;
8. ALU displays result on readout;
9. Eyes signal brain, brain recognizes this number as the result of the specific calculation;
10. Brain stores result, "8", in a location that it appropriately identifies to itself to facilitate later recall.

We shall now develop a classical computer and illustrate how it might be used to solve the same problem. To begin, note that the memory (Fig.3) is composed of storage space for a large number of words: each storage space is identified by a unique "address". The word stored at a given address may be either computational data or a machine directive (such as add, read from memory, etc.).

Two temporary storage registers, each capable of containing one word, complete the memory. These registers are designated as "memory address register" (MAR) and "memory data register" (MDR). The MAR contains the binary representation of the address at which information is to be read out of memory or written (stored) into memory, while the MDR contains the data being exchanged with memory.

Turning to the ALU, (Fig. 4) shows that

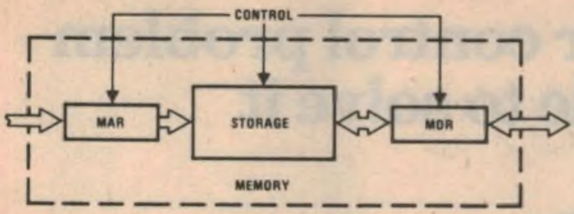


FIGURE 3. Elements of a Memory

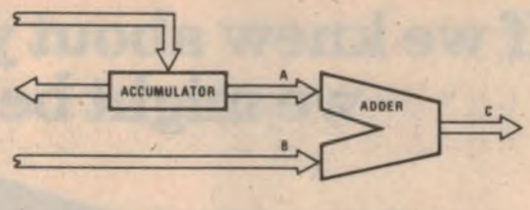


FIGURE 4. Arithmetic and Logic Unit

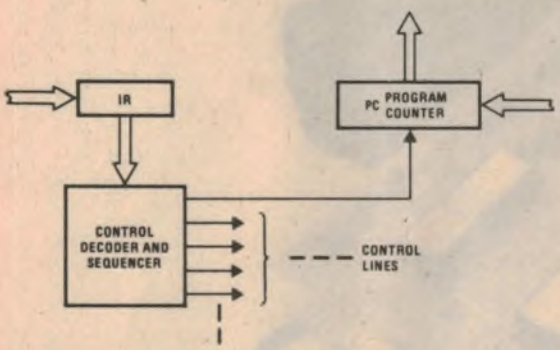


FIGURE 5. Computer Control

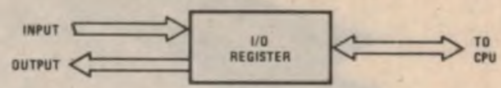


FIGURE 6. I/O Register Interface

TABLE 1. Sample Program

Memory Location	Instruction (Contents)
100	Input to accumulator
101	Store accumulator at 50
102	Input to accumulatbr
103	Add accum, Loc. 50 Place result in accumulator
104	Store accumulator at 60
105	Halt

this portion of a computer, in its simplest form, comprises an "adder" that adds (or performs similar logical operations upon) two inputs A and B and produces an output at C, and an "accumulator", which maintains intermediate results of a computation or numbers for a pending computation.

The remainder of the CPU, the control portion, is implemented using an "instruction register" (IR), a "control decoder and sequencer", and a program counter (PC). These are shown in Fig. 5. A machine directive (instruction) is transferred into the IR and is subsequently interpreted by the decoder/sequencer, which issues the appropriate control pulses to the other computer elements.

The PC contains, at any given time, the address in memory of the next machine directive or instruction. This counter is normally incremented by a count of one immediately following the reading of a new instruction. The PC contents may be replaced by the contents of a specified memory location if the last instruction was of the "jump" class. This causes the next instruction to be read from a program-specified location, instead of from the next sequential location as is the general rule.

Finally, a means of input/output (I/O) is provided by an "I/O Register", through which data is exchanged with external (peripheral) devices (Fig. 6).

We have now collected all the basic elements of a computer; all that remains to do is to interconnect them into a functioning, automatic processor. Fig. 7 shows such an interconnection, and represents a complete computer.

The analysis continues with the execution of the same problem used to illustrate the man-calculator, but somewhat rephrased:

"Read-in a number from the I/O. Store it in memory location 50. Read-in another number from the I/O. Add the two numbers together. Store the result in memory location 60, and halt."

A "program" has been written to execute this task, and is stored in consecutive memory locations beginning at 100. This program, written in an artificial symbolic language, is shown in Table 1.

All computers spend about equal periods of time in one of two distinct states: "fetch", or "execute". In the fetch state, the computer reads from memory the next sequential instruction and places it in the instruction register (IR). In the execute state, that instruction is carried out as a series of transfers from one register to another and as various ALU operations. Table 2 examines the program shown in Table 1, as it is actually execu-

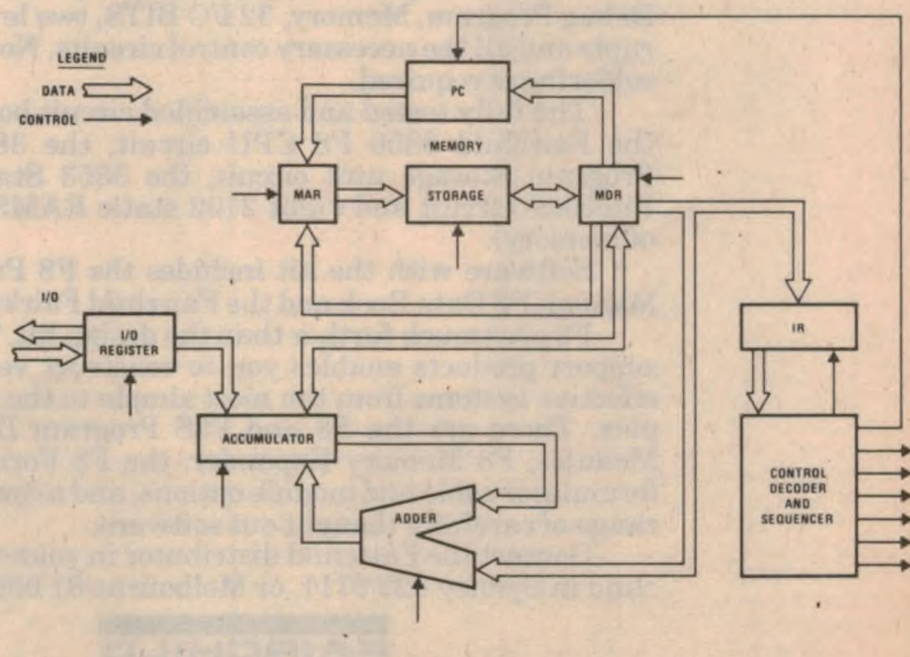


FIGURE 7. Simplified CPU and Memory

ted, by specifying the contents of each register at each machine cycle (time interval) and assuming the computer is now ready to fetch the first instruction in our program.

All computers (processors, CPU's, etc.) operate in a similar manner, regardless of their size or intended purpose, although many variations are possible within the basic architectural framework. Common variations include, for example, highly sophisticated I/O structures (some of which have direct and/or autonomous communications with memory), multiple accumulators for programming flexibility, index registers that allow a memory address to be modified by a computed value, multilevel interrupt capability, and on and on.

One of the most exciting architectural concepts to gain popularity in the past few years is that of microprogrammed control. A microprogrammed computer differs from the classical example in its control-unit implementation. The classical machine has for its control unit an assemblage of logic elements (gates, counters, flip-flops, etc.) interconnected to realize certain combinatorial and sequential Boolean logic equations. On the other hand, a microprogrammed machine uses the concept of a "computer within a computer". That is, the control unit has all the functional elements that comprise a classical computer, including read-only memory (ROM).

The "inner computer", which (generally) is not apparent to the user, executes the user's program instructions by executing a series of its own micro-instructions, thereby controlling data transfers and all functions from computed results. And this means that changing the stored microprogram that generates the control signals alters the entire complexion of the computer. By altering a few words stored in the ROM, the computer behaves in an entirely new fashion—it can execute a completely different set of instructions, simulate other computers, tailor itself to a specified application. It is this capability for "custom-tailoring" that allows a microprogrammed machine to be optimized for a given usage. By so extracting the utmost measure of efficiency, a microprogram-controlled machine is less costly and easier to adapt to any given situation, no matter how diverse or demanding.

It is possible to program a device that isn't a computer at all. An operational amplifier, for example, is a circuit that is basically a multiplier. Something is put in, something comes out; the op amp performs a linear function. But this building block can do something other than multiplication: a capacitor, for example, connected from the op amp's output to its input, creates a "programmed-by-wire" integrator.

As it is with the op amp, so it is with the microprocessor. A microprocessor is a super circuit—a black box with a transfer function that changes in accordance with a set of commands called a program. Inside the black box (i.e., on the chip) is a collection of building-block logic—an assemblage of many logic elements. You can in fact replace the microprocessor in any system with sets of random logic on PC boards, but you would have to change the logic boards on each clock pulse!

Thus, if you know what a flip-flop does you know what it does inside or outside a microprocessor; an AND gate AND's whether it's inside a microprocessor or on a lab bench. But in a microprocessor literally thousands of such logic elements are squeezed onto one or two chips. And this creates a problem: too much information, too few pins.

To overcome the pin problem, microprocessor manufacturers strap every logic element to every other logic element through a set of buses that allows mutual, element-to-element communications. Bus connections are made through a series of electronic switches; opening and closing the switches transfers the data through the microprocessor's maze to produce a control function. And it is software that sets the switches. System software is a set of tools, supplied by the microprocessor manufacturer, that allows you to construct application programs—programs that let the microprocessor do something.

To appreciate what software does for you, consider an elementary operation such as addition. Get A, get B, add them together and come out with C. Easy? In decimal notation, yes. But this trivial problem is not quite as simple when one speaks in binary. Dealing with long binary numbers is complex and difficult because one's and zero's aren't a natural language for Homo Sapiens. We have problems trying to figure out what's going on when we look at raw binary; writing it is even more troublesome.

Can you imagine looking down 14 sheets of printout, each with 65 lines of binary gibberish, attempting to determine what you did wrong? Yet this is ultimately how you program a job on a microprocessor. You have to write the story of how the processor is to wire itself from microsecond to microsecond. So all system software, the whole range of it that every manufacturer offers, is aimed at only one thing: to get you from the stated idea to the working program as painlessly and as rapidly as possible.

In the construction of application software, you first evolve a flowchart (Fig. 8A) that describes the functions to be performed and their order. (At this stage your thought processes and activities resemble those of the random-logic designer.) Once the chart is laid out, you start to code the program in either a high-level or a mnemonic-shorthand language that both you and your system under-

TABLE 2. Register Content

NOTES	PC	ACCUM.	MAR	MDR	I/O REG.	IR	MEMORY (R=READ) (W=WRITE)	STATE
	100	?	?	?	?	?	?	?
Start	100	?	100	(100)	?	(100)	R	Fetch
Input	100	6	100	(100)	6	(100)		Execute
	101	6	101	(101)	?	(101)	R	Fetch
Store	101	6	50	6	?	(101)	W	Execute
	102	6	102	(102)	?	(102)	R	Fetch
Input	102	2	102	(102)	2	(102)		Execute
	103	2	103	(103)	?	(103)	R	Fetch
	103	2	50	6	?	(103)	R	Fetch
Add	103	8	50	6	?	(103)		Execute
	104	8	104	(104)	?	(104)	R	Fetch
Store	104	8	60	8	?	(104)	W	Execute
	105	8	105	(105)	?	(105)	R	Fetch
Halt	105	8	105	(105)	?	(105)		Execute

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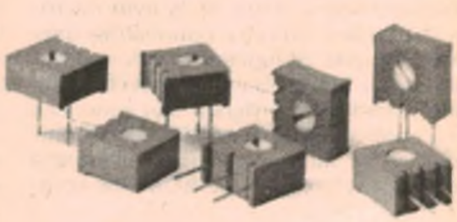

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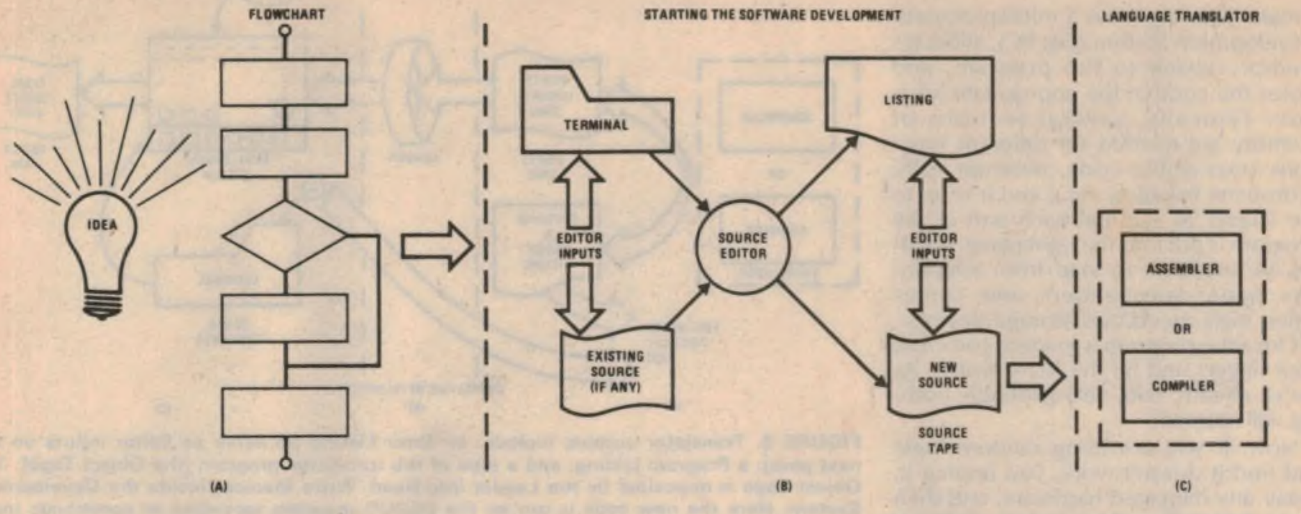

FIGURE 8. The programmer's ideas, expressed in a flowchart, are written out in mnemonic form to serve as Editor inputs. New inputs plus sections of existing programs are combined to form a new Source; this Source is the input to the language Translator.

stand. Here you encounter your first piece of software, the Text or Source Editor program (Fig. 8B).

Most microprocessor users write on continuous media (paper tape or cassettes), which do not allow you to get in and pull out one piece. Thus, corrections on a continuous source involve making a wholly new source—a constant problem and an awfully wasteful task. But there is a utility program called a Source Editor that lets you do the entire job with a teleprinter and a microprocessor Development System. If you make an error, just tell the Editor what changes to make and it's done! The Editor helps you "massage" the source code until it looks like it's going to work. Then, with the corrected (?) program in the Editor's memory cells, you push a button and a paper tape (or whatever) is put into your hands.

The "whatever" that has just been put into your hands has one minor, relatively insignificant, but fatal error—the microprocessor cannot understand a single bit or byte of it. But do not despair: an electronic Translator program (Fig. 8C) converts the continuous, source-mnemonic shorthand into something the microprocessor can understand.

The Translator (Fig. 9A) takes the source tape and generally gives back three outputs:

- The Program Listing—a copy of both the source and binary object codes;
- The Error Listing—a roster of all grammatical, label, and syntax errors; and,
- The Binary Object Code—a paper tape (or whatever) with the machine-readable binary translation of the program.

But there are two types of Translators—the Assembler and its exotic cousin, the Compiler—and there may be some argument as to which translation device is the more useful: Should you use an Assembler or a Compiler to translate the mnemonic sources? The difference is in the mnemonics.

If you happen to have run programs on minicomputers, then you've been exposed to the so-called "assembly language" mnemonics: LD means load; JMP means jump; ST means store; etc. It's the shortest language (outside of raw binary) used to talk with the processor. Programming with this shorthand is a bit tricky but an assembler-type Translator gives you a better feel for the machine and you can usually pare down the number of statements necessary to get the message across; and this saves time and money.

On the other hand, a compiler-type Translator lets you write in a high-level language that looks like English (Fortran, etc.). Its statements can easily be read by someone with no training at all. The Compiler translates these statements into a series of machine commands that carry out the desired function with the advantages of faster programming and a self-documenting program that you can read directly. But you often pay for this ease of use: since the Compiler deals with more general statements, it often translates in an inefficient way using more machine commands than really necessary at that level. Extra statements consume memory and result in slower program execution.

So, in retrospect, Compilers cut programming time and costs, but raise system costs. Assemblers do just the opposite. Which should you use? Compilers are most useful to those of you who constantly re-program your systems and make few versions of each program. Assembler users, on the other hand, will be those of you who will program the system once, then reproduce it a thousand or more times; programming costs are amortized over the production run and in memory savings.

At this point in the writing of a program many of you will wish that you could forget the whole thing, for there are programs with one hundred code lines that come out of the Translator with four hundred errors! But forge onward. Make another pass through the Source Editor (and another, and another...), to correct the errors that the Translator has spotted.

Eventually, you will get your reward, the sweetest line ever printed on a computer listing: "ASSEMBLY COMPLETE —NO ERRORS."

Actually, that statement simply means that the Assembler didn't find any errors. And you soon find out that this has almost nothing to do with whether or not the program will run on a machine. The reason is that the Assembler, although it helps you weed out logic errors from the program that you wrote, cannot tell you whether or not that program does exactly what you think it's going to do. In other words, there can be (and very probably will be) logic differences between your vision of what's needed to perform a function and that of the machine. Such an error may be one as simple as your forgetting to set a flag at some point; unimportant, perhaps, to your charting of a problem's solution, but all-important to the machine for without that bit of information your program cannot run. But other utility programs (such as DEBUG) are available to help you solve such problems.

Now that the Translator has provided you a binary tape with your program on it, you must somehow get the program into the machine's memory along with whatever other software routines your program needs for operation. The Loader program (Fig. 9B) does this for you;

it reads your tape into a microprocessor Development System (Fig. 9C), allocates memory space to the program, and stores the code in the appropriate location. Typically, several sections of memory are needed for different functions (executable code, interrupt calls, subroutine linkages, etc.), and it is up to the Loader to see that each part of the program is put into the right place. Loaders are available to load from teleprinters, paper-tape readers, and, sometimes, high-speed bulk storage devices.

Once the program is loaded, you cross your fingers and hit the RUN switch. As we've already said, very probably nothing will happen.

Now, if you are using random logic and find it doesn't work, you unplug it, repair any damaged hardware, and then try to determine what's wrong. With an oscilloscope on the gates and clocks, you try to see what's happening. But in the microprocessor only one set of logic exists, re-wiring itself at the speed of light. If you don't have any idea what's going on, the oscilloscope can't help you. What you need is a different type of fault-finding tool.

The tool is a program, called DEBUG, that lets you use a Teletype as a scope to help you find out what's happening. DEBUG is loaded into a Development System first, then your program is entered. You peck away at the TTY and say, "DEBUG, run my program from here to there, stop it, and tell me what is in memory". The TTY rattles and you've got the answer on a printout. "Show me what is in these accumulators." DEBUG does! "Show me this, show me that." Done, done.

As your program is stepped through, you'll encounter parts that don't work. These snags are cajoled and fondled individually until the whole thing runs—perfectly—and you have a working object code that represents your algorithm in ones and zeros.

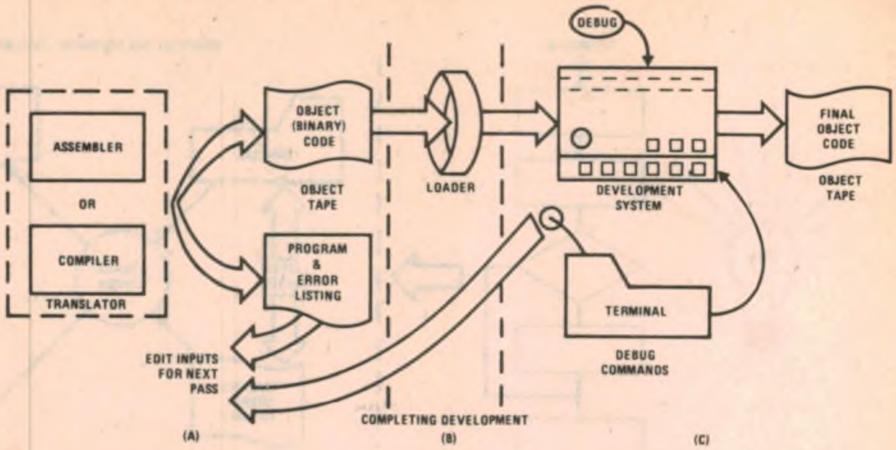

FIGURE 9. Translator outputs include: an Error Listing (to serve as Editor inputs on the next pass); a Program Listing; and a tape of the translated program (the Object Tape). The Object Tape is deposited by the Loader into Read/Write Memory inside the Development System. Here the new code is run by the DEBUG program according to commands input by you. The code can be modified via terminal inputs until it runs properly; working code is then dumped from memory. Note that although a workable object tape may exist at this time, your job is not complete until you edit and retranslate your source to produce code identical to the working code.

There is an alternative to the microprocessor debug section of a Development System. It is called a Simulator, and it typically runs on a large computer and includes both debug and simulation. To use it, load the binary code into the computer, call the Simulator, and then direct it to exercise the code to find the defects. However, this approach can only take you part of the way; it will not isolate timing problems that have to do with the outside world.

When the Simulator wants an input, it stops and asks for one. You sit there and peck away at the typewriter; which is fine if you want to test things that are slow. But if you wish to test a program that operates, say, a 100kHz I/O converter, you won't be able to keep up with it. So the Simulator can only take you so far. Ultimately you have to return to the hardware prototype approach, and this is why the microprocessor manufacturers have felt it necessary to produce sophisticated hardware prototyping tools.

We at National believe a Simulator really doesn't help. We encourage users to take the Development System itself, put in the actual interfaces to be used, and use DEBUG to massage the program in real-time and watch what it does.

(Reprinted from the National Semiconductor publication "Logic Designer's Guide to Program Equivalents to TTL Functions", Copyright 1976, by arrangement).

MICROPROCESSOR JARGON: the words you need to know

ACCUMULATOR: Specifically, a data storage device (register) for work in progress; part of the equipment in the arithmetic unit of a processor, in which arithmetical and logical operations are performed (the ALU).

ADDRESS: A number that designates a register, a memory location, or a device.

ADDRESS FIELD: That part of an instruction or word containing an address or operand.

ASSEMBLER: A program that translates symbolic language to machine language.

BINARY: Involving a choice or condition of two alternatives (yes/no; on/off); a number system using the base 2.

BIT: Binary digit.

BUFFER: An area of memory that is used as a work area or to store data for an input/output operation.

BUS: A circuit over which data or power is transmitted.

BYTE: A group of consecutive binary digits usually operated upon as a unit.

CARRY: A condition occurring during addition when the sum of two digits equals or exceeds the number base; or, the digit to be added to the next higher column as a result of the sum overflow.

CENTRAL PROCESSING UNIT (CPU): The portion of any computer that consists of the arithmetic unit, the control unit, and the storage unit.

CLOCK: A master timing device used to provide the basic sequence pulses for the operation of a synchronous computer.

COMPILER: A program that produces a machine-language program from a source-language program.

COMPLEMENT: In the binary number system there are two complements: the "ones complement," and the "twos complement". The ones complement is obtained by converting all ones to zeros, and all zeros to ones. The twos complement may be obtained by first converting a binary num-

Continued next page

Microprocessor jargon ctd. . . .

ber to its ones-complement and then adding one to the ones-complement. In binary logic, signals may be in one of two possible states: *true* or *false*, *high* or *low*, *on* or *off*. Thus, a signal is complemented by changing it from one state to the other state.

CONDITIONAL BRANCH: A branch that occurs only if a certain condition is present in the machine at the time the instruction is executed.

CONSOLE: The portion of the processor that may be used to control the machine manually, correct errors, determine the status of registers, counters, and storage, and manually revise the contents of storage.

CONTROL SECTION: The part of a processor that determines the interpretation and execution of instructions in their proper sequence, including the decoding of each instruction and the application of the proper signals to the registers, arithmetic and logic units in accordance with the decoded information.

DATA: A general term loosely used to denote any or all facts, numbers, letters, and symbols that can be processed or produced by a processor.

DEBUG: To isolate and remove malfunctions from a computer or mistakes from a program; also, a utilities program that helps correct application programs.

DIAGNOSTIC ROUTINE: A specific routine designed to locate either a malfunction in the processor or a mistake in coding.

EFFECTIVE ADDRESS: The addition of the contents of the base register and displacement plus, in some cases, the index register contents to form the address actually used in addressing main memory.

ENABLE: Restoration of a suppressed interrupt.

EXECUTE: To carry out an instruction or perform a routine.

FLAG: A bit used to indicate the status of an element.

FETCH: To retrieve a word of data from main memory.

FIRMWARE: Read-only memory (ROM), or the data or instructions stored in ROM.

HALT: A machine instruction that stops the execution of a program.

HEXADECIMAL: Related to a number system that uses the base 16.

HARDWARE: The physical equipment of the processor.

INDEX REGISTER: A register that modifies the operand address in an instruction or base address to yield a new effective address.

INITIALIZE: A program or hardware circuit that clears registers and sets counters and switches to their starting values.

INSTRUCTION:A user-coded macroinstruction that causes the microinstructions to perform certain operations.

INTERRUPT: A break in the normal flow of a system such that the flow can be resumed from that point at a later time. An interrupt is usually caused by a signal from an external source.

JUMP: An instruction or signal that, conditionally or unconditionally, specifies the location of the next instruction and directs the processor to that instruction.

LABEL: An ordered set of characters used to symbolically identify an instruction, an address, or a value.

LIST: An ordered set of items.

MACHINE LANGUAGE: The system of (binary) codes by which instructions and data are represented internally within a data processing system.

MACROINSTRUCTION: In general, any single instruction that causes a complete sequence of events to occur; a single instruction made up of a number of microinstructions that together perform a specific operation. A microinstruction is carried out in one microcycle.

MAIN MEMORY: Read/write memory that is external to the control ROM but is internal to the microprocessor.

MICROCYCLE: The basic machine cycle of the microprocessor.

MICROCODE: The steps or microinstructions of a microprogram, or the binary coded data contained in the microinstruction words of the control ROM.

MICROINSTRUCTION: See MACROINSTRUCTION.

MICROPROGRAM: A set of basic instructions (microinstructions) stored in read-only memory, programmable read-only memory, or read/write memory, and used by the control section of a processor to command registers, arithmetic and logic units.

MICROPROGRAMMING: Machine-language coding in which the coder builds his own machine instruction from the primitive basic instructions built into the hardware.

MNEMONICS: Operation codes written in easily-remembered symbolic code rather than the actual machine code.

OPERANDS: Any quantities entering or arising in an operation. An operand may be an argument, a result, a parameter, or an indication of the location of the next instruction.

OVERFLOW: The condition that arises, in a digital computer, when the result of an arithmetic operation exceeds the capacity of the storage space allotted.

PROGRAM: A group of related routines that solve a given problem.

PROGRAM COUNTER: A counter constructed in hardware that contains the address of the next instruction to be executed.

READ-ONLY MEMORY (ROM): A hardware (semiconductor) data storage device that may be programmed similar to read/write memory but that cannot be erased without destroying the device; the stored data may be read, but not changed.

READ/WRITE MEMORY: A hardware (semiconductor) data storage device in which the stored data may be read as well as changed; common usage refers to R/W memories as random-access memories (RAMs).

REAL-TIME: The performance of a computation during the actual time that the related physical process transpires.

REGISTER: A hardware device used to store a computer word, where the word is to be manipulated as either data or an instruction.

ROUTINE: A set of coded instructions arranged in proper sequence to direct the processor to perform a desired operation or series of operations.

SIGN BIT: The bit position in a computer used to designate the algebraic sign of the word.

SHIFT: To move an ordered set of bits one or more places to the right or left.

SOFTWARE: The totality of programs and routines used to extend the capabilities of computers (such as compilers, assemblers, routines, and subroutines).

SOURCE LANGUAGE: The high-level (often mnemonic) language in which you specify a program for the computer. It is translated (by Assembler or Compiler programs) to a machine-readable binary code.

STORAGE: Any device into which units of information can be copied.

SUBROUTINE: A series of computer instructions that performs a specific task for many other routines.

WORD: An ordered set of characters that occupies a single storage location and is treated by the computer circuits as a unit and transferred as such.

WRITE: To transfer information to a device.

W.H.K. MICROCOMPUTER SYSTEMS

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Our Software library consists of a few hundred different programs, including the following:—Math Programs, Engineering Programs, Data Reduction Programs, Plotting and Statistics Programs, Navigation-Course Calculation, Business Programs, Simulation Programs, Geometric Programs and various sport and games Programs e.g. Poker, Roulette, Blackjack, Bingo, Horse Racing, Math games, Monopoly, Bowling, Darts and various Picture Programs.

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Most items are available as kits and assembled units. You can start off in a small way and upgrade your system later. Our plug-in units make expansion quick and easy. Extra Software can also be purchased at any time.

For more details see W.H.K. Catalogue No. 7.

MODEL SR4148R PORTABLE

A 48 KEY, 14 DIGIT RECHARGEABLE SCIENTIFIC NOTATION ELECTRONIC CALCULATOR

$52.50

Sales Tax exempt

14 Digit Display

Dimensions

1¼" H × 3" W × 5¾" L

−123456.7891 −99

The display capacity of this machine is able to show values ranging from 1.0×10^{-99} up to $9.999999999 \times 10^{99}$ This represents a precision capability which exceeds those known to most of the physical constants in the universe There simply is no limit to the value of the angles you can enter for trigonometric functions.

EE The exponent key lets you make an entry in the exponent field of display.

Logic

The logic of the SR4148R has been designed for practical, easy entry. The system is algebraic so that computations are indexed into the machine just as you would write them onto paper.

Outstanding and Exclusive Features

For students, numerous fundamental math principles have been programmed into the logic of the machine. Among these tenets are:

—Any number raised to the zero power equals one

—Zero raised to any power equals zero

—All results are precise for immediate comprehension

EE↑ EE↓ For professionals, such exclusives as the exponent integer increase and decrease keys **EE↑** **EE↓** greatly facilitate complex calculations. Engineers, for example, commonly work with familiar values as 10^{-6} for microseconds. If, after a computation an exponent reads: 10^{-4} and the operator wishes to express this in microseconds, merely pressing the **EE↓** key permits him to step down the exponent accordingly

Performance Categories

Memories Two independent storage registers:

STO 1 **RCL 1**
STO 2 **RCL 2**

Σ1 Sigma or automatic memory summation key.

Special Keys

d/r Degree/Radian Mode Key

( ) Parenthesis Keys

→P Converts Rectangular Coordinates to Polar

→R Converts Polar Coordinates to Rectangular

Power Supply: Lifetime Ni-Cad Batteries & Adaptor/Recharger included.

Log Keys

e^x Calculates natural antilogarithm of x

log Calculates common logarithm of x

Ln Calculates natural logarithm of x

10^x Calculates common antilogarithm of x

Statistical Keys

xn The distribution key is pressed after each numeric entry in a mean/standard deviation example

x̄→σ To find the average distribution x̄ press the statistical key. Finally, to see the standard deviation σ press the exchange register key

Trigonometric Keys

arc used when determining inverse trig calculations

sin Calculates the sine of x

cos Calculates the cosine of x

tan Calculates the tangent of x

Power Keys

y^x Raises the base y to the x power

x^2 Squares x

√x Obtains the square root of x

$\sqrt[x]{y}$ Determines the x root of y

π Pi is an automatic constant which is recalled when this key is pressed

Standard Keys

x↔y Exchange register key

+/− Sign change key

1/x Inverse or reciprocal key

CE/C Clear Entry and Clear all

× **−** **+** **÷** **·** **=** ... And last but not least the standard four function and arithmetic keys

TV Games

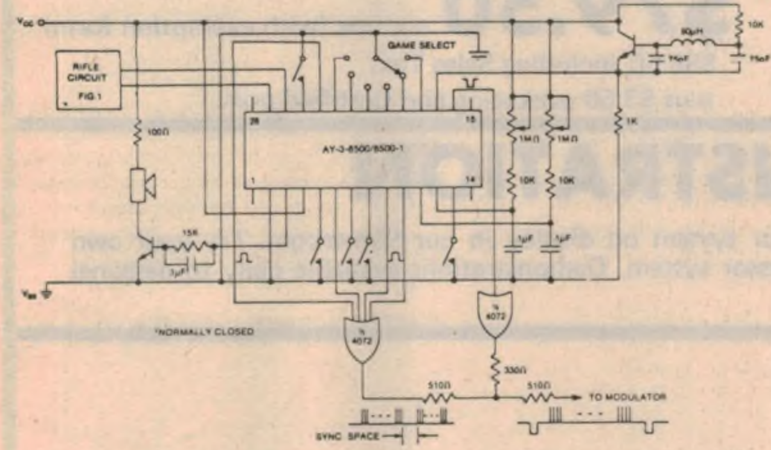
Fig.2 TENNIS GAME — Fig.3 HOCKEY GAME — Fig.3a RETURN OF 'GOAL SAVE'

Fig.3b 'SHOOTING' FORWARD — Fig.4 SQUASH — Fig.5 RIFLE SHOOT

FEATURES: *6 Selectable Games—Tennis, hockey/Soccer, squash, pelota and two rifle shooting games. *625 line. *Automatic Scoring. *Score display on T.V. Screen, 0 to 15. *Selectable Bat Size. *Selectable Angles. *Selectable Ball Speed. *Automatic or Manual Ball Service. *Realism Sounds. *Shooting Forwards in Hockey Game. *Visually defined area for all Ball Games.

DESCRIPTION: The AY-3-8500 circuit has been designed to provide a TV 'games' function which gives active entertainment using a standard domestic television receiver. The circuit is intended to be battery powered and a minimum number of external components are required to complete the system. A block diagram is shown below.

SYSTEM BLOCK DIAGRAM



Stock No	Part No	Price
72-308500	AY-3-8500 TV Games IC with Circuit & PC Board Layout	$28.00
72-318500	PC Board with Socket and RF Modulator Section	5.74
72-408500	Complete Kit with Rifle Shooting provision (no Rifle)	66.30
72-508500	Complete United assembled and tested with Socket for Rifle (Rifle to suit is available at a later date)	76.50

Discount: 1-4 units or IC's nett, 5-9 less 5%, 10-24 less 10% 25-99 less 15%. Prepaid orders received before August 28, 1976 an additional 10% discount is offered. Post and pack per Order $2.00

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- Digital Voltmeter IC's & Kits
- D to A & A to D Converter IC's
- Photoswitch with variable sensitivity
- 6-Decade Counter/Display Decoder IC
- Batch Counter IC
- Precision Timer IC, times from seconds to weeks
- Touch Control IC's
- Speed Controller IC
- Opto-Electronic Analogue LED Driver IC's
- Electronic Organ IC's
- Infrared Remote Control System IC's
- Magnetically Controlled Switches (IC)
- Laser Tube
- 1" Colour Vidicon
- Electronic Attenuator (0-90 dB)
- Frequency & Time Standard
- Programmable MOS Counter Time-Base IC
- Push-Button Switches
- Multi-Purpose Regulator IC with Current & Voltage adjustment
- Fixed and adjustable Dual-Tracking voltage Regulator
- 7-Decade Counter/Decoder/Driver IC
- Peltier Effect Devices
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- 1" 4-digit LED Clock Displays
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- 8-digit Stopwatch IC
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- Breadboards & Bus Strips (ideal for experimenting with IC's)
- Panel Meters
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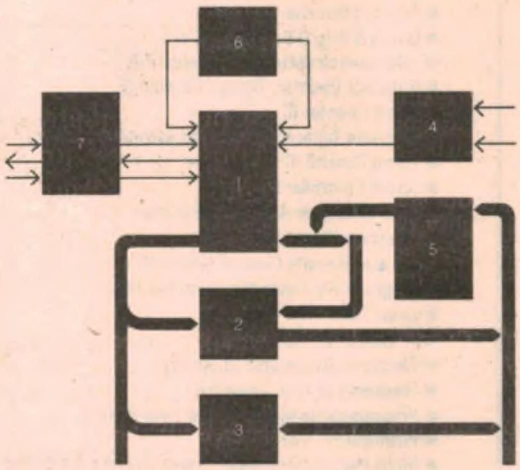
MICROPROCESSOR COMPONENTS



The "Scamp" Microprocessor System

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2. Read Write Memory
3. Kitbug Firmware (ROM)
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6. Timing Crystal
7. Teletype Interface

SC/MP 8 BIT LOW COST MICROPROCESSOR KIT

Much more than a bag of parts – the SC/MP kit includes all integrated circuits, firmware and discrete components required to build a completely functional microprocessor system. Once you have assembled the kit and applied power you are ready to explore the capabilities of the SC/MP microprocessor. The kit is supplied with a pre-programmed PROM so that you can enter your own program using a Teletype or similar ASC11 machine. The kit comes with programming manuals and full documentation.

$79.50 tax free (with exemption form)
$89.50 including Sales Tax.
plus $3.50 packaging and Certified post.

PACER DEMONSTRATION

We have available a PACER microprocessor system on display in our Showroom. Try your own programs on this easiest to use microprocessor system. Demonstrations available daily to personal callers. (phone for an appointment).

BITS

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7489	16 x 4	TTL STATIC	$ 3.50
74C89	16 x 4	CMOS STATIC	$12.75
2101	256 x 4	MOS STATIC	$ 6.95
2102	1024 x 1	MOS STATIC	$ 3.25
2112	256 x 4	MOS STATIC	$ 6.95
PROMS.			
82S23	32 x 8	FIELD PROGRAMMABLE	$ 5.75
82S123	32 x 8	FIELD PROGRAMMABLE (TRISTATE)	$ 5.75
1702A	256 x 8	ELECTRICALLY PROGRAMMABLE U.V. ERASIBLE ROM	$19.75
5203	512 x 4	ELECTRICALLY PROGRAMMABLE U.V. ERASIBLE ROM	$20.50
ROMS.			
2513		CHARACTER GENERATOR	$15.75
MM5240AA		CHARACTER GENERATOR	$17.50
UARTS.			
S1883		10K BAUD UART	$ 9.50
MM5303		30K BAUD UART	$ 9.50

Free data and application notes supplied with all the above devices.

Microprocessor compatible 13-bit CMOS A/D converter

Up until now, analog-to-digital (A/D) converters have been rather awkward to work with, requiring precision resistor networks and other complex interfacing circuitry. The Analog Devices AD7550 13-bit A/D converter should therefore be of interest to microprocessor users. It contains virtually all the required circuitry on a single IC chip, requires no precision resistor networks, and is directly compatible with microprocessors.

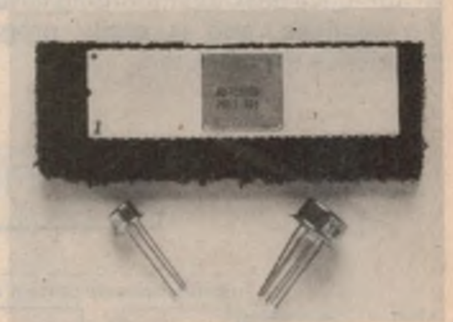


Fig. 1: The AD7550 A/D converter together with the AD580 voltage reference and the AD301AL operational amplifier.

The AD7550 is a 13-bit (2's complement) monolithic CMOS A/D converter packaged in a 40-pin ceramic dual-in-line package (DIP). The new device is claimed to have outstanding accuracy and stability (1ppm/°C) due to its revolutionary integrating technique, called "Quad Slope". This conversion consists of four slopes of integration, as opposed to the traditional dual slope, and provides much higher precision.

For most applications, the AD7550 needs only three resistors, one capacitor, and a reference voltage. The integrating amplifier, comparator, switches and digital logic are all contained on the CMOS chip. Fig. 1 is a photograph of the chip.

The voltage reference circuitry for the AD7550 is shown in Fig. 2. An Analog Devices' AD580 voltage reference is used in conjunction with an AD301AL op amp to supply the required voltage reference, which is adjustable by means of a 500 ohm pot.

The thirteen parallel output data lines (DB0, DB1 ... DB12) of the AD7550 have three-state logic and are made compatible with an 8-bit microprocessor through the use of two enable lines (Fig. 2). The low byte enable (LBEN) is used to control the eight least significant bits (LSBs) while the high byte enable (HBEN) controls the five most significant bits (MSBs).

Reference to Fig. 2 will show how this is achieved in practice. Lines DB8-DB12 are strapped to lines DB0-DB7 as shown (dotted).

What happens is this: first a control pulse is applied from the microprocessor to the START pin to initiate the conversion operation. This causes the BUSY and $\overline{BUSY}$ outputs to go high and low respectively. These latter revert to their previous states at the end of the conversion operation, and signal the end of the process to the microprocessor. (Note that actual conversion does not commence until the end of the START pulse.)

Once the cycle has been completed, the microprocessor applies an enable signal to LBEN so that data from the 8 LSBs can be read in and stored in memory. The LBEN signal is then removed and HBEN enabled, allowing the 5 MSBs to be read in.

(Continued on p 125)

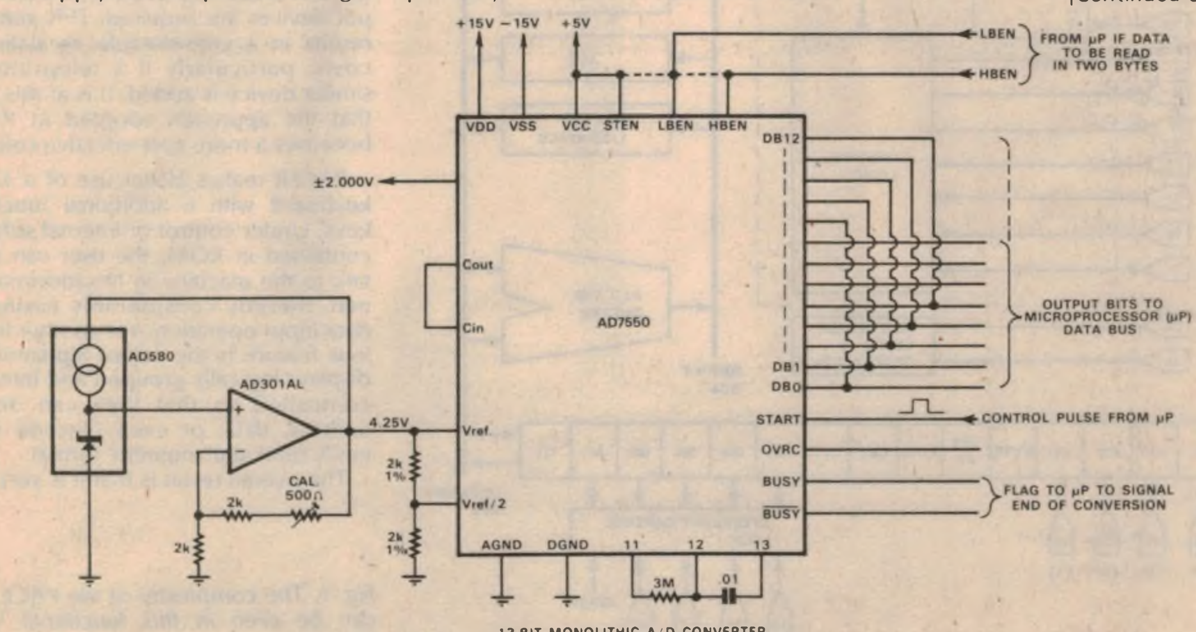
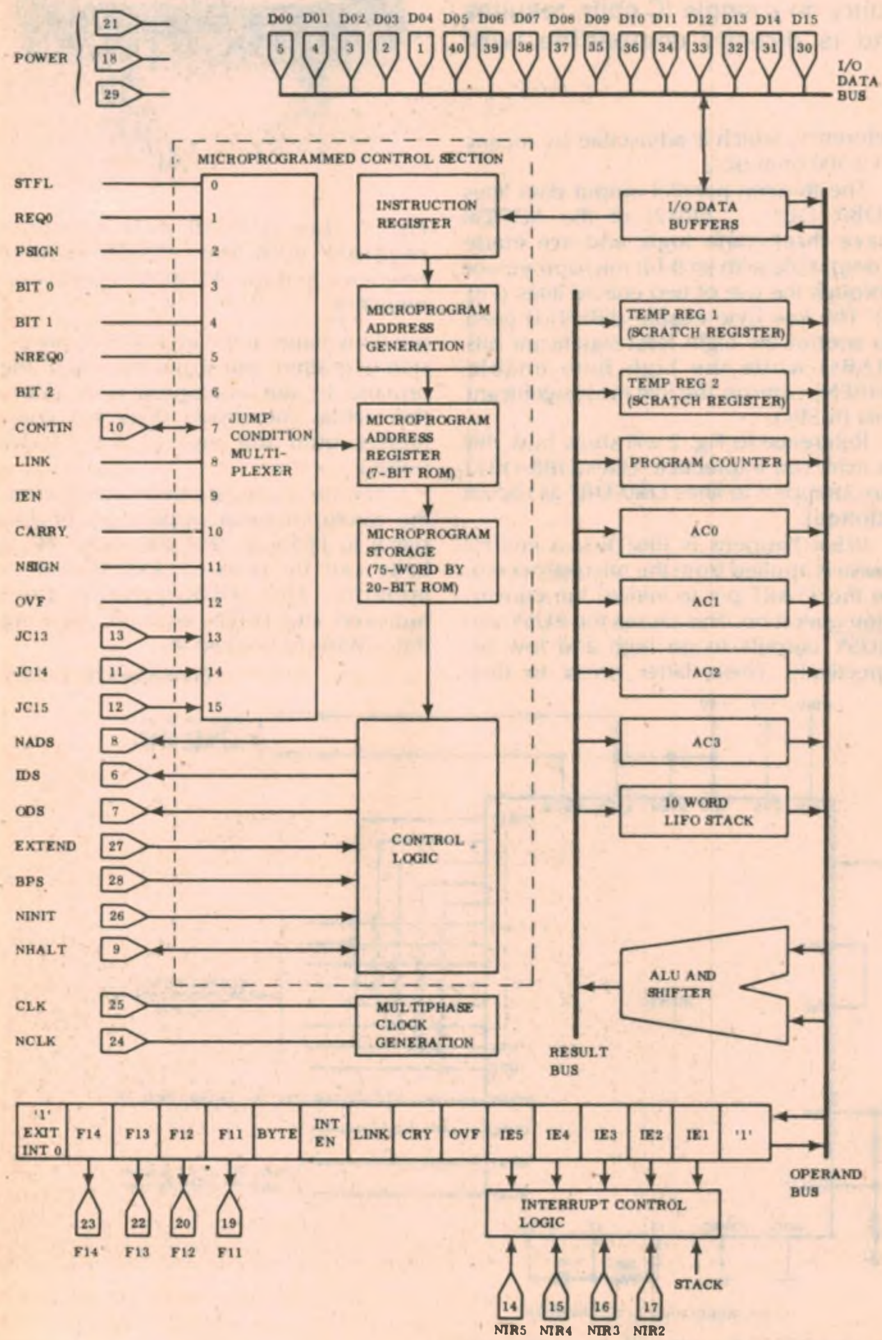


Fig. 2: Typical circuit configuration of AD7550 for use with microprocessors.

National Semiconductor's

PACER is a complete microcomputer system designed around the National Semiconductor PACE 16-bit microprocessor chip. Housed in an attractive desk top mounting case, PACER features inbuilt input/output facilities, and is easily programmed by anyone with a little experience in computers.



In the fast developing world of microprocessors the manufacturers of the actual microprocessor semiconductors soon realised that they had to be marketed in a different way to that for simple logic functions such as TTL or CMOS. One approach adopted (among many) was for the microprocessor manufacturer to develop a small general purpose printed circuit board containing the actual microprocessor and the necessary support hardware/software. The idea was that the prospective user could easily develop a simple system using the microprocessor card, by just adding the required power supplies and input/output devices.

These boards, with the addition of power supplies, memory facilities and a control panel can be used as minicomputers in their own right, with the control panel LEDs being used as output devices, and the control panel switches as input devices.

As a sole source of input/output this "bit by bit" approach soon becomes quite tedious and additional input/output devices are required. This generally results in a considerable escalation of costs, particularly if a teleprinter or similar device is added. It is at this point that the approach adopted in PACER becomes a more cost effective solution.

PACER makes clever use of a 32 key keyboard with 6 additional functional keys. Under control of internal software contained in ROM, the user can easily talk to the machine in hexadecimal format, thereby considerably easing the data input operation. Yet another ingenious feature is the use of alphanumeric displays logically grouped and internally controlled so that they can display address, data, or even function in an easily read alphanumeric format.

The overall result is that it is very easy

Fig. 1. The complexity of the PACE chip can be seen in this functional block diagram.

PACER

by OWEN J. HILL, BE
*Managing Director, Applied Technology Pty Ltd

to "talk" to PACER, because the operator/machine interface is greatly improved without the need for other expensive input/output devices. Consequently, as the manufacturers claim, PACER is one of the easiest microprocessor systems to understand and use available on the market today.

Before proceeding with a more detailed examination of the PACER system, we should first look at the "heart" of the unit: the PACE microprocessor chip itself.

This chip was developed and is manufactured by National Semiconductor in the USA. It contains on one semiconductor chip all the necessary buffers, registers, control logic, memory facilities, arithmetic unit and data buses to form a 16 bit processor unit. The PACE MOS/LSI chip is produced using silicon gate P-channel enhancement mode standard process technology, which the manufacturers claim offers many advantages over other technologies. Some idea of the complexity of this device may be gained from Fig. 1.

Some outstanding features of the PACE chip are:

- 16 bit instruction word offering addressing flexibility and speed.
- 8 or 16 bit data word interfaces to increase the applications flexibility.
- 45 instruction types for efficient programming.
- Common memory and peripheral addressing.
- Four general purpose accumulators to reduce memory data transfers.
- 10 word push down/pull up stack for interrupt processing and word storage.
- Six vectored priority-interrupt levels to speed the interrupt service and simplify hardware.
- Programmer—accessible status register.

PACER is a complete system using PACE, packaged ready to use. Provision has been allowed for memory expansion, as well as a number of peripheral interface options, such as teleprinters and cassette drives. It is available in kit form, partially assembled or fully assembled and tested.

We have only seen the completely assembled and tested version, and therefore cannot comment on the kit versions. The sample was supplied with an instruction manual and a set of circuit and assembly drawings.

The accompanying pictures give a good idea of the internal construction employed in PACER. A "mother" board is used to make interconnections between a number of plug-in printed circuit boards, and also to supply unregulated power to the boards, which have their own regulators. The keyboard and display assemblies connect to the mother board via a length of flat ribbon cable.

A large transformer is mounted on the mother board, along with its associated rectifiers and filter capacitors. A cooling fan is fitted to the rear of the unit. This appears to be large enough to cope with the full complement of boards which it is possible to use with the mother board, when the PACER is expanded from its basic form as supplied.

The basic unit is equipped with three plug-in printed circuit boards. These are—

1. CPU board containing PACE microprocessor with support chips and input/output buffers.
2. Control board containing the Control

This is the PACER control panel. Hexadecimal numbers are entered via the lower 16 keys, while the upper 16 are used for control. The alphanumeric displays are at the top.

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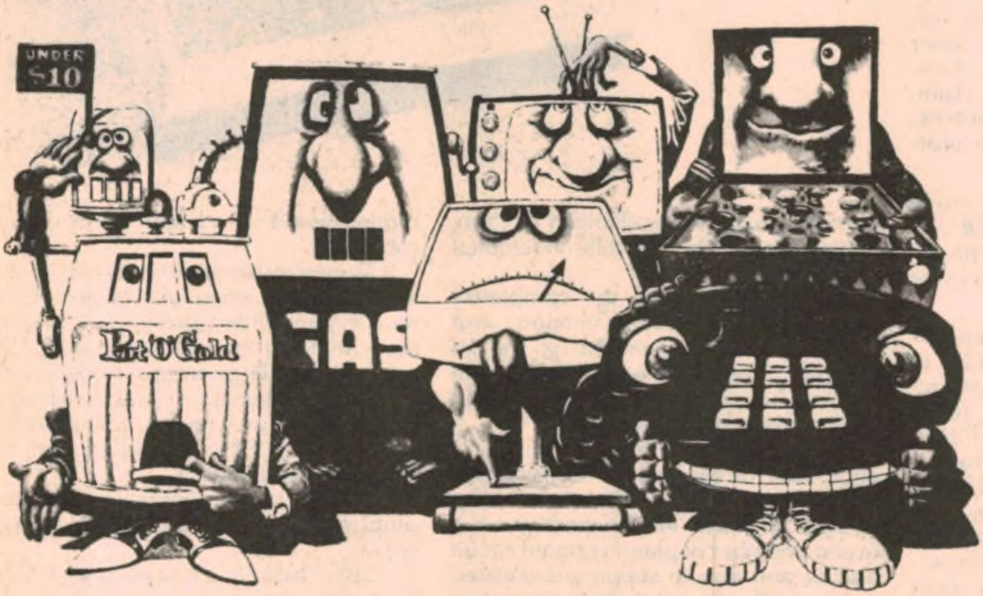
The "Simple Cheap Microprocessor."

At less than ten bucks apiece in volume, it makes microprocessor technology practical where it's never made sense before. In products like meters,



gas pumps, traffic-light controls, pinball machines, medical electronics, TV games, scales, motor controls, telephones, home appliances.

A whole world of machines and men has been waiting for such a thing.

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And it's not just the cheapest, least-complicated microprocessor on the market. It's also one of the most capable.

It shortens design time because of its architecture, and its ability to interface with standard memories and standard peripheral components.

It requires a minimum number of components and support chips.

Yet it gives you advantages that can't be found in many expensive microprocessors. Like an on-chip clock. Serial I/O ports that are TTL-compatible. Static operation. Bus allocation for multiprocessor system design. Plus built-in, programmable DELAY instruction.

It's on your distributor's shelf right now. For technical description of the chip and a complete data sheet, send us the coupon below.

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program in 1k x 16 ROM with 256 x 16 control RAM.
3. A RAM/PROM board which contains 256 x 16 RAM (expandable to 1k x 16) and space for 1k x 16 PROM.

As we have already mentioned, the major benefit of PACER lies in its built in input/output facilities. This means that PACER is an ideal instructional tool and should have great appeal to educational institutions, because it can readily demonstrate computer basics, programming and mathematical manipulations.

The PACER system can readily be expanded using optional modules to interface with teleprinters, cassettes and other keyboards. The memory can also be expanded with additional RAM, or even a disc file.

In use, PACER is very powerful, yet at the same time quite limited. Essentially it operates in two modes, "debug" and "run". In the debug mode, the control program stored in ROM accepts data from the keyboard as an input, and uses the display as an output. This program is used to interface with the memory, so that user programs can be easily entered, modified and executed.

The contents of any computer register or memory location can be readily recalled and examined or modified as necessary. It is only a single keystroke operation to examine/modify the current location and repeat this process for the next sequential or even previous sequential location.

A word scan facility can be used to scan through the computer registers or memory until a location is found having a particular content. The keyboard and display can be used as a hexadecimal calculator, with entries in either decimal or hexadecimal, or from the current address. This makes the calculation of jump instruction displacements very simple.

Up to 10 breakpoints may be inserted in a user program, to return control to the debug program. Altermatively, the user program can be interrupted at any time, and the current address displayed. These facilities greatly simplify program corrections.

In the run mode, a user program is executed, starting at a particular location. A green LED indicates that a program is running. If desired, the program can be advanced one step at a time, with control returned to the debug program after each step.

An intitial attempt at writing and using a small program, however, soon pointed up a few omissions from the PACER literature, as well as a major limitation of the machine itself.

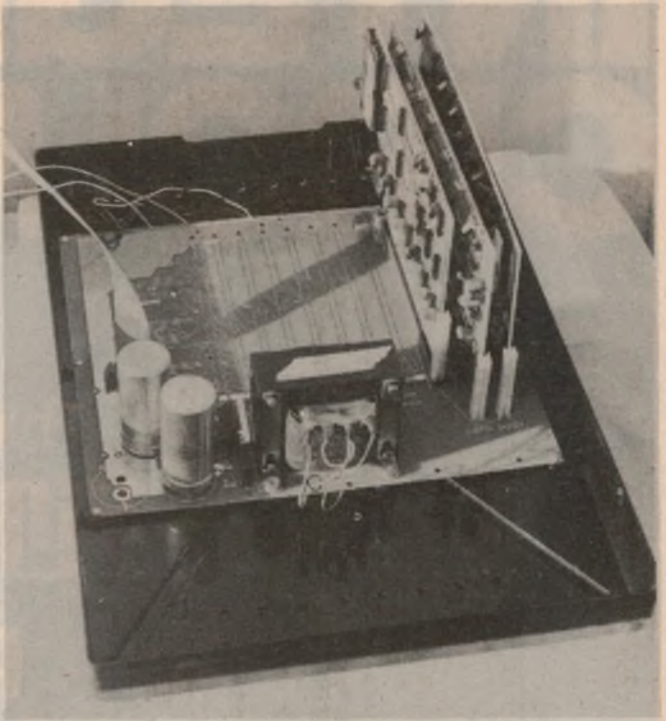
While a reasonable explanation of the way in which the debug program operates is given, the only guide to programming is a very sparse list of the PACE instruction set. There is only one very small, and very simple user program supplied.

The remainder of the instruction manual is concerned with interfacing to peripheral devices. This is of little use with the basic PACER system, which has no peripheral interfacing. The section on hexadecimal notation would be quite helpful for those unfamiliar with this notation, but more material on basic programming would be very worthwhile.

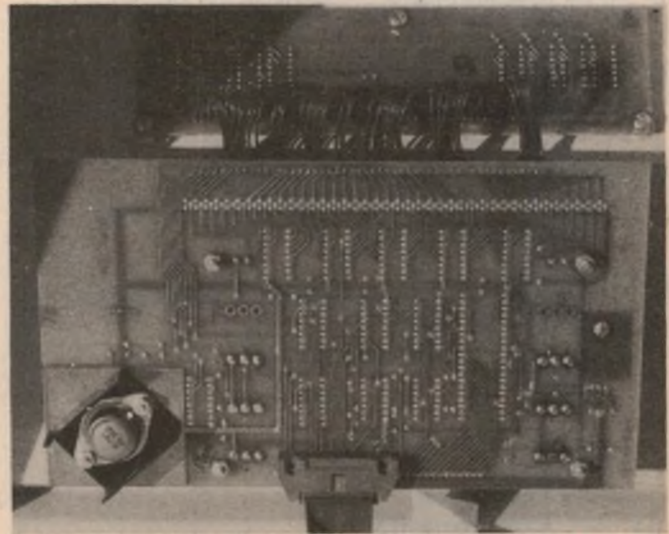
The major limitation of PACER as supplied, however, is that a user program cannot easily gain access to the keyboard and display for use as makeshift peripherals. A user trap has been incorporated in the debug program to prevent this, and the instruction manual does not tell how this can be circumvented.

A second limitation is that no listing is provided of the debug program itself, so that it is virtually impossible to use any of the routines existing in it. This means that even though we did manage to gain access to the keyboard and display, we had to write our own servicing routines.

Access to the keyboard and display is, in fact, obtained by altering a connection on the CPU board. Pin 8 of IC "B5" (a 7402 TTL NOR gate) must be isolated from the track which connects to it, and connected directly to the adjacent earth



The internal construction of PACER can be clearly seen in this photograph. The mother board at the bottom is used to interconnect the remaining boards, and to supply them with unregulated power. Note the expansion capability.



The upper board holds the alphanumeric displays, while the lower one holds the keyboard and associated components. The ribbon cable connects to the mother board.

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track (connected to pin 7). Both these tracks are on the top of the board, adjacent to pin 8. This alteration in no way modifies the normal operation of the machine.

Once this modification is done, access to the keyboard may be obtained via memory location DFE3. Data from the keyboard is placed in this location by the hardware and debug software. Similarly, data stored in location DFE5 is accepted by the hardware and debug software and transferred to the display. Both these locations must be addressed indirectly. We understand that National Semiconductor will in future be supplying listings of the routines and codes necessary to use the display and keyboard, as well as a listing of the debug program.

As a guide to beginners, David Edwards of Electronics Australia staff has written a small program which uses the keyboard as an input device, and the display as output. This program, which is by no means optimised as far as speed, simplicity and use of memory space is concerned, does give an indication of how PACER can be programmed.

Fig. 2 is a listing of the program, as it would be printed out by a teleprinter under computer control. Locations 0000 to 0020 contain the program, while locations 0060 to 007F are used for storage of constants, and also a small subroutine.

Note that the LOCATION and CODE columns are all that need to be fed into PACER, the MNEMONIC and COMMENTS columns are intended only to aid the programmer in understanding the operation and use of the program.

The program starts at location 0000, and will operate continuously, provided the INIT and RESTART keys are not depressed. These will halt the program, which must then be restarted.

Readers will notice that we have not explained just what the program does! This can be deduced by studying the program. Alternatively, PACER is on display at Applied Technology Pty Ltd at 109-11 Hunter St, Hornsby, NSW, and interested readers may see the program in operation there.

Although this program may seem to have somewhat little value, it is easy to see how variations can be developed so that you can play various games against the computer. In fact, with some more memory added to the basic system it is quite easy to program PACER to become a fully operational four function calculator. This readily demonstrates the long term purpose of microprocessors, i.e., using just software it is possible to program a basic general purpose module to carry out the same function as dedicated, hardwired systems in use today.

```
PACER DEMONSTRATION PROGRAM. BY DAVID EDWARDS. 21/6/76

LOCATION  CODE      MNEMONIC  COMMENTS
------------------------------------------------------------------------
0000      A07F      LD@       LOAD A0 WITH (007F)
0001      4B01      BOC       TEST CHARACTER
0002      1800      JMP       JUMP BACK TO START
0003      51EC      LI        LOAD A1 WITH FFEC (-20 DEC)
0004      526A      LI        LOAD A2 WITH FIRST LOC OF MESSAGE
0005      C200      LD        LOAD A0 WITH (A2)
0006      5F00      RCPY      COPY A0 INTO A3
0007      2C10      SHR       SHIFT A0 RIGHT BY 8, LOAD WITH 0'S
0008      6300      PUSH      STORES (A3) IN STACK
0009      CC69      LD        LOAD A3 WITH (0069)
000A      68C0      RAD       ADD A3 AND A0, RESULT TO A0
000B      B07E      ST@       STORE A0 TO DFE5
000C      1464      JSR       JUMP TO DELAY
000D      6400      PULL      RETRIEVE (A3) FROM STACK
000E      B07E      ST@       STORE A0 TO DFE5
000F      1464      JSR       JUMP TO DELAY
0010      C063      LD        LOAD A0 WITH (0063)
0011      F062      SKNE      COMPARE A0 WITH (0062),SKIP IF NOT =
0012      1814      JMP       JUMP TO 0014
0013      D069      ST        STORE A0 TO 0069
0014      7A01      AISZ      INC A2 BY 1
0015      7901      AISZ      INC A1 BY 1
0016      1805      JMP       JUMP TO 0005
0017      C062      LD        LOAD A0 WITH (0062)
0018      D069      ST        STORE A0 TO 0069
0019      C060      LD        LOAD A0 WITH (0060)
001A      7801      AISZ      ADD 1 TO A0, SKIP IF ZERO
001B      1821      JMP       JUMP TO 0021
001C      C061      LD        LOAD A0 WITH (0061)
001D      D060      ST        STORE A0 TO 0060
001E      5000      LI        CLEAR A0
001F      B07E      ST@       STORE A0 TO DFE5
0020      1800      JMP       JUMP BACK TO START
0021      D060      ST        STORE A0 TO (0060)
0022      1803      JMP       JUMP TO 0003


0060      FF80                DISPLAY TIME COUNTER
0061      FF80                DISPLAY TIME
0062      8000                TRIGGER NO 2
0063      0000                TRIGGER NO 1
0064      C068      LD        START DELAY: LOAD A0 WITH (0068)
0065      7801      AISZ      ADD 1 TO A0, SKIP IF ZERO
0066      1865      JMP       JUMP TO 0065
0067      8000      RTS       END DELAY: RETURN FROM SUBROUTINE
0068      FFF0                DELAY LENGTH
0069      8000                TRIGGER
006A      0000                MESSAGE
006B      0000                   "
006C      003E                   "
006D      4149                   "
006E      492E                   "
006F      3E41                   "
0070      4141                   "
0071      3E00                   "
0072      0000                   "
0073      0000                   "
0074      3F48                   "
0075      4848                   "
0076      3FFF                   "
0077      0204                   "
0078      027F                   "
0079      3F48                   "
007A      4848                   "
007B      3F70                   "
007C      080F                   "
007D      0870                   "
007E      DFE5                DISPLAY ADDRESS
007F      DFE3                KEYBOARD ADDRESS

GENERAL COMMENTS: START AT LOCATION 0000, PROGRAM RUNS CONTINUOUSLY.
                  DO NOT TOUCH RESTART AND INIT KEYS.
```

This program uses the keyboard as an input device, and the display as an output device. Can you deduce what it does?

The Serviceman

Colour servicing—a report

How is the average serviceman coping with colour? Has it proved to be as terrifying in practice as we were lead to believe? How much test equipment is really necessary to cope with the run-of-the-mill faults as normally encountered? While there can be no pat answers to these questions, this month's notes are based on the comments of a typical serviceman with a very profitable sales and service business.

For various reasons the turnover of colour sets in my own workshop has been quite small so far. So, to help keep my readers up to date, I asked a colleague who is currently in the thick of the colour scene, to make some brief notes on his day-to-day activities, pick out a selection of typical faults, and perhaps add some comments about the general scene. Here are his thoughts.

I have been repairing colour sets since C-Day and, like most others I have spoken to, have found them easier to repair than I first expected. In the beginning we were lead to believe that colour would create a serviceman's nightmare, but so far I have found colour faults to be little more difficult than those in monochrome sets.

I also have doubts about the need for a lot of expensive test equipment for colour servicing—at least at the present time. With most sets using modular construction—either exchange or throw-away modules—most of the intricate fault finding has been taken care of. In fact, I have been able to diagnose all my colour faults so far with a good multimeter, a standard VTVM, and a good pattern generator.

The pattern generator is a must for colour servicing, particularly for checking purity and convergence. A good dual trace CRO might be desirable but, at this stage, I feel it is not essential. I have used mine on only a couple of jobs, and then only to confirm what I already suspected.

A degaussing coil or wand is essential, as is an EHT probe to suit the particular VTVM employed. A white point reference tube might be desirable for those who are unsure of their grey scale settings, but could hardly be classified as essential.

In short, a good pattern generator, added to what most servicemen already have, should go most of the way towards equipping a workshop for colour.

I am keen on the idea of servicing only one or two brands of colour sets. I am doing this and I find it enables me to carry out repairs more efficiently and also reduces the stock of spares I have to carry.

Now let's look at some typical colour faults I have encountered recently.

A Philips K9A. No picture or sound. I measured the main HT, and found it to be about 20 volts instead of the normal 155. In the light of experience with solid state monochrome sets, I took a punt on the line output transistors, and sure enough, one was shorted between collector and emitter. To be on the safe side, I replaced both transistors, and checked the small choke in the base return lead. This choke sometimes becomes intermittently open and will destroy the output transistors. After re-soldering the choke leads as a precaution, I replaced it in the printed board. A slight convergence adjustment completed the repair.

An HMV Decca 33 series. Sound with raster but no picture. The sound and raster narrowed the field considerably, eliminating the sound channel, deflection circuits and possibly the luminence output and chroma stages. I fed video IF signal into the video IF section from the pattern generator and found the fault still in evidence, thus eliminating the tuner.

I could get a grey scale pattern on the screen, but this was too weak to produce colour bars. The same effect was present on the base of the first IF transistor, but when signal was fed to the collector, there was plenty of signal with locked-in colour. Well, we were getting somewhere. I measured voltages on the transistor and found the base and emitter voltages to be almost nil, while the collector voltage was normal. I replaced the transistor and the job was done.

A Rank Arena 14in portable. Picture but no sound. After removing the rear cover I noticed that the speaker lugs were reasonably accessible. I placed the multimeter leads across the lugs, having switched to the ohms range. Sure enough there was no click—at last I had beaten Murphy! Replacing the speaker restored the sound.

A Philips K9A. Pale colours—no red. My first suspect was the luminance-chrominance module, so I replaced it and the trouble disappeared. However, to be sure, I re-fitted the original module and again the set worked perfectly. I noticed that the fault would return if the module was moved. I removed it and found that the contacts were sticky. After cleaning them with "Servicemans Friend" and spraying some into the module socket, no amount of coaxing could make the fault re-appear. I phoned the customer about a fortnight later to check, and he advised everything still OK.

Pye T29. Colour intermittent or, quite often, no colour. As the owner had a poor antenna system I tried another set to determine if the antenna was at fault. The test set gave a locked-in colour, but did not give a very good picture. Back at the workshop, the customer's set gave locked in colour on a good antenna, but it was necessary to turn the colour saturation control full on to get an acceptable colour picture. I adjusted the ACC (automatic chroma control) a fraction, and this brought the set back to normal. A better antenna at the customer's home, and reception was really good.

A Philips K9A. Blue and yellow borders on both mono and colour pictures. A quick check of the convergence controls revealed that the blue sawtooth amplitude control was not working. A multimeter check showed that the 22 ohm resistor in series with this control was O/C. Fitting a new resistor restored the set to normal.

The resistor involved is a 2 watt wire wound type and should not be replaced with a carbon type. It is most important when replacing components in a convergence board to use the manufacturer's recommended replacements. If lower quality parts—particularly resistors—are used for replacements, you will strike trouble with drifting convergence as these parts age and change value. As many have found, the stability factor of convergence board components can be very critical.

An HMV Decca 33 chassis Galaxy. Overload cutout button kept tripping for no reason. After reading a fault sheet on this chassis, I decided to fit a new cutout assembly. A phone call to the owner several days later confirmed that everything was OK.

An HMV 26in. Purple patch on bottom of screen on both mono and colour. The lady of the house informed me that the purple patch appeared the day before after she had vacuumed the lounge room. A quick once over with the degaussing wand removed the offending patch of colour. I advised the good lady not to switch the cleaner off in the immediate vicinity of the set or she could have the same trouble again. She told me that she had never been told not to switch off such appliances when close to a colour set. In fact, she was quite surprised when I raised the point. Evidently, someone had slipped up on his homework.

A Philips K9A. Height varying rapidly, patterning on screen. Another cleaning job—this time on the frame control module.

A Philips K9A. Snowy picture. The set owner was a TV DX fan, and had erected quite an elaborate antenna system for receiving distant stations—with some success. He explained that the fault had occurred after a thunder storm the previous night. A quick ohms test across the antenna socket showed O/C and my nose told me the rest. The 300 to 75 ohms balun had cooked—presumably from lightning. As I did not have the correct balun in stock, I switched over to the 75 ohm aerial connector and plugged in an external balun. The set then gave normal reception.

These are a good cross section of colour TV faults which I receive and, as can be seen, most of them were fixed by using ordinary test equipment and standard service techniques.

When handling problem sets which might "bounce", it is a good idea to contact the customer a week or so later and check on the set's performance. If something is wrong, it is far better for him to tell YOU, than to tell someone else!

Well, those are my colleague's thoughts on the colour scene at the present time and, while it is only one opinion, it is one which I value. I feel that the comments on the equipment needed are most valuable. There was a tendency with the introduction of monochrome TV, and again with colour, to oversell the test equipment requirements. As a result, many servicemen invested in expensive equipment more suited to the laboratory than the service bench. Subsequently they found that they seldom, if ever, needed it.

A lot of the older service fraternity are opting out of colour, being content to carry on with monochrome while this demand lasts, hoping that this will keep them going until they are ready to retire. One reason is the cost of test equipment, and my colleague's comments could well encourage some of them to think again.

Another reason is the sheer complexity of colour—plus solid state—compared with the monochrome valves sets to which they have been accustomed. Here, two of my colleague's comments are worthy of their consideration; (1) that he has found the reality much less frightening than the prophesy, and (2) that restriction to one or two brands greatly simplifies the scene, both technically and economically.

So, if you're wondering whether to embrace colour, or buy a chicken farm, these comments may help.

PICTURE TUBE GLASSWARE DISPOSAL

With the tailing off of monochrome picture tube manufacture in Australia, there is no longer a market for old picture tubes, from which glassware was previously salvaged. As a result, many servicemen find themselves in possession of old picture tubes and are unsure of the best way to dispose of them safely. The following advice has been reprinted from the Philips publication, "Elcoma".

It must be remembered that the picture tube glass supports an evacuated interior with the normal atmosphere around us pushing down on the entire glass surface with a force of 14.7 lbs/sq inch.

While integrally protected picture tubes offer a great deal of protection against implosion under normal conditions of domestic usage, there are large numbers of older tubes that have no such protection mechanism apart from the strength of the glass itself. If the glassware is weakened in any way on the faceplate or cone area by scratching, bruising or a sudden blow, air pressure may push the glass inwards in a sudden violent action called an implosion. Flying glass may result in death or severe injury!

Therefore the vacuum must be let down to air in a safe manner that will not cause an implosion, and to this end the following procedure is recommended:—

1. The operator should wear clothing which adequately covers chest, arms and legs and most importantly safety goggles to protect the eyes.
2. Pick up the tube firmly with two hands under the face and place it face down on a soft clean surface such as a Miniwatt mat or cloth.
3. Wrap a thick blanket or strong canvas material securely around the bulb leaving only the end of the neck exposed.
4. Use a screwdriver to gently prise away the moulded base so that the glass exhaust tip is exposed to view.
5. Rest a broad screwdriver blade against the exhaust tip and using the screwdriver as a drift, firmly tap the end with a small hammer, until the exhaust tip cracks or breaks away.
6. When this happens the air will enter the bulb with a rushing sound until the volume is filled.
7. At this point the unwanted bulb may be treated as conventional glassware.
8. Avoid the risk of cuts from glass fragments since the chemicals used in the manufacture of the tube may cause infection.
9. After the bulb has been broken down to small manageable glass pieces in a suitable container such as a picture tube carton, they should be disposed of at the local tip and not placed in household garbage bins.
10. Remember the onus of responsibility for safe disposal is on you, and the above recommendations are provided for your benefit and the benefit of those who come into contact with the glassware.

In no circumstances should evacuated picture tubes be left lying around either in the workshop or on the council tip.

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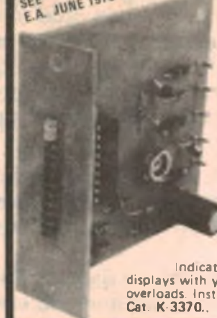

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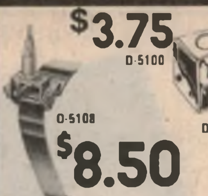

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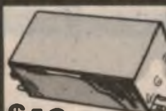

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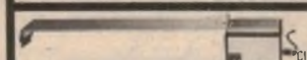

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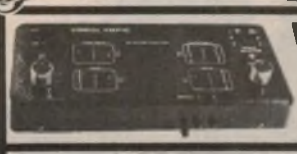

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AD58

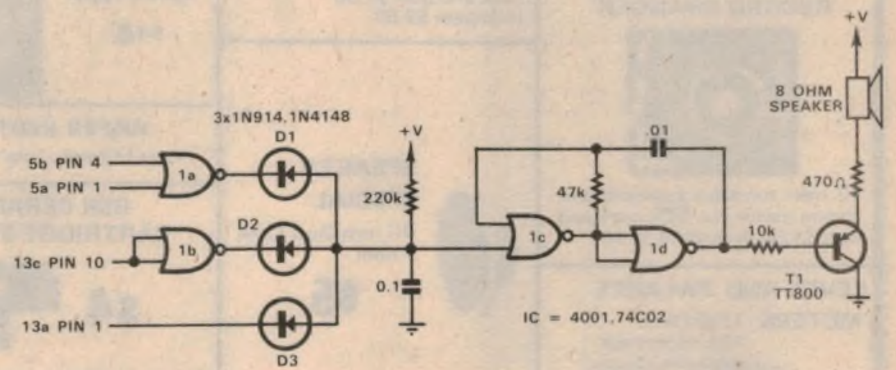
Circuit & Design Ideas

Conducted by Ian Pogson

Interesting circuit ideas and design notes selected from technical literature, reader contributions and staff jottings. As they have not necessarily been tested in our laboratory, responsibility cannot be accepted. Your contributions are welcome, and will be paid for if used.

Sound effects for video game

I recently constructed the Video Ball Game as described in Electronics Australia for May, 1976. It worked well but it rapidly became boring because of the lack of a "blip" sound when the ball hit the bat or side lines. Because of this I have constructed a simple and cheap circuit that produces a blip when the ball hits either the sides or bats.

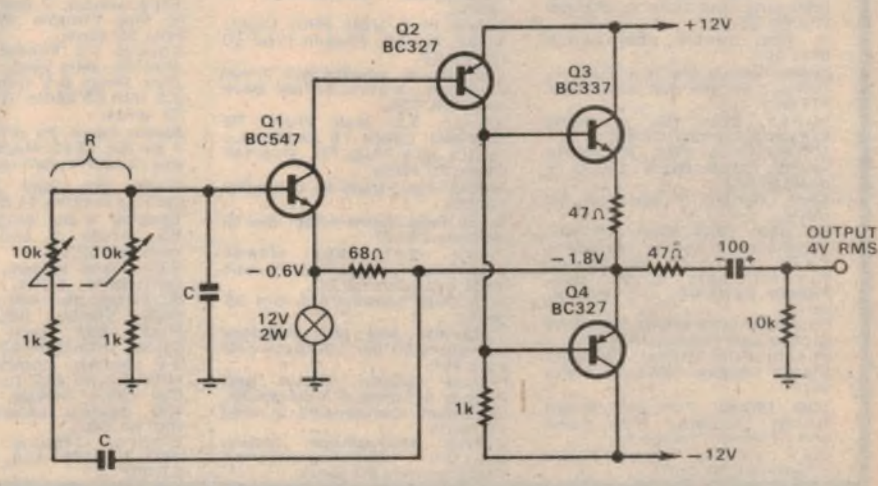


The circuit operation is as follows. Coincidence between the ball and either bat is detected by NOR gate 1a, and NOR gate 1b and D3 detect coincidence between the ball and upper or lower line. This coincidence causes the junction of the 220k resistor and the 0.1uF capacitor to go low and thus allow the oscillator to operate. The resistor and capacitor combination just mentioned stretch the input pulse and cause a blip of about 1/50th of a second. The loudspeaker can be anything from 4 ohms to 100 ohms. Volume is determined by the 470 ohm resistor.

(By Mr M. Hillman, 20 Marcella Street, North Epping, NSW 2121.)

Audio oscillator uses dial lamp for stabilisation

Most Wein bridge oscillators specify thermistor type R53 for stabilisation of the output and although this device is excellent in operation, it is rather expensive and it is now becoming difficult to obtain. The ordinary dial lamp has a similar non-linear characteristic, except that it has a positive rather than negative temperature coefficient. A lamp may be used in place of a thermistor in the feedback loop merely by reversing its position with the resistor.



The R53 thermistor has a cold resistance of about 5000 ohms and an operating resistance of about 2000 ohms at 3mW. The stabilised voltage is 2.5V RMS and the operating temperature is about 50°C. A 12V 2W dial lamp has a cold resistance of about 9 ohms and an operating resistance at 12V of about 71 ohms. If the voltage/current characteristic is plotted, the maximum non-linearity occurs at about 1V and 30mA. This gives an operating resistance of about 33 ohms at 30mW, and the stabilised voltage is 1V RMS at an operating temperature of about 500°C with the lamp just glowing. In the circuit, the output voltage will be three times this voltage or 3V RMS, and this is very similar to that obtained with the R53 thermistor.

The only problem is to design an amplifier which will deliver 30mW to the lamp, but this is quite simple. Unfortunately, it is just beyond the capability of the 741 IC, and a transistor amplifier has been substituted. The amplifier shown has a couple of interesting features and it is entirely satisfactory for the range 1Hz to 100kHz. Positive and negative supplies have been used so that the lamp and Wein networks could be earthed. Hum is then no problem and simple half-wave supplies are used. Current consumption is 25mA. Total power consumption is 300mW and 100mW of this is delivered to the lamp and 68 ohm resistor combination.

The Wein network forms the positive feedback to the transistor base and resistor values from 1k to 100k are permissible. Capacitance values from 470pF to as high a value as required may also be used. The 68 ohm resistor and the lamp form the negative feedback loop to the transistor emitter. If desired, the output may be varied over the range of 2V to 8V by varying the 68 ohm resistor from about 39 ohms to 100 ohms.

The lamp is also part of the DC feedback loop, and since the transistor base is effectively grounded by the Wein net-

work, the emitter will be at −0.6V. This voltage appears across the lamp, and is beneficial to the operation. It acts as a "setting up" voltage for the lamp, reducing output voltage bounce when tuning over the range. The output DC level is −1.8V (3 x 0.6) and the transistor Q4 delivers the 20mA DC to the lamp.

No quiescent current is given to the output pair, and a single emitter resistor is used for thermal stability. This is allowed by the high value of DC in Q4; the stage operates in mixed class A/class B.

Distortion in the output waveform is very low, in the order of .05%. The output is constant within 0.5dB over the range 10Hz to 100kHz. This performance compares very favourably when an R53 thermistor is used. The operating temperature of the lamp is 500°C compared with 50°C for the R53 and output is therefore not affected by ambient temperature changes when using a lamp. The power amplifier may be used to drive directly into a 50 ohm load and with a 47 ohm limiting resistor, it may drive into a short circuit. This allows loudspeakers to be driven directly at a reasonable volume, for such purposes as testing loudspeaker enclosures.

Various lamps were measured for curiosity and all show similar characteristics, from lilliput lamps to automotive stop lamps. In all cases the optimum operating condition is at the point where the lamp barely glows and this occurs at about 10% of the rated voltage. The resistance at this point is about half the rated value and the feedback resistor should be made this value; for example:

12V, 2W lamp: Current = 2/12 = 0.17A.

Resistance = 12/0.17 = 70 ohms. Use 68 ohms.

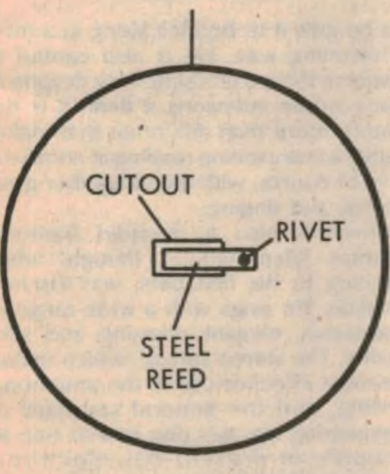
Output = 3 x 10% of 12V = 3.6V RMS.

Naturally, the more powerful the lamp, the more powerful the amplifier must be. The amplifier shown is suitable for lamps up to the standard 2W size. For 6V lamps the resistors should be reduced four times and the power supply rail reduced to ±6V.

(By R. James.)

CW super selectivity

Here is a method of achieving a degree of CW selectivity heretofore deemed impossible. In fact, total elimination of a CW signal only 5 or 10Hz from the desired signal is possible with this new system employed by the author.



As will be seen in the illustration, the normal headphone diaphragm has been replaced by a non-magnetic diaphragm featuring a small metallic reed inserted in a cutout at the centre of the diaphragm. The reed employed is magnetic and is dimensioned to vibrate at 440Hz. Frequencies other than 440Hz will produce no response from the reed.

I selected 440Hz so that WWV would cause a response in the altered headset, allowing use of WWV's transmissions when necessary. The 440Hz frequency also provides a suitable tone for CW reception. Fortunately, the necessary pair of reeds may be obtained from two small harmonicas. The reeds must be made of steel, to ensure response to the headset's magnetic field.

To locate 440Hz, or A above middle C reed, tune in WWV's 440Hz tone. Then use a common drinking straw to blow into each opening of the harmonica. When the two notes coincide, you have located the wanted reed. This reed is usually about the centre of the harmonica.

To construct the new diaphragms, remove the present diaphragm from your headset and use them as templates to cut out a pair of aluminium discs. Aluminium sheet of a thickness similar to that of the present diaphragms should be used. Using a nibbler tool, cut a rectangular opening in the centre of each of the aluminium diaphragms. To allow for mounting, this hole should be dimensioned slightly shorter than the length of the harmonica reeds used. Drill a small hole adjacent to one end of the opening and rivet the reeds in place, as shown in the illustration. Care should be exercised to ensure that the portion free to vibrate is of exactly the same length as that portion free to vibrate in the harmonica. This will assure correct frequency response. Make sure also that the mounted reeds clear the opening on all sides to allow free movement for a 440Hz signal.

Tuning across the CW bands for the first time with this arrangement will be a new experience. As you tune, each signal will "pop out" at you. Should you desire to return to SSB, simply replace the new diaphragms with the ones originally fitted. Alternatively, retain one half of your headset as normal and change the other one for CW super-selectivity. In this case, slide the desired half over one ear, leaving the other half away from the other ear.

(By Tinh Ehres, WH0OP, in "QST".)

Editorial note: I must say that I am somewhat intrigued by the name and call sign of the author. It must also be noted that the item was extracted from the April issue of "QST". While these points make one somewhat suspicious of the genuine intentions of the author, I must also confess that having read through the details, it all makes sense. What do you think?

Classical Recordings

Reviewed by Julian Russell

Donizetti—Lucia di Lammermoor

DONIZETTI—Lucia di Lammermoor. Complete Opera. Renato Cioni (Edgardo); Robert Merrill (Enrico); Joan Sutherland (Lucia); Kenneth Macdonald (Arturo); Cesare Siepi (Raimondo); and others with the Chorus and Orchestra of the Santa Cecilia Academy, Rome, conducted by John Pritchard. Decca Ace of Diamonds Stereo GOS663/665. (Three Discs.)

I seem to remember that Joan Sutherland first won universal acclaim in the "Mad Scene" in this opera. But strangely, among glorious, accurate and sometimes vividly dramatic singing throughout her entire role, I found in this scene the only few moments that disappointed me ever so slightly. But despite this quibble it is still a splendid "Mad Scene" and I cannot think of any other soprano singing today who could match it.

Elsewhere she is at the very top of her illustrious form, her unclear diction easily forgiven and forgotten in enjoyment of her lovely voice. Her interpretation is an enduring example of vocal dramatisation at its finest. Her coloratura is beautifully smooth and unforced.

It might be of interest to recall that though the obbligatos to most of these coloratura passages have for many, many years been supplied by a solo flute, Donizetti originally conceived them for an armonica—in other words musical glasses. This precursor of the celeste was particularly effective in expressing mental disturbance, and it may also be recalled that Arthur Benjamin used a celeste theme in his now forgotten opera "A Tale of Two Cities" to illustrate the mental wanderings of the character Dr Manette.

Sutherland's is not the only fine performance in this excellent cast. Renato Cioni sounds fresh and virile in the tenor role of Edgardo, though he seems at the time under effort to sustain an established rhythm. Baritone Robert Merrill (Enrico) sings pleasantly, though his sense of dramatic vocalisation shows up as far less effective than Sutherland's. Disappointing too is Cesare Siepi (Raimondo) who has learned to focus his voice more clearly since he made this recording some 15 years ago.

Despite its age the sound of this early stereo engineering has worn very well indeed. The orchestra of the St. Cecilia, Rome, is clearly detailed, the dynamic range very wide. Pritchard's reading is always alive in dramatic content and sympathetic in its accompanying responsibilities. The balance between voices and orchestra is as good as you will find in many of the best modern recordings. The chorus is in fine form too, full-toned, and immaculate in attack and release.

At its budget Ace of Diamonds price this set is a real snap and I can recommend it with only minor qualifications hardly worth mentioning.

BEETHOVEN—Symphony No. 7 in A Major. The London Philharmonic Promenade Orchestra conducted by Sir Adrian Boult. Astor Stereo Gold Star Series MWC 1002.

I cannot recommend this as one of Boult's best recordings. The sound is clear but rough textured and tends to be congested in loud tuttis. It undoubtedly has its moments but will be far from satisfying to those seeking the best, and there are many other versions in circulation that offer formidable competition.

Even the utterly charming allegretto starts beguilingly but develops coarseness in the loud passages. Throughout the entire symphony the faults are minor yet paradoxically important when better versions are recalled.

There is, however, one feature that might appeal to those who are not too demanding of refinement in this work that has often been labelled the Dance Symphony—its very low price. At just under $3 there may be many who will want to acquire it. Later on if they buy another competitive version it might help them, by comparison, to learn what to look for in a first class performance and recording.

By the way my admiration for Boult didn't make it any easier to write this unenthusiastic review.

Orff—Carmina Burana: "highly recommended"

ORFF—Carmina Burana. Cantata for Soloists, Chorus and Orchestra conducted by Andre Previn. Sheila Armstrong (soprano); Gerald English (tenor); Thomas Allen (baritone); the London Symphony Orchestra and LSO Chorus, and the St. Clement Danes Grammar School Boys' Choir. HMV Stereo/Quadraphonic OASD 3317.

That Carmina Burana has been recorded so many times since its composition may explain why EMI has not put out texts with their new issue. Are buyers expected to know the words already or else use those which came with another set they already own? I used the texts from the Jochum set that I have when I found I had forgotten the words.

It is a long time since I have played Carmina which, I think, is all to the good. It is a strange work. One knows that one is listening to music that it would not be unjust to call at times meretricious. Yet if not heard too often it can still generate a strong elemental appeal that goes a long way to suspending the critical faculty of the listener—at any rate that's the way it affects me.

You know this version is going to be good right from the very first fortissimo attack and the immediate reduction to the pianissimo chorus in the first movement. All through Previn is careful not to exaggerate the rhythmic accenting yet he gets it to bounce along in a most exhilerating way. He is also careful to preserve the music's simplicity despite its many subtle inflexions. I think it is this feature more than any other that makes it such a fine exciting reading in combination, of course, with the altogether great playing and singing.

There is also a splendid baritone, Thomas Allen, who, I thought when listening to his first bars, was Fischer-Dieskau. He sings with a wide range of expression, elegant phrasing and silky quality. The stereo spread, which makes the most effective use of the antiphonal writing, and the general standard of engineering lifts this disc into as fine an example of present-day electronic musical reproduction as any around today.

As to Previn's conducting I admired enormously, among his many merits, his changes of tempo and rhythm in mid-piece. They are all brought off without a single hitch. The boys' singing has a wonderfully angelic sound though I expect the kids are no better than the average little monsters outside their choral work. All through, the combined choruses avoid the cooing that mars so much English choral work.

The counter tenor, Gerald English, the kind of voice I usually dislike intensely, is here so good at expressing the humor of the Roasting Swan item—without burlesquing it—that I enjoyed every note.

Sheila Armstrong's soprano contribution may sound a little too romantic to some ears, but I found it, though a little unusual, quite enchanting, especially in the Trutina item. Elsewhere, too, she is persuasively sensuous in tone.

Altogether I thought Previn's interpretation more unbuttoned than Jochum's "official" reading that bears the composer's note of approval—or "imprimatur" would be a more suitable word here—on the sleeve. To me Previn captures the spirit of medieval, disreputable, monkish carryings-on to perfection. Very highly recommended.

By the way, though the record is made for either stereo or quadraphonic listening I played it with fine effect on stereo. I have no quadraphonic equipment and after having listened to many of the 4-channel recordings now available I am extremely unlikely to buy one.

★ ★ ★

BEETHOVEN—Moonlight, Pathetique and Waldstein Piano Sonatas. Rudolf Firkusny (piano). Decca Phase 4 Stereo PFS 4341.

It is so long since I heard a Firkusny recording that I thought he must be dead. Contradicting this is this record made, in Phase 4, only last year.

But not even the super gloss of Phase 4 engineering can quite disguise the fact that his playing is not what it used to be, or let's say as I remember it. He seems to have developed mannerisms that I cannot recall having heard in his earlier Beethoven discs. For instance in the Moonlight Sonata's first movement despite many—too many—changes of tempo, pauses and rubatos he never seems to make it sound convincingly romantic. He gives the impression of pecking at the notes with a tone that shows very few changes of sonorities.

Again, in the second movement his many abrupt staccatos are strange indeed. And of matching strangeness is his ultra-strict tempo, and the lack of sensitivity in the nuancing.

I liked him a little better in the Finale but I have the feeling that he won its fast tempo only at some considerable effort. He seems to be pumping energy into it.

His Pathetique is much the same. Here you have the same lack of spontaneity, the same squarish, ungraceful phrasing and parts of the middle of the first movement are oddly percussive. The Waldstein, though it sounds comparatively simple, is always difficult to bring off satisfactorily, and to my ear Firkusny does no better in this than in the previous two.

I admit that all this might well be due to Firkusny having done some deep rethinking of Beethoven since I last heard him. If this is so I can only say that he has emerged from his retreat with curiously idiosyncratic ideas on the subject with which, it seems to me, he will find only few musicians to agree.

SONGS OF THE AUVERGNE—Collected and arranged by Joseph Canteloube (1879-1957) and sung by Victoria de los Angeles with the Lamoureux Orchestra of Paris conducted by Jean-Pierre Jacquillat. HMV Stereo/Quadraphonic OC 063 025150.

I am afraid some of the gloss has gone from de los Angeles beautiful voice in these songs, which incidentally also have no texts to accompany the record. Perhaps it has gone out of fashion to send texts to critics. They are badly needed here though the general subject of the songs is summer.

Canteloube's settings, too, are a little too fancy for mostly peasant songs, though nobody could deny their beauty in their own right. The sleeve notes tell you more about Canteloube and the character of the Auvergnats who inhabit the Massif Central of France than they do about the music. In these the writer, James Harding, informs you that Pascal and Pompidou were Auvergnats but doesn't mention another, more notorious one, Pierre Laval.

The Auvergnats are generally disliked by the rest of their fellow-countrymen as sly and mean. Yet I once travelled to France from Australia with a delightful retired cavalry officer from the Auvergne who was as charming a companion as anyone could wish to meet. And he was certainly not without wit. We were leaning on the rail together as we turned into the Mediterranean and as we passed Gibraltar he pointed to it, turned to me with a grin, and said "La Concierge".

Anyway the disc is well worth having for the beauty and variety of its contents—there are 15 brief songs in all. And if de los Angeles isn't quite what she used to be one can forgive this in gratitude for the endless pleasure she has given us only a few years ago.

★ ★ ★

PENDERCKI—Magnificat. The Polish Radio National Symphony Orchestra and Polish Radio Chorus of Krakow with Peter Lagger (bass) conducted by Krzystof Penderecki. EMI Stereo-Quadraphonic EMD2254.

This composition will surprise nobody familiar with Penderecki's religious music—the St. Luke Passion, Utrenji, or even his opera The Devils of Loudon. Like the old crack about the Bourbons, he apparently never forgets and never learns. At least, this seems to be the case according to his Magnificat. Have the successes of the aforementioned pieces betrayed him into preserving an accepted formula? It may be so.

At any rate he has little to say in the Magnificat that shows any development of style or even technique. What appeared to be a new authoritative voice among the avant garde in the "St. Luke" is singing the same old song. There are the same highly individual features, particularly his gift for dramatic urgency, but many of them seem to have settled down into a series of mere mannerisms. You will hear the same massing of tone upon tone, the same undeniable reverence, though I suppose no one can blame him for the latter since he is a fervent Roman Catholic living under and apparently challenging an atheistic regime.

Perhaps it is my enjoyment of the earlier pieces, especially the "St. Luke", that makes the lack of difference in the Magnificat's sound seem rather like a tired priest mechanically repeating his liturgy. But to hold interest in later works Penderecki needs to add to his musical vocabulary. Is he resting on his laurels while awaiting fresh inspiration? I am afraid it appears so, and more's the pity.

The moving drama of the "St. Luke" is again manifested in the Magnificat which sounds like he is glorifying a God of fear rather than one of love. But then I admit that I am not best qualified to comment to this aspect of a religious work.

What is immediately apparent is the splendour of the performance, both orchestrally and vocally. And the stereo/quadraphonic engineering is fine, at any rate on stereo. Since the work was conceived for performance in a large cathedral the four-channel version may here improve on the stereo.

I think I can sum this last work up by saying that if Penderecki's music is new to you you will find it exciting and eloquent. But if you are an admirer of his earlier music it may well sound merely repetitious.

Lighter Side

Reviews of other recordings

Devotional Records

GOSPEL SHIP 2. Combined groups. Stereo, Destiny D-2012-S. (From S. John Bacon Pty Ltd, 12-13 Windsor Ave, Mt Waverley 3149.)

I gather from the rather brief jacket notes that the music on this album is performed by 5 groups in combination, forming the Icthus team. The three groups positively identified are "Hallelujah, Redemption and Master/Peace". Together, they provide vocal solos, choral backing and instrumental accompaniment including flute, organ, congas, drums, and pedal steel.

It's all youth-style modern Gospel, of course, but it's not way out and it's presented with a high degree of musicianship. The titles: Harvest Time — He Cares Enough For Me — Behold The King — Power To Change — Liberation Song — Never Live Without You — Open Arms — Be Glad In The Lord — Anti-Satan Boogie — Light Of God.

You probably won't know many of the lyrics—if any—but the diction is such that you won't have any difficulty to follow the words and share in the themes. A fully imported album, the quality is excellent and, in all, it's an enjoyable album of contemporary Gospel sound. (W.N.W.)

* * *

THE PSALMS OF DAVID. Volume 3. King's College Choir, Cambridge, conducted by Philip Ledger. Stereo/quadraphonic HMV OCSD-3768.

Reacting purely to the front of the jacket, I commenced playing this album in ordinary stereo. It was some minutes later that the modest letters "SQ" caught my eye on the reverse side and I realised that it was, in fact, a quadraphonic pressing being sold mainly for "stereo". In this case, bringing up the rear channels has the main effect of adding a delayed echo, understandable in the King's College Chapel.

The rear of the jacket carries detailed notes on the Book of Psalms, the evolution of the musical settings to the present chant form, and the conductors and organists who, through the years, have contributed to that form. It's very much material for the devotee.

The Psalms in this volume 3 include nos. 93, 94, 49, 107, 45, 37, 53, 130 and 131, encompassing a variety of moods and emotions. Coming from such a notable venue and choir, the musicianship can be taken for granted but I imagine that the appeal will be limited mainly to those who have a traditional liturgical background. Accompanist, by the way, is Francis Grier.

The gentle, elegant chant makes no demand on recording dynamics and, as one might expect, the recording quality is clean and unstressed. (W.N.W.)

CHUCK GIRARD. Stereo, Good News GNR-8102. (From Sacred Recordings Aust., 181 Clarence St, Sydney 2000, and other capitals.)

Chuck Girard is obviously a young man of many talents. The words and music of all but one number on this album are his. He does most of the vocals, helps provide vocal backing by means of double recording and plays piano and organ bass in at least one number. For good measure, he is listed also as producer.

The program opens with a heavy rock number in which he expresses surprise at his transition into a "Rock & Roll Preacher". However, while the style throughout remains modern, it becomes progressively more restrained with: You Ask Me Why — Evermore — Quiet Hour — Everybody Knows For Sure — Galilee — Tinagera — Lay Your Burden Down. The reason for the progressive restraint becomes evident with "Slow Down", an exhortation to pause and consider. The final track is "Sometimes Alleluia", a commendation of the spiritual life. The words are given in full on the inner sleeve.

Recorded in Los Angeles, the production reflects a high order of dedication and musicianship and is technically of excellent quality. For the Gospel youth scene: recommended. (W.N.W.)

Instrumental, Vocal and Humour

HANDEL: SIXTEEN ORGAN CONCERTOS. E. Power Biggs, Sir Adrian Boult and the London Philharmonic. CBS 3-record set, stereo, S3BR 220613.

In the notes with this set, E. Power Biggs describes the long search which was carried out prior to this new recording to try and find an organ which would provide the sound Handel had in mind when he composed the organ concertos. The search led finally to what is probably the only authentic Handel organ still in existence, in the parish church of the village of Great Packington, in Warwickshire, England. Handel not only played on this organ, but virtually designed it: the original owner, his friend and patron Charles Jennens, had it built to his specifications.

Happily, they found the instrument to be in good playing condition. Not only that, but the church acoustics and the quiet rural setting turned out to be perfect for recording purposes. And the producers of the recordings had access to the original scores of the organ concertos, so that they were surely in an ideal position to produce an up-to-date definitive reading.

In short, I believe that they have done just that. The performances are of a very high quality, and entirely convincing. The balance between organ and orchestra seems to be excellent, and the full impact of the antiphonal movements is able to emerge clearly.

The recording is excellent, too, with sound at times reaching a level I can only describe as "delicious".

If you're after a really modern recording of these rollicking and enormously enjoyable examples of Handel's music, this is a set you must listen to. (J.R.)

* * *

THE WORLD OF THE VIOLIN. Decca "World Of Great Classics" series SPA-350.

One would not need to be a genius to guess at the nature of this album as a highly melodic, generally romantic offering that is intended to sooth rather than stir—one that (for me) went well with a Friday evening, no television, and a warm fire.

Recorded at various times between 1965 and 1972, the tracks feature violinists: John Georgiadis, Willi Boskovsky, Ruggiero Ricci, Itzhak Periman and Campoli. In most cases, the associated orchestra is the London Symphony conducted, amongst others, by Richard Bonynge and Sir Malcolm Sargent.

Track titles are (from): Thais — Meditation (Massenet); Romance No. 2 Op 50 (Beethoven); Caprice No. 13 Op 1

Reviews in this section are by Neville Williams (W.N.W.), J. Rowe (J.R.), Leo Simpson (L.D.S.) Norman Marks (N.J.M.) and David Edwards (D.W.E.).

(Paganini); Violin Sonata in A major (Franck); Violin Concerto in E minor (Mendelssohn); Violin Concerto No. 1 in G minor (Bruch); Gypsy Airs (Sarasate); Liesleid (Kreisler); Violin Concerto in D major (Tchaikovsky).

Despite the varying age of the recordings and the fact that one track is electronically reprocessed, the quality is entirely acceptable for the role that the album is most likely to play in your listening. Pleasant. (W.N.W.)

* * *

JOHANNES BRAHMS. Samtliche Orgelwerke. Wolfram Rehfeldt an den orgeln des Freiburger Munsters. Stereo, Pelca PSR-40555. (From Crest Record Co, 122 Chapel St, St Kilda 3182. $6.50.)

By sheer coincidence, and hard on the heels of E. Power Biggs' recording on the four antiphonal organs of the Freiburg Cathedral (CBS SBR-235761, June page 99) this album came to hand from an entirely different source. Fittingly, it is not a demonstration of the instruments, but a recital by a young organist (born in 1945) who studied at the Freiburg Conservatorium and under the Cathedral organist. He is therefore thoroughly familiar with the instruments.

Most of the tracks are played on the

Marien Organ, the newest and largest of the four, a 4-manual tracker instrument. Three tracks use the 2-manual Nave organ and the final track involves both the above, plus the 2-manual Gallery Organ, presumably played from the central console.

Detailed notes and a diagram give the specifications of the instruments, and introduce the organist, the composer and his music. There is one problem, however; every word is in German and, if you decide to invest in the album, it would be helpful to seek assistance with the text. The same would apply to the 15 track titles, which would take far too much space to list here.

The sound is cleanly recorded, never ponderous but often delicate with touches of gentle tremulant from one or other of the manuals. Classical organ enthusiasts can buy with confidence. (W.N.W.)

* * *

BOLERO, Ravel. 1812 Overture, Tchaikovsky. Stereo, Astor Masterworks collection MWC-1010.

For those who may want to add to their collection a couple of very well known concert classics, for a modest $2.95 outlay, this Europa recording from the Astor catalog could be of interest.

Ravel's Bolero is played by the Vienna Symphonic Orchestra conducted by Eduard van Remoortel. The performance is okay but the recording quality passable only. Some surface murmur is evident behind the very low level opening section and, while it is ultimately swamped by the louder passages, the higher level sounds themselves are not as clean as they could be.

The 1812 Overture on side 2 is played by the London Philharmonic Orchestra under Vernon Handley and the more open sound quality is immediately evident. Some pressing noise is still apparent in the occasional quieter passages but the final climax comes through very well indeed. The real value of the album lies in side 2, with Bolero a routine bonus. (W.N.W.)

* * *

THE WORLD OF "YOUR HUNDRED BEST TUNES", Vol 10. Various orchestras. Stereo, Decca, SPA-400.

In his jacket notes, Alan Keith says that this album completes the set of 10 necessary to accommodate the full hundred "best tunes".

The final 10 are: Londonderry Air (Trad.) — Romeo & Juliet Fantasy Overture (Tchaikovsky) — Ptolemy, Silent Worship (Handel) — Violin Concerto 2nd Mov. (Mendelssohn) — Prince Igor, Polovtsian Dances (Borodin) — Ride Of The Valkyries (Wagner) — The Swan Of Tuonela (Sibelius) — The Lord's My Shepherd, Crimond (Irvine) — The Russian Creed Op 29 No 8 (Gretchaninov) — Warsaw Concerto (Addinsell).

All the items are from recordings by well known orchestras, conductors and artists dating, in one case, from 1958 through to quite recent performances. Not surprisingly, there is some variation in the ultimate quality but, on average, it is good (some tracks are very good) and the music offered should make it a very acceptable addition to many record collections. (W.N.W.)

* * *

GREATEST HITS. Arthur Lyman Group. Astor Records, stereo ASF-508. 3-record set.

Here is a collection of some of the world's greatest hits played in a very relaxing style. My only comment is that the general style can become somewhat monotonous if one tries to listen too seriously for too long to too many sides. With that reservation, I can well recommend this 3-record set as excellent

STEREO CASSETTES

THE WORLD'S GREATEST ACCORDION HITS. Stereo, Astor Musicassette BCT-5274.

Modesty was obviously not a problem for the producer who chose the title for this particular tape album but then, could you think of a more representative list of numbers to back up such a title?

La Golondrina — O Sole Mio & Santa Lucia — Tango Elena — Tango Continental — Claire De Lune — Musetta's Waltz — Prago Tarantella & Funiculi, Funicula — Fascination — Dark Eyes — La Paloma.

Whether you would relish two full sides of accordion sound would depend largely on your reaction to the instrument, and on the occasion, but it's pleasant enough and the sound quality is clean. Once again a natural for the cassette player in the family car. (W.N.W.)

LATIN QUARTER. The Sid Sidney Orchestra with Enrico Mirando, the Modern Latin Boys, and the Montenegro Trio. Contata, Dolby stereo cassette AA-101. (From Goldring Sales & Service in all states.)

The Latin rhythm in the opening track is immediately reminiscent of wheels pounding down the expressway and this is where Contata's "Latin Quarter" would be at its best—sharing the listener's attention with the passing scenery. In the home, it would be a typical album of Latin-American sound, pleasant enough but not specially notable. The tracks: Manzanilla — Delicado — Cieltito Lindo — Cucurucucu — Adalita — Bamba La Bamba — Malaguena — Manolita Mi Amor — Rhumba Tamba — Guantanamera — La Cucuracha — Ave Maria No Morro.

Recorded on TDK tape and Dolby processed, the quality is well up to standard. Playing time is about 30 minutes. (W.N.W.)

background music.

Some of the tracks featured are: Aquarius — Love Is Blue — Mrs Robinson — Theme From A Summer Place — Hey Jude — The Look Of Love — Yesterday — Blowing In The Wind — Everybody's Talking — The Sounds Of Silence.

Recording quality is very good, with negligible surface noise. (G.S.)

★ ★ ★

THE CHRIS FARLOWE BAND LIVE! The Chris Farlowe Band. Stereo. Polydor 2383 367. Phonogram release. Also available on cassette.

Chris Farlowe has been very quiet of late (remember "Out Of Time"?), but recently decided to form a new band. Recorded live at two locations in London late in 1975, this record is quite a creditable effort. On the first side, the outstanding track to me was the last one, a cover version of Alice Cooper's "Only Women Bleed".

On side 2, two tracks are especially appealing: Chris' version of the English/Kerr song "Mandy" just has to be heard to be believed, while "Handbags & Gladrags" is superb. The remaining tracks are good, but pale somewhat in comparison to the three mentioned.

Technical production is very good; crowd noises have been kept sufficiently in the background, while still giving a "live" atmosphere. This record would be a good addition to any contemporary rock collection, and must be recommended. (D.W.E.)

★ ★ ★

PLACES AND SPACES. Donald Byrd and Blue Note. United Artists L 35791. Festival Release.

If you are a fan of Negro jazz, then this album by top American jazz player Donald Byrd and his band Blue Note could be well worth a listen. The most memorable feature of the album is the ever present rhythmic drumming. And the trumpet on occasions just seems to glide from the speakers and into the room.

Other instruments played include acoustic piano, fender bass, guitar, trombone and tenor sax. Tracks are:

Change — Wind Parade — Dominoes — Places And Spaces — You And Music — Night Whistler — Just My Imagination.

All in all, a very enjoyable jazz session. Recording quality is hard to fault. (G.S.)

★ ★ ★

CHANGING ALL THE TIME. Smokie. RAK Records SRAKA.517. E.M.I. Release.

Smokie is a four man British band, comprising Chris Norman, Alan Silson, Terry Uttley and Pete Spencer. I find it difficult to get enthusiastic about this record. While none of the songs are mediocre, none of them are particularly inspiring either. Similarly, the band is neither terrible nor brilliant. Technically, however, the record is quite good, with nice clean highs and very little noise.

It was not until the last track that the album seemed to have any life at all. This track, titled "Back To Bradford", has a catchy tune, and appealing lyrics. But it hardly has enough life to stir up the remainder of the album. Summing up, all I can say is that this is an average rock-style record. (D.W.E.)

★ ★ ★

ALL THE BEST FROM COLIN STUART. Stereo, Astor Gold Star series, GGs-1476.

Native born Scot, Colin Stuart is a familiar cabaret singer in his own country, with overseas tours also of Canada and Europe. Recorded in Edinburgh last year, this album brings together a collection of his most popular numbers, backed by a small orchestral group, with an accordion well to the fore: I want A Bonnie Lassie — In Any Other Land — Campbeltown Loch — The Dark Island — The Flo'er O' Scotland — The Fiery Cross — A Hundred Thousand Welcomes — Lonely Scapaflow — The Lights Of Lochindaal — The Star O' Robbie Burns — Scotland The Brave — A Scottish Trilogy: Auld Lang Syne, Amazing Grace, Ye Banks and Braes.

Colin Stuart has a pleasant baritone voice and the whole presentation is a typical Scottish cabaret performance: accent, mood, sentiment, nostalgia and high jinks all evident. Technically, the quality is average with one peculiarity: on side 1, the level is lower on tracks 4 and 5 than on the preceding three, becoming noticeably thinner on track 6. But it won't spoil your enjoyment if you have nostalgic memories of Scotland (W.N.W.)

* * *

WELCOME TO MY NIGHTMARE. Alice Cooper. Anchor ANCH-2011. RCA Release.

After listening to this record, I feel a little sad that Alice Cooper was not allowed to tour in Australia. While the theme of his work may not appeal, it is certainly well executed. From the opening track to the concluding one, this album is really good rock.

The best track on the album is undoubtedly "The Black Widow", which has a magnificent introduction by Vincent Price, playing the part of a museum curator. I thoroughly recommend that you sample this track at least.

I won't spoil your fun by attempting to analyse the album as a whole, I'll just mention that all the lyrics are supplied, so that you can do it all by yourself. Technical quality of the recording is very good, with only slight traces of background noise. This is definitely a recording that will give an excellent account of itself on a good stereo system. (D.W.E.)

* * *

GOON SHOW CLASSICS. Vol 2. The Jet-Propelled Guided Naafi & The Evils Of Bushey Spon. BBC Mono 2964 039.

Every now and again one receives a record which can immediately be catalogued as a load of lunacy without fear of contradiction, even from the distributor (or worse, the Editor). In fact, the distributor, Phonogram Pty Ltd, probably wholeheartedly agrees. But this does not mean that I am condemning the "Goons". Far from it! I am glad to see that their brilliance lives on long after their last broadcast. They are as uproariously funny as ever. (L.D.S.)

NEIL DIAMOND. 20 Super Hits. Stereo, MCA (Astor) MAPS-7740.

In essence, this is a Neil Diamond sampler, with tracks presumably listed from the 10 other albums depicted on the rear of the jacket. Best I list the titles for your reference:

Holly Holy — Brookly Roads — Goldwater Morning — Cracklin' Rosie — Gitchy Goomy — Free Life — Brother Love's Travelling Salvation Show — Done Too Soon — Song Sung Blue — High Rolling Man — I Am . . . I Said — Solitary Man — Porcupine Pie — Shilo — Canta Libre — Solaimon — Stones — Play Me — A Modern Day Version Of Love — Sweet Caroline.

If you don't already have a collection of Neil Diamond Records, this one would offer quite a good cross section of the songs with which he is identified—a full hour's playing time. On the other hand, you may already have most of the tracks in your collection; it's over to you. Recording quality is okay. (W.N.W.)

* * *

SONGS OF THE BRITISH ISLES. Nana Mouskouri. Stereo, Philips 9120 051.

Take Nana Mouskouri, provide her with a simple piano or guitar accompaniment, ask her to sing a dozen traditional English folk songs—just for you—and you have this record: gentle, intimate, unhurried.

He Moved Through The Fair — An Eriskay Love Lilt — Danny Boy — An English Country Garden — O Waly Waly — Ar Hyd Y Nos — Spinning Wheel — Lullaby (Suo Gan) — Skye Boat Song — The Ash Grove (Llwyn On) — Early One Morning — I Gave My Love A Cherry.

I enjoyed the songs but another member of the household, who is something of a Nana Mouskouri fan wasn't sure she was in peak voice, but it still sounded pretty good to me. If you like the content or the artist, have a listen to a couple of tracks. (W.N.W.)

BING: IT'S EASY TO REMEMBER. Bing Crosby. MCA (Astor) TVS-1005.

"It's Easy To Remember" is a good title for this collection of Bing Crosby's songs because, in fact, that's exactly what the songs are. There are 21 altogether and I don't propose to list them individually. Sufficient to say that the collection begins with an Irish group ("Galway Bay", etc.) and samples the gamut of his talents, with love ballads, country and western, jazz and "modern". Glancing down the list, one picks up "Never On Sunday", "Temptation", "McNamara's Band", "Tumbling Tumbleweeds", "Begin The Beguine" and, to round it off, "Now Is The Hour".

Technically, the quality is good enough and even enough not to get in the way of a relaxed hour of nostalgic listening and, over a meal, it's a pleasant change from the high pressure stuff from the goggle box! (W.N.W.)

A COUPLE OF SONG AND DANCE MEN, Bing Crosby and Fred Astaire. United Artists L35799 Festival release.

This durable duo certainly show that age is no bar to giving an excellent account of themselves, as in this collection of favourites from movies over many years. The thirteen tracks are: Roxie — Top Billing — Sing — It's Easy To Remember — In The Cool, Cool, Cool Of The Evening — Pick Yourself Up — How Lucky Can You Get — I've A Shooting Box In Scotland — Change Partners — The Entertainer — Spring, Spring, Spring — A Couple Of Song And Dance Men — Top Billing.

Recorded at Wembley, with the backing of the Pete Moore Orchestra and The Johnny Evans Singers, the record would be popular with Crosby-Astaire fans wishing to put away some of the old 78s they may have had (N.J.M.)

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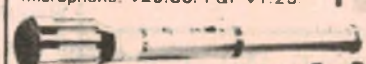

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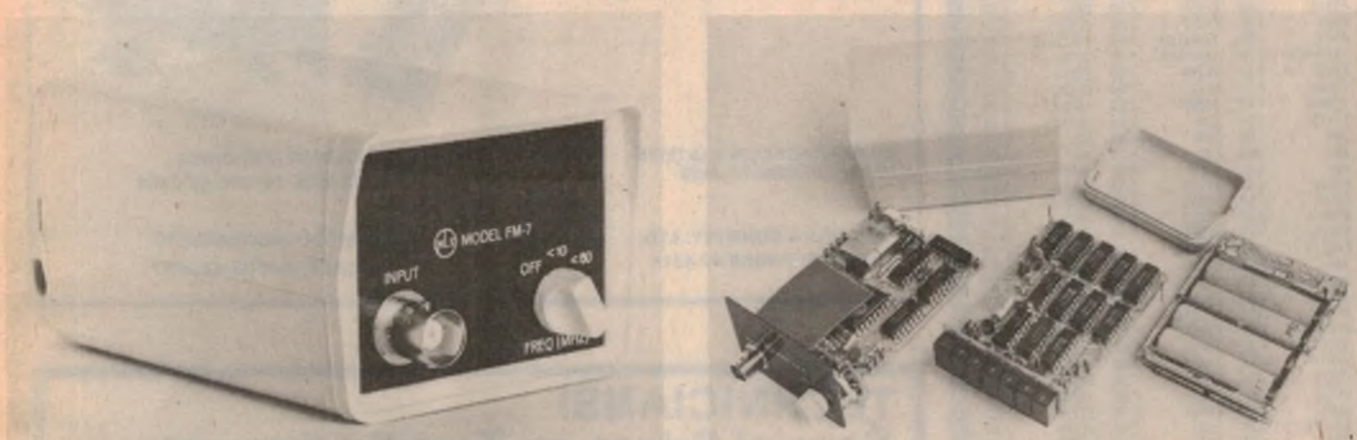
New Products

Non-Linear Systems 60MHz Counter

What is not much bigger than a packet of cigarettes and measures up to 60MHz? Answer: Non-Linear Systems' FM-7 60MHz frequency counter. It is supplied complete with AC adaptor and connecting leads at $180, plus sales tax where applicable.



Two views of the FM-7 60MHz counter in assembled and disassembled form. Most of the integrated circuits are CMOS types.

Perhaps the FM-7 is just too compact. It is difficult to treat anything as small as this a worthwhile piece of test equipment, rather than just an intriguing and pretty toy. Even the "duck-egg blue" of the case tends to give this impression.

And in practice the compact size and light weight sometimes presents a physical problem—the combined on-off switch is too small and fiddly, and the low mass of the unit means that it can be dragged off the test bench by the mere weight of test leads.

Overall dimensions of the unit are 68 x 48 x 103mm (W x H x D) while mass is a mere 272 grams.

But do not let the small size of the FM-7 mislead. Just to be able to measure up to the region of 60MHz (guaranteed to 54MHz) with a seven digit readout indicates that it is a very advanced instrument. And to pack it all in that absurdly small case makes it a boon for the technician or field serviceman.

As our photographs show, the FM-7 is a clever piece of engineering and it can be disassembled in a matter of moments. The battery box, which houses the four penlite size nickel-cadmium cells, is itself manufactured from sections of PC board —a surprising feature in view of today's labour costs.

The seven-digit display employs seven-segment LED readouts which have 9mm high numerals. All of the integrated circuits and transistors are available locally, so servicing should never be a problem.

With just one small knob and a BNC input socket, the front panel can hardly be called crowded. At the rear of the unit is a socket for DC input from the AC adaptor-cum-charger.

The charger included with the unit is manufactured locally and by comparison with the neat packaging of the FM-7 itself, is a clumsy affair. It would have been better if the power supply had been integrated with the power plug in the manner of other "battery eliminators" on the market. Better still, the power supply could be a "piggy-back" unit clipping on to the rear of the FM-7.

Discharge time of the internal batteries is two hours and recharge time is 12 to 15 hours. The unit may be used while the batteries are on charge.

We found the unit performed entirely according to the specifications. Input sensitivity was close to 30mV for frequencies below 30MHz, while above 30MHz it was close to 100mV RMS. We noted that for reliable measurements above 30MHz it was necessary for the batteries to be close to full charge, or for the mains adaptor to be used. Cut-off frequency was 54MHz—exactly as guaranteed.

There is no over-flow indication. So if you feed in 15MHz while switched to the 10MHz range, the readout is zeros. This can be misleading. The FM-7 also has a problem which is common to many counters. In the area of 10MHz or so above the cut-off frequency, it appears to go into a type of "subtraction" mode whereby the frequency indication bears no relation to the input. For higher frequencies again, the readout is zeros.

So a row of zeros on the counter may mean that there is no input or it may mean that the counter is overflowing. Part of this ambiguity would be removed if the FM-7 had leading zero suppression. This would also make the seven-digit display easier to read for low frequencies.

While we raise these minor disadvantages they should not unduly temper enthusiasm for what is really an innovative and highly usable product. Combine this FM-7 with one of the Non-Linear range of similarly compact digital voltmeters plus a modern solid state oscilloscope, and you really have a comprehensive measurement system.

While the FM-7 is available from a number of electronic parts stockists, our sample was submitted for review by Radio Despatch Service, 869 George Street, Sydney, NSW 2007. Radio Despatch Service have the full range of Non-Linear test instruments, plus a very wide range of electronic components and other test equipment.

Recommended retail price of the FM-7 60MHz frequency counter is $180 plus sales tax where applicable. Included in that price is the AC adaptor/charger, test leads and specification sheet. Optional accessories comprise a panel-mount flange, tilt-stand and leather case. (L.D.S.)

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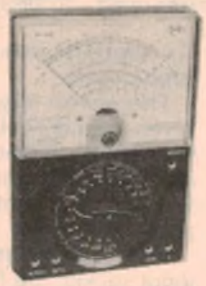

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Oscilloquartz Quartz Frequency Standard

When considering equipment for frequency standards and precision timekeeping, one generally thinks of the United States, in particular the National Bureau of Standards and the United States Navy. While the United States has possibly paved the way to a large extent, there are other countries who have made substantial contributions. Oscilloquartz SA in Neuchatel, Switzerland have been serious contenders in the standard frequency field for some time.

The piece of equipment reviewed here is this firm's Quartz Frequency Standard, Type 2200. As may be deduced from the title, this is not a Caesium Beam standard, but something more modest in the form of a precision crystal oscillator. This offers a very high order of precision—not as good as the Caesium Beam, but the lower cost makes it an attractive proposition for many applications.

The frequency standard is offered in basic form. This includes the precision crystal oscillator, outputs at 1, 5 and 10MHz, a carefully designed power supply and a standby battery of nickel cadmium cells to provide several hours of operation in the event of a mains power failure.

In addition, a considerable number of options are available. Apart from the frequency outputs just mentioned, the output frequency range may be extended from between 1Hz to 100MHz.

The unit which we have examined includes a clock module option. The clock features a digital display of the time. The design permits the time offset between its seconds pulses and those of an external reference to be measured without any additional instruments. Facilities are also included to insert leap seconds as required from time to time by international agreement. A digital phase shifter is provided by means of a number of thumbwheels, whereby the seconds pulses may be delayed by a predetermined amount.

Although it has been inferred that this is a precision frequency device, so far no figures have been quoted. According to the makers, the long term stability of the 5MHz output, is better than 1×10^{-10}/day after 90 days of continuous operation. In layman's terms, it may be re-stated as having time keeping qualities where it will be better than one second in 300 years.

The short term stability is quoted statistically for one second and ten second periods and it is in the realm of 1×10^{-12}. This is a very high order of stability and no effort will be made to express it in terms for the layman.

It is pointed out by the makers that due to the high order of stability, any comparisons and checks on its frequency stability should only be done with the likes of a Caesium Beam standard, and then only after 60 days of continuous operation. If any significant deviation is noted, then it can be corrected by adjusting a thumbwheel trimmer on the front panel. The thumbwheels are calibrated and it is possible to dial up the right amount of trimmer adjustment. After a long period of ageing, it is possible that this adjustment may not be sufficient. This is overcome by making use of a coarse frequency adjustment on the back panel.

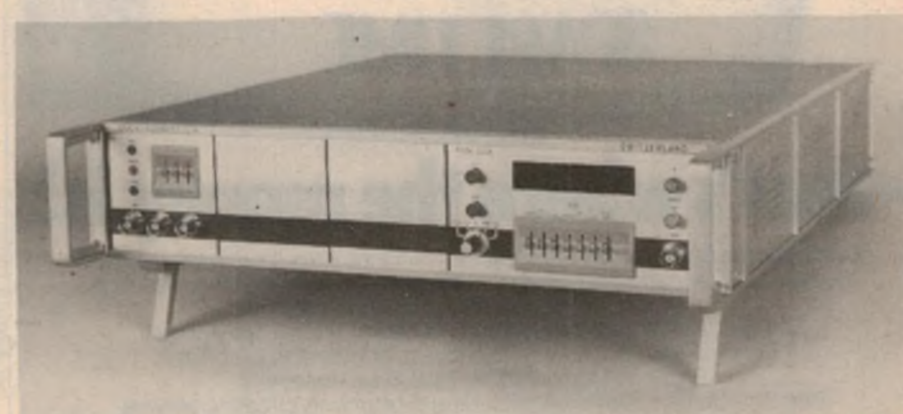
Quite fortuitously, the Oscilloquartz Frequency Standard came to my attention at the time I had got my NWC-derived Frequency Reference going (the one which is currently being described). I have been able to display the 100kHz pulses from my unit and the 1MHz output from the Oscilloquartz unit on a double beam CRO. This proved to be a very interesting exercise and it showed two points of interest as far as I was concerned. The short term stability of the Oscilloquartz unit was superior to mine but my unit was able to detect a constant drift in the Oscilloquartz. Taken over a short period of a few minutes, the drift amounted to about 1 part in 10^8, being equal to about one second in three years.

I must hasten to point out that this figure is not very flattering for such a precision instrument and that the result is of dubious validity in that the instrument was only in operation for about four hours when the reading was taken. It is interesting however, to note that with the unit switched on and off each day, that its behaviour against the NWC-Derived Frequency Reference was consistent. Suffice to say that if the Oscilloquartz Standard were left on for the prescribed 60 days, then the story would probably be quite different, no doubt giving the order of stability claimed.

In keeping with the type of device, the unit is housed in a very well finished cabinet, the panels of which are covered with a pleasing blue coloured vinyl. The cabinet fits the standard 2-unit 19in rack. The dimensions are, 428mm wide × 86.5mm high × 460mm deep. The weight is approximately 15kg.

Controls on both the front and the rear panels are virtually foolproof, in that they are either suitably locked or more than one operation must be performed to effect an adjustment. This precludes those "itchy fingers", that cannot resist having a fiddle with the controls, from upsetting the normal operation of the instrument.

An inspection of the inside shows a very high degree of workmanship and finish generally. In accordance with the options available, the whole device is divided into modules, many being of the plug-in type. As may be expected, the nickel cadmium batteries take up quite a bit of space, together with the automatic charging facilities.



The oscilloquartz Frequency Standard Type 2200 features long-term stability of better than 1 second in 300 years. Standard outputs are 1, 5 and 10MHz.

The Operating and Instruction Manual which goes with the unit is written in French and English and instructions for setting up and operating are clearly given. Circuit diagrams are given for most of the device but very little is given in the way of how all the circuitry works. With an instrument of this type, possibly the outlook of the manufacturers is to confine the more detailed type of servicing to the specialist in the particular field.

After observing the operation of the Oscilloquartz Frequency Standard, I must say that I am very impressed with all aspects of the unit. Fairly obviously, such an instrument is not going to be installed in every laboratory. I imagine that it will find a place in the more scientifically inclined establishment, where a high order of time and frequency determination is requisite.

Further details, including price, may be had on application to Australian Time Equipment Pty Ltd, 192 Princes Highway, Arncliffe, NSW 2205. (I.L.P.)

NEW PRODUCTS

Miniature power switch

C & K Components Inc has just announced its new model 9201 miniature DPDT power switch, designed to meet dimensional and electrical requirements of international specifications. Contact rating of the new switch is 6A with resistive load at 120VAC or 28VDC, 3A with resistive load at 240VAC. Electrical life is rated at 25k make-break cycles at full load; dielectric strength 1500V RMS at sea level.

Further information from C & K Electronics (Aust), PO Box 101, Merrylands 2160.

Tester-reactivator for picture tubes

The Arlunya TC.46 has been designed to meet the needs of the Australian and New Zealand TV service industry for a rugged, compact CRT tester reactivator. It had been designed to minimise the possibility of costly operator errors through application of excess heater voltage or misreading of meter scales, etc.

The TC.46 tests CRT's in situ in TV receivers or monitors, and it is not necessary to remove the tube EHT cap when testing. The base box covers the common CRT's in use in Australia and New Zealand, and separate connector leads are available for unusual types. Provision is made to accurately set up the heater

voltage from 4V to 12.6V with overcurrent protection, with a calibrated 6.3V position.

The TC.46 tests inter-electrode leakage with the tube at operating temperature, using a 300V DC test voltage between a selected electrode and all others. Emission is measured with the beam current collected at the first anode, avoiding difficult connections to the final anode.

Push-button operation enables fast comparison of the red, green and blue guns.

A cathode surface reactivate facility is included to extend the life of tubes that are not exhausted. A short circuit removal facility enables the application of a current pulse which burns out tiny metal shorts that are sometimes present in CRT's after transporting.

The instrument incorporates an insulation test facility via a built-in 100V DC, 50 Meg ohmmeter which enables many voltage dependent insulation weaknesses to be detected. This is useful for transformer primary to secondary insulation checks, chassis isolation checks, etc.

Further information from the manufacturer, Arlunya Pty Ltd, at PO Box 113, Balwyn, Victoria 3103.

Quartz chronograph has LC display

The new Seiko digital quartz chronograph features a liquid crystal display, together with the ability to function as a digital stopwatch at the touch of a button. A built-in lamp illuminates the LC display at night, when desired.

As a stopwatch, the chronograph reads

to tenths of seconds. It has a lap timing feature, also a facility to allow timing of both the winner and runner-up where times are very close. There is also an elapsed-time facility, counting to 1 hour.

Combining a watch, calendar, stopwatch and elapsed timer, the new chronograph sells for around $340 at Seiko quartz watch stockists.

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7492	Divide by 12 counter	90c.
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74107	Dual J.K. M/S flip flop	95c.
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9001	J.K. M/S flip flop (74105)	$1.30
9368	5 Bit latch BCD to 7 seg. decoder	$3.10

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LM709	14DIL	High Performance Op. Amp.	$1.00
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LM3900	8DIL	Quad Op. Amp.	$1.60

TRIACS

SC141D	400V	6A	$1.90
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SC151D	400V	15A	$2.20
SC250D	400V	15A	$8.00

SCR's

C103B	200V	800mA	$1.65
C106YI	30V	4A	95c
C106DI	400V	4A	$1.40
C122D	400V	8A	$2.00
C122E	500V	8A	$2.50

SILICONE BRIDGE RECTIFIERS

PD10	100	1.8A	$1.30
PD40	400	1.8A	$1.70
PD100	1KV	1.8A	$4.10
PA40	400	8A	$5.80
PA60	600	8A	$6.60
PA100	1KV	8A	$8.50
PB40	400	25A	$7.00
PB100	1KV	25A	$9.00

SILICONE RECTIFIER DIODES

A14A	100V	1A	20c
IN4002	200V	1A	20c.
IN4004	400V	1A	20c.
IN4007	1KV	1A	30c.
IN5624	200V	5A	$1.50
IN5625	400V	5A	$1.70
M25/400	400V	25A	$3.20
M25/400R	400V	25A	$3.20

DIACS

ST2	$1.20
ST4	90c

All chips are supplied by National Semiconductors and Motorola.

POST AND PACKAGING 50c.

Prices correct at time of going to press.
5% discount on orders over $15.00.
5% discount on quantities of 100 and over.
Please send me the following items and/or your free catalogue.

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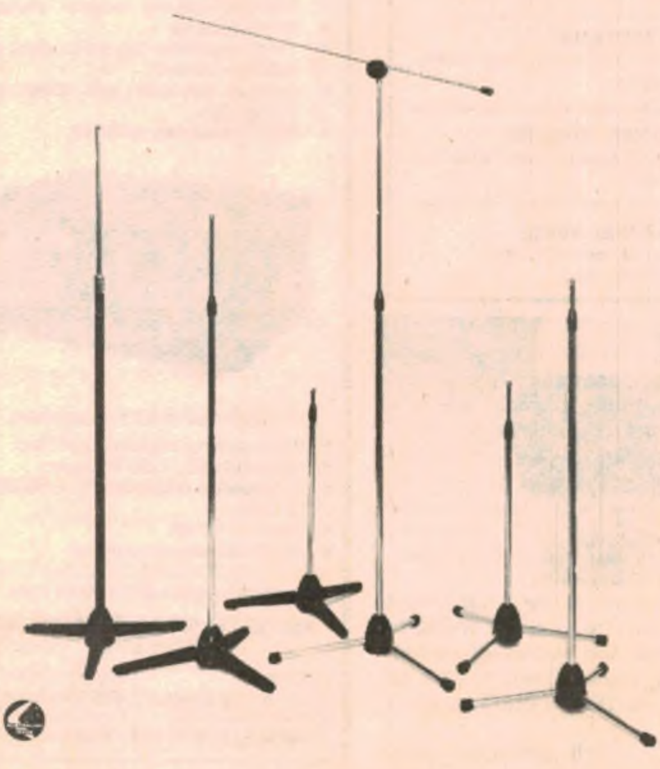
....

Enclosed is a cheque for ....

Name ....

Adress ....

.... (EA8.76)



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The stands incorporate a number of functional features which make them extremely smooth, silent and sleek . . . a well balanced combination that makes them more than comparable to anything available from overseas.

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Letters to the editor

Magazine birthday

I was very surprised to see that the April issue was the "36th Birthday Issue". Did the publishing company change somewhere along the line?

I haven't missed even one copy in 52 years. I started buying "Wireless Weekly" at that time, and through the years I thought it had only changed its name, through to monthly publications, named "Radio and Hobbies", "Radio Television and Hobbies" and "Electronics Australia"—maybe another which I have forgotten.

I started building crystal sets at that time, and built one on which I could receive 2FC, in Melbourne, faintly on a loud speaker (Horn type, naturally).

At that time the broadcast band was somewhere up at 1700 to 1900 meters (I think 3LO was 1760) without much interference, except V.I.S. and V.I.M. Whenever these stations started to transmit to ships, with "spark", everything was blotted out.

I hope you continue in your good work, and I hope I still never miss a copy. I'm still building some of your projects—and haven't they changed, from battery operated valves, neutrodynes etc!

H. N. Joy
Bonbeach, Victoria.

COMMENT: The "Birthday" referred to our existence as a technical monthly, divorced from programs and program personalities. However, it is true that our publishing traditions go back to August, 1922.

Misleading figures?

I find your magazine of considerable interest, and a valuable source of ideas. However, there are one or two things which I find to be irritating and/or frustrating! These are generally associated with errors and omissions in diagrams and text which plague editors (and readers) from time to time.

One such example which caused me no little irritation occurred in your recent Year Book. A table of frequencies for the various pitches in the Tempered Scale of music is given, the values being to 11 figures. A simple test—doubling the frequency of the lower C to check the octave shows the values are only accurate to nine figures.

As a teacher, I regularly point out to my students that it is a sign of ignorance to state results to more figures than the calculation—or calculator—is capable of giving accurately. Then to find this same thing in a published collation of reference data to me immediately casts doubt on its veracity. May I suggest that you give results only to the real accuracy of the calculation?

J. D. Smith
Hawthorn, S.A.

COMMENT: The figures concerned were calculated using a program running on quite a large computer. We were aware that the program had "rounded off" the results, but published all of the available digits in case people wished to perform further calculations. The dubious digits could then serve as "buffer" material.

Organ keyboards

I notice in your March issue you stated that electronic organ keyboards were hard to get even overseas. You did not mention England so I presume you do not know of the firm I mention below. This firm makes a wide range of organ parts at very reasonable cost—Dick Smith's prices are rather high. I was quoted £60.14 for 2 only 49 note keyboards including contacts for each manual; for one keyboard they were to supply 3 contact switches and the other 4 contacts. This includes surface post and insurance, also associated hardware.

Their address is: Kimber Allen Ltd
Broomfield Works
London Rd
Swanley
Kent BR8 8DF

Hope this information is helpful.

R.S. Cole
Mt Hagen, P.N.G.

COMMENT: Thanks for your courtesy in writing. We were aware of the firm and their products, but also of the costs in getting the products sent to Australia. As it happens, two of our advertisers have stocks of their products, and this may offer an attractive alternative. The firms are Jaycar Pty Ltd, PO Box K39, Haymarket 2000, and Maxwellectronics, of PO Box 140, Tongala 3621.

The views expressed by correspondents are their own and are not necessarily endorsed by the editorial staff of "Electronics Australia". The Editor reserves the right to select letters on the basis of their potential interest to readers and to abbreviate their contents where this appears to be appropriate.

Books & Literature

Audio servicing

AUDIO TECHNICIAN'S BENCH MANUAL by John Earl. Published 1972 by Fountain Press, London. Hard covers, 182 pages, 222 x 145mm, illustrated by pictures and diagrams. Price in Australia $9.00.

Take a broadly trained technician/repairman, give him special tuition in colour TV and you have someone particularly equipped to maintain colour TV sets. My impression of this book is that it seeks to provide an alternative—but comparable—enhancement of knowledge to assist a technician to gain proficiency with hifi equipment.

A basic knowledge of electronics is assumed and the reader is first introduced to the background and the type of instrumentation involved in this special field. Then follow four specialised chapters: Amplifier Tests—Tuner Tests—Disc Playing Equipment Tests—System Tests. A handy final chapter is "Audio Standards and Definitions".

What about loudspeakers? The author talks about them in general terms but is content to leave the instrumentation (and all the argument about its merit) to those with the rather specialised background and equipment. And I think that signifies the role of this book: it is a well written BENCH manual for TECHNICIANS, exactly as per its name.

If you already have this kind of background, and want to read about the more esoteric and controversial aspects of hifi equipment evaluation, you'll have to search elsewhere. (W.N.W.)

Well-known text

FOUNDATIONS OF WIRELESS AND ELECTRONICS by M. G. Scroggie, 9th edition, published 1975 by Newnes/Butterworth, London. Stiff paper covers, 521 pages 215 x 135mm. Price in Australia $8.50.

I would guess that there's hardly an old-timer in the Australian electronics industry who did not gain some assistance from Graham Scroggie's original 1936 "Foundations of Wireless". Since then, it has been reprinted, revised, updated, and then substantially rewritten for the 8th edition in 1971. Still more material has been added for this 9th edition, covering integrated circuits, ceramic filters, SSB radio and new photoelectric devices.

As might be expected, the 9th edition is much larger than the early versions and it indeed needs to be, to cover, as it does, the whole gamut from fundamentals to modern technology. Of necessity, the coverage of the more advanced subjects is sketchy but the reader who could absorb the contents of Scroggie's book would indeed have a good broad knowledge of wireless—sorry, electronics!

The opening preamble "Shorthand of Electronics" summarises mathematical terms, graphs, circuits and symbols and leads naturally into chapter 1: "General View Of A System"—the concept of sound, frequency, wavelength, wireless transmission and reception, and so on.

Electrons, electricity, conductors, insulators etc., make their appearance in chapter 2 and, from there on, succeeding chapters cover capacitance, inductance, alternating currents, resonant circuits, etc. Diodes and triodes (both thermionic and solid-state) are covered next, then transmitters, aerials and radiation, and all aspects of reception and receivers. Sections on modern technology take in TV and radar, waveform generators and switches, computers and power supplies.

In fact, the contents list is 9 pages long and is, itself, a most useful feature of a very comprehensive and useful textbook. Highly recommended.

The review copy came from Butterworths, 586 Pacific Highway, Chatswood, NSW 2067. (W.N.W.)

Mobile audio

AUDIO ON WHEELS by Vivian Capel. Published 1975 by Newnes-Butterworth, London. Hard covers, 199 pages, 220 x 140mm, illustrated by photographs and diagrams. Priced in Australia $14.00.

When I picked this book off the stack for purposes of review, I rather expected it to be American, to be preoccupied with the specifics of equipment on the US market and therefore to be of limited value to Australian readers. In fact, it turned out to be British, to be not the least concerned with specifics, and to be as applicable here as in that country.

The author has set himself quite a task, however, in professedly trying to cater at the one time for "the radio engineer, the motor mechanic and the amateur DIY man". The first 35 pages on the basics of audio amplification, radio reception and sound recording will be completely wasted on the already skilled. But, equally, there is no way that they will turn others into instant experts, ready to assimilate the facts peculiar to mobile entertainment gear.

Sample reading turned up a few phrases with which I could quibble but, in general, it is clearly written and illustrated. Perhaps the fairest assessment is to describe the book as a fairly basic tuitional manual, slanted towards vehicular rather than domestic equipment.

Whether it's going to be worth $14 will depend on how neatly it fits your individual need. Our copy came from Butterworths, 586 Pacific Highway, Chatswood, 2067. (W.N.W.)

The Amateur Bands

by Pierce Healy, VK2APQ

IARU prepares for WARC challenge

How will amateur radio fare at the 1979 ITU—WARC? This is a topic which should be the concern of all amateurs as well as those preparing to join the ranks of this unique worldwide activity.

Throughout the world, amateurs are being alerted by their national societies to challenges to the present status of amateur radio at the 1979 ITU World Administrative Radio Conference. A highlight of this activity was an International Amateur Radio Union meeting in Miami, USA, in April, 1976. This was held following the IARU Region II Conference.

Participating in the meeting were:—IARU Headquarters: Noel B. Eaton, VE3CJ (president); Richard L. Baldwin, W1RU; David Sumner, K1ZND. IARU Region I: Louis Nadort, PA0LOU (chairman); Roy Stevens, G2BVN (secretary). IARU Region II: Victor Clark, W4KFC (president). IARU Region III: Michael Owen, VK3KI (director).

In addition, from The Radio Society of Great Britain: John Allaway, G3FKM (president) and Tim Hughes, G3GVV. The Japan Amateur Radio League: S. Hara, JA1AN (president). The Wireless Institute of Australia: David Wardlaw, VK3ADW (president). The Luxembourg Radio League: Jean Wolff, LX1JW. USKA Switzerland: Harry Laett, HB9GA.

For the information of non-members of the WIA, the following statement (from the WIA official magazine, "Amateur Radio"), was issued at the conclusion of the inter-regional meeting.

"Meeting in Miami, Florida, over six days in April, 1976, officers and directors of the International Amateur Radio Union and its three regional organisations discussed in depth the problem facing radio amateurs in preparation for WARC-79, and solutions to those problems. Deliberations resulted in the following actions:

"(1) The need for close liaison amongst the regions was recognised, as was the desirability of conformity between the regions where possible. The avoidance of duplication of effort by separate regions was also acknowledged. In lengthy informal meetings the representatives of the regional societies were able to prepare a basis for a position paper that could be used as a model by IARU member societies or others, as appropriate.

"(2) Detailed consideration was given to the frequency needs of the amateur service, as indicated by position papers already submitted by several societies.

"(3) Changes in various definitions and radio regulations were discussed at length.

"(4) Consideration was given to dates and importance of several regional and international meetings that are scheduled, and attendance of suitable amateur representatives was discussed.

"(5) There was detailed comment on, and analysis of, the preparation in each region by several major societies represented.

"(6) The president of IARU asked that there be a meeting of Roy Stevens, Michael Owen, Victor Clark, David Sumner and himself in Geneva during September, 1976 (at the time of the ITU—IFRB Frequency Management Seminar) to finalise the document described in paragraph (1) above.

"(7) It was agreed that there should be a guide available for those who might be travelling abroad and who might be willing and capable of assisting in WARC preparatory work. IARU Headquarters staff agreed to work on this.

"(8) There was an analysis of the WARC newsletter and the functions it is supposed to be serving.

"(9) There was extensive discussion of the problems which arise when there are competing societies in a country, and it was agreed to continue with the existing policy, which discourages official IARU contact with such societies.

"(10) It was agreed that the contests and awards committee of the American Radio Relay League would study the feasibility of establishing an IARU award, whose purpose is to encourage amateur knowledge and interest in IARU.

"(11) Finally, there was extensive discussion of the need for adequate representation on each administration's delegation to WARC-79."

A fact to be mindful of is that the ITU-WARC decisions in 1979 will probably affect amateur radio until the year 2000.

There are at present 148 member countries of the ITU, each with equal voting rights. Administrations of each of these countries will prepare submissions for the WARC.

A delegation under the control of the Australian Postal and Telecommunications Department will be presenting the Australian case. The Australian preparatory group is meeting regularly to examine submissions by interested parties. This group consists of seven committees, each studying a particular aspect of matters to be discussed.

The committees are—1. Aeronautical; 2. Amateur; 3. Broadcasting; 4. Fixed, mobile, standard frequency, Special requirements; 5. Maritime; 6. Space (including radio astronomy); 7. Radio determination.

The federal president of the WIA Dr David Wardlaw, VK2ADW is the convenor of the amateur committee. Draft terms of reference have been stated as:—

1. To determine Australian requirements for amateur and amateur satellite services for the period covered by the WARC.

2. To co-ordinate Australian amateur and amateur-satellite service requirements with the requirements of other services.

3. To examine proposals submitted for consideration by the committee.

4. To prepare and submit draft proposals for the work of the conference to the Australian preparatory group in the form of modification, deletions, or additions to the radio regulations.

5. To make recommendations to the Australian preparatory group concerning Australian attitudes to the work of the conference, including attitudes to proposals by other administrations, for inclusion in the Australian brief for the WARC.

6. The chairman of the amateur committee may establish working groups whose terms of reference do not exceed those of the committee.

It should also be realised that the terms of reference may be varied by subsequent decisions at meetings of the Australian preparatory group.

Because the WIA has been officially recognised as representing all Australian amateurs, it is imperative that non-members of the WIA express their views to the committee, and not blame the WIA for shortcomings at a later date. The most effective way to ensure that views are considered is to join the appropriate state division and add weight to their representations.

RADIO CLUB DIRECTORY

An invitation is extended to radio clubs to supply details for the Radio Club Directory in the December, 1976, issue of these notes.

Only details received between now and 19th October, 1976, will be included.

Please give details in the following format.

Club name:— ....
Club call sign:— ....
Meeting place:— ....
Day and time:— ....
Affiliation:— ....
Net frequency:— ....
Contact:— ....

In past years this facility has been the means of publicising your club and assisting visitors and prospective members in your area.

Do not delay—write now.

REMEMBRANCE DAY CONTEST

The annual RD contest, sponsored by the WIA to perpetuate the memory of Australian amateurs who paid the supreme sacrifice in World War II, will be held over the weekend 14th—15th August, 1976.

All Australian and New Zealand amateurs are invited to participate.

Rules for this year's event had not come to hand as these notes were being compiled. However, the format will be the same as previous years and the contest will commence at 1800 hours EAST, preceeded by a recorded address broadcast over WIA official stations.

THE CYPRUS AWARD

The Cyprus Award Certificate has been sponsored by the Cyprus Amateur Radio Society. It will be awarded to any licensed amateur radio operator outside Cyprus who makes a specified number of two-way contacts with licensed amateurs on the island of Cyprus. The conditions are set out below.

To reduce as far as possible any advantage accruing to stations by reason of their geographical location, and to encourage activity on the less frequently used bands, the certificate will be awarded on a points basis determined by zone location and band. This is shown in the table.

The total points required to win the award is dependent on the number of bands used:

If all contacts are made on only one band—32 points are required.

If on any two bands—24 points are required.

On any three bands—16 points are required.

On any four bands—12 points are required.

Any mode may be used, but operation must be in accordance with standard amateur practice. Contacts to count must be made after July 1st, 1962. A certificate awarded for contacts made in the VHF bands will be suitably inscribed. Contacts with any one Cyprus station can only count once per band.

To claim the award, copies of log entries should be submitted under the following headings:

Date/Time GMT; station worked; frequency band; signal reports sent and received. Each log sheet should be headed with the call sign, zone number and full postal address, preferably typed or printed in block capitals. These should be supported by the appropriate QSL cards or a certificate from the applicant's national society certifying that the QSL cards have been produced to them. In countries without a national society a similar certificate signed by two other amateurs will suffice.

Radio clubs and other organisations, as well as individual amateur operators, are cordially invited to submit news and notes of their activities for inclusion in these columns. Photographs will be published when of sufficient general interest, and where space permits. All material should be sent direct to Pierce Healy at 69 Taylor Street, Bankstown 2200.

AMATEUR BAND Mc/s	1.8	3.5	7	14	21	28	144	432
ZONE		Points Scored Per Contact						
20	4	2	0	1	2	4	16	32
1, 2, 3, 6, 7, 10, 12, 19, 24, 25, 26, 27, 28, 29, 30, 31 and 32.	16	8	4	2	4	8	+	+
All Other Zones	8	4	2	1	2	4	16	32

Log sheets accompanied by ten international reply coupons (IRC's) or equivalent should be sent to :—

Awards Manager, Cyprus Amateur Radio Society, PO Box 1267, Limassol, Cyprus Republic.

Log entries will be checked and, at the discretion of the CARS, the certificate will be awarded. Unsuccessful applicants will be notified of the reason for rejecting their claim.

FOOD FOR THOUGHT

If a particular award is being sought, is being helped to make contact with a particular call area or a rare DX station really in keeping with the spirit which prompted recognition of such contracts?

Does being advised by landline or VHF channel that such a station is on the air detract from the achievement of making the contact for an award?

Do such contacts equate with those "made under your own steam"?

Is it being fair to a fellow amateur who may not be reached by landline or VHF that he has not the opportunity to "keep up with the Jones's"?

How many times do you hear a station which has a good signal path with a DX station or an exotic call area say: "Will you listen for a friend of mine? His name is . . . his call is . . . he comes from . . . and he would like a QSO to help towards the . . . award.

The thoughts arose from reading and discussing an article in "CQ" February, 1976, "Thanks, I needed that one". Maybe it is the accepted practice. What do you think? Here are some extracts from the article.

"Somewhere between making DXCC and making the Honor Roll, every DXer reaches the point where it is harder to find new countries than it is to work them.

"Members of the National Capital DX Association have found a way to help each other keep up the pace. It's called the Needed List, and it's dynamite.

"The Needed List is a five page register of who needs what. Each country is listed by prefix, followed by the calls of each NCDXA member who needs the country. The list is neatly typed and revised several times a year by our hardworking secretary.

"Everyone whose call is on the list keeps a copy in the shack. If a 9Q5 puts in a sudden appearance on 20 metres, we know immediately who needs it. Word goes out quickly on our 2-metre simplex frequency, and any members who are not monitoring receive a call on the landline.

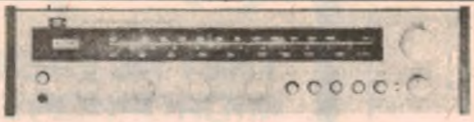
"Page one of the Needed List lists all members by call and name, and also gives their home address and office telephone numbers. If a really rare one shows up in the middle of the day, it's surprising how many suddenly decide to take extended lunch hours."

The article mentions two pitfalls. One is the failure of a rare station to appear after members had been alerted and in some contests such contacts would place you in the multi operator category.

Referring to the latter, should such type of contact

136 VICTORIA RD . MARRICKVILLE, NSW 2204 PHONE 51-3845

A.C.E. RADIO



EXPO FM/AM/MPX STEREO RECEIVER

Top-quality, low-cost home entertainment. Illuminated dial, brushed aluminium panel, walnut cabinet.
420 x 330 x 100mm high model DX 2400. Specs. 12 + 12 W RMS-freq response 30-25,000 Hz: Distortion better than 0.8%. Inputs for mag. ceramic tape, aux., bass, treble, loudness controls. FM-88-108 MHz SEN/2.5 UV. only **$129.95** p.p. N.S.W. $7.50 reg.

PLAYMASTER 25 + 25 STEREO AMPLIFIER

Complete kit of top quality parts **$89.00.** Fully constructed **$118.00.** P.P. N.S.W. $3.50, interstate $4.50.

Chassis and cover only **$16.95** p.p. $3.50. Brushed aluminium front label **$7.30** p.p. $1.20. Printed circuit board **$4.95** P & P $1.00

MUSICOLOUR II

Magical Colour Organ operates in conjuction with your home stereo or PA system—simple to connect and operate. 3 channels, 1,500 watt max load per channel.

Complete kit of parts	$59.50
Constructed ready to operate	$69.50
P&P	$2.50
Interstate	$3.50

PLAYMASTER 3-45L
LOUDSPEAKER SYSTEM

Features the mighty 8-30 woofer. 6J midrange and the incomparable Philips AD016/T8 tweeter. This top quality low cost 3 way hifi system is available from stock in either walnut or teak veneer and complies with the specs as per April '75.
$84.00 EACH

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Latest design speed auto or manual operation. 11in heavy weight diecast turntable driven by fully shielded 4 pole dynamically balanced 240V motor. Noise suppressor. Silicone damped cueing device. Square section brushed aluminium pick up arm. Adjustable counter-balance. Calibrated stylus pressure control. Antiskate bias compensator fitted with magnetic cartridge diamond stylus **$55.00**
Postage NSW $1.85. V, Q, SA, T **$3.50**. WA **$5.50.**
Postage: Reg. N.S.W. $3.60. Q., V., S.A. $4.75 to $5.50 W.A. $6.75 **$55**

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3 speed auto/manual changer—player 2 spindles. Motor, 2 pole 240V 50Hz. 10½" turntable, cue and pause, tubular section pick up arm. Sonatone cartridge, diamond stylus. Great value **$28.50** P.P. Reg N.S.W. $3.60. Q., V, S.A. $4.75 T. $5.50 W.A. $6.75. Pre-cut base **$14.50**. Perspex cover **$14.00** add p.p.

GUITAR AMPLIFIER

50 watts RMS solid state guitar amplifier. PM125 4 inputs, 2 channel with separate volume, bass and treble controls; speed and intensity controls for vibrato. Remote foot switch with plug and lead. Black vynex carry cabinet. Fully constructed and ready for operation off 240VAC **$125.50**

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8-16 OHMS	30-16,000Hz
6WR MK5 12W RMS	$9.90
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10WR MK5 16W RMS	$11.50
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P&P	0.65

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Send S.A.E. for full technical specs. and super low price **$135**

NEW MODEL MAGNAVOX SPEAKERS

10-40 10" base. 8 ohms **$20.95**. 625 6" mid range 8 ohms **$14.95**. XJ3 dome tweeter **$7.80**. Famous 8-30 8 ohms **$13.50**. Magnavox 3 way cross-over for 10-40, 625 and 2 XJ3 **$19.50**. P & P N.S.W. $1.40. Interstate $2.20

WESTON 5 WATT C-B TRANSCEIVER

Great boat or mobile rig. Auto noise limiter, squelch, A.G.C. over-mod. limiter. Low pass filter for bandwidth. SPECS. T-mitter. Crystal locked, 5 watts input to RF stage. Freq. coverage. Any 11 channels in 27 MHz band. Receiver, crystal locked, double superhet. 6.5 MC and 455 Kc. 1fs 3" speaker, dynamic mic. 50 ohm antenna. 20 t'sistors. 8 diodes. 12VDC operation. Sensitivity. 0.5UV 10dB S/N. Size 6½" x 2½" x 7¾". Wt. 4½ lbs.
PRICE $135.50 p.p. N.S.W. $4.50, Interstate $5.50

HI FI CABINET KITS

Do it yourself—big savings. Our kits are extra easy to finish. Top, bottom, each side and back are factory assembled, baffle is pre-cut. Veneered pyneboard. Teak or walnut. Complete with innerbond and speaker grille cloth. 8-30. 3-45L, 3-41L systems **$48.00** pair
MV-50 system **$65.00** pair

CROSS-OVER KITS

3-45L Kit $7.85 each
3-41L Kit $9.75 each
Add $1.50 p.p.
1MH 0.2MH 0.35 MH
Chokes $2.00 ea. p.p. 80c

KENWOOD TRIO OR 666 COMMUNICATION RECEIVER

New improved version. Send SAE for full tech. data. **$265.00** plus freight.

SANYO NI-CAD
Rechargeable Batteries

Type A Penlight **$1.85** ea. 4 for **$6.90.**
Type C **$3.20** ea. 4 for **$11.50.**
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P.P. N.S.W. $1.00 other states $1.75.

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WHEN IT COMES TO + — ÷ x % ETC.

Be smart. Let the MPI 8 digit 5 function, electronic brain do it for you. Only **$12.95** p.p. $1.50.

TAB POTS—'A' CURVE

3 meg. 2 meg. 1 meg. 250K. 50K. 25K. 2.5K. 1K. 10 for 95c p.p. 55c tandem W/W pot ¼" shaft. 30K. 20 watts **$2.75** p.p. 75c. Colvin 1K 3 watt W.W. short shaft ¼ x ¼ 75C

AM/FM STEREO TUNER

$69.95

Illuminated, easy to read dial. Nice walnut cabinet, 11" x 7 x 3½" H. 240V 50H2 power. Specs. FM freq range 88-108 MHZ. Sen 5 UV for 30dB S/N. Sig to noise, 55dB. Dist 1% AM 525—1650 KHZ sen 300UV/M. Sig to noise 40dB. Output 200MV. Size 290 x 180 x 100mm H.
p.p. N.S.W. $3.50. Interstate $4.50.

PLESSEY X20 HORN TWEETER

3-30KHZ. 20W. 80 ohms. **$9.95.**
p.p. $1.50.

RESISTORS

3 watt. 50.100, 180, 750, 390, 470, 1K. 1500, 4700, 10K, 15K 33K, 1meg. 5 watt. 750, 1500, 5K, 10KJ.
Mixed 10 for **$1.75** p.p. 75c.

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Add $2.50 p.p.

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Solid back
300-6000Hz
$11.95 p.p. 90c.

LEADER LSG-16 R.F. SIG. GEN

Solid state. 6 bands. 100 KHz to 300 MHz (90-300 MHz calibrated harmonics) RF output. 100 MV to 35 MHz. Int. mod. 1 KHz ext. mod. 50 Hz 20 KHz audio output. 1 KHz 1V crystal osc. 1-15 MHz 240V 50 Hz power. Size. 150 x 250 x 130mm **$63.95**
P.P. N.S.W. $3.50, Interstate $4.50

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be accepted for awards as individual achievement or rather classified as a contact for a club station?

A little help is always appreciated and is an attribute of amateur radio. But using that help to indicate that you are an above average DX operator is—or does it depend on one's conscience? What do you think?

Do you disagree, or is it food for thought on how to get those contacts?

Maybe it could be classified as an extension of the publicity given to impending DXpeditions or spreading the news of band openings.

WIA YOUTH RADIO CLUB SCHEME

A successful meeting of the NSW division, YRCS committee, was held at the Gosford High School on Sunday 20th July, 1976. Representatives from Sydney, Newcastle, Central Coast and Blue Mountains areas attended. It was decided as a temporary measure that short-wave listener's awards issued by the Sydney DX group and the Westlakes Radio Club would be made available to YRCS members who log the required number of stations.

A weekly schedule on 3560kHz has been set for YRCS stations each Friday night at 9.00pm.

RADIO CLUB NEWS

AUSTRALIAN CAPITAL TERRITORY DIVISION WIA: The May 1976 issue of "Forward Bias", the monthly newsletter of the ACT Division, contains interesting details of the Canberra repeater and the news that plans are being prepared for a second repeater at Mount Ginini.

The present repeater, VK1RAC is located at Mount Majura, elevation 888 metres. The site is controlled by the Department of Transport which operates, on a 24 hour basis, a 3000MW ERP 12GHz radar, plus VHF/UHF DME and communication links.

The Department's antennas are on a 31 metre mast. VK1RAC's antennas are also on this mast, at the 11 metre level. The main operations building is temperature controlled and commercial power is normally used. In the event of a power failure backup generators are used and come into operation within 20 seconds. VK1RAC is housed in the main building and is constructed in standard 19 inch box form. A standard PMG type rack, complete with 240 volt AC, was made available by the Department.

The transmitter is a modified STC MTR151 with an output power of 10 watts. The receiver is a modified STC MTR 131 with a narrow band crystal filter fitted for the first IF at 10.7MHz. The receiver will accept deviation up to approximately 10kHz peak without significant distortion. The interface from the receiver muting circuit to the control logic is a miniature reed relay operated from an LM311 comparator IC, which provides additional sensitivity and positive switching.

The power supply is a 13.5V, 10A regulated unit using a uA723 voltage regulator IC, two parallel series pass 2N3055's driven by a single 2N3054.

The antennas are two vertical skirted dipoles mounted 4.9 metres apart on a horizontal wooden boom fed with double screened type RG9B/U cable.

Due to the close proximity of the transmit and receive antennas extensive filtering is provided by five quarter wavelength coaxial filters.

The timing and control unit uses the 7400 series TTL logic with all timing derived from a single NE555 clock generator. The call sign VK1RAC is in F3 mode, approximately 3kHz deviation, 800Hz tone at 9.5WPM. The call sign is generated from a 256 bit programmable read only memory (Signetic 8223). The first time out is at 3.5 minutes for 0.5 minute and final time out at 4.5 minutes. The time out is automatically reset when the incoming carrier is released.

GEELONG AMATEUR RADIO-TV CLUB: The GARC was successful in the John Moyle Memorial National Field Day Contest.

Operating portable from Mt Cowley, members scored over 5000 points; the highest score in the phone section. As well as winning the phone section, the score was only 200 points behind the winners of the open section, VK3ATM, the Melbourne University Radio and Electronics Club.

The GARC is in its 28th year of operation. Founded in 1948, the club has used four different locations for its meetings and now owns its own premises. The present committee recently gave approval to Mike, VK3ASQ, to produce a film on the club's history.

This history makes interesting reading and Mike hopes to turn this into a super 8 colour film with sound track. However, there is a lack of information; particularly photographs of the 1948-1960 period. Mike would welcome the loan of any photographs, colour slides, newspaper clippings, etc.

WESTLAKES RADIO CLUB: The status of the WRC and its worth to the community has been highly commended by those associated with community affairs. The most recent evidence of this was given in a letter received from the Hon. R. Jackson, MLA, NSW Minister for Youth and Ethnic Affairs, advising that a grant of $1000 had been made for the purchase of equipment.

The Novice Licence Manual by Keith Howard, VK2AKX, published by the WRC is well on the way to being a best seller in the field of amateur handbooks for the beginner.

Copies may be obtained by writing to the Secretary, Westlakes Radio Club, PO Box 1, Teralba, NSW 2284.

The price is $2.50 post paid anywhere in Australia.

CRESTWOOD RADIO CLUB: Formed in July, 1974, the CRC has 36 members aged from 12 to 17 years. The club is under the guidance of Mr Bob Lloyd-Jones and meets at 16 Turon Avenue, Baulkham Hills, NSW, each Saturday night. Membership fees are 30 cents each night attended.

The format of the Saturday night meetings is 7.15 pm to 7.45pm—Morse code practice; 7.45pm to 8.45pm—theory instruction; 8.45pm to 9.00pm—supper; 9.00pm to 10.00pm—practical work.

For theory instruction there are two sections, novice and advanced, and it is expected that ten members will sit for the novice licence and three for the AOCP at the next PMG Dept. examination.

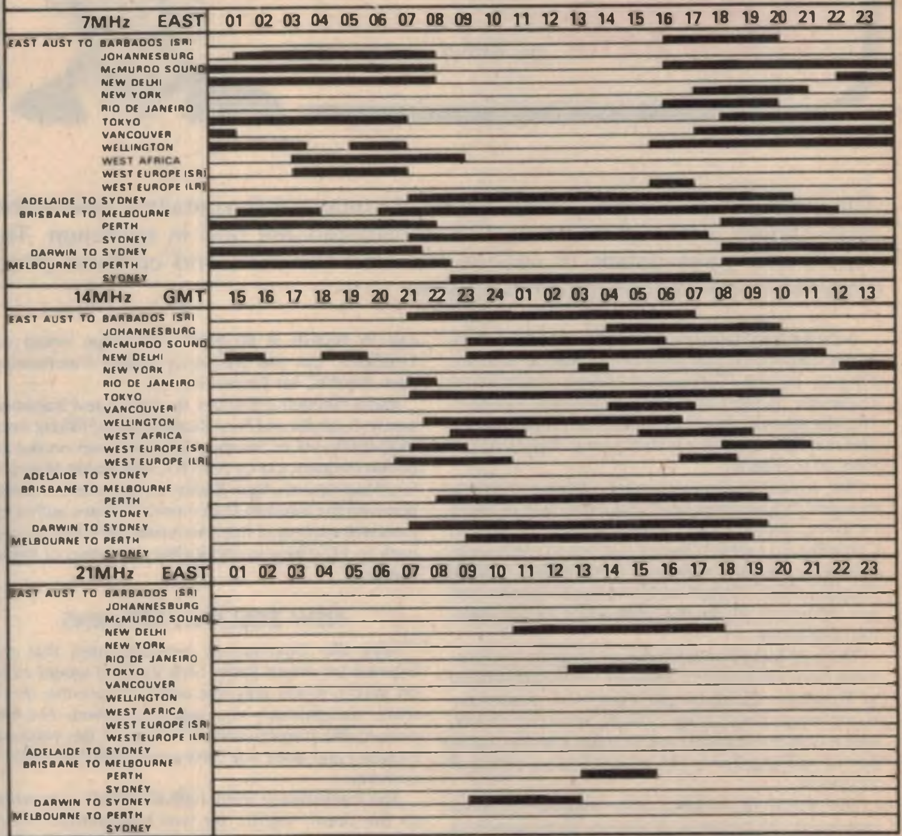
On the third Saturday of each month there is a general discussion on digital electronics and once a month there is a general business discussion on club activities.

The club has received an invitation to take part in the 1976 Orange Blossom Festival, an annual event in the Hills District. Plans are to take part in the procession and stage a display publicising the WIA Youth Radio Club Scheme and amateur radio.

There is no age limit for club membership and the only requirement is a keen interest in radio and electronics. Intending members may obtain further particulars from the Secretary, Robert Beggs, Crestwood Radio Club, 16 Turon Avenue, Baulkham Hills, NSW 2153.

IONOSPHERIC PREDICTIONS FOR AUGUST

Reproduced below are radio propagation graphs based on information supplied by the Ionospheric Prediction Service Division of the Department of Science. The graphs are based on the limits set by the MUF (Maximum Usable Frequency) and the ALF (Absorption Limiting Frequency). Black bands indicate periods when circuit is open. 8.76



Shortwave Scene

by Arthur Cushen, MBE

The Voice of America has recently released a report giving details of their global relay station, which shows that 113 transmitters are now in operation. The report also gives details of various technical facilities, and contains photo material on the various transmitting sites.

In the United States the Voice of America is operating 41 transmitters and these are located at Bethany, Ohio 6; Delano, California 8; Dixon, California 8; Greenville, North Carolina 18; Marathon, Florida 1. The Marathon transmitter operates on medium-wave and the others are all on short-wave. Power ranges from 50 to 500kW.

The Voice of America relay stations overseas include 72 transmitters which use the power of 35kW or over. These include Bangkok, Thailand 1; Colombo, Sri Lanka 3; Kavala, Greece 11; Monrovia, Liberia 8; Munich, Germany 5; Okinawa, Ryukyu Islands 4; Poro, Philippines 8; Rhodes, Greece 3; Tangier, Morocco 10; Tinang, Philippines 13; Woofferton, England 6.

Three of these transmitters operating on medium-wave have the power of 1,000kW. These are located at Bangkok, Okinawa and Poro. The short-wave transmitters range from 500kW down to 35kW, which is the power used at Colombo. The total number of transmitters is 113 and the total output is 23,010kW.

The Voice of America also employs technical monitors in 50 locations in all parts of the world. In the Pacific area, these are located at Perth, Melbourne and Maroubra in Australia, and at Invercargill, New Zealand.

QATAR EXPANSION

According to the BBC Monitoring Service the State of Qatar is to build a new radio station, supplementing the existing installations, as part of the Information Ministry's plan to make Qatar's voice heard in as many parts of the world as possible. There are also plans to improve the present high frequency transmitters for transmissions to Europe and the Americas. The new station is expected to be operational in 20 months.

MEMORIAL CARD

Radio Nederland has issued a special verification card to mark the death of Edward Startz. This special card is being issued when the station confirms reception reports and shows a recent photo of Edward Startz at the microphone. As well as the photo, the card traces the history of Edward Startz and the Happy Station Program which was broadcast from Holland for over 40 years. Edward Startz was born on 20 February 1899 and died on 18 March 1976.

SWEDEN'S NEW CHANNELS

Radio Sweden at Stockholm is now using a new frequency in its service to the Far East from 1200-1330GMT, and this is 15120kHz which replaces 15275kHz. Stockholm has also been noted in English at 2300GMT on 6120kHz in a transmission to North America. This transmission is on the air to 2400GMT, with the last 30 minutes in Swedish. A further broadcast in English at 0030GMT has been noted on 11955kHz, but this frequency suffers interference from the BBC Far Eastern Station.

Radio Sweden continues to carry a test transmission to Australia and New Zealand on 11705kHz from 0630-0800GMT in Swedish. This has been on the air on this frequency since March 7, and during May suffered interference from Radio France. After consultation with the Swedish Telecommunications authority, Paris was advised of this interference and has moved back to 11710kHz to allow clear reception of Radio Sweden.

Notes from readers should be sent to Arthur Cushen, 212 Earn Street, Invercargill, NZ. All times are GMT. Add 8 hours for West, 10 hours for East and 12 hours for NZT.

NEW ZEALAND RETURNS

After the Government announcement that the External Service of Radio New Zealand would close on May 1, it was only five weeks before the short-wave transmission was again resumed. For the present the transmission is a relay of the National Program and does not carry any special short-wave content.

The transmission from 1800-0700GMT is beamed to the South Pacific on two transmitters. From 0700-1030GMT only one transmitter is beamed to the South Pacific, and the other to Australia.

It is understood that the mail received from listeners from the South Pacific, Australia and throughout the world was the reason for the change in policy. The Minister of Broadcasting, in his announcement concerning the recommencement of the service, said this would be a much cheaper method than sending telex news to radio stations in the area.

There were many letters of concern when the station closed and the first comment on its re-introduction to short-wave came from DX Post in Adelaide, which said "Welcome back New Zealand—May was a long month without your pleasant programming".

CANADA FREQUENCY CHANGE

Radio Canada International has been broadcasting to the South Pacific on the same two frequencies for many years, but recently a change of frequency was made. There have been changes in the transmission time over the years and the present broadcast is 1000-1100GMT.

The frequency change concerns 9625kHz, which has been replaced by 9570kHz. The reason for this is that co-channel interference form 1030GMT was noted from Radio Canada's Northern Service, which is also broadcast on 9625kHz. This meant that for the last thirty minutes two transmissions from Montreal were received on the one frequency and though in theory interference should not be significant it was proved otherwise. The same service to the South Pacific continues to be carried on 5970kHz.

LATIN AMERICAN NEWS

BOLIVIA: Radio Panamericana at La Paz has been heard on 6035kHz at 1100GMT. The station was noted by Jack Buckley of Sydney around 1055GMT and followed until after 1150GMT. Our own reception was at 1100GMT when full station identification was given and from this we learn that the call sign is CP92 and the schedule is 1000-0500GMT. CP92 employs a woman announcer, who gives station identification after every second record.

PERU: Radio Santa Rosa in Lima on 6045 has been heard by Jack Buckley at 1055GMT with typical Spanish programing, but the signal suffered from interference from Radio Malaysia. The transmission could be heard till after 1200GMT.

MEXICO: Radio Mexico on 15385kHz has been giving fair reception in New Zealand up to sign-off at 0350GMT. Latin American music is played with full announcements each thirty minutes. The station leaves the air abruptly after an announcement at 0350GMT.

COSTA RICA: Radio Capital has changed name and is now heard as Radio Ajos. Other identifications used are Emisora Ajos, Radio Reloj numero uno Costa Rica. Transmission frequency is still 4832kHz. The same program is heard on 6006kHz and this frequency operates 24 hours a day, but transmissions on 4832kHz appear to close at 0730GMT.

LISTENING BRIEFS
EUROPE

HUNGARY: Radio Budapest has been noted opening at 2200GMT on 7180kHz with a transmission in Spanish. This is a new frequency and signals are fair, though the BBC Far Eastern station also opens at this time on 7180kHz with a service in Japanese.

POLAND: Radio Warsaw broadcasts to North America in English 0200-0230GMT and 0300-0330GMT. The period 0230-0300GMT and 0330-0400GMT is in Polish. New frequencies have recently been announced for these transmissions and these are 6095, 6105, 6183, 9675, 11815, and 15120kHz. The best reception in this area has been on 6095kHz, though for the last hour of the transmission there is some interference from HCJB, which is using the same frequency.

SPAIN: The new transmission in English from Madrid for listeners in Europe has been heard on 6075kHz in place of 5955kHz. The broadcast in English is heard daily except Sunday, 2030-2130GMT on 6075kHz and repeated 2130-2230GMT on 6075 and 9505kHz.

AFRICA

SOUTH AFRICA: Radio South Africa is using some low frequencies for its service to Central Africa, and signals have been noted in English up to 0426GMT on 4875kHz. The same transmission is on 3230 and 3995kHz, while a session in Lozi is broadcast 0428-0458GMT on 3995 and 4875kHz. The signals are best on 4875kHz as 3995kHz suffers interference from Deutsche Welle.

BURUNDI: According to a recent verification received by Peter Bunn of Melbourne, Radio diffusion Nationale du Burundi at Bujumbura has recently expanded its transmission times. The schedule is now as follows: 0600-1600GMT on 6140kHz using 25kW; 1600-2100GMT on 6140kHz using 10kW; 0330-0600GMT on 3300kHz using 25kW; and 1600-2100GMT on 3300kHz also using 25kW.

ASIA

TAIWAN: The Voice of Free China at Taipei is operating to the following schedule according to Bill Vogel of Adelaide. English is broadcast to Australia from 0200-0300GMT on 11825, 15345 and 17890kHz; to North America 0300-0400GMT and 1830-1930GMT on 11825, 1534 and 17890kHz; and to the Middle East 2000-2100GMT on 9570, 11860, 15370 and 17720kHz.

SARAWAK: Radio Kuching has been observed on 6060kHz at 1130GMT. Our reception at this time found a good signal and the station carried a news bulletin in Iban. This frequency is seldom reported in this area.

AFGHANISTAN: Radio Kabul has been heard by a Japanese listener on the new frequency of 3284kHz, from around 1300GMT until after 1700GMT. A program in Urdu was noted until 1400GMT, then English from 1400-1430GMT. This frequency replaces 4775kHz.

NORTH KOREA: Radio Pyongyang is being widely reported with good reception on 9420kHz during its English broadcast. The two transmissions best received are 2000-2100GMT and 1000-1100GMT. This frequency also carries an English program from 1200GMT.

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INFORMATION CENTRE

1976 AUTODIM: I have been buying E.A. for around 20 years now and have built, quite successfully, many projects. I attempted the Automatic Light Dimmer of January 1976, but have had little luck with it. When set on Manual, the lamp will dim and brighten manually for a few minutes, and then will not dim below about ¼ brilliance.

When switched to either increase or decrease, the lamp switches immediately to full brilliance. I am quite sure the circuit is wired correctly (they all say that!), and I went to the expense of buying another SL440 (quite expensive), but nothing altered.

I am hoping you will be able to shed some "Autodim Light" on my problem. (W.J.G. Hawthorn, Vic 3122.)

● We are unable to shed any light on why the lamp functions normally in the manual mode for a short time, and then starts to misbehave. However, its failure to operate in the automatic modes may be due to excessive leakage current in the 2500uF electrolytic capacitor. This can be cured by reforming the capacitor. Remove it from the circuit, and apply its maximum rated DC voltage through a 1k resistor for about ten minutes. Then simply reconnect it to the circuit, and check for correct operation.

TAPE CORRESPONDENT: I wish to tapespond with anyone about hi-fi stereo, electronics or shortwave, on either open reel (any speed, and reel sizes up to 19cm) or cassette—stereo or mono, Dolby or Cr02. Would you please print my name and address so that interested parties can contact me directly. Thanks for a very enjoyable magazine—keep up the good work. (Mr Michael Stevenson, "Attunga", RMB 59, Harden, NSW 2587.)

● We have done as you asked. Thanks for the compliment.

CRITICISMS: I have been reading EA for some years now, and find the news and project articles of considerable interest. Your staff are doing a fine job in providing this material for both students and hobbyists. However I have some criticisms. The first is that the magazine seems almost entirely practical, with little theory. A few pages each month giving the complete design procedure for a small project would surely be of great interest and value. The second point is that I would like to see more material on digital electronics, especially theory. Finally, could you tell me why my copies of the magazine take more than three months to reach me here in India? (D.P.Rao, Secunderabad, India.)

● We try to include as much theory as possible, Mr Rao, but this depends on staff commitments and the articles submitted by outside contributors. We will certainly look at the suggestion regarding articles giving full design information on small projects or circuit modules, however, As for digital electronics, by now you will no doubt have seen that we are updating our earlier study course on this subject. We hope this is of interest and value to you. The delay in receiving copies is most likely to be due to their journey by surface mail. This is unfortunate, but the cost of sending subscrip-

If you are unable to complete an "Electronics Australia" project because you missed out on your regular issue, we can usually provide emergency assistance on the following basis:

PHOTOSTAT COPIES: $2 per project, or $2 per part where a project spreads over multiple issues. Requests can be handled more speedily if projects are positively identified, and if not accompanied by technical queries.

METALWORK DYELINES: Available for most projects at $2 each, showing dimensions, holes, cutouts, etc., but no wiring details.

PRINTED BOARD PATTERNS: Dyeline transparencies, actual size but of limited contrast: $2. Specify positive or negative. We do not sell PC boards.

REPLIES BY POST: Limited to advice concerning projects published within the past 2 years. Charge $2. We cannot provide lengthy answers, undertake special research or discuss design changes.

BACK NUMBERS: Only as available. Within last 6 months, face value. 7-12 months, add 5c surcharge; 13 months or older, add 10c surcharge. Post and packing for 60c per issue extra.

OTHER QUERIES: Technical queries outside the scope of "Replies by Post" may be submitted without fee, for reply in the magazine, at the discretion of the Editor.

COMMERCIAL, SURPLUS EQUIPMENT: No information can be supplied.

COMPONENTS: We do not deal in electronic components. Prices, specifications, etc., should be sought from advertisers or agents.

REMITTANCES: Must be negotiable in Australia and made payable to "Electronics Australia". Where the exact charge may be in doubt, we recommend submitting an open cheque endorsed with a suitable limitation.

ADDRESS: All requests to the Assistant Editor, "Electronics Australia", Box 163, Beaconsfield, 2014.

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tion copies by airmail tends to be prohibitive.

CAPACITOR DISCHARGE IGNITION: I am interested in building the CDI system described in July 1975 (File No. 3/TI/12) and I have a question concerning the circuit. I intend to fit the unit to a Peugeot 504 Automatic (negative chassis). The part I am not sure about is the lead going from the "+12V via Ballast" I have done some checks on voltage delivered to the coil and these are the results:

With ignition on and points open, voltage across coil is 10.5 volts; with high tension lead removed and starter turning over, voltage across coil is 9 volts. I am at present using a standard 12V coil with, as far as I can see, no ballast resistor.

Now what effect would there be if I connected the 12V positive rail directly to the 12V supply from the ignition switch, not using a ballast? If this is not recommended, could you please advise me of the value of a ballast resistor suitable and also the recommended voltage to be applied to the 12V positive input of the CDI system. (P.S., Hawthorne. Qld.)

- It is largely immaterial whether the 12V rail for the CDI system is derived from the ballast resistor or connected directly to the ignition switch. From your voltage readings it would appear that your car does have a ballast. The main reason for making the 12V connection via the ballast is that it makes connection simpler.

TRANSVERTER: I am 17 years old and I have been reading your informative magazine for four years. My main interest is amateur radio and I intend to sit for a Novice Licence when the next examination is held. Your article on the 80 metre Transverter was very interesting but I would like to know if in the near future you intend to describe a transverter for the Novice portion of the 15 metre band? An article on 80 metre aerials would also be useful. If there is anyone about my age and who also intends to sit for the Novice Licence and who would like a pen friend, I would be glad to hear from him. Congratulations on a fine magazine. Keep up the good work. (Mr B. Tassoni, 4 Quarry Rd, Upper Ferntree Gully, Victoria 3156.)

- Thank you for the kind remarks and good wishes relating to the magazine. We are glad that you like it. The idea of extending the 80 metre concept of the Transverter has already occupied some of our thoughts and we do intend to present some variations on this theme. We have not directed our intentions specifically to a 15 metre version and it should be mentioned at this point that there may be some obstacles along these lines. However, it is one aspect which we intend to study more closely soon. We have also noted your request about 80 metre aerials and we will look at this one too. As for pen friends, we have given your full name and address: the rest is up to the readers.

ADDRESS WANTED: In the March 1976 issue an item appeared on these pages under the heading "CDI PRAISE" by P.T., Canterbury, Victoria. Another reader, M.B., Whyalla, S.A., is anxious to contact P.T. and asked us to forward a letter on his behalf. Unfortunately, P.T.'s original letter did not contain his full address and the letter was not delivered. If P.T. will supply his full address we will pass it back to M.B.

A-D converter . . . from p107

Conversion time is about 40ms with a 1MHz clock, which can be externally supplied or internally generated by simply connecting a capacitor to the clock pin.

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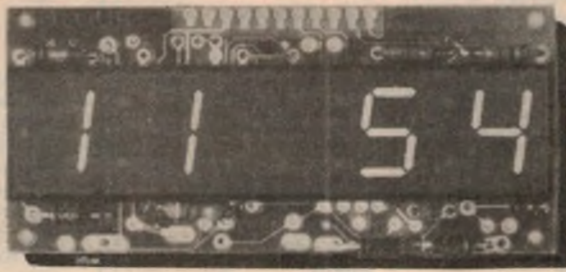

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EA. May, 1976

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