ELECTRONICS Australia

HIFI NEWS

NOVEMBER, 1976
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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 troublesome, 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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ELECTRONICS Australia

Australia's largest-selling electronics & hi-fi magazine

VOLUME 38 No 8

This month, we review SX-950 FM-AM stereo receiver, a top-line performer from the Pioneer stable. Main features of the unit include comprehensive control facilities, top-class FM tuner performance, and a power output of 85W per channel. Our review on page 21 has the details.

Published last May, our video ball game has proved an immensely popular project, with at least 1,500 built so far. This month, in response to many pleas, we describe a simple add-on sound effects circuit which greatly enhances the appeal of the unit. Turn to page 61.

On the cover

The theme on the front cover dramatises the recent move by JVC Nivico in releasing high quality microphones for the amateur nature recordist. Also shown is the TL-E71 sound focusing reflector which, together with a new portable hifi cassette recorder (the CD-1635), was released at the same time. Two of the new microphones will be reviewed next month. (Photo courtesy Hagemeyer (A/Asia) B.V., 59 Anzac Parade, Kensington, NSW 2033.)

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world of electronics and hi-fi

projects and technical

regular features

Roll over, chromium!

Extracts from an address by Mr. E. Nakamichi, President Nakamichi Research Inc. at a recent Seminar in Sydney for Nakamichi dealers.

"TDK Super Avilyn Cassettes are recommended for use with all Nakamichi tape decks. Before leaving our factory, all Nakamichi equipment has bias voltages set for TDK SA to achieve optimum performance".

"Chromium Dioxide tape is not recommended for use with any Nakamichi tape decks."

"The wear on recording heads is significantly reduced by using TDK Super Avilyn as compared with any Chromium Dioxide tape."

From the report by Louis A. Challis & Associates Pty Ltd. Consulting Acoustical & Vibration Engineers, NATA laboratory.

"TDK Super Avilyn Tape looks like being one of the most important advances in tape formulations in the mid-seventies"

TDK SA breakthrough in tape technology

Super Avilyn's performance exceeds that of Chromium Dioxide formulation which previously was the best choice for linear high frequency response and high-end S/N, but Cr02 suffered from reduced output in the middle and low frequencies (SA provides 1.5-2db more output than the best Cr02 in those ranges, equal output at high frequency).

SA also outperforms the ferric oxide tapes (regular or cobalt energized) which are unable to take full advantage of the noise reduction benefits of the Cr02 equalization because their high end saturation characteristics are not compatible with this standard (they require 1EC 120ms, normal or high EQ).

The net result of SA's characterists and this EQ difference is a tape with an impressive 4-5db S/N gain over the latest top-ranked high output ferric oxide tapes and more than 10-12 db S/N gain over many so-called low noise ferric oxide tapes.

Ask for TDK SA Cassettes.

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Editorial Viewpoint

Science unveiled—warts and all

After all the criticism levelled at the ABC-TV people lately over controversial programs, I would like to hand them a big bouquet for running a superb series of programs on the history of science. The series I am writing about was the BBC production "Microbes and Men", which presented a carefully researched dramatisation of the lives and discoveries of Semmelweis, Pasteur, Koch, Ehrlich and the other 19th-century researchers who laid the groundwork for modern bacteriology and immunology.

If you managed to see this series, I think you'll agree that it made fascinating viewing. Unlike previous attempts to dramatise scientific discovery, it presented the major researchers "warts and all", as well-rounded human beings rather than cardboard super-heroes. Far from reducing the impact, this really brought the process of scientific investigation down to earth, and helped the viewer to gain a better insight of the way real people react to real-life science.

While watching the series I couldn't help but compare its approach with the rather dull and dreary way science and technology have often been taught in our schools. So often they have been presented to pupils as little more than a vast montage of well-polished facts. As a result many people regard these disciplines with either apathy or suspicion, visualising scientists and technologists as cold, ruthless and unemotional folk who spark neither warmth nor interest.

The fact is, or course, that science and technology are like most other disciplines—dull and dreary a lot of the time, but now and again exciting to the point of exhilaration. As for those working in these fields, on the whole they're no different from any others. Sure they strive for objectivity and clarity of thought, but like most of us they often fall far short.

It is surely dangerous for a significant proportion of our society to view science and technology in an unrealistic manner, because this tends to lead to apathy and stifle healthy criticism. Scientists and technologists are like everyone else—if they are not open to pressure to explain or justify their actions from time to time, they can tend to get into mischief in the social sense.

All the more reason, then, why we need more programs like "Microbes and Men". In the meantime, I think everyone concerned with producing this series is to be congratulated. And thanks to our beleaguered ABC-TV for letting us see it out here—even if it was in a rather late timeslot!

—Jamieson Rowe

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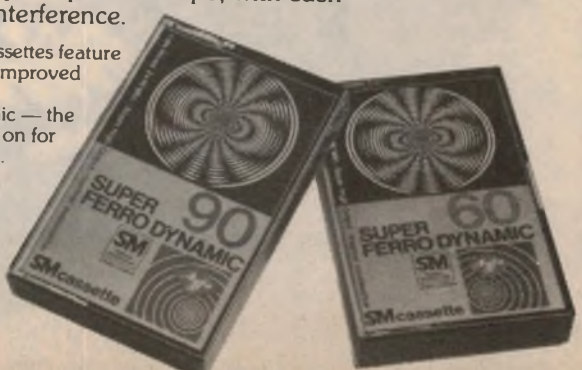

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PA11D

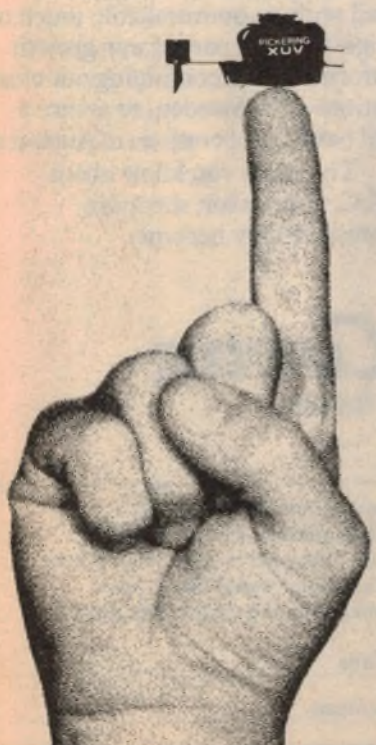
What is your first component?

Is it your receiver?

Your Turntable?

Your speakers?

or is it your cartridge?



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Let's face it, the cartridge *is* that important *first* point where the music begins, and if the stylus cannot follow its path accurately, no amount of expensive equipment . . . speakers, turntable or receiver . . . can make up for the distortion it can produce. That is why you need a cartridge you can depend on. One that's the best your money can buy. Specifically, a Pickering:

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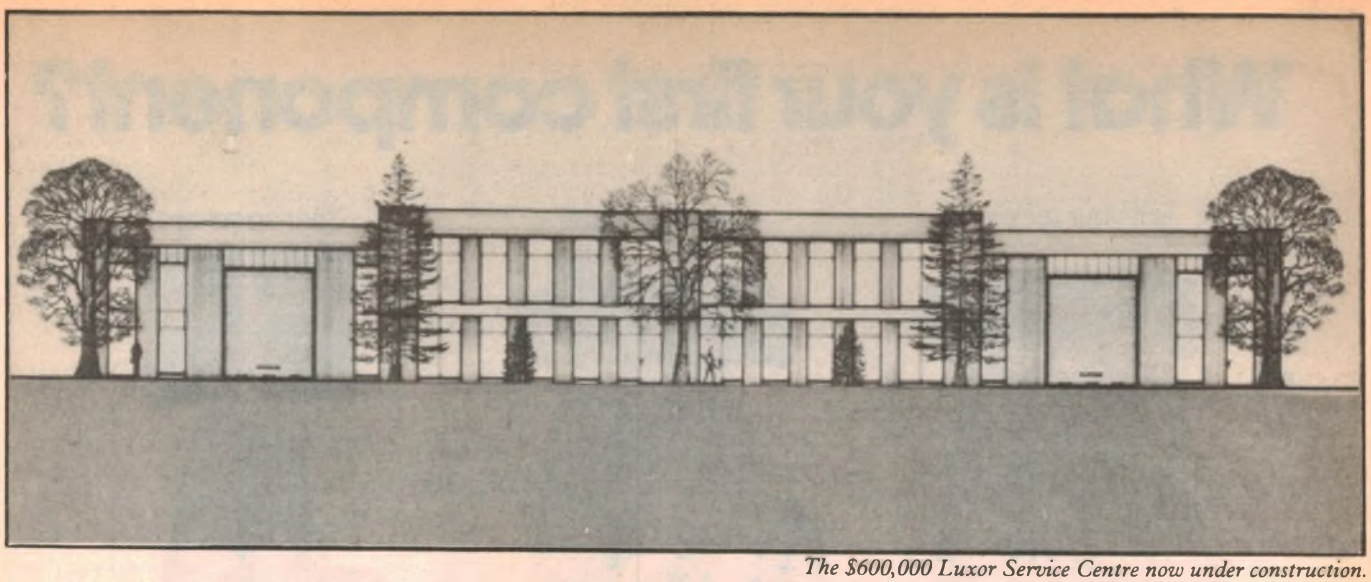

The $600,000 Luxor Service Centre now under construction.

O.B.C. Imports are investing over $1,000,000 to build the future of Luxor in Australia

We could very easily set ourselves up simply to import Luxor colour televisions into Australia, but that's not a good background for growth. That's why we're spending over $1 million to secure our future.

O.B.C. is building for the future

The nerve centre of Luxor operations is found in Melbourne, where everything is co-ordinated from the now well established O.B.C. (Imports) P/L. head office. To meet the rapidly increasing sales demand for Luxor sets – a new warehouse is being built. And, a new $600,000 Service Centre is currently under construction. Similar service centres are also planned interstate as the Luxor name builds around the country.

The 49cm (20") set.

A well-planned promotional campaign

The growth of Luxor is carefully planned, we don't intend to become Australia's colour television market leader overnight.

Informative full-page press advertisement

A recent full-page press campaign in the Melbourne Herald achieved phenomenal results – a matter of talking to the right people at the right time.

Our future expansion programme involves a similar step-by-step campaign, already well under way, selling colour television, stereo, hi fi and video-cassette recorders.

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As Volvo is to automobiles, so Luxor is to colour television. Combining a careful attention to detail with an unmistakable touch of design flair. As part of our growth platform, we are continuing our close relations with Sweden, to assure a solid basis for operations in Australia.

The more you know about O.B.C. and Luxor, the more impressive they become.

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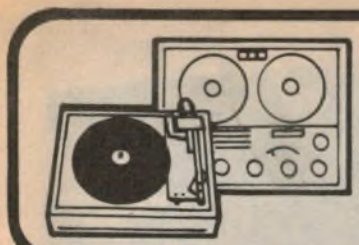


Hi Fi News

PCM for better master recording

In an effort to force the noise and distortion in disc records to even lower limits, Nippon Columbia Ltd have gone over to a pulse code modulation system in the pre-disc chain, in lieu of more traditional methods. The resulting PCM "Denon" brand recordings are being handled in Australia by AWA.

by NEVILLE WILLIAMS

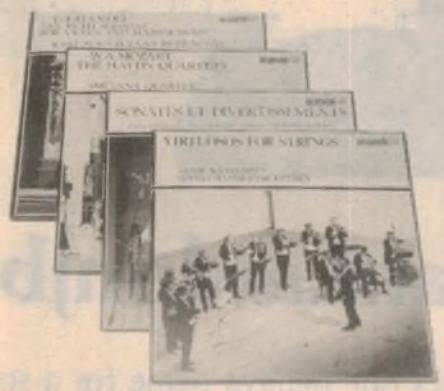
In a conventional chain, operating in what one might describe as "analog" mode, progressive variations in audio signal amplitude are handled intact all the way from the original sound source to the ears of the remote listener.

Sound pressure waves at the microphone are transduced into an electrical signal which varies in a strictly linear fashion, proportional to the sound waves. This signal may then be passed to a tape recorder to become proportional variations in the strength of a magnetic pattern on the tape. Still later, the signal may be recovered from the tape and translated into proportional deviations in a disc groove, then recovered again and amplified to produce proportional movements in a loudspeaker cone, thereby recreating the original sound pattern.

Even this highly simplified word picture of a reproducing chain suggests a rather daunting number of processes. In each one, it is essential to maintain a strictly continuous and linear relationship between the input and output signal. In practice, this is no mean task.

Any departure from linearity within the signal chain can result in:

1. Harmonic distortion, or the generation of additional frequencies which are multiples of the original signal frequencies. A second harmonic is twice the original frequency; a third harmonic is three times, and so on.
2. Intermodulation distortion, or the generation of still other spurious frequencies equal to the sum and difference of other frequencies present.



Whatever their technical merits, presentation of the Denon discs is noteworthy, most of them being in an envelope style plastic cover inside an outer paper sleeve.

An increasing percentage of distortion gradually modifies the sound as heard, producing an unnatural "edge" or harshness, and compromising definition to the point where instrumental and other sounds gradually merge into a sonically matted mess!

Another problem of the conventional audio system is the possibility of noise being introduced as, for example, by amplifier stages handling the wanted signal at very low level. Once noise has been added to the signal, it is faithfully preserved by the rest of the amplifier chain, just as if it were a legitimate part of the program.

A vital aspect of the struggle towards higher fidelity has been the evolution of amplifiers and transducers exhibiting a more linear input/output relationship, and therefore introducing a lower overall distortion content. Modern amplifiers are particularly good in this respect, but transducers and recording processes still have a way to go.

Similarly, a lot of effort has gone into increasing the signal/noise ratio, by maintaining a higher average signal level through the system and, at the same time, lowering the intrinsic system noise.

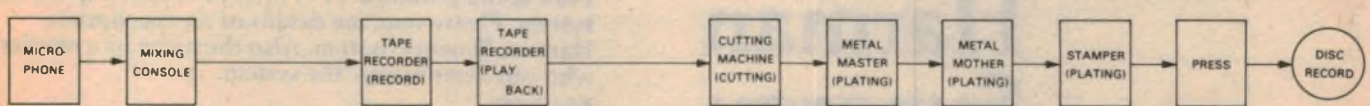
Considerable advances have been made but the problem has not been completely overcome. If the system is set up so that the loudest signal peak does not cause undue distortion or actual overload, the softest passage may be getting down to a level where system noise can be noticed. As a result, musicians and/or sound engineers have to modify the dynamics of program material to keep it within limits convenient for amplifier and recording chains.

In fact, signal/noise ratio is probably the most worrying aspect for audio-hifi engineers. If everything can be held precisely inside system limits—loud passages just short of overload, soft passages just clear of the noise level—a modern recording can be very impressive, despite the many mutations through which the signal passes. A reviewer may genuinely rate the loudest passages as "very clean", and softer passages as "sound out of silence".

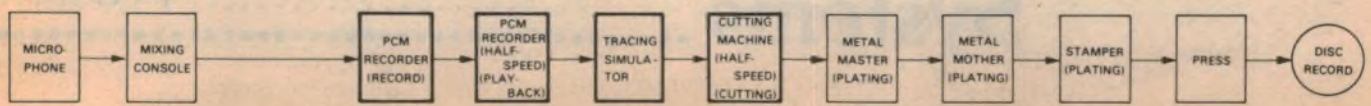
The problem isn't so much what can be achieved under precise, optimum conditions but one of evolving methodology which is a little more tolerant of conditions short of optimum. Anything which can broaden the area between maximum signal level and the noise threshold will make the handling of ordinary reproduced music that much less critical, while also opening the way to truly superb reproduction having a wider dynamic range then ever before.

Some quite notable contributions along this line have been made by tape mastering equipment having exceptional characteristics. The efforts of Enoch Light come to mind, with his pioneering use of magnetically coated 35mm movie film.

More recently, the Dolby system has become almost a standard in recording studios, in association with master tape facilities. By automatically boosting low level passages before they are applied to the tape, then attenuating them by a cor-



Illustrated above are the stages between microphone and the finished disc for the conventional "analog" approach. The PCM system emphasised in the heavier boxes below, aims to minimise noise and distortion in the mastering processes.



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HA 122

responding amount during replay, the effective signal/noise ratio for low level signals is improved, without prejudicing the response of the system to loud passages.

While very effective as a means of improving signal/noise ratio, the Dolby system and other automatic noise reduction systems are open to some criticism on the grounds that they may compromise linearity slightly, if not precisely adjusted, and they may also produce some slight "pumping" of the signal as amplifier gain is modified.

Nippon Columbia would appear to have taken an entirely different road in an effort to achieve reduced noise and wider dynamic range for their Denon label discs. They have resorted to a pulse sampling system for that part of the mastering chain between the mixing console and the input to the cutter drive amplifier.

For those who have not given the matter much thought, it may be helpful to explain that principle in broad terms:

Instead of being handled in the normal linear fashion, the audio signal is fed into a high frequency gating system which produces a continuous train of discrete pulses, each coded in a particular way to represent the amplitude of the audio signal at the relevant instant.

In a PPM (Pulse Position Modulation) system, the position of each pulse in the output sequence is advanced or delayed by an amount proportional to the signal amplitude it is supposed to represent. The sequence of PPM pulses can be decoded, when necessary, to recover the amplitude information, and resultants integrated to reconstitute the original audio envelope.

In a PTM (Pulse Time Modulation) or PWM (Pulse Width Modulation) system, the width of the individual pulses varies in proportion to the audio signal amplitude. As in the previous example, PTM (or PWM) signals can be decoded and integrated to recover the original audio signal.

Yet another system, the one being used by Nippon Columbia, is PCM, short for Pulse Code Modulation. In this method, the audio sample is examined electronically and allotted one of a range of discrete values to which it most closely approximates. It's as if we all had to write down our height, correct to the nearest centimetre!

This discrete value is then identified and translated into a train of digital "bits" and fed through the system as such. Each group of digital bits—each digital "word"—conveys the message: "at instant A, the amplitude of the audio signal was X millivolts".

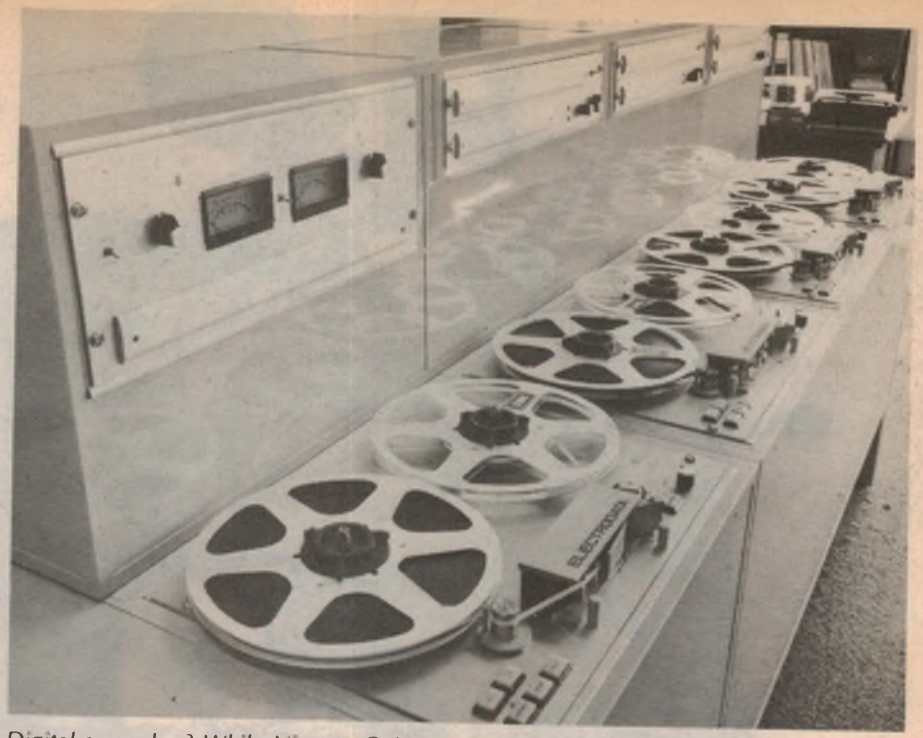
The next word might say: "at instant B, the amplitude of the signal was Y millivolts", and so on to the end of the program.

Assuming ordinary binary coding, a 6-bit word per sample could nominate any one of 64 possible discrete levels. A 7-bit word would cover 128 levels, an 8-bit word 256 levels, and so on. Obviously, the larger the number of bits allocated per sample, the more precisely can the system represent the level of the original analog input signal.

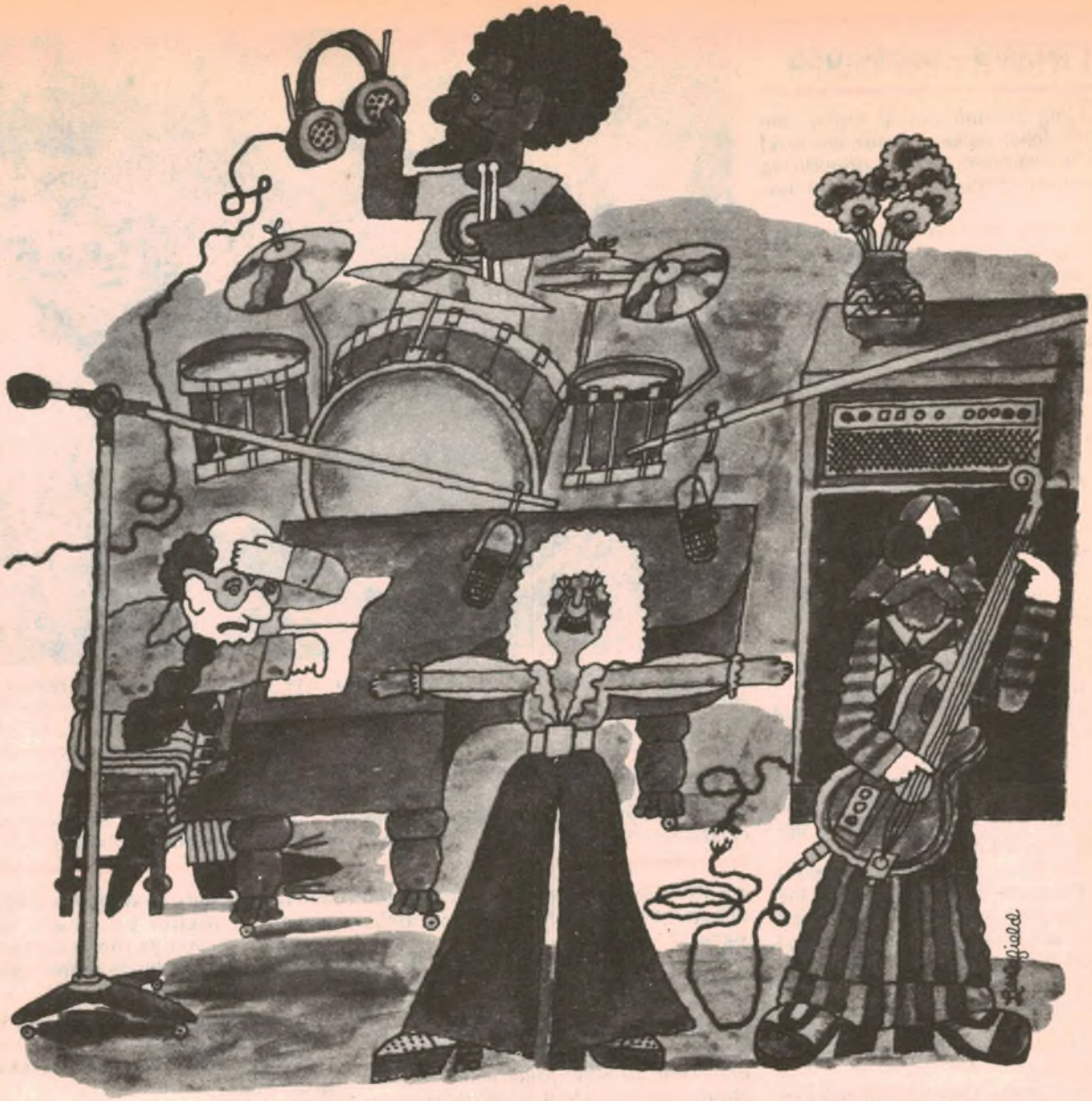
It is usually considered that the sampling rate in a pulse system must be at least twice that of the highest frequency which it is hoped to reproduce. Thus, for a maximum signal frequency of 15kHz, the sampling rate would have to be at least 30,000 per second, and preferably higher. This would apply for PPM and PWM systems but, for PCM, it would have to be multiplied by the number of bits, so that even an 8-bit code would result in a bit rate of 240,000 per second.

An obvious question emerges: why become involved in all this? Why go about things in what seems the hard way?

The answer rests basically on the fact that a pulse type signal is intrinsically



Digital or analog? While Nippon Columbia have started to make loud noises about their PCM system, it remains to be seen what impact it will make on the normal analog approach. In the meantime, this 4-deck tape duplicator has been installed recently in EMI's Emisound studios in North Sydney. Described as System 4400, it was manufactured in Australia by Electrodata Associates Pty Ltd, of 18 Coward St, Mascot, NSW. Using crystal locked motors for precise speed control, it operates normally at 60ips and can adapt to any likely ¼-inch tape format by the use of plug-in heads. The master reproducer will service any required number of slaves.



Hot talent and hot material need Hot Sound Tape by Ampex

An ordinary tape just won't do these days for most audio recording jobs. You need the hot Ampex 406/407 studio mastering tape or, the hottest, Ampex GRAND MASTER. With 406/407 you'll get 72 dB s/n ratio, high output, low noise and low distortion. If your requirements call for an even hotter tape, then you need Ampex GRAND MASTER. This spectacular mastering tape offers a full 76 dB s/n ratio and as much as 3 dB extra sensitivity on the high end. You can drive GRAND MASTER tape harder than you've ever driven a tape before. From a whisper to a scream, it responds with more undistorted output across the entire audible range than any other mastering tape available. It has high erasability so it is fully reuseable. And there's no need for bias adjustments: use GRAND MASTER at the same settings you've established for Ampex 406/407 or for 206/207.

Detailed technical specifications and performance curves are available in our free brochure, offered to all audio professionals. Just ask us for literature on the Ampex Hot Sound Tapes, GRAND MASTER and 406/407.

AMPEX

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"rugged", because the essential information does not depend on subtle variations in signal amplitude throughout the entire amplify/record/reproduce process. Nor is it anything like as open to penetration by inherent system noise. Basically, the circuitry has to distinguish and respond only to two states: pulse or no pulse, on or off, saturation or cut-off, etc.

Thanks largely to intensive research into video recording, and in the computer area, there is a wealth of technology available to generate, record and process pulsed or digital information with considerable facility.

From the brief information available, it would appear that Nippon Columbia have evolved a system which makes use of a fairly standard 4-head low-band video recorder for tape mastering using standard 2-inch wide video tape running at 38cm/sec, and giving a head/tape relative speed of 40m/sec.

By analysing the accompanying Denon diagram in conjunction with other published information, conventional analog signal from the mixing console passes to a PCM encoder which has a sampling rate crystal locked to 47.25kHz. This is 3 times the line rate of a NTSC TV signal, suggesting that audio samples are distributed on the basis of 3 per TV line.

Another figure indicates that each audio sample is described in a 13-bit simple binary code, suggesting that the system provides for up to 8192 possible discrete levels between whatever limits are set on the peak-peak amplitude.

Together the figures suggest a bit rate of something over 0.6Mhz, which would be "chicken feed" for a modern video system. It would appear, however, that up to 8 distinct audio channels can be accommodated simultaneously, using a clock frequency quoted at 7.1825MHz.

The composite, fully encoded signal is handled by the recorder almost as if it were an ordinary TV signal, with the notable exception of the vertical sync and blanking pulses. Once on video tape, it can be edited and dubbed (copied) largely using television techniques and equipment.

For playback, for the purpose of making the master disc, the tape is run at half speed, with two advance heads giving prior indication of forthcoming signal amplitudes, thereby cueing the variable pitch mechanism in the recording lathe.

The pulse train, now at half speed, is decoded and integrated back to an audio signal and fed to the disc cutter system, also operating at half speed. When the finished discs are played later at normal speed, the music is heard at normal speed and normal pitch.

In fact, the half-speed technique is not unique to Denon, but it does effectively lower the frequency band by 2:1, reducing the problems of getting full drive to the cutter at frequencies which would otherwise approach or exceed 15kHz.

Whether the Nippon Columbia enterprise will spur other record manufacturers to break with conventional techniques remains to be seen, but the specifications are certainly impressive:

DYNAMIC RANGE: 75dB. Assuming that the maximum signal level is set by the groove parameters in the disc, the clear inference is that the inherent system noise ahead of the cutter amplifier must be very low indeed.

DISTORTION: Less than 0.1% at operating level. This is probably the figure from PCM input to cutter drive but, by inference, includes the tape master. If so, it would be an outstanding accomplishment.

WOW AND FLUTTER: Not measurable. By ensuring that the sampling is done at precisely timed intervals and that the information is ultimately presented to the decoder at precisely timed intervals—a routine precaution in computer circuitry—any wow and flutter in the tape mastering equipment would be ignored.

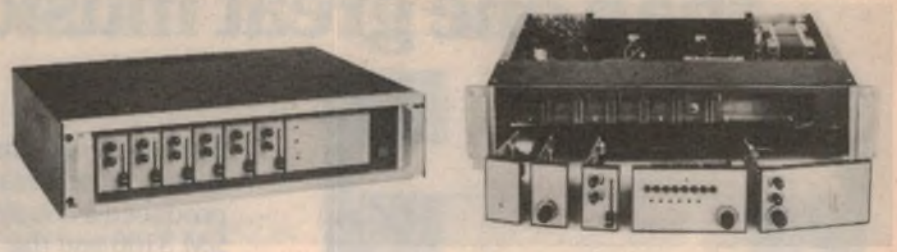
CROSSTALK, INTER-CHANNEL: Virtually none (better than −80dB). Just as pulse circuitry can largely ignore system noise, so can it ignore low level spurious signals.

PRINT THROUGH: Virtually nil, for the same reason.

FREQUENCY RESPONSE: Within ± 0.5dB from DC to 20kHz. Since the circuitry is handling only digital information, it is not subject to the influences which, in an analog system, might cause variations in the gain/frequency characteristics.

MODULATION DISTORTION: Nil, or at least not measurable. It opens an interesting area for discussion as to the differences between non-linearity in an analog system (which does cause intermodulation) and non-linearity in a digital system caused by the substitution of discrete values or true values, at the sam-

MILLBANK AUDIO PRODUCTS IN AUSTRALIA



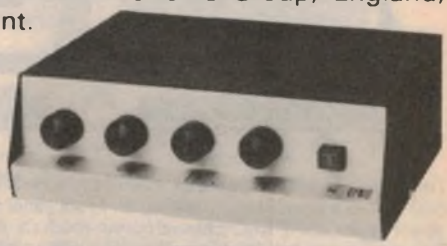
Already well known as distributors of a wide range of complementary product lines, Messrs R. H. Cunningham Pty Ltd have been appointed distributors in Australia for the Millbank Electronic Group, England, which specialises in audio equipment.

Announcing the new arrangement, Tony Hinman, Export Sales Manager of Millbank, said that his company was launched only in 1967 but, in the ensuing period, has grown enormously, with export markets established all around the world.

Current emphasis is on the company's so-called PAC-SYSTEM range of power amplifiers and associated peripherals, the latter including input modules, mixers, auto-tape players and multi-facility tuners.

Intended primarily for professional situations, there are three PAC-SYSTEM amplifiers in the present range, offering power output ratings of 30, 50 and 100 watts. Each has a 6-input capability and can be combined with preamplifiers, etc, to produce what is virtually a custom built installation to meet the specific needs of a hotel or hospital, office or factory, restaurant or conference centre.

The plug-in input modules can be selected as required to cope with microphones, radio tuners, tape or disc players, automatic announcement equipment, as well as specialised facilities such as tones, pips, gongs, security alerts, etc.



Illustrated at the top is one of Millbank's PAC-SYSTEM amplifiers, showing the use of plug-in modules. Above: one of the Company's simpler integrated amplifiers.

Where less specialised equipment is needed, typically an amplifier with two microphone inputs, paging over-ride and a music source, Millbank can provide 30-watt and 60-watt "economy" integrated amplifiers with a high order of reliability.

Other products in the range include three different sound mixers, loudspeakers systems and paging microphones.

For further information on the Millbank range: R. H. Cunningham Pty Ltd, 493-499 Victoria St, West Melbourne 3003, or from branches in other capitals.

Toshiba admit there is more than one great music system.

Toshiba SM 2900 Features FM/FM Stereo/MW/LW Receiver. Built-in 4-track, stereo cassette deck. Front panel control of cassette, player or deck. 8W RMS/channel output (both ch. driven into 8 ohms). Two-speed auto return player with high quality ceramic cartridge. Two-way speaker system incorporating 16cm woofer, 5cm tweeter. Dimensions: Centre Unit (WxHxD) mm 690 x 200 x 380 Speaker Box (WxHxD) mm 215 x 380 x 160.

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So now we tempt you with a complete Family of Toshiba Music Centres.

Toshiba SM 3100 Features FM/FM Stereo/MW/LW Receiver Built-in 4-track, stereo cassette deck. 12W RMS/channel output (both ch. driven into 8 ohms). Full ASO mechanism, memory system and chrome/normal selector stereo cassette deck. Two-speed belt driven player with moving-magnet cartridge, diamond stylus and semi-automatic lower/return/cut functions.
Includes 2 way speaker system incorporating 16cm woofer, 5cm tweeter.
Dimensions: Centre Unit (WxHxD) mm 690 x 200 x 380.
Speaker Box (WxHxD) mm 275 x 470 x 190.

All three systems have a few features in common. (Like a sensitive MW/FM 3 band radio. A supreme quality record playing unit. And a top performance stereo cassette deck.)
Yet each three-in-one is uniquely different.
The SM 2900 has a standard rim drive turntable with ceramic cartridge.
Both the SM 3100 and the SM 3500 have a high precision belt drive turntable with magnetic cartridge.

Toshiba SM 3500 Features FM/FM Stereo/MW/LW Receiver. Built-in 4-track, stereo cassette deck. Dolby noise reduction system. 12W RMS/channel output (both ch. driven into 8 ohms). Two-speed belt driven player with moving-magnet cartridge, diamond stylus and semi-automatic lower/return/cut functions. Two quality microphones.
Dimensions: 690 mm (W), 360 mm (D) and 200 mm (H).

And the SM 3500 has the famous Dolby noise reduction system that lets you record and play back with the absolute minimum tape hiss.
So now the only choice you have to make is which Toshiba Music Centre fits your pocket. From the budget priced SM 2900 to the SM 3500 at around $650*.
Hear them all. At leading retailers.
And let your ears persuade your wallet.

*This price includes the SS 200 speakers (not illustrated) recommended as optional extras.

Design and specifications subject to change without notice.

Toshiba TOSHIBA

TOS8289

pling rate.

Add to these claims: no fluctuation in levels, no fluctuation in signal phase and amenability to automatic editing and splicing, and you have a pretty impressive story; one that is sure to spark plenty of debate in places where audio boffins congregate!

The Denon record catalog handed out by AWA at the recent consumer electronics show lists something over 50 albums, some of them multiple record sets. The large majority are of classical works performed by continental artists and orchestras, others being by Japanese artists, with an occasional recital of ethnic music.

Also mentioned in the literature is a set of 3 discs intended for technical testing. Record number 1 contains swept frequency bands for both channels, one sweep being over the subsonic range; there is provision for wow and flutter tests and bands of ⅓ octave noise for both channels.

Record 2 contains musical sounds—different instruments, different microphones, different angles of sound pickup, recordings made in studios, halls, with different mic setups, &c. It would appear to provide examples of what hifi enthusiasts often talk about, without the opportunity of being specific.

Record 3 concentrates on imperfections in reproduced sound—the audible effects of wow and flutter, variations in frequency response, crosstalk, limitations on dynamic range, the audible effects of harmonic distortion, and the problems of poor tracking. Price of the Audio Technical 3-record set is quoted as $27.00.

It sounds an interesting brew but, unfortunately AWA did not have a spare set for us to play with up to the time this article was written. In fact, the supply of Denon records would appear to be well short of the demand, currently from enthusiasts as much interested in the technology as in the actual music.

However, AWA did make available copies of several discs not as handpicked samples, we understand, but simply on the basis that they were some of those still left in stock. Since the emphasis was on technology rather than program content, at this point of time, we passed them to members of our technical staff with the request that they react to them primarily as examples of recording technique.

The discs are listed below, together with very brief comments on each:

J. S. BACH. Three Keyboard Concertos, No 1 in D Minor; No 4 in A Major; No 5 in F Minor. The Tokyo Bach Players, with Yuji Takahashi, piano. Recorded July 1973. Denon stereo OX-7033-ND. Price $9.90.

Musically, an excellent performance, very cleanly recorded but marred by a tape hiss that will be noticed by those blessed with keen ears. Perhaps it is significant that this was the oldest of the records submitted for observation.

Pictured above are two recent additions to the Toshiba-EMI range of hifi equipment. At the top is the ST-220 AM/FM stereo tuner, which combines excellent specifications with good appearance and simplicity of operation. The SB-220 power amplifier has a matching brushed anodised panel, with all normal input, output and control facilities and click-stop bass and treble controls. It has a power rating of 22W RMS per channel, both channels driven, and has facilities for two sets of loudspeakers. (Toshiba-EMI Australia Pty Ltd, 301 Castlereagh St, Sydney 2000.)

G. F. HANDEL. The Eight Sonatas for Violin and Harpsichord. Josef Suk, violin; Zuzana Ruzickova, harpsichord. Recorded July 1975. Denon stereo, 2-record set, OX-7037-8-ND. Price $19.90.

Comment: Zestful, precise playing, a 1710 Stradivarius and a rich concert harpsichord make this musically interesting, although a couple of the sonatas emerge as a trifle clinical. The recording itself is very clean, very quiet.

W. A. MOZART. The Haydn Quartets. No 14 in G Major, KV 387. No 16 in E-Flat Major, KV 428. Smetana Quartet. Recorded in the Church of St Mary, Lucany, Czechoslovakia, June 1975. Denon stereo OX-7034-ND. Price $9.90.

You don't need to be a classical buff to enjoy this music. The quality is very good and the only discernible background noise as the gain comes up ahead of each track is the faint low frequency ambience of the church itself.

DIE NEUE DOMANE FUR OBOE. Heinz Holliger oboe and flute, with Camerata Bern. Compositions by Sando Veress, Krzysztof Penderecki, Isang Yun, Edison Denisow, Heinz Holliger. Recorded in Tokyo, November 1974. Denon stereo OX-7031-ND, price $9.90.

The quality is excellent and the noise level very low. The performance is also good but these are modern compositions and may not appeal to everyone, on that account.

SONATES ET DIVERTISSMENTS. Pierre Pierlot, Hautbois; Paul Hongne, basson; Robert Veyron-Lacroix, piano. Compositions by Boimortier, Telemann, Haendel, Mozart. Recorded in June 1974. Denon stereo OX-7030-ND. Price $9.90.

A very pleasant program, whether or not you are familiar with the music. Quality on hautbois and basson is superb but, to my ear, harpsichord and piano could have been a trifle more prominent. The recording is very quiet.

VIRTUOSOS FOR STRINGS. Sofia Chamber Orchestra conducted by Vassil Kasanjiev. Purcell, Suite in E Minor for Strings; Gluck, Sinfonia in G Major; Vivaldi, Sinfonia No 3 in G Major; Haydn, Divertimento in E-Flat Major. Recorded in September 1974. Denon stereo OX-7040-ND. Price $9.90.

The interplay of the strings produces an extremely complex sound pattern but it remains clean, with none of the breakup that can so easily occur. Quality is first-rate but not necessarily better than other top quality orchestral recordings.

One point that will be obvious is that the recordings date back, in one case, to 1973, the implication being that Nippon Columbia had PCM recording equipment available and on site more than 3 years ago. If they didn't, it would seem a rather futile exercise to translate a conventional tape master to PCM, purely for the sake of the PCM endorsement on the jacket.

The equipment actually pictured in the sleeve material is a fairly compact group of rack mounting "grey boxes", complete with knobs and meters, and surmounted by a transportable type of video recorder. Technically, there seemed to be no reason why it should not have been operational for that time.

AWA representatives were not able, off the cuff, to put the chapter and verse to the PCM story but their impression was that Nippon Columbia had, in fact, developed the system some time ago. Originally, their prime interest had been in the professional field and there had been copyright and other problems inhibiting more direct exploitation of the system. Now, however, they were marketing the records around the World and publicising the technology behind them.

Based on the very limited sampling outlined above, our own reaction is that the PCM system is capable of producing recordings equal to the best produced by conventional analog methods. This is not meant as faint praise. The simple fact is that the original acoustics, microphone

(continued on page 19)

Top Disc Cutting Studios, like The Mastering Lab, rely on Stanton's 681-Calibration Standard in their Operations.

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LER 146

Acoustics & sound quality

Have you ever considered the influence your listening room has on the reproduction of music? You should, and in so doing may quite rightly question the whole subject of accuracy of reproduction.

*by MALCOLM D. McLEOD

Listen to a friend's voice as you walk through different environments. To illustrate the extremes of change; a bare unfurnished hall, tunnel, or subway will make the voice sound full and resonant. Quite likely clarity will be poor due to reverberation or echo of the original voice competing for your attention. The audible effect of excessive reverberation is reduced definition, not unlike the visual effect when a TV image is cluttered with ghosts.

As you walk out of this "field of influence" into the open air, the voice tends to lose its fullness, the apparent volume is reduced, and clarity is restored.

Which was really your friend's voice? Of course it's a silly question—it was the same voice in each case. However, it does demonstrate the profound effect that the surroundings play in moulding the tone of sound. Before we come to the point of questioning the accuracy of a reproduced performance we must establish what we mean.

For example, large pipe organs, by their very nature, exist in very large structures—mostly churches. Familiarity with the original source of sound necessarily establishes a long reverberation time with pipe organ sound. So much so that a large pipe organ without its accompanying reverberation would be judged abnormal. This problem is not likely to arise with a pipe organ—they can't be moved around.

But other instruments and singers, indeed whole symphony orchestras, can be moved from place to place. Some buildings exhibit qualities acoustically favourable, others less so, some disastrous. Furthermore, certain types of music evolved within an environment, and its performance should embrace that concept. Chamber music is an example, requiring a large room rather than a hall.

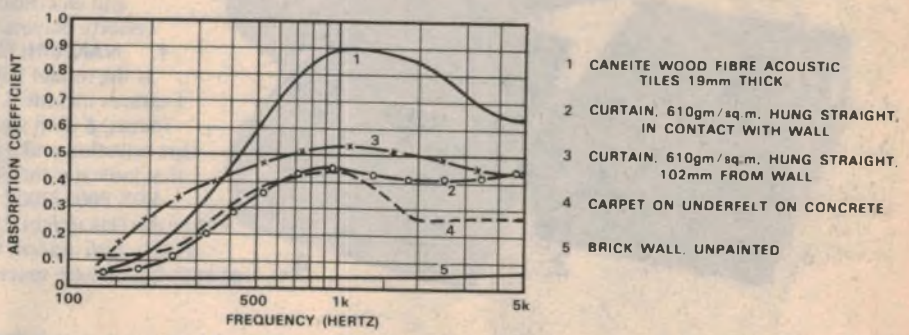
We haven't even arrived at the problems of reproducing recorded performances yet. I'm simply trying to establish the delicacy of the situation, and the influence that the acoustics of an environment have on an original performance.

In my experience of concert halls, quite apart from their individual characteristics, I have found enormous differences in different areas of the same hall. When we come to the reproduction of sound, we tend to make our judgements relative to our best experiences of live performances. This is as it should be, as recorded performances are generally made in favourable circumstances.

Well, at last we have arrived at our own listening rooms, where I trust we are going to attempt, as far as is possible, to accurately reproduce the original performances.

What are the requirements of the room, and how do we establish them? From the music lover's point of view, we must be entirely practical. We must ensure that in our quest for accuracy, the method does not become self-defeating through complication beyond the resources of the amateur.

The equipment required to measure the reverberation time constant of a room at various frequencies is extremely costly. Nevertheless, we can come to terms with the problem and achieve the required end result, even if we can't state the results in figures. We would not be discouraged from laying out a pathway because we couldn't justify a surveyor's theodolite. We could devise an entirely satisfactory method using little more than a ball of string, some pegs, and those most important ingredients, patience and common sense.



The reverberation time constant of a room is the time in seconds after a steady state tone is stopped, to decay in intensity by 60dB, which is one millionth of the original loudness. The requirements for the average room is a decay time of 0.9 of a second in the mid frequency region.

Regardless of absolute figures, observation of a single impulse of sound is a most revealing method of testing. A suitable source of impulse is two 18mm thick blocks of chipboard, about 10cm x 10cm, clapped together. This sound source is intense, wide band, and reasonably repeatable. The observer must familiarize himself with "after ring" between the extremes of a tiled bathroom and a heavily dampened room.

It is worth while taking advantage of available rooms for subjective analysis, at the same time observing construction, materials and contents. The observer should concentrate his attention on the "after ring" resulting from clapping the two blocks together. In a live room, the after ring will be very obvious, diminishing in intensity and duration in surroundings with more aborption, until ultimately, in an anechoic chamber, it cannot be detected. It comes as something of a surprise to find that, in the open air of a back yard, individual reflections can be heard from fences, garages and walls.

I have found over many years of experimenting, that the most favourable listening rooms are those in which after ring can just be detected, with concentration, using the "two block" method. This will be close to the ideal conditions. It is not advisable to go beyond this point of absorption, as an over damped room sounds lifeless.

I used the term "ideal conditions". Perhaps it would be better to say happy compromise, for we are attempting to fulfil two conflicting requirements.

The recordings we play will contain some reverberation from the studio or hall where the recording was made, and is to some extent controllable. Close microphone placement, particularly to a solo instrument, will increase the proportion of direct to reflected sound.

The degree of reverberation we get on records, will be related to the type of music and the likely surroundings of its performance, hence our expectations of long reverberation time for a pipe organ, and short reverberation for small works such as chamber music.

Recreating the music at home, we now reproduce the recorded reverberation along with the music, and are now in trouble, for the reverberation is coming from the same speakers as the music, rather than from every direction, includ-

*204 Wattle St, Malvern, S.A. 5061

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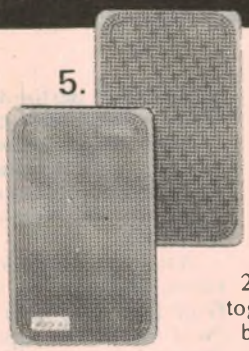

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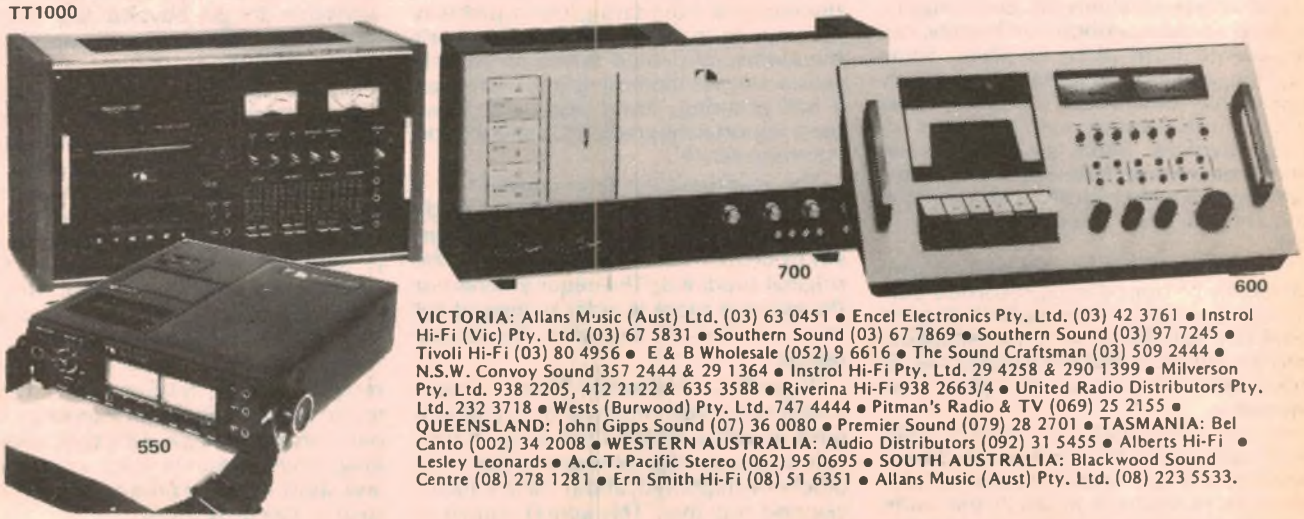

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ACOUSTICS & SOUND QUALITY—Cont.

ing the rear, as in the live performance.

Furthermore, by reducing the reflected energy in our listening room by introducing absorption, the source of sound, normally a pair of speakers, becomes more clearly definable. Taken to extremes, we shall hear two separate sources of sound rather than the illusion of a fairly solid area of sound from and between the speakers. We must tame the room, leaving enough reverberation to disguise the shortcomings of reproducing the recorded reverberation along with the music from the front, and additionally, to help fill the area between the speakers.

As this is clearly a matter of compromise, opinions may vary to some extent as to the "ideal solution". We could quite logically conclude that, for quadraphonic reproduction, rooms should be more heavily damped than for stereo.

It is important to understand what is happening so that corrective measures can be applied. Everything has a coefficient of absorption which can be expressed as a figure. This figure will lie between 0 and 1; 0 meaning no absorption (or total reflection) and 1 meaning total absorption (no reflection). Remember that the figure of absorption applies at a given frequency but, for our needs, the figure of absorption at 500Hz will be satisfactory.

The following list gives the coefficient of absorption of different materials at 500Hz, and serves as a guide to the possibilities that can be applied to correct an over live room.

Cane-ite acoustic tiles, ¾" thick	.6
Cane-ite acoustic tiles, ½" thick	.45
Plaster acoustic tiles	.35
Heavy curtains against wall	.35
Heavy curtains, 4" from wall	.45
Carpet on concrete	.2
Carpet on underfelt on concrete	.35
Brick wall, unpainted	.03
Brick wall, painted	.015
Plaster ceiling	.05

From experience, I have found that most rooms need considerable treatment. The exception are rooms with thick wall to wall carpet, large areas of heavy drapes and plenty of soft upholstery, book cases and other objects which break up reflective surfaces, though it's still a good idea to check it out. Careful observations using impulse testing should reveal mild reverberation which you should be able to pin-point, more than likely to the upper wall areas.

This represents the conditions we require. Why? Many reasons. First, the remaining degree of mid-range reverberation which, after all, is echo, has been tamed to the point where its relative magnitude will not have a deleterious effect on clarity, but still exhibit the "life" so essential to mask the point source(s) of sound.

Additionally, you now have a chance of achieving a fairly even frequency response. No matter how fine your equipment, and whatever evidence you may bring to demonstrate a level response, you are having yourself on if you exclude the influence of the room. A highly peaky mid-range, due to reverberation, gives an equally nasty effect as if it had been caused by part of your equipment. Many an amplifier spends its life on bass boost or with the loudness switch on, or both, in an attempt to "pull the response into shape".

Do some testing in your room and observe the conditions in other people's rooms. Refer to the chart for ideas that will increase absorption, and try to distribute the absorption around the room. Don't go to extremes. Enough, no more. Cane-pite acoustic tiles offer about the highest absorption per dollar, and are so effective that I must caution you against the idea of a full ceiling of them. It has proved excessive. 50% coverage at most.

Good listening, and I hope your wife likes the new drapes.

HIFI NEWS—continued

management and mixing are common to both methods; so also is the cutting, pressing, and the replay and reproduction in the home. Once a certain standard of excellence has been reached at the mastering stage, the final result is determined by the front end and back end of the reproduction chain.

It may well be that the contribution of the PCM system may not be to outperform today's analog best, but to provide a way around some of the attendant problems which result in the production of recordings short of the best. PCM will represent a major forward step if it opens the way to consistently lower distortion, consistently lower noise, and consistently wider response.

If it doesn't work out that way, it won't be for the want of trying. The Denon discs are packaged in a plastic sleeve with envelope type flap, in some cases inside a further paper sleeve. They come out looking really immaculate. The titles are in the original European language (which we simply copied) but all the rest of the copious jacket notes are in Japanese.

Denon PCM records are currently being handled by a few of the leading retailers but stocks are very limited. They can, however, be ordered through local record shops from the distributors: Amalgamated Wireless (Australasia) Ltd, 554 Parramatta Rd, Ashfield, NSW 2131.

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Auto stop on all functions. High density permaloy heads. CrO2 Tape selector for bias and equalizing.

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MR239

Pioneer SX-950 stereo receiver

Pioneer have recently released three high power stereo receivers which have performance equivalent to much higher-priced separate components. Here we review the least powerful of the series, the SX-950. It is rated 110 watts per channel into 4 ohm load, over the range 20Hz to 20kHz and for less than 0.1% harmonic distortion.

Considering the impressive size and power rating of the SX-950, it is hard to credit that there are two higher rated models in the Pioneer range of stereo receivers. The higher rated SX1050 and SX-1250 are both very similar in appearance and facilities offered.

Dimensions of the SX-950 are 527 x 173 x 410mm (W x H x D) while mass is 19.1kg. A wrap-over timber case is supplied and included in the price. Finish on the front panel is identical to that on other current models in the Pioneer range.

As can be seen from the photographs, there are a large number of knobs and switches on the front panel so that some time is needed for the user to familiarise himself with all the facilities. The most often used controls, which are the Volume and Tuning knobs are close together and at the right-hand end of the control panel so that one does not have to grope around for too long to adjust the volume or tune to another station.

No less than three separate pairs of loudspeakers can be connected to the SX-950, although the push-button switching allows only two pairs to be driven at any one time.

Facilities for the tone controls and filters seem over-complicated considering that their overall effect is really no more than on a fairly basic stereo amplifier. Maximum boost is limited to plus 12dB at 50Hz and plus 11½dB at 15kHz, while the figures for maximum cut at these frequencies are a little higher. The filter switches give effective attenuation from 30Hz and 6kHz of 6dB/octave, which is hardly worth bothering about. Yet to provide this limited degree of frequency control, there are five switches and two knobs. Two lever switches actuate the filter stages; two more select the turnover frequencies for the bass and treble controls; the fifth acts to switch out the tone control circuitry completely. The effect of this last switch is merely to change the gain by 1dB. There is no measurable effect on frequency response or distortion. This complexity seems rather pointless as the click stops on the tone control knobs are just as effective.

More useful are the four lever switches which allow for connection of two cassette decks or tape recorders, plus an Adaptor such as a Compressor/Expander (eg DBX 117) or a Graphic Equaliser. One of the switches is marked "Duplicate" and allows copying from one cassette deck to another. These facilities are certainly desirable on a receiver in this price range.

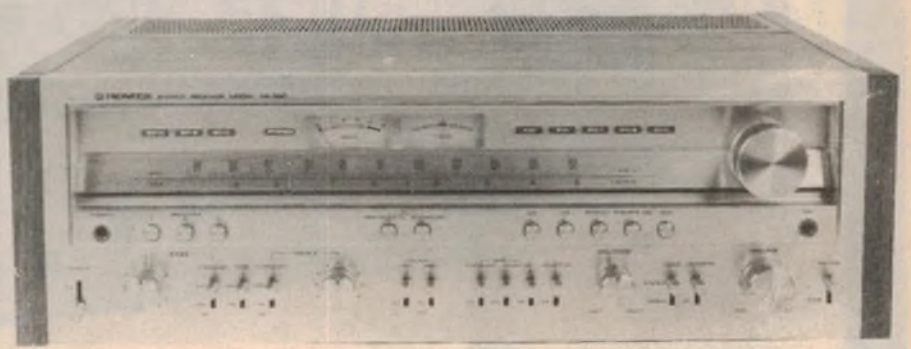
Besides the facilities for tape recorders just mentioned, there are five push-buttons which allow for selection of FM or AM tuners, two Phono inputs and one Auxiliary source such as Television sound. An appropriate window on the dial lights up to show which source has been selected.

Another control worthy of mention is the Muting switch, which provides 20dB of attenuation additional to the Volume control. This allows momentary reduction in the volume level to allow telephone answering or to order another can of the amber fluid (if that is what appeals). The Muting switch also allows the system to produce very soft background music levels, which can be hard to set with the normal Volume control. This is because most Volume control potentiometers fail to provide progressive control action when set towards their minimum—they are also usually poorly matched at minimum settings.

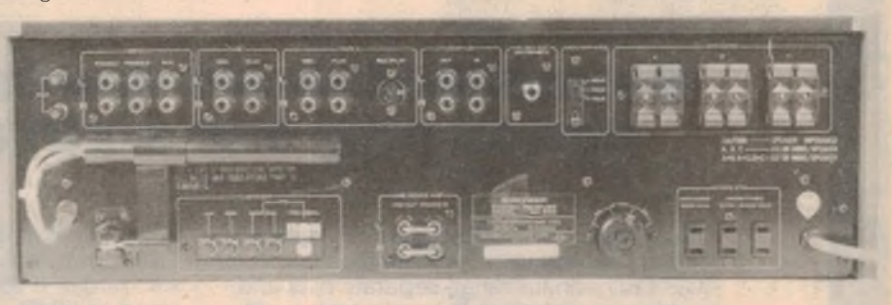
While we approve of the facilities provided for tuning FM stations we found the deeply recessed meters hard to see when the receiver was mounted on a waist-high bench. The control panel needs to be at eye-level to allow the meters to be used. This means that the user has to bend over to tune a station.

The usual conglomeration of input and output sockets abounds on the rear panel. There is a swing-out AM aerial rod which requires adequate clearance at the rear of the chassis so it can be orientated for best reception. A three-core mains flex and approved three-pin mains plug is fitted.

We had some doubts about the combined fuseholder and mains voltage selector. It is usually necessary to remove the voltage selector plug when a fuse has to be changed. This raises the possibility of reinserting the plug incorrectly (for say, the 110V mode) and thus the further possibility of serious damage. This problem could be avoided by ensuring that the fuseholder cap firmly grips the fuse when it is removed.



A large number of controls and facilities are provided on the high power SX-950.



Removing the wrap-over timber cover reveals what appears to be a relatively uncluttered chassis. However, as our photographs show, there is a large amount of circuitry on the underside of the chassis.

Surprisingly for a unit of this complexity, none of the PC boards use plug-in connections—nor is there a mother board. Instead all interconnections to the boards are wire-wrapped. This is possibly more reliable, but it sure must add to the cost.

SONY HI-FI NEWS No3

New from Sony: Front loading Cassette Decks

TC 206SD

Sound that rivals reel-to-reel in a space only one sixth as high.

Sony's new front loading cassette decks are loaded with features. For example the TC 206SD with full range separate bias and equalisation selectors to handle high quality ferric, chrome dioxide and Sony's superb double coated ferri-chrome cassettes. Fully flexible Dolby* controls with multiplex filtering to get the best from FM broadcasts. LED peak indicator as well as easy to read VU's. Automatic shut off. Lockable pause key for precise cueing. Sony's famous long life Ferrite and Ferrite head. Illuminated cassette well and upright tape positioning for easy viewing of cassettes. Featuring the new 'Soft Eject' mechanism.

And the sound? Strictly 'Front of the House'. Virtually linear smooth response over a tremendous range of 20-16,000Hz (Fe_2C_r, C_rO_2 tape). Wow and flutter at reel-to-reel standard of 0.08%. Signal to noise – an amazing 59dB.

If you want space saving, front-loading convenience and quality sound, check the range of Sony cassette decks soon; the TC 206SD for superb sound, the TC 209SD strictly for connoisseurs with specifications to match. And the budget priced TC 186SD for Sony quality – at a significant saving.

*Dolby is a trademark of Dolby Laboratories Inc.

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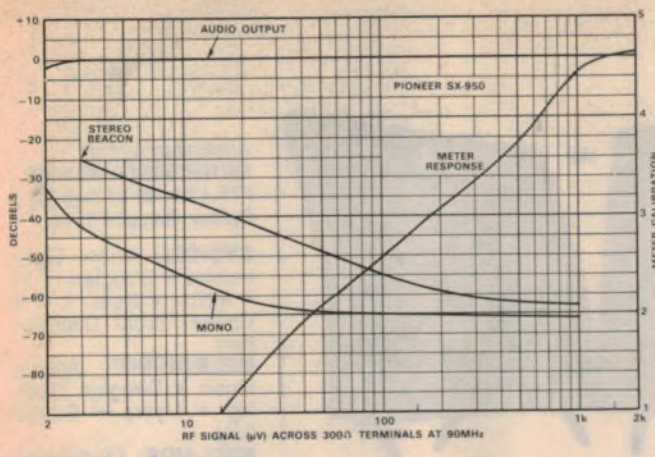
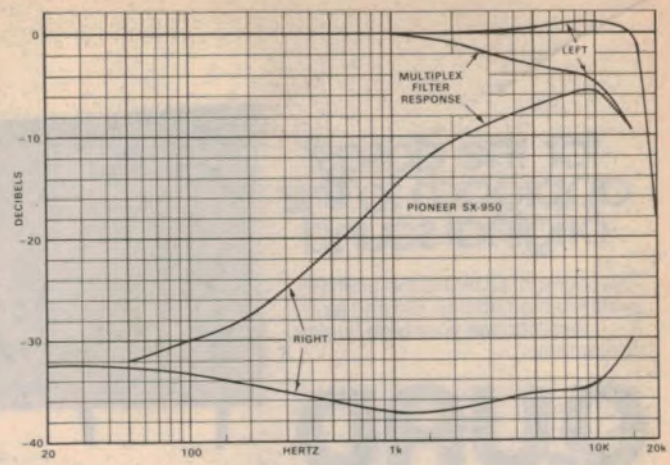




We were interested to note the care taken with shielding of the input sockets and associated wiring from the output transistors. In fact, the more closely one examines the chassis of the Pioneer SX-950, the more one becomes impressed with the amount of work involved in it, both in design and assembly.

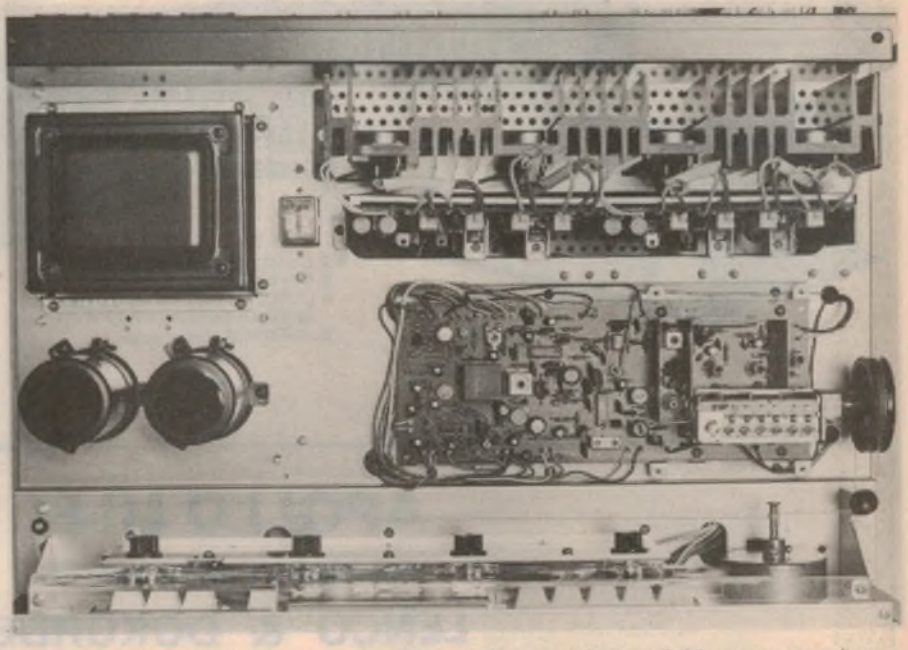
A glance at the circuit of the SX-950 confirms the visual impressions—that this is a very complex unit. Most of the FM and AM tuner circuitry is comprised of three integrated circuits. The remainder of the circuitry uses discrete components.

The power amplifiers are direct-coupled and employ balanced supply rails of plus and minus 50V. The filter capacitors for these rails are each 22000uF. To obtain adequate power rating there are four output transistors per channel. The output stages are fully complementary.

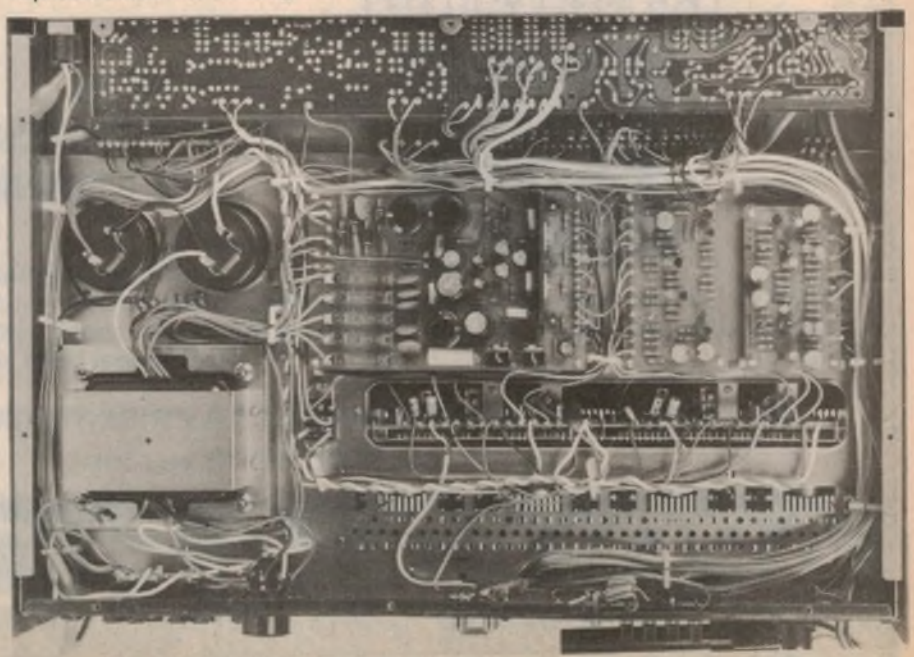
Of particular interest in the power amplifier is the protection and muting circuitry which involves a relay switching the power circuits. The relay driving circuitry monitors the conditions of the output transistors. If excessive loading, excessive drive or a DC fault occurs, the relay disconnects the loudspeakers. If a short circuit is maintained the relay cycles on and off until the condition is corrected.

This system of protection is more satisfactory than some "load line" protection schemes which can interact with some loudspeakers to produce nasty screeching sounds. However, for the relay system to be employed the output transistors must be inherently rugged to withstand the momentary overloads which the relay allows before it switches. The output transistors in the Pioneer SX-950 would appear to be very rugged.

Both the preamplifier and power amplifier circuits follow fairly conventional lines, once the overall complexity is allowed for. Most of the supply rails, with the exception of those to the output stages, are regulated. Thus, there are no less than nine separate regulated supply rails. In fact the power supply board is



Top and underside views give some idea of the complexity of this stereo receiver.



PIONEER SX-950

bigger than that employed in some power amplifiers.

As in some other high power units we have reviewed, the power transformer was noisy. We were able to reduce this to an extent by tightening the clamp screws, but it was still noticeable as a faint buzz in a quiet location. Another problem inherent with a large transformer is that it can have an extensive hum field. While this does not affect the amplifier or tuner circuitry it certainly affects nearby magnetic cartridges and cassette decks.

With the SX-950 we found that a turntable or cassette deck had to be positioned at least 30cm away from the receiver transformer before the hum field did not audibly affect their operation. We are not singling the Pioneer out for special criticism here; these remarks apply to most high power amplifiers, with the exception of those employing C-core or toroidal power transformers.

Performance specifications of the SX-950 are detailed at length in the comprehensive owners' instruction manual. The power amplifier and preamplifier sections are specified separately, as are the tuner sections. Naturally our performance tests applied to the preamplifier and power amplifier sections as a whole.

Power output is specified at 85 watts continuous per channel into 8-ohm loads or 110 watts per channel into 4-ohm loads, for a bandwidth of 20Hz to 20kHz and a total harmonic distortion of less than 0.1% over the whole band.

Suffice to say, this spec was confirmed. Briefly, we measured power output at 105 watts from a single channel into an 8-ohm load or 98 watts per channel with both driven.

With 4-ohm loads, power output was a whopping 160 watts into a single channel and 138 watts per channel with both driven. These tests were performed using a regulated 240VAC supply (as are all our tests on amplifiers).

Just to be difficult, we ran full power tests into 2 ohm loads. This blew the main fuse. This was a little surprising—we expected the relay to operate instead.

Frequency response at 1 watt was 3dB down at 10Hz and 70kHz. Square wave response was good and stability with capacitances up to 2uF shunting the load was satisfactory.

If the SX-950 is used with loudspeakers of average or high efficiency, the Loudness control should only be used in conjunction with the Muting switch. Otherwise a silly situation occurs where a Volume control setting of around 9 o'clock produces quite loud sound levels yet the Loudness control adds substantial bass boost. Better not to use it at all.

Phono sensitivity for 90 watts into 8-ohm loads was 2.5mV while Auxiliary input sensitivity was 150mV. RIAA equalisation is stated to be within 0.2dB and we confirmed that as best we could—these tight limits challenge those on audio oscillators and AC millivoltmeters.

Signal to noise ratio for Auxiliary inputs was 78dB with respect to 90 watts with open-circuit inputs, and 84dB with short circuit inputs. For Phono inputs, signal-to-noise ratio was 79dB with respect to 90 watts and a 10mV/1kHz input signal using a typical magnetic cartridge as input source. This last figure can only be achieved with the magnetic cartridge well away from the influence of the power transformer. Even so, it's very quiet, one of the best figures yet.

Figures for separation between channels of the preamplifier and power amplifiers are equally impressive. We obtained results of 75, 60 and 50dB at 100Hz, 1kHz and 10kHz respectively, with the undriven channel input short circuit. These figures ensure that there is no degradation of separation between channels for any likely signal source.

Performance results for Quieting, Meter response, Frequency response and Separation between channels are all indicated in the two graphs. The Multiplex filter has the usual drastic effect on separation but does give a useful reduction in high frequency noise in poor reception conditions.

While the tuner certainly has good Quieting characteristics it seemed more prone to be affected by ignition noise than some other good tuners, when the received signal was weak. This would not ordinarily be expected because the AM rejection ratio (not tested) is fairly high at 55dB.

Muting and stereo beacon threshold is 3uV. We tend to the opinion that 10uV would be a better setting. In addition, the circuit hysteresis should be increased to prevent erratic switching between mono and stereo when the signal is at the critical level.

19kHz pilot rejection was 60dB while 38kHz and other residuals were unmeasurably low. Harmonic distortion in mono mode is 0.4%, 0.5% and 1% at 100Hz, 1kHz and 16kHz respectively. In stereo the equivalent figures were 0.9%, 1.2% and 1.1%. These figures are quite a lot higher than the specification, but still adequate.

Overall assessment of the SX-950 is along the following lines: it has an amplifier and preamplifier of superlative performance which would be difficult to better. Its FM tuner is also good, but perhaps not quite up to the same high standard. Still, it would be far more expensive to obtain a separate tuner of higher standard plus a separate preamplifier/amplifier of the same power and performance, and this would be difficult to justify in Australia at present.

Recommended retail price is $669. The SX-950 is available from high fidelity retailers throughout Australia. Further information can be obtained from Pioneer Electronics Australia Pty Ltd, 178-184 Boundary Road, Braeside, Victoria or interstate offices. (L.D.S.)

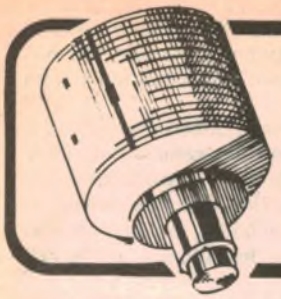
Comfortable headphones from Sennheiser:— HD400X

The outstanding features of the new Sennheiser HD-400X headphones is their light weight and wearing comfort. Mass is only 80 grams, not including the cable. It has a light cable 3 metres long terminated in a 6.5mm jack plug. The black plastic headband is fully adjustable and the bright yellow foam earpads are removable for washing or replacement.

The foam earpads provide little acoustic isolation from external noises but the phones are so light it is possible for the listener to forget that he is wearing them. Sound reproduction is clean and natural even though the frequency response is not particularly extended. Bass response is satisfactory for most music although it is lacking for pipe organs (as are most headphones, for that matter).

Load impedance of the HD-400X's is quoted as 500 ohms. Combined with a modest sensitivity, this acts to prevent overload when connected to normal stereo headphone jack on an amplifier, but allows adequate drive from the headphone socket on most cassette decks. Many low impedance headphones are not adequately driven by the socket on cassette decks, so this is a favourable feature.

Further information on price and performance can be obtained from high fidelity retailers or from the Australian distributors, R. H. Cunningham Pty Ltd, 493-499 Victoria Street, West Melbourne, Victoria.



News Highlights

America rolls out the first space shuttle

The flagship of a new era of space transportation was unveiled at Palmdale, California, on September 17 last when Orbiter 101, the first reusable Space Shuttle vehicle, was put on display by the National Aeronautics and Space Administration (NASA). The Space Shuttle, a versatile and reusable spacecraft, is scheduled to begin Earth orbital flights in 1979.

Although Orbiter 101 is the first vehicle off the assembly line, it will not fly into space until the early 1980s. Its first job in 1977 will be as a test vehicle. It will be launched from the top of a modified 747 jetliner in a series of manned flights (Approach and Landing Tests—ALT) to verify its aerodynamic and flight control characteristics at NASA's Dryden Flight Research Center (DFRC), Edwards Air Force Base, California

Subsequent to ALT, extensive ground vibration tests will be conducted in 1978 at NASA's Marshall Space Flight Center (MSFC), Huntsville, Alabama. When these tests are concluded, Orbiter 101 will be returned to Palmdale, California, for modifications to prepare it for space flight. The second Orbiter (OV-102) will be used in the initial Earth orbital flights from NASA's Kennedy Space Center, Florida, in 1979.

The Orbiter, workhorse of the Space Shuttle program, is designed to be used as many as 100 times. It is as large as a commercial jet airliner (DC-9); its empty weight is 67,500 kilograms (150,000 pounds); it is 45 meters (122 feet) in length and it has a wingspan of 14.4 meters (78 feet).

The Space Shuttle is composed of the Orbiter, two solid rocket boosters and an external fuel tank which feeds the Orbiter's three main engines. The Orbiter is attached to the back of the fuel tank and the solid boosters are attached to each side of the external tank. The solid rocket boosters will be recovered, refurbished and reused.

With the Space Shuttle, the rather large stable of launch vehicles that we use today—both civilian and military—will be eliminated. The Shuttle will be used to place almost all our satellites into orbit and, more importantly, it will have the capability to retrieve malfunctioning satellites and repair them in orbit or return them to Earth. No longer will it be necessary to write off a multi-million-dollar satellite due to a malfunction following launch.

The Space Shuttle will also be capable of carrying the Spacelab into orbit. Spacelab, carried in the Shuttle cargo bay, will provide a shirtsleeve, pressurized environment for scientific and technical investigators to work in space. Airlocks and a pallet external to the pressurized area will be available for experiments that require direct access to the space environment.

For lunar and planetary missions, the Shuttle will be capable of carrying upper stages into Earth orbit which will propel probes and satellites into outer space. These upper stages will also be used to place satellites into high geosynchronous orbits.

After its Earth orbital mission is completed, the Orbiter will return to Earth and land like an aircraft.

Major public showing for Viewdata

Viewdata—the revolutionary new British Post Office system for displaying telephoned information on television sets—recently had its first major public showing at the new National Exhibition Centre in Birmingham. Here, a businessman uses a custom-built terminal to make a telephoned request for details of current share prices.

The system harnesses the ordinary telephone to a modified domestic TV receiver. By pressing a key on the push-button control unit the television set is automatically linked to a 'library' of hundreds of thousands of items of information. This appears on the screen in up to seven colours with a maximum of 960 characters (about 200 words) on each 'page'. The page can be held for any length of time and after use another page can be called up.

Viewdata is based on an encyclopaedic store of constantly updated information on subjects of interest to all members of the community—from the family at home to business and industrial users at work. A public service is being planned by the Post Office and more than 70 organisations are to take part in a full-scale pilot trial. This will enable the Post Office to determine the range of information to be provided, consider charges for the service and assess the likely demand.

Satellite tracking contract to Plessey Australia

Plessey Australia has been awarded a contract by the Department of Science for the supply and installation of Turn Around Ranging Station (TARS) equipment.

The station, to be installed at the Orroral Valley Tracking Station in the ACT, is one of three, the others being in Japan and Thailand, which will be used to determine the position in space of the Japanese geostationary meteorological satellite to be launched in mid-1977.

Plessey Australia is prime contractor for the project. The equipment itself is being manufactured by Fujitsu Limited, Japan. The Turn Around Ranging Station transponds ranging signals from a command and data acquisition station in Japan to measure the "round trip" time of the signals. Together with similar information from the other stations the position of the satellite can be determined regularly by computation.

The Australian Bureau of Meterology will, later, be installing a ground station to receive data from the satellite.

Export order for AWA speaker columns

Australian speaker columns, designed and built by Amalgamated Wireless (Australasia) Ltd, are to be installed in a new Opera House in Guatemala City, capital of the Central American Republic of Guatemala.

The columns, unique in the field of sound reproduction, were recommended for the Guatemala City Opera House by Dr V. L. Jordan, the world-renowned Danish acoustic consultant, who recommended the same type of columns for the Sydney Opera House.

The AWA speaker columns are specifically designed for speech reinforcement in reverberant concert halls. AWA developed the revolutionary new design for the Sydney Opera House concert hall, which has since been recognised as having one the the best sound characteristics of any concert hall in the world.

In a reverberant hall it is necessary to produce a beam of sound which does not reflect from the walls. The shape of the beam normally varies as the speech frequency moves between high and low notes, which results in people sitting in different parts of the hall hearing the sound differently.

AWA's electrically tapered column overcomes this difficulty and maintains the shape of the sound beam, giving clear and uniform speech reproduction in all parts of the hall. The column incorporates 19 loudspeakers in a 4 metre enclosure.

Record turnover at Dick Smith Electronics

The past year has seen the turn-over of the Dick Smith Electronics Group almost double. Turn-over for the last financial year was at a record level of $3.6, million compared with $2 million for the previous year.

"I think our success is due to the fight we put on to hold costs", says Dick Smith. "While last year certainly wasn't a boom year for the industry, we were able to peg most of our prices by rationalising buying or opting for larger quantities. Too many suppliers seem to accept price rises as being inevitable and price themselves out of business."

Two new interstate stores have just opened in Brisbane and Melbourne and the Dick Smith Dealer network has also started operation in Hobart and Darwin. This new venture is planned for up to 20 dealers who will maintain control and ownership of their own business.

Mail order sales have continued to grow with the Artarmon headquarters handling about 1000 orders per week. Stock control has been computerised using an IBM System 32 with the revolutionary hard-goods package for electronic distributors—the first such installation in Australia. Over 3,500 basic lines are currently stocked.

Automatic map reader for air pilots

Marconi-Elliott has introduced an automatic map reader (AMR) which enables the pilot of a light aircraft or helicopter to see his current position at a glance, using the same map as he normally employs for navigation. The map is folded so that it shows the area over which the pilot plans to fly, and is then inserted under two superimposed 254mm diameter transparent discs. These discs can be rotated independently by servo motors, and a radial line and spiral engraved on them can thus be made to cross each other anywhere over the map's surface in order to indicate a position.

Controls on the AMR enable the starting point to be entered by the pilot, and the self-contained microprocessor continuously calculates and automatically displays present position. This is worked out from speed, course and wind information entered by the pilot or fed by an "umbilical" cord from navigation equipment in the aircraft. The AMR is less than

25mm thick and weighs under 1½kg, allowing it to be held in the hand or strapped to the pilot's knee.

The AMR is designed to reduce the workload in military helicopters, general aviation aircraft and small ships by providing a simple aid to navigation.

First pictures of Henry VIII's warship

Using this new British 'low-light' television camera—which can operate at depths in excess of 30 metres without the need for artificial light—the first pictures of Henry VIII's warship, the 'Mary Rose', were beamed to the surface in southern England recently.

The 700-tonne Mary Rose sank off the English south coast in 1545 while leading 60 British ships to face a French squadron. The excavations are described as 'the most important maritime archeological project in the world at this time' and it is hoped that the hull of the vessel, together with the possessions of the men who perished in it may still be intact, encased in a shield of clay. First pictures from the camera show that the timbers are still in a superb condition.

A team of 40 divers is working on the wreck with the main task of digging a

trench around the vessel's keel. If the rest of the timbers are in as good condition as is believed it is hoped that the Mary Rose could be raised within three years.

Lecture series on medical electronics

"Electronics in Medicine" is the theme of a series of public lectures to be held in the five mainland state capitals and in Canberra; and in summer schools in Sydney and Melbourne between November 29 and December 22.

The lectures and summer schools will be conducted by Professor B. McA. Sayers, Professor of Electrical Engineering Applied to Medicine, and Dr J. C. Vickery from the Engineering, in Medicine Laboratory, Department of Electrical Engineering, Imperial College of Science and Technology, London.

The lectures have been organised by

Professor Sayers

the Institution of Radio and Electronics Engineers (IREE) from which further information and registration forms can be obtained. Interested readers should contact the General Secretary, IREE, 157 Gloucester St, Sydney 2000. Telephone 27 1039.

NEWS HIGHLIGHTS

New spectrometer analyses particles down to 1um

Scientists at the National Bureau of Standards (NBS) have developed a new instrument capable of routinely analyzing very small particles, 1 micrometre in size or larger. Called a laser-excited micro-Raman spectrometer, the device will be of special interest to scientists studying the role of very small particles in air pollution.

The unique spectrometer was developed by Dr Greg Rosasco and Dr Edgar Etz, chemists in the NBS Institute for Materials Research (IMR), with support from the US Air Force Technical Applications Center.

The micro-Raman spectrometer has a unique design that combines commercially available components with several innovative features. The resulting operation of the one-of-a-kind instrument is routine in that any specific particle of interest in a sample can be simply located and then rapidly and precisely positioned for measurement.

A key feature of the instrument is that it optimizes detection of the very weak Raman signal from the particle of interest in a sample and minimizes all other sources of interference. The entire instrument is connected to a minicomputer which allows automatic data acquisition over a long period of time.

Raman spectroscopy offers a unique "fingerprint" that provides specific information about the structural or molecular formula of major chemical units in a material. For example, the Raman spectrum of a substance containing sulphur and oxygen can be used to determine if the sulphur and oxygen are present as sulphates, sulphites, or as metal sulphides or oxides. Raman spectroscopy also provides information about the state of aggregation of the chemical units in a material, for example, whether they exist in a crystalline or glass-like phase.

The analytical capabilities of the micro-Raman spectrometer are under investigation by NBS scientists. Chemical and physical characterization of micrometre and submicrometre-sized particles is of major importance in enviromental analysis. It is believed that particles in this size range breathed into the lungs may damage the respiratory apparatus.

Europe's largest ultra-clean workshop

This new 'clean room' of the Mullard plant at Southampton in southern England is claimed to be the largest and cleanest workshop of its type in Europe. The room has an ultimate capacity for the production of about 2500 silicon slices a day for the computer industry in a super-clean environment better than 'Class 10,000'. This means that the air within the room contains no more than 10,000 half-micro-metre sized particles in every cubic foot—compared with a typical factory environment usually rated at around a million particles per cubic foot.

The more critical parts of the clean room are restricted to Class 1000 and the supercritical areas are down to Class 100, although in fact most of these sections have an actual particle count of less than 10.

Oil from coal—CSIRO research shows promise

A process to extract oil from coal is showing promise in research testing by the CSIRO, the Minister for Science, Senator J. J. Webster, said in Sydney recently. The Minister was inaugurating a laboratory-scale flash pyrolysis reactor built by the CSIRO's Minerals Research Laboratories at their North Ryde site.

"Flash pyrolysis is a process which can virtually 'cream off' the valuable oil-forming products from coal, leaving a low sulphur char residue which can be burned for the production of gas or electricity," Senator Webster said. He said that the process was likely to be much simpler than other alternatives, and so could cost less to develop.

The reactor inaugurated today processes 20 kilograms of coal per hour, and will be used to examine important engineering problems, and to test the sensitivity of the process to scaling up for use by industry.

"If successful, we hope that this work will encourage industry to participate in the development of a pilot plant, and that it will eventually lead to a full-scale process designed to satisfy a significant proportion of Australia's liquid fuel needs," Senator Webster said.

University students on FM radio

Melbourne University students went to air with the University's first experimental FM broadcasts, during August—and, from the students' viewpoint, the three-day experiment was a success.

Studio equipment for the students' experiment was supplied by Philips Electronics Systems (Vision & Sound) and included the newly released LDN 5664 broadcast consolette, microphones, turntables, LBH 1309 motional feed-back loudspeakers, an ITC cartridge recorder and a PRO 36 reel recorder.

The FM transmitter used in the experiment was located in the University grounds and was restricted to an operating radius of about 10 kilometres, broadcasting on a frequency of 92.1MHz.

The three-day experiment enabled the students to get a clearer understanding of the problems associated with programming and operating an FM radio station. In addition, it gave them training in taping recorded segments and then putting a completed program to air.

As a follow-up, the experimenters are conducting a survey amongst student listeners to find out what program material students want to hear.

This information will form part of their submission to obtain a full FM licence to broadcast educational material and university news.

Lencoclean L as shown optional extra

Presented with pride...

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Swiss engineered for near perfect sound reproduction.

Photimport presents with pride, the Lenco range of precision-engineered Hi-Fi turntables. Australian test results have shown that wow and flutter are almost impossible to measure in Lenco equipment! So, people who are looking for near-perfection in sound reproduction . . . listen to Lenco. Combine this superb reproduction with Lenco's very reasonable price and you have a very sound bargain!

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New solar panel tracks the Sun

Array of solar energy spheres

A major challenge facing solar cell manufacturers is to reduce the cost of their cells relative to the electrical output, both by increasing cell efficiency and by reducing manufacturing costs. One interesting new development, aimed at improving efficiency, is a revolutionary solar panel that automatically tracks the Sun, and yet has no moving mechanical parts.

by MICHAEL KENWARD*

The world's abundant solar energy can be turned into electricity easily enough. Photoelectric solar cells have been doing it for many years—but electricity from these cells costs much more than electricity from conventional power stations or even from nuclear power stations.

Now Derek Mash, of Standard Telecommunication Laboratories (STL) of Harlow in England has invented a solar 'eyeball' that could bring down the cost of "solar electricity".

Most work on solar electricity concentrates on silicon solar cells which, like other photoelectric solar cells, convert sunlight directly into electricity. Unfortunately, silicon solar cells are more than 100 times more expensive than they need to be if their electricity is to compete with that from modern power stations. Much of today's research and development on solar cells is concerned with new techniques for making cheaper silicon solar cells. But Derek Mash's work at STL takes a completely different approach.

STL is working on gallium-arsenide solar cells. The company already uses gallium-arsenide in its work on semiconductor lasers and other electro-optic devices. This substance has a significant advantage over silicon in solar cells in that the Sun's light can be focused onto the cell's surface by a lens which concentrates more solar energy on to a given surface area. Of course, you can do this with a silicon solar cell but you run two risks.

To begin with, the concentrated sunlight can produce a temperature so high that it damages the cell—gallium-arsenide cells can withstand higher temperatures. Also, as the intensity of light rises on a silicon solar cell it "saturates" and the electrical output levels off before the Sun's energy is very high—gallium-arsenide cells do not saturate so easily.

This means that a small area of gallium-arsenide solar cell can generate much more electricity than the same area of silicon solar cell. But of course it also means that some sort of lens has to be used to focus the Sun's light on to a gallium-arsenide cell.

Solar energy systems that use optical focusing have a major drawback—they must follow the Sun as it moves across the sky during the day. There are numerous ways in which a cell can be made to keep watching the Sun, but most of these involve mechanical devices that are both expensive to build and need careful maintenance. Derek Mash has invented a system with no mechanical parts.

The STL device is a plastic "eyeball" about the same size as a football. The sunlight shines through a lens in the eyeball and onto the solar cells. As the Sun moves, its light shifts off the cell—which is surrounded by four gas reservoirs.

When the sunlight strikes one of these reservoirs the gas inside it—this is just air—heats up and expands, moving a small magnet inside the eyeball. This internal magnet interacts with an outside magnet and as a result the eyeball, which floats on water and can turn freely, moves so that the solar cell once again looks straight at the Sun.

The solar eyeball has very good prospects, says Mash, who has his doubts about the possibility of making silicon solar cells cheaply enough. He points out that while a gallium-arsenide cell might cost a little more than a silicon cell—the materials cost a little more but the production costs should be about the same—gallium-arsenide cells can be put into a focusing system that concentrates the Sun's light by a factor of 500 to 1000.

STL is quick to point out that its research and development is in early days yet, but it tentatively predicts that a kilowatt's electricity generating capacity might cost £350 to £500, which is not far off the cost of a kilowatt of generating capacity in a modern nuclear power station. The material used so far for experiments has been Perspex, which is both transparent and fairly easy to machine; production devices might use a cheaper material and a mass production process.

The fuel for the solar cells is, of course, free. Running costs should be very low because the tracking system has no moving parts to go wrong. And the eyeball's lens surface can easily be cleaned by washing it in the water in the float tank. Derek Mash reckons that solar eyeballs could last a very long time indeed.

The solar eyeball system can produce more than electricity. Solar cells are not 100% efficient at turning sunlight into electricity—more than three quarters of the solar energy escapes. Some of the energy left over can be captured in the solar eyeballs' water tanks. So the system can produce both electricity and hot water—two of the major domestic energy requirements.

*Technology Editor, "New Scientist", London.

The world that was inside a test tube

Michael Faraday: the father of refrigeration

Most of us know of Michael Faraday as the scientist who made great contributions to our knowledge of electricity and magnetism in the early nineteenth century. But did you know that it was Faraday, more than any other scientist, who was responsible for the development of the domestic refrigerator? This intriguing article tells the story of the scientific discoveries that lead to refrigeration.

by DR C. K. COOGAN

CSIRO Division of Chemical Physics, Clayton, Victoria 3168.

"That tube's dirty—it has oil in it", said the rather sharp-tongued and rank-pulling busy-body, Dr Paris to Michael Faraday, Sir Humphrey Davy's young laboratory assistant at the Royal Institution of Great Britain, one evening in 1823. "Don't be so careless in the future."

That was the scant thanks that Faraday received for a scientific discovery which was to have a profound effect on the world. And thus started a chain of carping, controversy and heart-burn which was to dog the mild-mannered, humble but proud Faraday. It arose out of jealousy over his climactic discovery.

Faraday had heated chlorine hydrate, a solid compound of chlorine and water, in one side of an inverted, closed U-tube while he cooled the other, and he had not noticed any "oil" in the tube before he started the experiment. Later, after the officious Paris, a crony of Faraday's boss, Sir Humphrey Davy and later Davy's biased biographer, had departed, Faraday filed off the end of the tube which promptly exploded. The room was filled with the acrid smell of chlorine. Accordingly, early the next morning Dr Paris received the following laconic note:

"Dear Sir,
The oil you noticed yesterday turns out to be liquid chlorine.
Yours faithfully
M. Faraday"

In succeeding in liquefying chlorine, Michael Faraday had started a chain of discoveries which led to refrigeration. He made a number of other basic discoveries in chemistry and physics, some of which suggested further experiments to others, which all added up to the gleaming white refrigerator in the corner of the kitchen.

A watercolour by Harriet Moore of Faraday's magnetic laboratory. Faraday's great electromagnet, used in many experiments, can just be seen beneath the table.

Dalton, who developed the Greeks' theory of atoms to lay the foundations of modern chemistry, had suggested a few years before that the so-called "permanent" gases might be liquefied by a combination of high pressure and cold. But how to produce the high pressure? Faraday thought he saw the answer. On heating chlorine hydrate, a compound in which chlorine is weakly bonded to water, masses of yellow chlorine had been evolved. When the tube cooled there was clear water in the heated side of the inverted U-tube and yellow, oily, liquid chlorine in the other. The chlorine evolved from the decomposition of the chlorine hydrate had liquefied under its own pressure.

Later he tried a syringe to compress chlorine and again produced liquid chlorine. Then he set off on an exultant jaunt of discovery, all in off-duty moments, to see if he could liquefy other gases. He repeated his success with chlorine in a number of cases, but he also repeated the original explosion several times too, burning his eyes on one occasion and ending up with 13 fragments of glass in his eye on another.

Success was in the eye of the beholder!

His troubles arose from the growing jealousy of his superior, Sir Humphrey Davy, who tried to claim that he had suggested the liquefication experiment to Faraday. The fuss this generated led later in 1823 to Davy also suggesting that Faraday had plagiarized from Wollaston when he invented the electric motor in 1821, and to Davy trying to bar Faraday's election to the Royal Society, the top science club of England, in 1824.

Davy had good cause to be jealous; in his protege a star of the first magnitude was rising and outshining him in his own institution!

At the beginning of the 19th century it was not even possible to conceive of artificial cold. It was not until a number of leading discoveries had been made by unfettered, curious minds, not bent on project-oriented or "relevant" research, that it began to dawn on people that it was possible to produce cold by mechanical means. The refrigerator would never have emerged but for the men in the ivory towers.

Before anything else it was necessary to get ideas about the basic nature of heat right, and this did not happen until the start of the 19th century. Until then, everyone believed Lavoisier's idea that heat was a kind of ghostly fluid called caloric ("calorique" to Lavoisier) which could flow into or out of matter. Hot things had more caloric that cold things. Didn't bodies expand when they became hot?

The logical next step was to weigh a hot body and to see if it lost weight on cooling, and this is just what Count Rumford (who, incidentally, established the Royal Institution in which Davy and Faraday were working) did on a new balance capable of an accuracy of one part in a million. The results ruled out heat having any weight—just another case of a profound forward step in science being made possible by better, more precise, instruments becoming available. Joule and Davy both reasoned that the only other property of matter left was motion, or vibration. Heat, then, is the mechanical energy of atoms vibrating at enormously high frequencies.

Then came more precise studies of the tie-up between pressure, volume and temperature. This appeared to be settled when Charles and Boyle set forth their famous Laws, which can be stated in combined form as PV/T is constant. But there were small discrepancies.

Modern ideas about the nature of a gas were beginning to gel in the early 19th century. It was becoming apparent that a gas was composed of atoms or molecules rushing about, colliding with one another and with the walls of the container. The pressure exerted by the gas was simply the pinging of rapidly moving gas molecules on the walls of the container.

Joule calculated in 1821 the mean velocity of hydrogen molecules at 0°C needed to produce a pressure of one atmosphere by bombarding the walls of the container. Clausius, Boltzmann, Maxwell, Meyer and Van der Waals all elaborated on this calculation and the picture of a gas as a sea of minute billiard balls began to look secure.

However, in 1835 Thilorier used Faraday's methods to liquefy carbon dioxide, and found that when liquid CO_2 was allowed to evaporate rapidly it formed "snow", or the now-familiar dry ice. As Thilorier said about this unexpected result:

"Inside a Faraday tube was a new world in which totally unexpected phenomena occurred!" The rapid evaporation had so cooled the liquid CO_2 that it froze. The "freezing" of tissue by evaporation of methyl iodide by your friendly neighbourhood Medibank man is another application of this principle.

There had been prior clues to this. In 1811(?) Leslie and Wollaston (the same very productive scientist who was inadvertently involved in the dispute over the discovery of the electric motor) had succeeded in freezing water by evacuating the space around it to accelerate evaporation. Somehow, the densely packed molecules of liquid needed to take extra energy with them when they set off above into space as gas molecules. But there the matter rested for a while.

Above: Michael Faraday. Below: the bound volumes of Faraday's diary.

Meanwhile Faraday seized on Thilorier's new dry ice and using it to produce temperatures as low as −110°C liquefied other gases. By 1844 all the known gases except hydrogen, nitrogen, oxygen, carbon monoxide, methane and nitric oxide had been liquefied. Of course helium, argon, neon, krypton, and xenon had not yet been discovered, but they and the others were eventually tamed by Dewar and Ohmes. As Faraday said, the fact that a number of scientists were working in the field was very beneficial, not wasteful, as they stimulated one another:

"... it is wonderful how much good results from different persons working at the same matter. When Science is a republic, then it gains; and though I am no republican in other matters, I am in this". The now prevalent ideas of politicians about rationalizing research so that only one person or group works on one topic flies in the face of the facts of history—scientists are seldom productive unless they can throw the ball backwards and forwards to one another.

Enter another giant, William Thompson alias Lord Kelvin. Joule and Thompson, who had been appointed to the chair of Natural Philosophy (physics) in Glasgow at the age of 22, got together to study this expansion and cooling in detail. They allowed highly compressed gases to expand through a porous plug into a region of lower pressure, whereupon the more widely, dispersed gas cooled. It is this principle which is at the heart of the normal domestic refrigerator.

Thompson, another universal genius like Faraday, but this time of the highly-educated, university ilk, laid the first Trans-Atlantic cables, and later became Lord Kelvin and one of the first members of the British Order of Merit. Working together in the years 1851-1856 they established the basis of the science of cooling by expansion of compressed gases, the essence of almost every domestic 'fridge's operation. In fact, the first refrigerators were called Kelvinators.

It soon became clear that the mole-

The development of refrigeration

cules of a gas, far from being mere stunted billiard balls, clung together fairly strongly when they were close together. Thus in order to expand a gas, or to evaporate a liquid, those bonds had to be broken. This required work, or heat, which had to come from somewhere and it had to come from the thermal energy of the gas or liquid. So on evaporation or expansion the temperature dropped, and in some cases this could lead to the freezing of a liquid, as with dry ice, or the lowering of temperature when a gas expands—which is what happens in a refrigerator. Van der Waals worked it all out, and found that this tendency of gas molecules to cling together accounted for the discrepancies in Boyle's and Charles' Laws at high pressures.

From then on inventions in the field of refrigeration came thick and fast. All the gases, including air, hydrogen, and the rare gases were liquefied. It was found necessary to produce better insulated containers than those currently available to hold liquefied gases, and Dewar obliged with a double-walled, silvered glass container, or Dewar vessel, now a permanent resident in every home under the name of Thermos. This was yet another unplanned spin-off of tremendous value.

There is another commonly used principle of refrigeration—the absorption, or Electrolux system—in which the refrigeration gas is absorbed in a liquid and released again by the application of heat. It was invented by a Swedish student as a lateral thought while working at an exercise on thermodynamics. In the guise of the "Silent Knight" it soon covered the face of Australia. Now out of favour for domestic refrigerators, it is now rapidly coming into its own again as a solar powered refrigerator for freezing and for solar powered air-conditioning.

Faraday had already contributed the other major discoveries which made your refrigerator possible. The electric motor is incredibly simpler to operate than any other type of motor—no fuel, no adjustments; just switch on. He invented this in 1821, complete with the ingenious device we take for granted, the commutator.

Jubilant with his discovery he went off to the theatre to celebrate in the evening, but while waiting in the queue, Faraday, a small man, was beaten up by a bully, so he promptly went home and wrote a brilliant paper on his discovery. This caused him trouble, too, as the jealous Humphrey Davy tried to suggest that he had pinched the idea from Wollaston, and the matter came to a head in 1823. Wollaston himself nobly exonerated Faraday and cut the ground from under Davy. Throughout all this controversy, Faraday bore no grudge against Davy.

The other essential was of course the electric generator and its alternating current. The first electric motors were direct current and battery driven. In order to crack this nut, Faraday had first to puzzle out the rules applying to the induction of electricity. He systematically studied the current induced in a coil when the magnetic field passing through the coil was changed—for example when a magnet was withdrawn from the coil.

Just like the now crazy idea of caloric in heat, at the start of Faraday's magnificent work on electrical induction it was thought that there were four distinct types of electricity. Now we know it is all one and due to electrons flowing one way or another in electrical conductors. But the electron had to wait till 1899 for J. J. Thompson (no relation to Kelvin Thompson) to discover it. By 1831 Faraday had mastered the secrets of electric induction of current, probably the greatest discovery he ever made.

Faraday's tour de force culminated in the dynamo or generator, which others like Siemens in Germany took up and perfected. If the electric motor made domestic refrigeration possible, then domestic refrigerators also made the electric motor industry. Do you remember the early thirties when about the only electric motor in the average home was in the electric fan? The first refrigeration plants were powered by steam or diesel engines, and were thus large, non-domestic affairs which produced the ice little boys lugged home in billy-carts from the local ice-factory.

Australia played a prominent role in the early development of refrigeration. In 1856 and 57 journalist James Harrison of Geelong took out patents for a refrigerator using ether as the gas-liquid expansion cooling fluid. His machines were first made in NSW in 1859 and began to be used in the UK, industrially, to extract paraffin from oil. He set up an ice-works on the banks of the Barwon and in 1859 established a 10 ton per day ice plant in Franklin Street, Melbourne. In 1866 he was sub-editor of the Melbourne "Age" and he maintained an intermittent relationship with the "Age" until he died.

In 1868 J. Davy Postle read a paper to the Royal Society of Victoria in which he suggested that frozen meat might be shipped to the UK in vessels fitted with air-expansion refrigeration machines. He rolled up his sleeves and showed by experiment in 1869 how it could be done.

At that time frozen meat could only be shipped if accompanied by ice, which

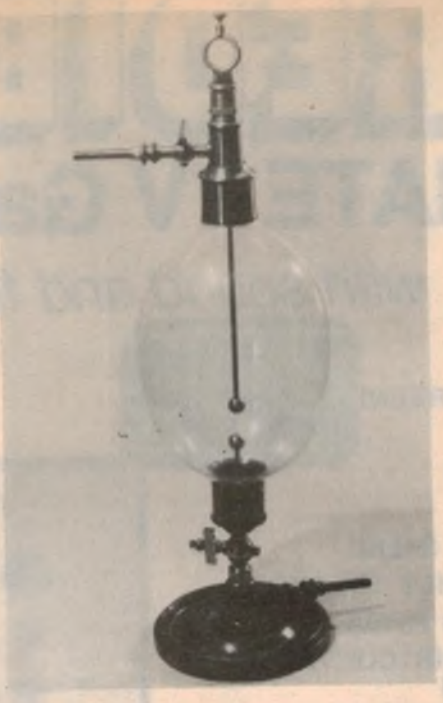
practically ruled out the UK as a market for Australian meat. In 1873 Harrison became notable as the proposer of a new process for preserving meat—freezing—and it worked well on mutton, keeping it indefinitely. He won a gold medal at the 1873 Melbourne Exhibition, but on trying to repeat the trick with a cargo of 25 tons of frozen beef to London, he found that while his process was perfect for mutton, the beef was unusable on thawing.

However, Postle's system was not developed commercially, and the honour of the first successful shipment of refrigerated meat went to J. J. Coleman of Glasgow, whose compressed-air refrigerator was fitted to the "Circassia" to bring chilled beef from America to the UK in 1879. Later that year the first Coleman-refrigerated shipment of frozen mutton travelled from Australia to the UK.

Some years later, Carl Linde of Munich showed that ammonia was a better fluid than air or ether for refrigeration, and for many years this reigned supreme. Nowadays, various Freons are preferred for a number of reasons.

Faraday died in 1867, and may never have seen one of the refrigerators which came from his work. Incidentally, don't get the idea that Faraday was preoccupied with electricity and liquefication of gases. In 1820 he discovered a compound of carbon and hydrogen, which he called "bicarburet of hydrogen" and which we now call by the simpler name of benzene. A few years later he succeeded in "chlorinating" (or exchanging chlorine atoms for hydrogen) this compound.

By these two experiments he probably established the best claim to be called the father of modern organic chemistry, and the vast industries which grew out of it. The family of Freons now used as refrigeration gases are hydrocarbons in which some or all of the hydrogen atoms are replaced by chlorine or fluorine. On the side, he was making the first stainless steels, laying the foundations of the understanding of magnetism, making great contributions to optics and laying down the laws of electrolysis and hence of electroplating.



Shown at left is the "Electric Egg" used by Faraday for studying discharge phenomena in gases. At right is a close-up of Faraday's "great electromagnet". It was made from a section of ship's anchor chain, supported by a wooden stool.

All this came from a man with little or no formal education who started work at the age of 13 as a bookbinder's apprentice. His mathematics were so poor that he returned a paper on electrostatics to its author, Poisson, with apologies that he could not understand it. Faraday himself quipped that the greatest feat he ever performed was when his friend Charles Babbage, Lucasian Professor of Mathematics at Cambridge, allowed him to turn the handle of his first computer!

It's hard to imagine our world today without refrigeration. Our whole food industry depends on it, our economy depends on it, our medical services depend on it. No freeze dried beans, no penicillin, no stored blood for transfusions, no frozen scallops, no liquid oxygen for the steel industry, no neon lights, no argon for welding, no air-conditioning. And it's only just started — the world of super-conduction achieved by liquefying helium is around the corner, allowing trains to hover above rails, electrical energy to be stored and current to be transmitted great distances without loss.

Dalton, Gay-Lussac, Davy, Avagadro, Magnus, Thilonier, Natterer, Deville Caignard de Tour, Graham, Joule, Young, Rumford, Kelvin, Andrews, Herepath, Wollaston, Clausius, Rankine, Maxwell, Boltzmann, Stoney, Tait, Van der Waals, Mendeleef, Amagat, Rayleigh, Crookes, Pictet, Cailletet, Wrohlewski, Olszewski, Kundt, Warburg, Onnes, Young, Ramsay, Leduc, Mathias, Siemens, Kirk, Coleman, Linde, Postle, Harrison and Dewar are all names on the roll of honour, but it was Faraday who provided the key experiment, the motor, the generator and the cooling gas!

It's modish nowadays to accuse today's scientists of doing research that is not relevant to the needs of society. Hardly a link in the chain that led to refrigeration took place for reasons other than the native curiosity of men trying to unravel the secrets of nature. Yet when all was added up the result was the most practical and needed of inventions in the modern world, with spin-off in all directions, totally inconceivable at the start. How relevant was their research?

Puns and Knighthoods

Thompson and Faraday between them gave rise to two of the most outrageous puns in the reign of Queen Victoria, both over the topic of knighthoods.

In 1835 Faraday was approached to accept a knighthood, which he politely but firmly turned down on the grounds that it might go to his head and affect his work! Fraser's Magazine heard about it on the grapevine and printed an article on it in which they said "Far-a-day was near a knight".

Thompson was deeply involved in the laying of the first successful Trans-Atlantic cable in 1866 and went off to sea in the "Great Eastern" to assist in its installation. He was not a good lecturer, and had a habit of haring off after any new thought that entered into his mind during a lecture and working out the mathematics there and then on the board—a habit which his students detested as they found him impossible to follow.

While he was away his duties were assumed by a man named Day, whose lectures were models of succinct clarity. Also whilst away, Thompson was knighted for his considerable services. On the occasion of Day's last lecture, he entered the lectureroom to find on the board ... "John chap. 9 v.4; Work while the Day is at hand for the Knight cometh when no man can work."

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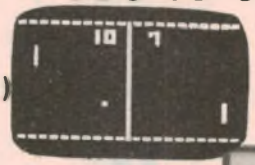

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MICROPHONES

Part 2: Dynamic, capacitor and electret types

Reproduced by courtesy of Sennheiser Electronics, this series of articles is intended to assist sub-professionals and amateurs who need to use microphones, but without the advantage of formal acoustic training. This article discusses dynamic and capacitor types and matters of sensitivity and impedance.

by G. PRAETZEL and E. F. WARNKE*

According to the Brockhaus Encyclopeadia a microphone is an apparatus for transformation of sound vibrations into electric alternating voltages. We want to consider here only those types of microphones which are of importance today for sound recording and similar applications.

MOVING COIL: The moving coil microphone is by far the most used in microphone recording practice. Its mode of operation is illustrated in Fig. 4. A coil of copper wire is fixed to its diaphragm. When the diaphragm moves—activated by the sound—the coil follows the movement in the gap of the magnetic system and the copper wire windings cut the magnetic flux lines. This generates an electric voltage in the moving coil and this voltage can be taken by a connecting lead directly to the mixer or tape recorder.

CAPACITOR: Because of cost, capacitor type microphones have, for decades, been largely limited to use in professional studio situations. Recently, however, "Elektret" (often spelled electret) capacitor microphones have brought the principle into the sub-professional market in a less pretentious and less costly form. Fig. 5 illustrates the operation of a capacitor microphone.

A very light, tightly stretched electrode of metal or of plastic foil covered by vapourised metal, is placed in front of a rigid electrode of metal or metallized ceramics, the two electrodes thus forming a capacitor. If the light electrode used as a diaphragm vibrates under the influence of sound pressure, the capacitance between the two varies. This variation of capacitance is used in the DC-capacitor microphone for generating an alternating voltage in the following way:

The microphone capacitance is charged via a very high resistance from a polarizing voltage source. Due to capacitance variations caused by the sound pressure fluctuations, the electric voltage across this capacitor varies too, as the charge cannot flow away fast enough.

Because of the low amplitude of the voltage variations, and the very high impedance of their source, the output from a capacitor microphone element cannot conveniently be coupled directly to a distant amplifier. Instead, the signal has to be applied first to a preamplifier adjacent to the microphone capsule to produce an effective signal source of higher amplitude and lower impedance. (See Figs. 5 & 6.)

As mentioned earlier, the most recent variant of the ordinary capacitor microphones is the electret type. In this, the polarizing voltage is, so to speak, "frozen" in this capacitor, and the otherwise necessary external polarizing voltage is not required, reducing cost to some extent. However, the acoustic properties of those plastic foils, which can be "electretized", are not as good as the foils normally used in the studio capacitor microphones. Thus the quality standard of today's electret capacitor microphones is somewhere between the simple dynamic microphones and the wideband dynamic microphones for studio purposes.

RF CAPACITOR: While similar structurally to other capacitor microphones, the "RF" type is used in a quite different circuit configuration. There is no polarizing voltage as in the "DC" system, and no built-in field as for the "electret". Instead, the microphone capacitance is made part of the frequency determining circuit of a radio frequency oscillator operating, usually, at about 8MHz. Variations of microphone capacitance with incident sound pressure frequency modulate the RF signal and an FM discriminator circuit turns this back into an audio signal.

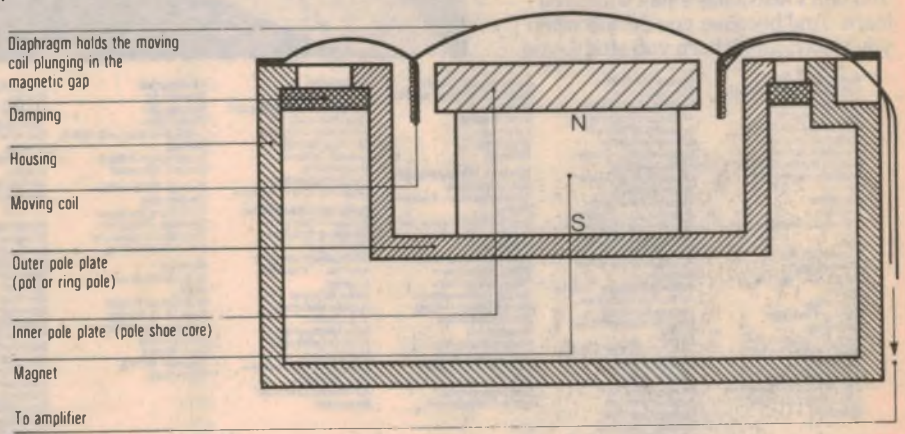

Fig. 4: Illustrating the basic principles of a moving coil or "dynamic" microphone.

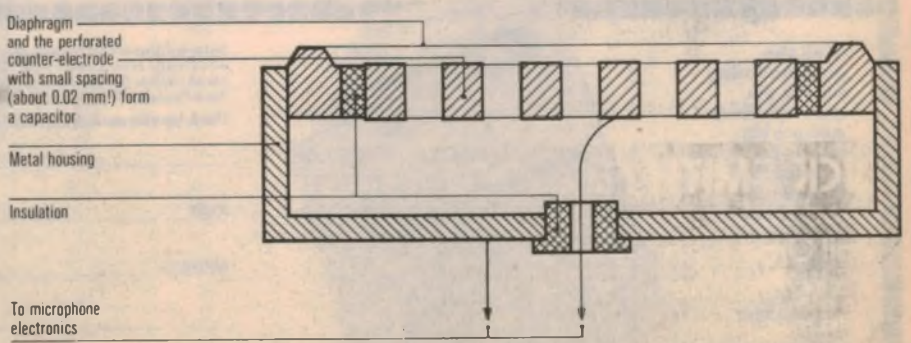

Fig. 5: There are three familiar variations on the capacitor microphone theme: the conventional DC type, the RF type and the new and very popular "electret" version, now finding wide application in the sub-professional field.

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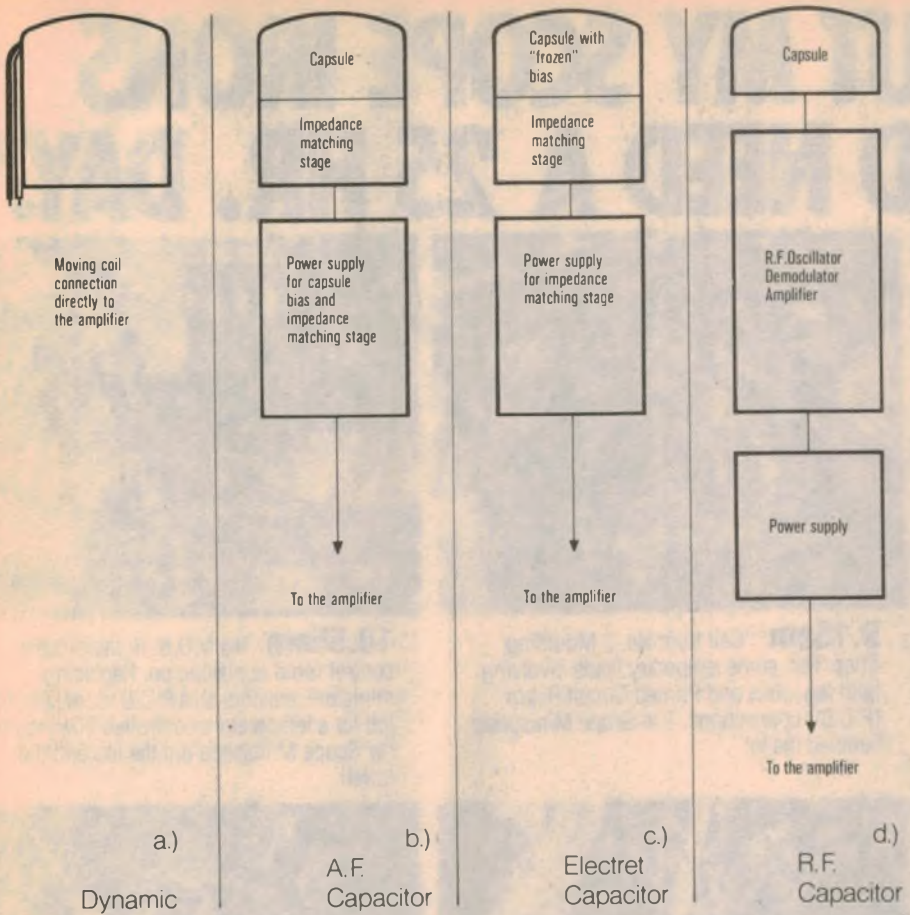


Fig. 6: Capacitor type microphones (b, c, d) often have a higher output than low impedance dynamics because they have an in-built preamplifier/impedance matching stage.

RF capacitor microphones have a particularly low inherent noise figure but, because of the rather special nature of the associated circuitry, they are mainly used in studio applications. (See Fig. 6.)

Having looked at the main types of microphone, it is appropriate next to consider the more important characteristics which form the basis of published data.

SENSITIVITY: The sensitivity figure for a microphone normally specifies the electrical voltage in millivolts supplied by the microphone when it is brought into a soundwave of a sound pressure of 1 ubar.

It should be noted that, under the new SI system of units pressures are being expressed in "Pascal" (Pa), which is defined as the pressure which a force of one Newton (N) exercises on an area of one square metre:

$$1\ Pa = 1\ N/m^2$$

The relationship of the old and new units is indicated by the equation:

$$10\ ubar = 1\ Pa$$

The sensitivity of a microphone can be converted from one unit to the other thus:

$$1\ mV/ubar = 10\ mV/Pa$$

Sensitivity measurements are normally made on a microphone unloaded in a free sound field, i.e., without terminating impedance across the microphones output which otherwise would influence the measurement. A sound pressure of 1 ubar might be generated—for instance—by a man speaking with normal volume of speech at a distance of about one metre.

If the sensitivity of a dynamic microphone is quoted as 0.2 mV/ubar, it means that it would generate a voltage of 0.2 mV when placed at a distance of 1 metre from a man speaking at a normal level.

If the associated tape recorder or mixer requires an input signal of not less than 0.2 mV for a fully modulated recording, it is evident that the volume control would have to be turned fully up, unless the voice level into the microphone can be increased.

It is also evident that inherent amplifier noise could become a problem in such circumstances.

It follows that higher microphone sensitivity can be of advantage to the user, because a higher signal/noise ratio can be achieved. Good dynamic microphones today exhibit sensitivity values of 0.2 mV/ubar, while capacitor microphones mostly have sensitivities of 2 mV/ubar, so that the volume controls of the following units need to be turned up less.

Against this, the signal supplied by the microphone must not be so large as to overload the input circuit of the associated amplifier. It can easily happen in cases when a capacitor microphone with a high output level is connected to an input designed for the lower signal voltages of dynamic microphones. In such a case the too-strong microphone signal has to be reduced by means of suitable voltage dividers, so that overload by the highest expected sound pressure can be avoided.

IMPEDANCE & MATCHING: The source-impedance or simple impedance, denotes the intrinsic alternating current impedance of the acoustic transducer. As the impedance often depends upon frequency it is measured in ohms at 1000Hz. It amounts frequently to 200 ohms for low impedance dynamic microphones, is between 500 ohms and 5k ohms for medium impedance mics and between 25 and 150k ohms for high impedance microphones.

To connect a microphone properly to a tape recorder or to an amplifier, two points have to be observed:

1. The microphone must be connected to the following unit by means of suitably wired plugs by cabling no longer than appropriate for the particular microphone.
2. The impedance and sensitivity of the following unit input must also be appropriate for the microphone.

In special cases, a design engineer may elect to match the output impedance of the microphone to the input impedance of the associated amplifier. This will usually ensure maximum power transfer and can loosely be described as "power matching".

More commonly, designers are interested in obtaining maximum transfer of signal voltage and this is obtained when the load impedance presented by the amplifier is much higher than the output impedance of the microphone. Since the the aim is to transfer voltage at a suitable amplitude, this situation can be loosely described as "voltage matching".

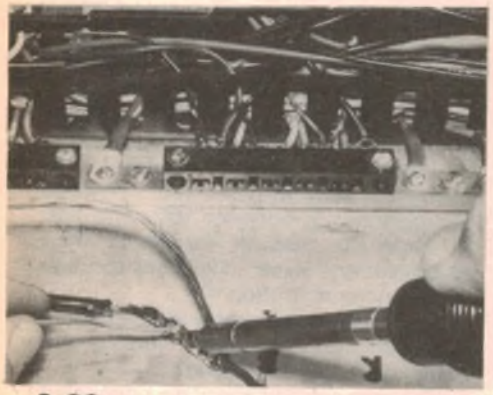
Sennheiser microphones are normally designed and calibrated on the assumption of "voltage matching", with the input impedance of the amplifier about 5-10 times the output impedance of the microphone. For all practical purposes, this can be regarded as no-load or unloaded operation.

Where the amplifier has a very high input impedance input—typically 250k or more—it is not unusual for the sensitivity to be lower, so that a somewhat higher signal voltage is required. In such a case, the gap can often be bridged by the provision of a step-up transformer, either external to or integral with the microphone, to convert it from an effective low-output low-impedance type, to a high-output high-impedance equivalent.

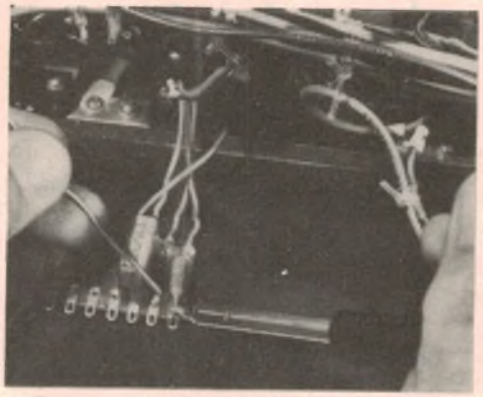
It should be noted that cables carrying signals at high impedance should be kept as short as possible to minimise the risk of high frequency loss due to capacitive shunting, and the pickup of hum or extraneous signals from broadcast, television or other transmitters.

(To be continued)

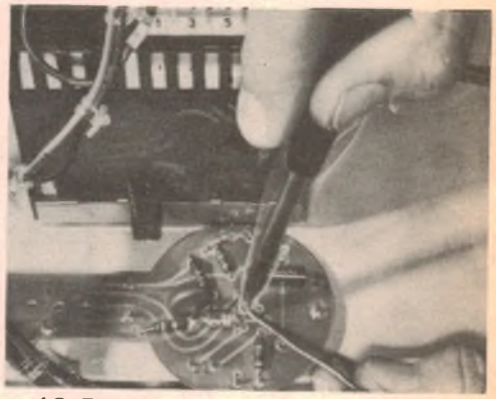
"WITHOUT MY SCOPE IRONS I RECKON I'D NEED A 25 HR. DAY."



8.00am "Start the day with a heavy earth connection on the emergency power plant. Need a 130 watt iron. My Superspeed's got that and more. Just as well, the workshop's 400 yards away".

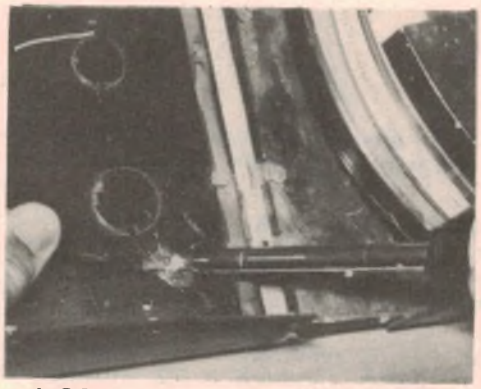


9.15am "Call from No. 2 Moulding Shop. Ran some temporary leads involving both tag joints and Printed Circuit Board (P.C.B.) connections. The Scope Minispeed handled the lot".

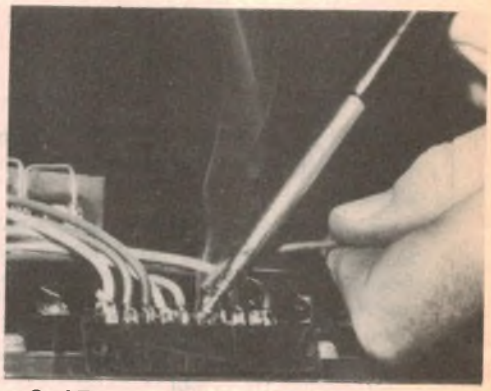


10.55am The V.D.U. in the process control room is playing up. Replacing miniature resistors on a P.C.B. is, ideally, the job for a temperature controlled 60w iron but my Scope Minispeed did the job and did it well.

11.15am "Fix the speaker leads in the canteen P.A. Need a 30-40 watt iron, but my Scope Minispeed did the job".

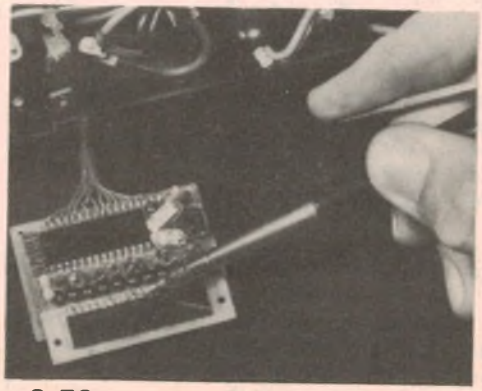


1.30pm "Resolder a 7/036 earth to sheet metal — LP gas flame would work, but too much risk of heat damage to PVC cable. The Superspeed iron produced its full 150 watts and did the job".

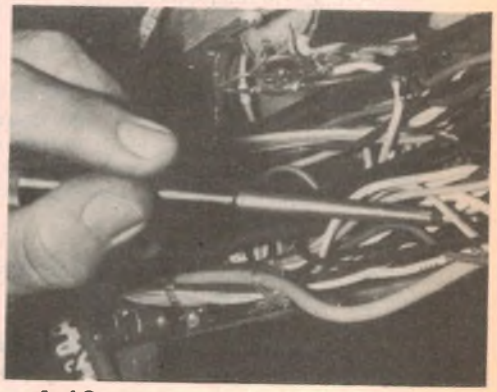


2.15pm "Fred borrowed my Minispeed to tackle an open circuit on the fork lift's headlights. He permanently soldered the wires to the terminal block, and used the Mini's 75 watts to do it".

2.17pm "Tag soldering in the workshop and a desolder job on a P.C.B. Using the Minispeed saves swopping between conventional 60 watt and 25 watt irons".



3.58pm "Emergency in shop six. I used my Minispeed to unsweat the leads of the main heater control circuit and then desolder the pyrometer circuit on the P.C.B. One iron, two different jobs".



4.18pm "This wiring's a real birds nest. Passed through the wires with the Minispeed stone cold, desoldered the three joints, let the iron cool down, then withdrew through the PVC insulation. The 5 second heat up and low tip mass let's me do this".

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SL1

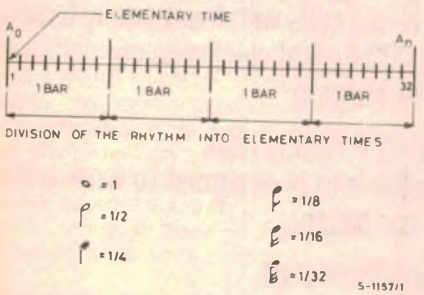
Auto Rhythm Unit For Electronic Organs

Here is the second article giving constructional detals of a rhythm unit. Details are given of how to connect the SGS-ATES M252 Rhythm Generator chip to the previously described instrument simulator. Details are also given of a suitable case for the completed unit.

by DAVID EDWARDS

A rhythm generator is a timing system which generates trigger pulses for a set of oscillators whose damped, amplified outputs simulates the acoustic sensation of the musical instruments in the rhythm section. The rhythm generator, therefore, is not a true source of sounds, but only a means of timing the switch-on of the oscillator circuits which constitute the true sound sources.

To realise such a system, each cycle of the rhythm must be divided into a number of "elementary times" using a counting technique. A fixed memory then determines whether or not a given instrument should be triggered during each of these elementary times.



This diagram shows how a rhythm is divided up into elementary times, and grouped into bars.

The elementary times which constitute the smallest subdivisions of the rhythm can be grouped into bars or measures (usually 1, 2, 3 or 4). Within the complete rhythm, each of these bars can be programmed differently. Each bar, then, consists of n elementary times in which the beats of each instrument will be programmed to occur. In terms of musical notation, the length of these beats is described as a fraction of a known reference period (see Fig. 1).

When the sum of the beats in a bar comes to 4/4, the rhythm is described as 4/4. Similarly, it is possible to have a 3/4 rhythm and so on. The number of elementary times in the bar fixes the minimum duration of each beat; in other words, the greater the number of elementary times the shorter will be the minimum length of the beats and the richer the resulting rhythm.

For example, a 4/4 rhythm programmed in 4 bars over 32 elementary times, i.e. 8 per bar, can only use musical beats of length 1, 1/2, 1/4 or 1/8, but if the same rhythm is programmed in two bars of 16 elementary times each, musical beats of length 1, 1/2, 1/4, 1/8 and 1/16 can be used. The basis of such a rhythm generator is illustrated by the block diagram of Fig. 2.

The counter must be able to count to the number of elementary times corresponding to rhythms in 3/4, 4/4 and 5/4 time. This means that the counter must stop and reset to its initial position after a certain number of counts, the number depending on the selected rhythm.

The two characteristics of the rhythm which determine the count requirement are the minimum beat length and the number of bars in the complete rhythm. Thus a 4/4 rhythm with a minimum duration of 1/16, and with 2 bars per rhythm requires 16 x 4/4 x 2 = 32 counter states, while a 3/4 rhythm with a minimum duration of 1/16 and with 2 bars per rhythm requires 16 x 3/4 x 2 = 24 counter states.

The read only type memory (or ROM) must have outputs which reset to zero after each "reading", so that the outputs will always be able to provide the correct trigger edges during following beats.

The system described in principle above can be realised with integrated circuits or with discrete devices. TTL devices can be used to fabricate the counter, and a standard MOS memory used to store the rhythms. Alternatively, the counter could be realised with discrete components, and a diode array used to store the rhythms. Such approaches, however, tend to use large numbers of components, and are not recommended for this reason.

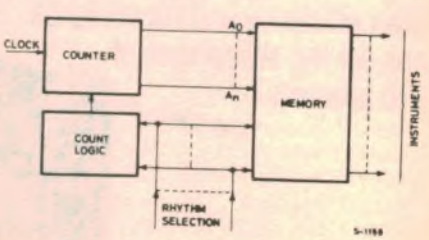
SGS-ATES have developed two rhythm generators implemented in single chips, using low threshold P-channel silicon gate technology, which are specifically designed for use with electronic organs and other musical instruments. These are the M252 and M253 devices, which are supplied in 16 and 24 pin DIL packages respectively.

These are both available with a standard musical content, and so can be used directly with the instrument simulator described previously. All that is required is a variable speed clock and a reset mechanism. In this article, we will concentrate on the M252 device.

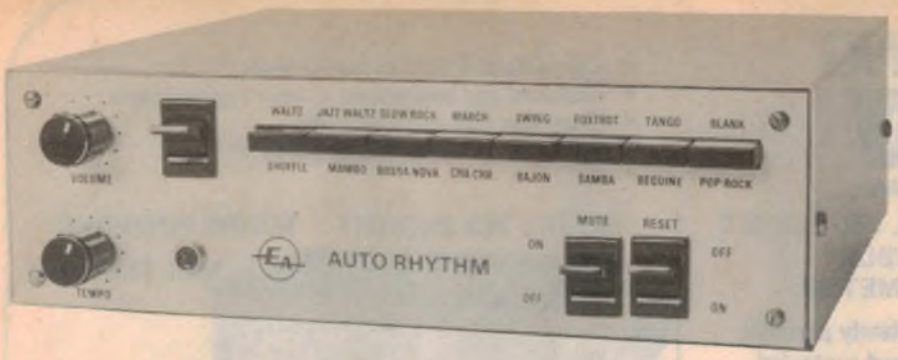
Fig. 3 shows the block diagram of the M252 device. This can generate 15 different rhythms, and can drive up to eight instruments simultaneously. An external reset facility is provided, as well as a downbeat indicator, to show when the rhythm pattern repeats. Only a single phase clock is required.

A four bit binary code must be generated to select the rhythm, as only four pins are available for this function. Fig. 5 shows the required codes, and the corresponding standard ROM rhythm content. Note that the sixteenth code does not generate a rhythm at all, and so can be used as an off position, if required.

The M252 has open drain outputs,



The block diagram of a basic rhythm generator is shown above. All this is contained in the M252.



low power dissipation, and operates from a single power supply. It is available from Warburton Franki (Sydney) Pty Ltd, 198 Parramatta Road, Auburn, NSW 2144. It should also be available from their interstate branches, as well as from your usual component supplier.

Functionally, a complete rhythm generator unit should have the following features. 1. the different rhythms should all be selectable by an easily operated switch.

2. a reset switch should be provided, so that the rhythms can be started at a time determined by the player.

3. a mute switch is necessary, to give an alternative starting procedure.

4. tempo and volume controls are required.

5. a visual device to indicate the tempo and beat should also be provided.

In order for full use to be made of the unit, it is necessary to achieve synchronisation between the rhythm unit and the player. This is accomplished by the visual tempo indicator, in conjunction with either the mute or reset switches.

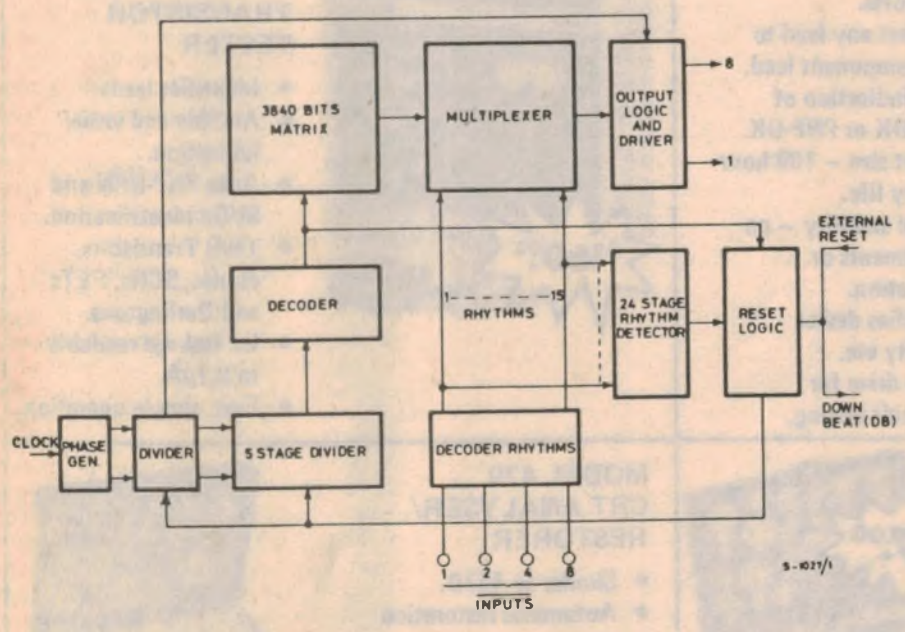
The first method of achieving synchronisation is by means of the reset switch. In the off position, the rhythm unit is stopped, and produces no sound. When this switch is moved to the on position, the rhythm commences with the first beat of the bar, so that synchronisation will be achieved if the player commences to play at the same time as he manipulates the reset switch.

When the mute switch is in the on position, the rhythm unit operates, but no audio signals are passed to the output connectors. The downbeat light shows the state of the rhythm, so that the player can use this as a metronome, and keep in time with the rhythm. This means that when the mute switch is returned to the off position, the rhythm will be in step with the player.

However, because of the internal configuration of the M252 chip, the downbeat light normally does not function as a true metronome. This is because it lights only to signify the start of the rhythm, and not the start of every bar (there can be at least two bars per rhythm, before the pattern repeats). It is possible, however, to trigger the downbeat light from one of the instrument outputs (typically the bass drum) so that it lights once in every bar. The details showing how to do this will be given at a later stage.

We can now turn our attention to Fig. 5, the circuit diagram. The M252 and its associated components are supplied with power from the +30 and +15V rails of the percussion instrument simulator. Since the total circuit drain is in excess of that which the +15V rail can sink, it is necessary to buffer this rail.

This is done by the BC557 transistor and associated components. The diode is used to compensate for the base-emitter drop of the transistor, while the zener diode clamps the voltage during turn-on. This is necessary because the +15V rail takes an appreciable time to stabilise when power is first applied. The 0.1uF capacitor removes switching spikes, and prevents them from affecting the instrument simulator.



The complete schematic diagram of the M252 is shown at the left. Note that a code is used to select the rhythm.

PARTS LIST

SEMICONDUCTORS
1 M252 B1 AA Rhythm generator chip
1 555 timer IC
1 BC548 NPN transistor, or equivalent
1 BC557 PNP transistor, or equivalent
2 silicon diodes, 1N914A, 1N4148 or equivalent
1 18V 400mW zener diode

RESISTORS (all ½W)
1 390 ohm, 1 15k, 3 47k, 2 82k, 4 100k
1 2M log. pot.
1 47k dual log. pot.

CAPACITORS (all plastic)
1 0.01uF, 3 0.1uF, 1 0.22uF

SWITCHES
3 NKK DPDT toggle switches, part no. SP2022
3 NKK bezels to suit, black, part no. AT-205
1 Schadow 8-way 4-pole interlocked push button switch, part no. TS-539

MISCELLANEOUS
2 knobs
1 case, 230 x 205 x 68 mm
1 front panel to suit, see text
1 PL24/24/20VA 24v 24V transformer, or equivalent
1 piece Veroboard (1/10" spacing)
1 output connector
Solder, hookup wire, rainbow cable, shielded cable, PCB standoffs, rubber feet

Note: resistor wattage ratings and capacitor voltage ratings are those used in our prototype. Components with higher ratings may generally be used provided they are physically compatible. Components with lower ratings may be used in some cases, providing ratings are not exceeded.

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The clock is formed by a 555 type timer IC, connected in the astable mode. This drives the M252 direct. The clock rate, or tempo, is varied by the 2M potentiometer.

The reset function is performed by the reset switch, in conjunction with the BC548 transistor. When the reset switch is open, the diode isolates the downbeat signals, which come from the reset pin, from the oscillator. The oscillator is not reset (pin 4 is held high by the 47k resistor) and the rhythm pattern is generated. Downbeat signals from pin 7 trigger the downbeat monostable (on the percussion instrument simulator board).

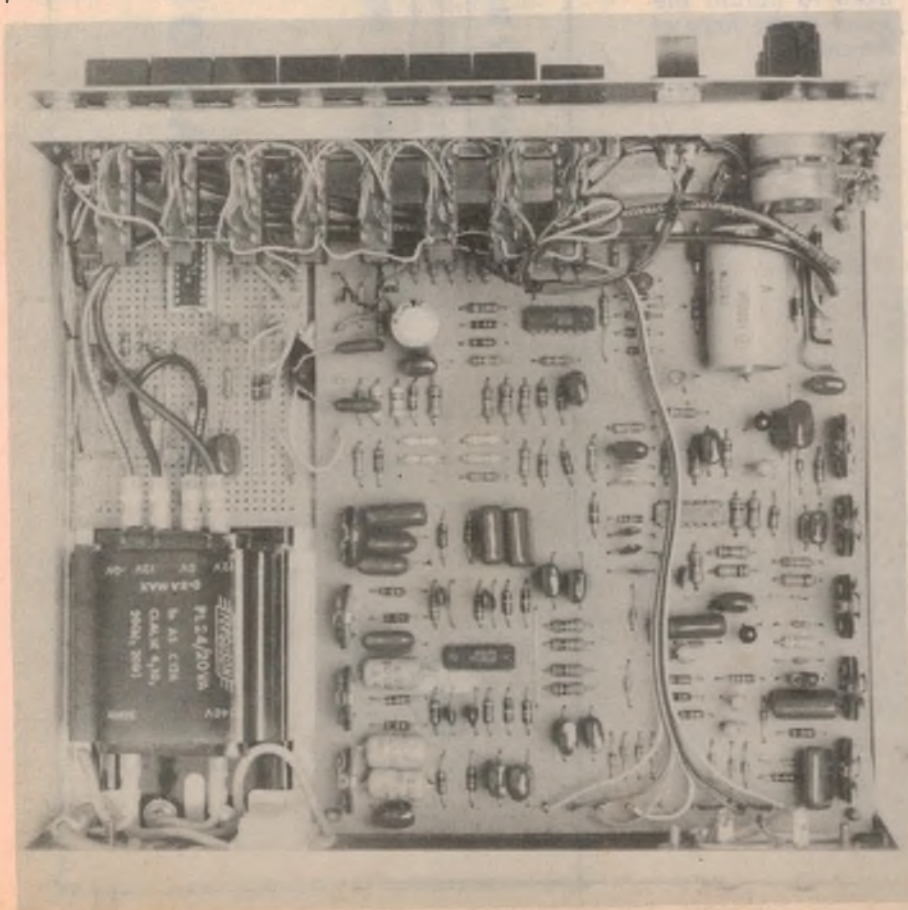
When the reset switch is closed, pin 7 is held high, and the M252 is held in the reset mode. At the same time, the BC548 transistor turns on, and resets the 555 by forcing pin 4 low. When the reset switch is released, the oscillator commences to operate, and the M252 starts at the beginning of the rhythm pattern.

The coding for the rhythm selection is performed by a switch bank. We have used an eight-way interlocked push button switch, in conjunction with a paddle switch. While it would have been better for the user to have a fifteen-way interlocked switch, these are much more difficult (and expensive!) to obtain, and so we were forced to compromise.

RHYTHM	CODE				STANDARD CONTENT	
	INPUT 8	INPUT 4	INPUT 2	INPUT 1		
1	1	1	1	0	Waltz	3/4
2	1	1	0	1	Jazz Waltz	3/4
3	1	1	0	0	Tango	2/4
4	1	0	1	1	March	2/4
5	1	0	1	0	Swing	4/4
6	1	0	0	1	Foxtrot	4/4
7	1	0	0	0	Slow Rock	6/8
8	0	1	1	1	Rock Pop	4/4
9	0	1	1	0	Shuffle	2/4
10	0	1	0	1	Mambo	4/4
11	0	1	0	0	Beguine	4/4
12	0	0	1	1	Cha Cha	4/4
13	0	0	1	0	Bajon	4/4
14	0	0	0	1	Samba	4/4
15	0	0	0	0	Bossa Nova	4/4
No selected rhythm	1	1	1	1		

This table gives the required coding of the four rhythm select inputs necessary to select the fifteen different rhythms available.

The arrangement of the various component parts can be seen in this photograph. Note how the Veroboard is positioned.



Sample switches for our prototype were kindly supplied by IRH Components, The Crescent, Kingsgrove, NSW 2208. The part numbers are listed in the parts list.

The interlocked switches are used to select the correct codes for three of the four M252 inputs, so that each of the eight positions selects two rhythms. Final selection of the rhythm is done by the paddle switch, which only has to switch the remaining input. The switches are also used to connect pin 12 to either the snare drum or the low bongo, as required, for the various rhythms.

The outputs from the instrument simulator are decoupled by 0.1uF capacitors, and attenuated by the volume control. A mute switch is then used to enable the rhythm unit to be disconnected from the following circuitry, without affecting the timing of the rhythm.

We can now turn to the constructional details of the unit. As this is a rather specialised project, and because we intend in the future to give details of other rhythm generator chips, we have not designed a printed circuit board for use with the M252. Instead, we constructed our prototype on a small piece of Veroboard. Of course, individual constructors can always use a PCB of their own design, to achieve a neater finished project.

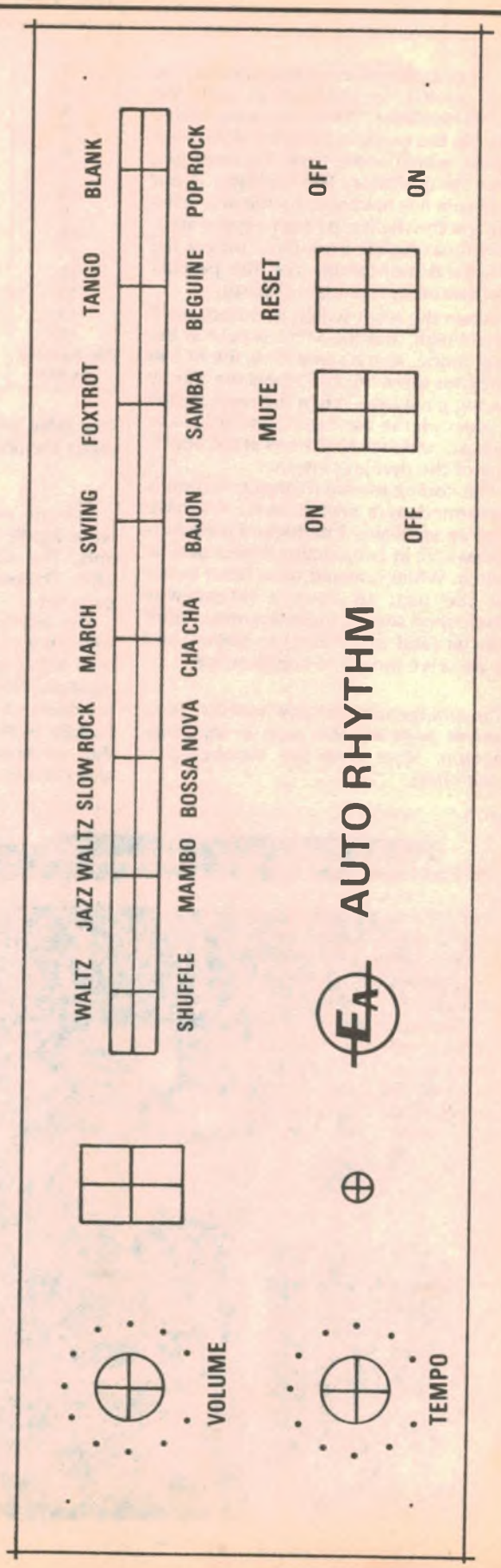
We constructed our prototype in an aluminium case supplied by Dick Smith Electronics Pty Ltd. This is the same basic case as used for the Video Ball Game (May 1976, File No. 3/EG/8). It measures 230 x 205 x 68 mm, and is supplied blank (with no holes).

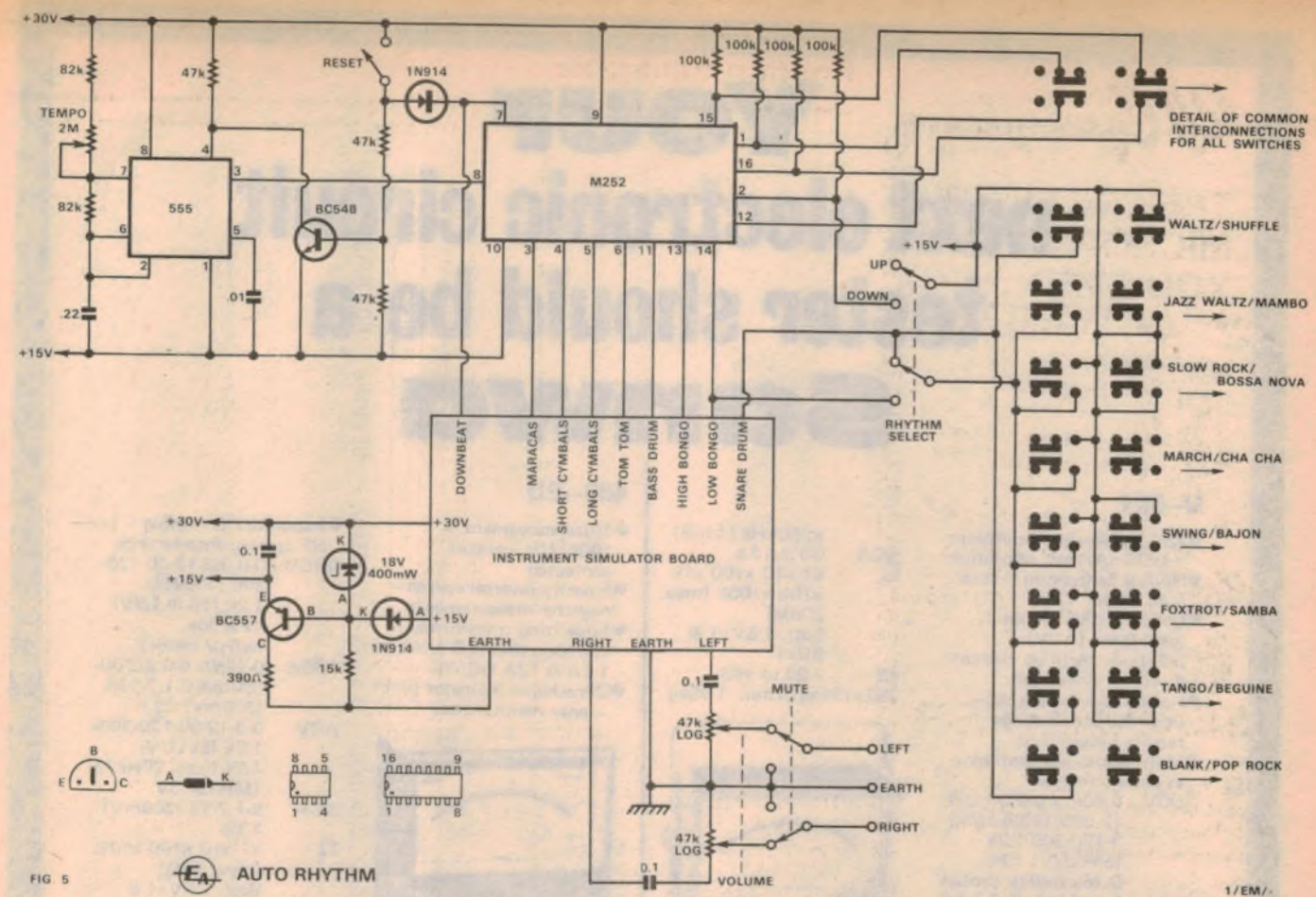
We have designed a front panel for the box, the details of which are included in this article. If you intend to build the unit into your organ console, then this panel can be used to mount all the switches and controls, with the actual circuitry mounted in some more convenient location.

We used a type PL24/20VA transformer, kindly supplied by Ferguson Transformers Pty Ltd, of 331 High Street, Chatswood, NSW 2067. As you can see in the photographs, we mounted this in rear right hand corner. The percussion instrument simulator printed circuit board fits neatly to the left of this, with the remaining space being used to mount the M252 and associated components.

We mounted these on a small piece of Veroboard, and used colour coded hookup wire (rainbow cable) to make

This full size reproduction of the front panel can be either copied or used directly. The dots in each corner are the positions of the four machine screws used to mount the panel to the front of the chassis.





This circuit diagram shows how the M252 is interfaced to the player and to the instrument board.

the interconnections to the PCB and to the switches. We then laced the wires into a loom, to give a neat finish to the project. We made the connections to the volume control and mute switch with shielded cable, to minimise hum pickup.

The layout of the components on the Veroboard is fairly simple. We made the strips run at right angles to the IC pins, and then used tinned copper jumpers to make the various connections. We used PCB pins to make the connections at the edge of the board, as these are very robust mechanically.

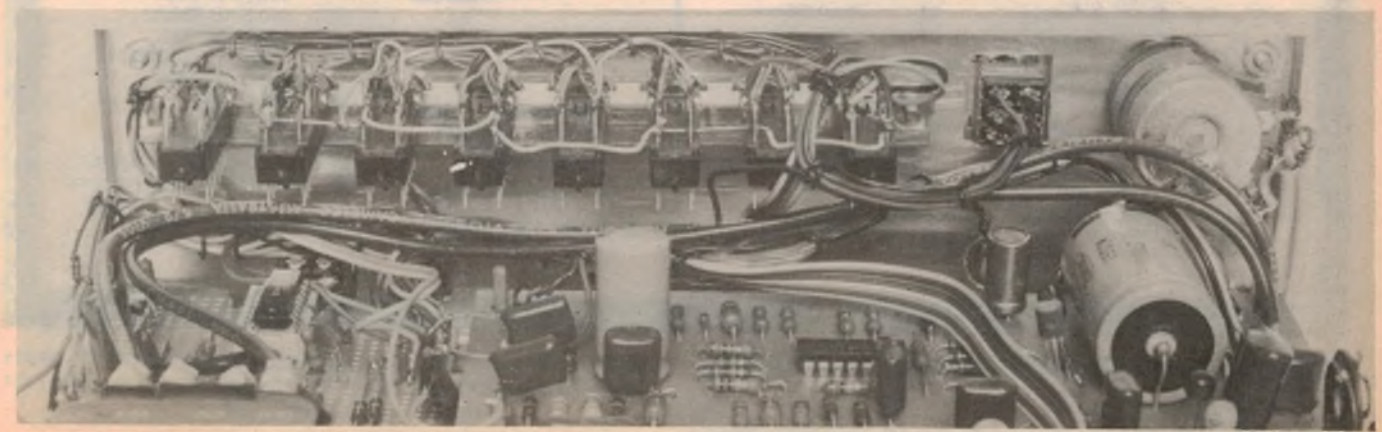
It is not necessary to use an IC socket for the 555, as these devices are quite robust. However, we recommend the use of one for the M252, as this device, like all MOS chips, is prone to damage from static electricity. If a socket is used, the M252 can be installed after all interconnections have been made and checked.

The circuit diagram shows a schematic representation of the wiring for the interlocked switches. This can be used as a guide for wiring the switches. First make all the connections to the centre posts (shown on the diagram as the common interconnections), and then complete the remaining wiring on the switches. Lastly, add the seven wires connecting the switch bank to the remainder of the circuit.

Once construction is complete, the unit can be tested. Apply power, and check the operation of all switches and controls. It may be necessary to adjust the trimpots on the instrument board to achieve suitable sounding instruments. Follow the instructions given in the previous article for this.

We also found that it was necessary to change one resistor on the instrument board to achieve a more realistic sound

This view of the interior of the prototype shows how the interlocked switches are wired, using the lugs provided.



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±DCA 0-12μA 0-0.3-3-30-300mA 0-1.2-12A (300mV) ±2%
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ACA 0-1.2-12 (300mV) ±3%
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dB –20 to +63
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- Measurement ranges available.

DCV 0.1 0.5 2.5 10 50 250 1000 (20kΩ/V) (25kV w/HV probe extra)
ACV 2.5 10 50 250 1000 (8kΩ/V)
DCmA 0.05 2.5 50 500 (500mV drop; 100mV for 0.05mA)
Ω Range – X1 X10 X100 X1k Midscale –50Ω 500Ω 5kΩ 50kΩ Maximum – 5kΩ 50kΩ 500kΩ 5MΩ Batteries 1.5V dry cell (UM-3 or equivalent) X2

LI	0.06mA	0.6mA
LV	3V	3V

LI	6mA	60mA
LV	3V	3V

- Allowance. Within ±3% f.s.d. for DCV & DCmA Within ±4% f.s.d. (±6% for 2.5V) for ACV Within ±3% of scale length for Ω
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μF 0.0002–0.6) external power
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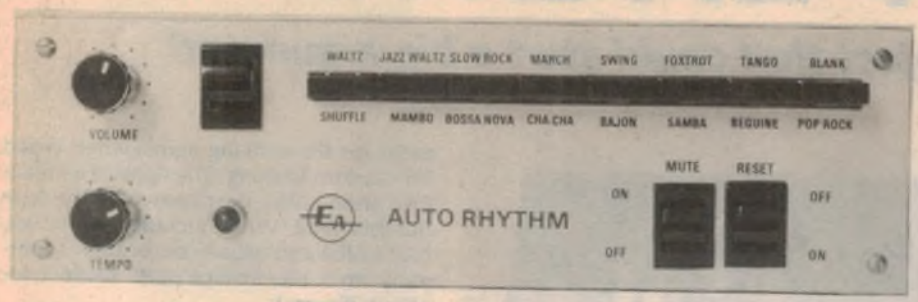


ABOVE: This photograph shows what an organist would see when using the Auto Rhythm unit.

BELOW: A diagram to aid in positioning the components on the Veroboard, and in making the cuts in the tracks.

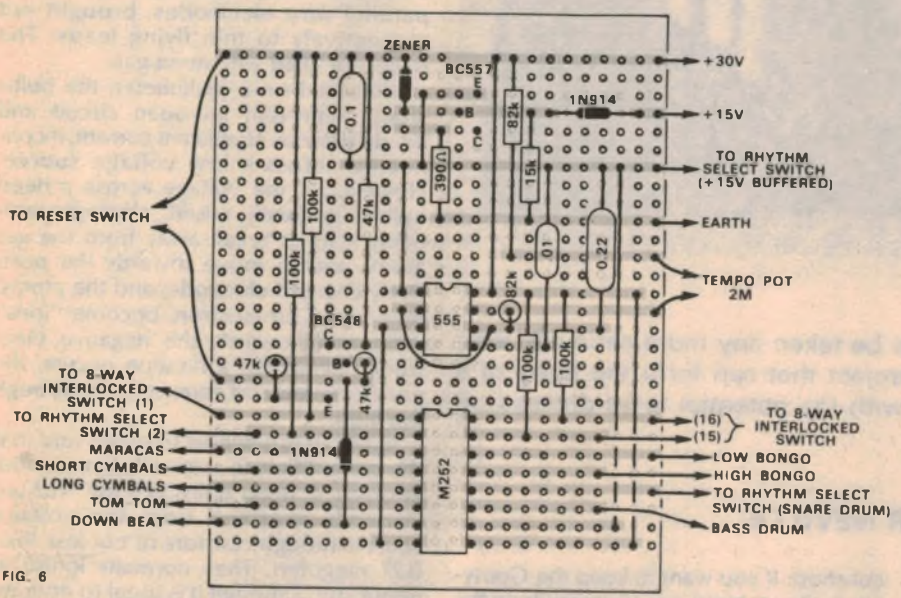


FIG. 6

balance. We altered the 1M resistor connected to the 0.1uF capacitor at the input of amplifier B2 to 100k. Note that we did not alter the feedback resistor, but the resistor connected to the FET source.

In order to give an improved sound when rapid tempos are used, we found it advantageous to alter the time constants of the white noise derived instruments. This can be achieved in several ways.

The time constants of each of the final R/C combinations connected to the FET gates must be reduced in value by a factor of about four. This is done by reducing either the resistor or capacitor values.

Economically, the best solution is to reduce the capacitors, from 0.47uF to 0.1uF, and from 0.22uF to 0.047uF. However, if you have already purchased these capacitors, then it may be cheaper to replace each of the trimpots with suitably lower values.

Reduce the 2.2M trimpots to 470k, and the 1M one to 220k. A third alternative, which is cheaper but less desirable, is to simply add extra resistors in parallel with the existing trimpots, on the underside of the board.

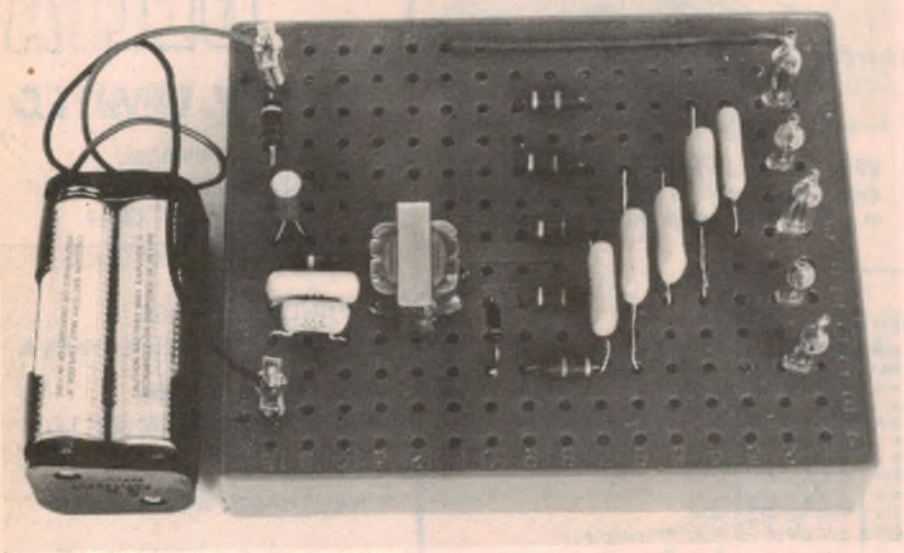
To operate the downbeat light from the bass drum, rather than from the downbeat output of the M252, it is necessary to change the downbeat monostable from negative to positive edge triggering. Refer to the previous article for details of how to accomplish this. This modification is necessary because the signal from the bass drum is positive going, rather than negative going like the downbeat signal.

Then simply connect the input of the downbeat monostable to the bass drum output of the M252 (pin 11), at the same time disconnecting the lead coming from the downbeat output (pin 7). No other modifications are necessary. We have tried this arrangement, and it did appear to give a satisfactory result musically, although since we do not have access to a listing of the standard musical content of the M252, we are unable to be completely definite about this.

In a future article, we intend to give details of other ICs which can be used instead of the M252. At the time of writing, these chips include the M253, from SGS-ATES, and the S8890 and S2566/S2567 chips from American Microsystems.

GOOFY-LITE...

A simple tuitional project that could start a big argument!



The "Goofy-Lite" is not intended to be taken any more seriously than its name suggests—a goofy little project that can form the basis of a practical lesson in electronics, but with the potential to be dressed up into a novelty display.

by WALTER NEVILLE

The Goofy-Lite is basically a "Science Fair" kit project (number 28-130) sold by Tandy Electronics stores throughout Australia. It sells complete, except for batteries and solder, for $5.95. To construct it, you will need a few hand tools, soldering iron and solder, and four ordinary 1.5V "penlight" cells. It can be put together, easily enough, in an evening, with the aid of a step-by-step assembly brochure which is packaged with the kit.

The basic idea is that the circuitry, powered by the four 1.5V cells, energises five small neon bulbs, causing them to flash randomly or in a certain sequence, according to how the wiring is arranged. The current drain at 6 volts is only about 7 milliamps and, according to Science Fair, one set of batteries can last for weeks. Since we didn't have ours going for that long, we can only take their word for it!

Like many of the simpler Science Fair kits, this one is intended to be built up on the red plastic box in which it is packaged. Coding on the box makes it easy for even the uninitiated to effect the right connections but it is rather untypical, in the physical sense, since the leads within the box tend to be rather loose unless they are crimped over and cut short. If you want to keep the Goofy-Lite built up, build it as suggested; on the other hand, if you want to recover the parts later for other projects, keep the leads reasonably straight and spot solder them, for easy disassembly at a later date.

On the other hand, the Goofy-Lite kit could provide the basis for a more permanent decorative project. For example, it could be built inside the base of a small garden pot holding an imitation shrub, with the winking lights as the "flowers". As the brochure observes, the lights do have something of the visual fascination of a flickering fire.

Fig. 1 shows the basic circuit arrangement for the winking lights, when wired for random flashing. The lights are miniature neon bulbs, best known by the type number NE2. While included in the kit, NE2 bulbs can usually be bought separately from electronics parts dealers for about 25c each.

They are essentially short lengths of glass tube, sealed at both ends and measuring about 25mm long and 5mm in diameter. Internally, there are two parallel wire electrodes, brought out respectively to thin flying leads. The bulbs are filled with neon gas.

Measured on a multimeter, the bulbs would represent an open circuit and would draw no significant current, if connected across a low voltage source. However, if the voltage across a neon bulb is gradually raised, electrons suddenly start to break away from the gas atoms and to move towards the positively charged electrode; and the atoms, now minus an electron, become "ions" and move towards the negative electrode. When this ionisation occurs, the gas glows red and current flows through the bulb.

In fact, it is essential to make sure that the current flow is externally limited and, in practice, neon bulbs like the NE2 are normally supplied from the voltage source through resistors of not less than 0.27 megohm. They normally ionise at about 70V, although it is usual to operate them from a supply significantly above this figure. If, while a bulb is ionised, the supply voltage is gradually reduced, ionisation will usually cease at about 55V.

Reverting to Fig. 1, when the positive line is connected to a voltage source, typically of 100V or higher, current begins to flow through each of the 2.7 megohm resistors to charge the 0.22 capacitors, connected across the respective NE2 bulbs. When the voltage across the bulbs reaches about 70, the neon gas inside ionises and glows red, and the resulting increased current discharges the 0.22uF

WIRING FOR RANDOM FLASHING

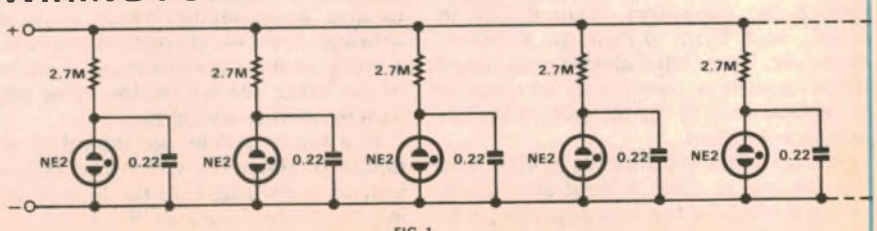


FIG 1

Any number of NE2 bulbs can be wired as shown, given adequate power supply.

capacitor faster than it can be charged through the 2.7M resistor. When the voltage falls to about 55, it can no longer maintain ionisation; the bulb ceases to glow and to draw current, and the charging cycle begins all over again.

Because the charge/discharge cycle is continuous, the circuit can be regarded as a type of oscillator, having a natural frequency determined by the supply voltage, the values of the resistor and capacitor and the characteristics of the bulb. Curiously, a small kit style electronic organ, popular a few years ago, used a whole array of neon oscillators.

In Fig. 1 the values have been selected to produce a readily visible flashing rate and, while they are nominally the same for each bulb circuit, the natural variations in component values produce slight differences in the flashing rate and therefore a random overall effect.

The Goofy light kit allows for only 5 bulbs, probably because that is as many as could reasonably be operated from the small battery powered supply. If operated from a more generous power supply (as from an old radio or TV receiver) almost any number of neon bulbs could be strung together, as per Fig. 1.

With the circuit as shown, it would be wise to keep the supply voltage down to about 100, even if it means using a couple of resistors to form a voltage divider across a higher voltage source. If the neon bulbs are connected directly to too high a voltage, the charging cycle will be speeded up and the flashing rate will be so high as that the bulbs will begin to look as if they are glowing continuously, and the visual effect will be lost.

While the random flashing hook-up of Fig. 1 is the most obvious one to use, particularly if the number of bulbs is increased, the construction leaflet suggests an alternative and intriguing way of interconnecting 5 bulbs, as in the original kit, and as shown in Fig. 2.

When so connected, the bulbs tend to flash in a sequence which may be repeated many times before it will change to another, and another. It will change also, if you disconnect and then immediately reconnect the positive battery lead. The effect is intriguing to watch; and the circuit is likewise intriguing because it is quite tricky to figure out just how it works! Here's a starting point, if you want to try:

When the unit is first switched on, one of the bulbs will ionise—which one will depend on slight differences in their characteristics. But the moment one bulb ionises, the voltage across it will drop from about 70 to, say, 55 and this negative-going excursion will be coupled through the ring of capacitors to the positive electrodes of the other 4 bulbs. As a result, they will be prevented temporarily from ionising.

However, this is not a stable condition. With one end held at a low voltage and the other connected to the positive supply through 2.7 megohm resistors, certain of the capacitors will begin to charge, allowing the voltage across the associated bulbs to increase towards the full supply potential. When another bulb ionises, the sudden reduction in the capacitor ring voltage extinguishes the first bulb and temporarily locks out the others; then a further redistribution of currents and voltages begins, which culminates in the ionisation of yet another bulb.

And so on .....

The third portion of the Goofy-Lite, illustrated in Fig. 3, is the DC/DC inverter section. Its job is to change the low DC voltage available from the batteries into a much higher voltage (albeit at a low current) sufficient to operate the five neon bulbs.

To achieve this purpose, the inverter stage incorporates a PNP transistor which is connected to the primary winding of a centre-tapped transformer in such a way as to form an oscillator. Thus, when 6V DC is applied to the transistor circuit, it begins to oscillate—in this case at about 900Hz—and an alternating voltage at this frequency appears across the primary winding of the transformer.

The secondary winding has many more turns than the primary and the alternating voltage across it is much higher—nearly 200, according to the pamphlet with the kit. This is rectified by a single half-wave diode and appears on the plus line to the bulbs as pulsating DC having a nominal value, as measured on a meter, of just over 100V DC.

While the circuit of Fig. 3 is a true DC/DC inverter, it is a very simple one, mainly by reason of the fact that the output current which it has to supply is very small. Inverters designed to supply higher current (and perhaps higher voltage) output become progressively more complex. The basic oscillator commonly uses two transistors in a push-pull circuit, with everything very carefully designed to protect them against excessive dissipation and voltage peaks which can easily cause transistor breakdown. Knowing this, you will be prepared for the difference between the very simple inverter in the Goofy-Lite and more complex inverters you may come across later.

Even so, it can be assumed that the transformer in the Goofy-Lite inverter is especially designed for the job and it does not follow that it could be made to work with just any small step-up transformer. In short, you can have fun and games with the circuits of Figs. 1 & 2, using ordinary bits and pieces and an available power supply but, if you want to reproduce the inverter section, the easiest way would simply be to buy the complete Goofy-Lite kit.

So that's the Goofy-Lite: goofy, elementary, to be sure. But how did you get on trying to work out the operation of Fig. 2?

SEQUENTIAL FLASHER CIRCUIT—Figure out how it works:

The Goofy Light seems to be such an elementary little project but, before you get snooty about Goofy, try your skill at figuring out how this sequential flashing circuit works. It's good for a head scratching argument at any level of expertise—enthusiast, technician, engineer or academic.

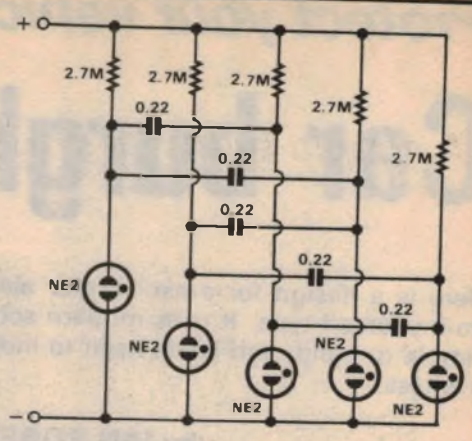


FIG 2

THE DC/DC INVERTER

Neon bulbs like the NE2 will not work at all at voltages less than about 70. This elementary little DC/DC inverter steps up the 6V available from the four small cells to about 100V DC. How it works is explained in the accompanying article.

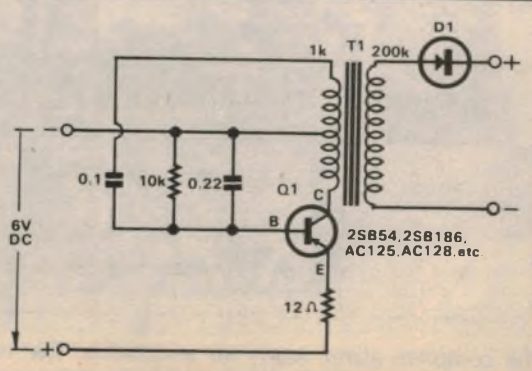


FIG 3

Protect your vehicle—fit this

Car burglar alarm

Here is a design for a car burglar alarm which should appeal to the do-it-yourself type. It uses modern solid state technology, is relatively simple to build, and lends itself to individual options for greater effectiveness.

by IAN ROBERTSON*

A number of car burglar alarms have been described for home construction, and commercial units are available from car accessory outlets. Of the available versions, the so-called "flashing light alarms" are perhaps the most sought after. The alarm to be described is of this general type.

Two features of this alarm are:—

a) A light that flashes whenever the alarm is set. It is felt that the flashing light makes the car less attractive to a potential thief and, in addition, the flashing light reminds the owner to disable the unit upon entering the car.

b) A battery detector that senses when entry is made to the car, detecting the drop in battery voltage which occurs when the load on the electrical system changes. It only requires a door to be opened, the brake pushed, headlight switched on or any of several other items operated, to trip the alarm.

This operating principle simplifies installation, as almost all vehicles have courtesy lights with actuating switches installed in at least two doors. If not already fitted, switches may be installed in the rear door pillars, the boot, bonnet and glove box. It is essential to power these from a fuse which remains on even when the ignition is off.

Momentarily operating a push button sets the alarm. The ignition switch must be off or it will override any attempt to set the alarm. An indicator (previously off) will now light for a period of 12 seconds. This is the exit time and allows the driver to leave the vehicle without triggering the alarm. Doors or other protected areas should be closed before the end of this time.

After the exit time the indicator will flash at the 1Hz rate, showing that the alarm is set and will be triggered by any disturbance to the electrical system.

When entering the car a delay of 6 seconds occurs before the horn sounds. This gives sufficient time for the driver to cancel the alarm (by setting the ignition switch to the "accessory" position) but very little time for the burglar to overcome the alarm system.

Unless cancelled the horn will sound (pulsing at half second intervals) for approximately two minutes before being shut down. The system is retriggerable; the horn will again sound if the vehicle's electrical system is further disturbed.

The alarm circuit is best considered as a number of separate sections. These are:—

1. Input bi-stable
2. Exit delay
3. Oscillator
4. Indicator
5. Battery detector
6. Enter delay
7. Horn shutdown mono-stable
8. Relay

A description of the circuit requires the reader to have a basic knowledge of the LM3900 quad operational amplifier.

The LM3900 represents a departure from conventional amplifier designs. Instead of using a standard transistor differential amplifier at the input, the non-inverting input function has been achieved by making use of a "current mirror" technique (see Fig, 1). Whereas the conventional op amp. differences input voltages, this amplifier differences input currents. The term "Norton amplifier" has been given to this arrangement.

By using input resistors to convert input voltages to input currents, all of the standard op amp. applications can be realised. Many additional applications are easily achieved, especially when operating with a single power supply voltage.

Fig. 1. The differential amplifier arrangement used in the LM3900. Sometimes called a "Norton Amplifier" the configuration responds to differences in input current, rather than input voltage.

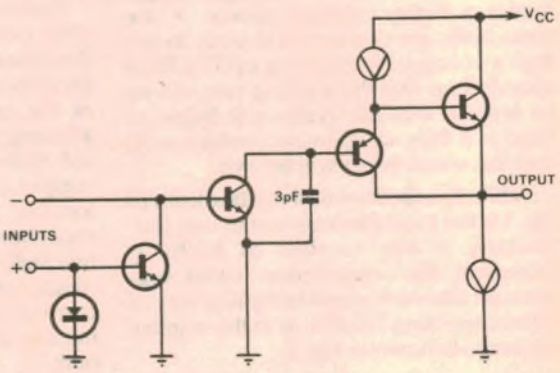
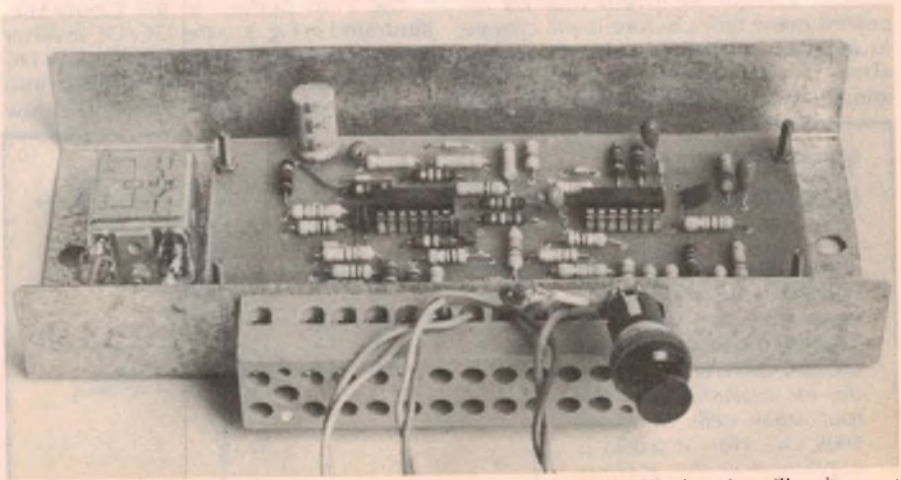


FIG. 1 BASIC OPERATIONAL AMPLIFIER



The complete alarm, ready for installation. The simple "U" chassis will suit most situations, but check its depth if a larger relay is used. The push button and LED are shown connected temporarily above the terminal block.

*36 Hume Drive, Helensburg, N.S.W. 2508

Each LM3900 contains four such operational amplifiers, as independent units except for common supply terminals. The circuits uses two LM3900s, shown marked as A1 to A4 and B1 to B4.

1. Input Bi-stable (A1):

This bi-stable is controlled by the ignition switch and the push button. A low output occurs whenever the ignition switch is in the accessory position, while pressing the push button (with the ignition switch off) gives a high output. The low output disables the alarm, while the high output initiates the exit sequence.

Different inputs are used for the accessory switch connection in positive and negative chassis systems. It is necessary to invert the accessory signal for a positive chassis vehicle, before passing it to the input bi-stable. This is performed by B2 which, otherwise, is not used.

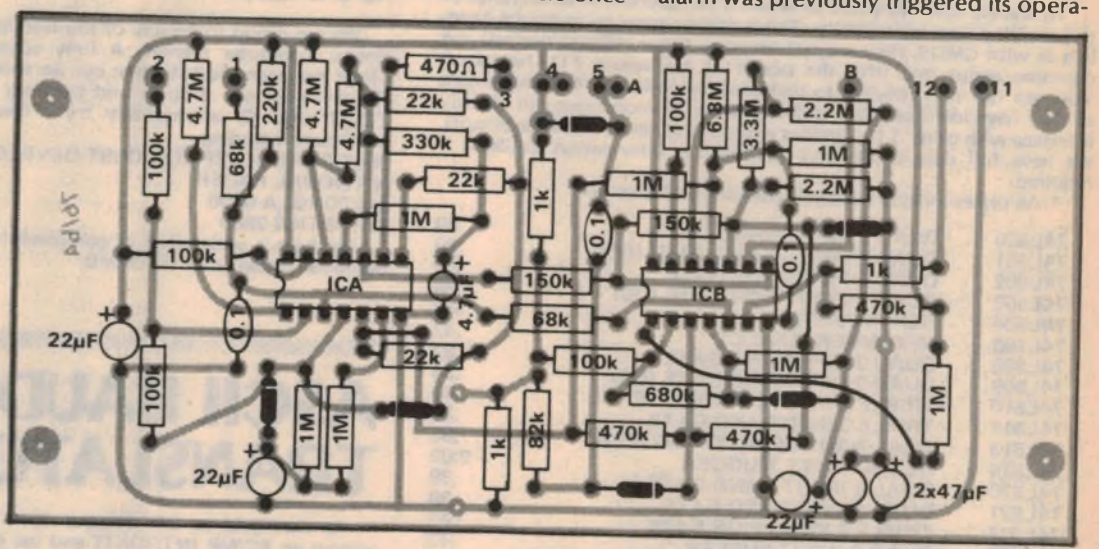
This is the only circuit modification involved to cope with positive chassis vehicles. The unit is constructed on a fully floating basis and either its positive or negative rail may be connected to the vehicle chassis.

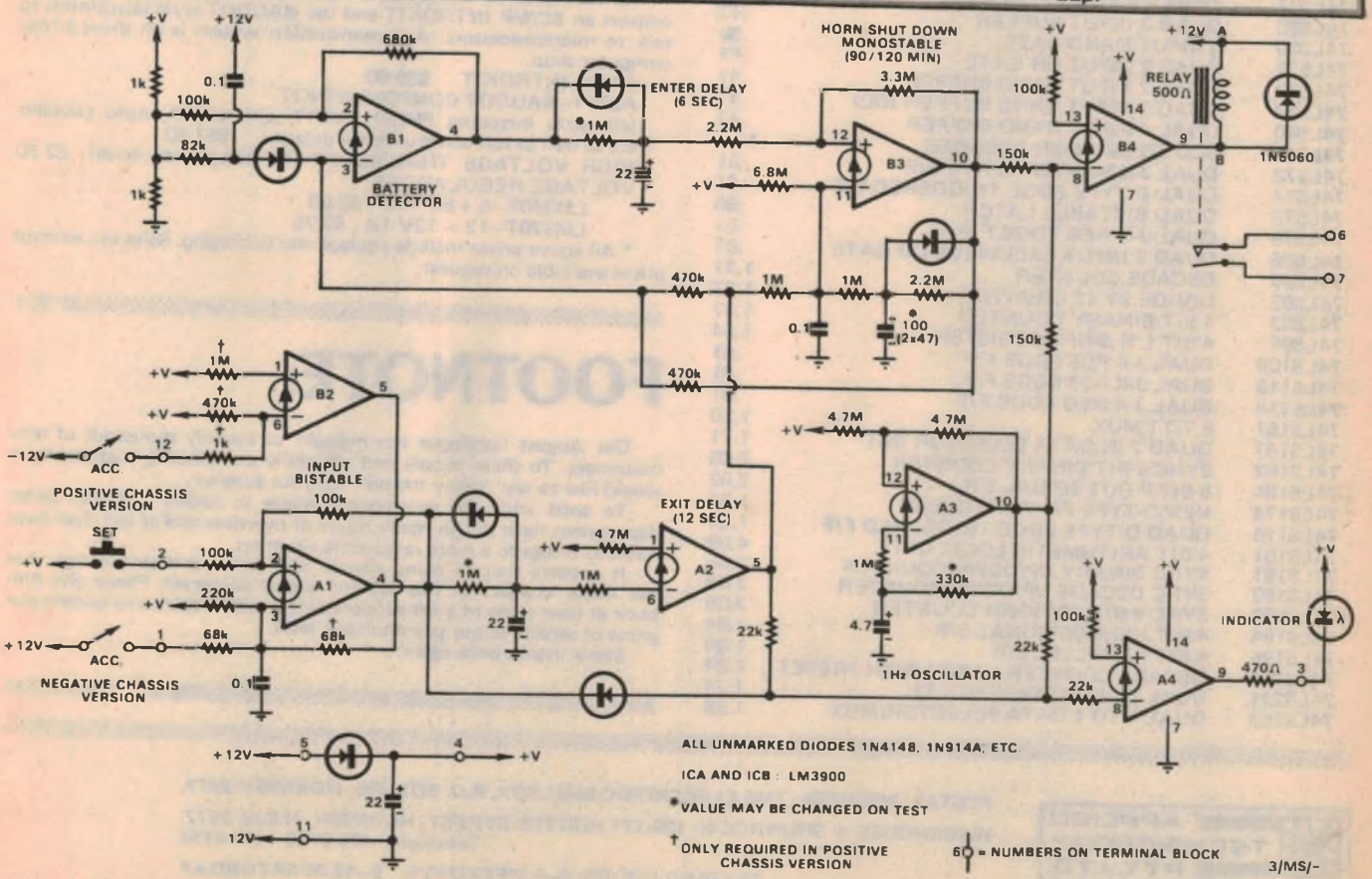
2. Exit delay:

To allow time to exit the vehicle once the circuit is armed, a 12 second delay follows the input bi-stable. The delay is obtained from the R/C network in the inverting input of the second amplifier (A2). It takes 12 seconds for the current in the inverting input to reach a point where it will override the fixed current in the non-inverting input.

In the absence of an inverting input the output of this stage is high and this cancels both the battery detector and the horn mono-stable by feeding current into their inverting inputs. Operation of the horn is thus prevented, and if the alarm was previously triggered its opera-

Component layout diagram, from the component side of the board, superimposed on the copper pattern. External connections to the board are shown on accompanying diagrams for negative and positive chassis electrical systems.





Circuit diagram of the complete alarm system. The four operational amplifiers in each LM3900 are shown as separate devices, identified as A1, A2, etc; B1, B2, etc. Note that most of the circuit is fed from the de-coupled supply point "+V", an exception being the sensing input to the battery detector, which comes from the battery.

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74LS08	QUAD 2 INPUT AND GATE	.39
74LS09	QUAD 2 INPUT AND GATE (OC)	.39
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74LS11	TRIPLE 3 INPUT AND GATE	.39
74LS13	DUAL NAND SCHMITT TRIGGER	.86
74LS14	HEX SCHMITT TRIGGER	2.02
74LS20	DUAL 4 INPUT NAND GATE	.39
74LS21	DUAL 4 INPUT AND GATE	.39
74LS27	TRIPLE 3 INPUT NOR GATE	.43
74LS28	QUAD 2 INPUT BUFFER	.43
74LS30	8 INPUT NAND GATE	.39
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74LS37	QUAD 2 INPUT NAND BUFFER	.47
74LS38	QUAD 2 INPUT NAND BUFFER (OC)	.47
74LS40	DUAL 4 INPUT NAND BUFFER	.43
74LS42	BCD TO DECIMER DECODER	1.53
74LS73	DUAL J-K MASTER SLAVE F/F	.51
74LS74	DUAL D TYPE EDGE TRIGGERED F/F	.61
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74LS93	4 BIT BINARY COUNTER	1.37
74LS95	4 BIT L R SHIFT REGISTER	1.84
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74LS113	DUAL J-K POS EDGE F/F	.61
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74LS151	8 TO 1 MUX	1.80
74LS157	QUAD 2 IN DATA SELECTOR (NI)	1.71
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tion will be terminated.

The indicator is also controlled; this will be covered under a separate heading.

3. Oscillator (A3):

This operational amplifier forms a 1Hz square wave generator. Its output is the source of interrupted horn and indicator lamp functions. The 4.7uF capacitor alternately charges and discharges via the 330k resistor, swinging between voltage limits established by the resistors feeding the inverting and non-inverting inputs. This oscillator runs continually with the output gated when and where required.

4. Indicator (A4):

The indicator light (LED) displays the state of the alarm. It is driven by the square wave generator via A4, and will flash at 1Hz unless otherwise overridden.

With the input bi-stable (A1) in the cancel position all pulses trying to reach the indicator will be by-passed to the negative rail (via the diode on the output of the bi-stable) and the lamp will remain off.

Setting the bi-stable will remove the blocking effect of the diode, but for twelve seconds while the exit timer (A2) output remains high, a current will flow into the indicator driver via the 22k resistor and the indicator will be held on.

At completion of the exit time the indicator will be under control of the oscillator and the LED will flash, half second on half second off. The flashing indicator signifies the alarm is set and will be triggered by any change in battery loading.

Using a light emitting diode instead of a lamp for the indicator reduces the current demand on the car battery. In addition, the LED will not trigger the detector circuit as it switches on and off.

5. Battery Detector (B1):

A common centre tap—the junction of the 1k resistors—is used for both amplifier inputs, but the lower value resistor feeding the inverting input drives the output low.

If a negative pulse occurs on the supply rail this pulse is coupled into the inverting input by the 0.1uF capacitor. Providing this pulse overcomes the bias on this input, the output will go high and will be held in this state by the feedback loop to the non-inverting input.

The diode in series with the inverting input ensures that a minimum positive voltage is maintained at this input (along with other sections of the unit feeding this point) regardless of the amplitude of the negative pulse. Otherwise the operation of this and other stages of the circuit can be upset.

The detector may be blocked, by the input bi-stable and horn mono-stable, as explained elsewhere.

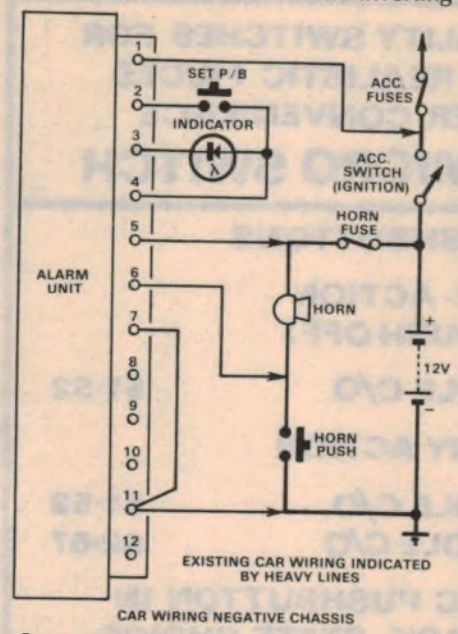
6. Enter delay:

A network similar to the exit delay follows the detector. This introduces a delay of six seconds between entering the car and the horn operating. Here, as in the other areas where this form of delay is included, fast resetting is ensured by a diode across the capacitor charge path; the diode quickly discharges the capacitor each time the amplifier output returns to zero. It is important that the diode is a low leakage silicon, otherwise delay times will be unpredictable.

7. Horn shutdown mono-stable (B3):

To place a limit on the time the horn will sound once the alarm is triggered a mono-stable is fitted to cancel the horn after 1.5 minutes operation. This is re-triggerable, so that a further impluse into the detector (after the mono-stable has returned to normal) will start the cycle again.

Operation is as follows: The 6.8M resistor normally holds the output in a



Connections for a negative chassis electrical system. The few connections required should be readily accessible.

PARTS LIST

1 Printed board 76/b/4 (138 x 65mm)
1 12V relay (coil 500 ohm or greater)
1 N/O push button
1 12 way terminal block

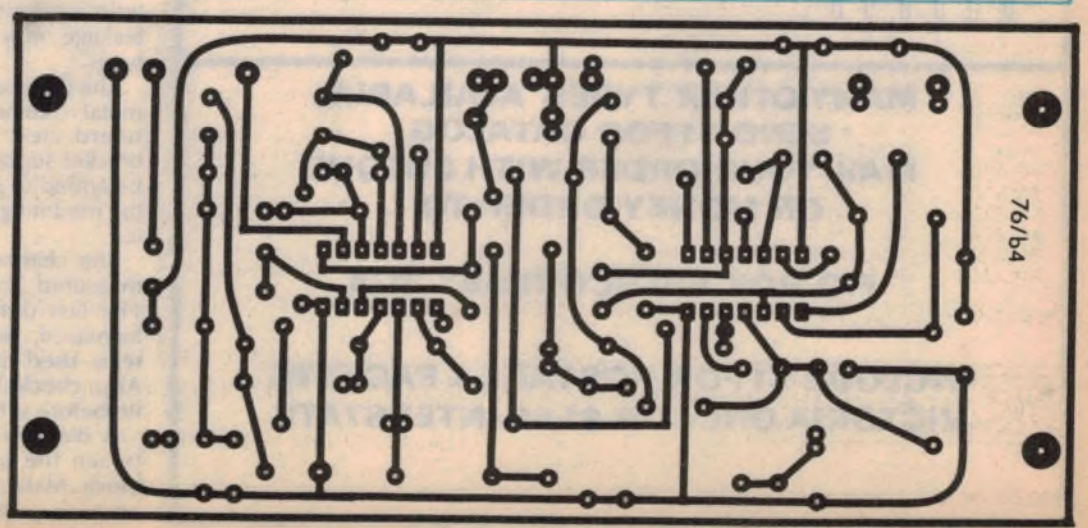
SEMI CONDUCTORS
2 LM3900 integrated circuits
6 1N4148/1N914A diodes
1 1N5060/EM404 diodes
1 LIT 21/TIL22B LED (with bezel)

CAPACITORS
3 0.1uF ceramic capacitor
1 4.7uF 25V TAG tantalum capacitor
3 22uF 16V TAG tantalum capacitor
2 47uF 6.3V TAG tantalum capacitor

RESISTORS (½ watt)

1 470 ohm	*1 330k*
3 1k	*2 470k*
3 22k	*1 680k*
2 68k	*7 1M*
1 82k	*2 2.2M*
5 100k	*1 3.3M*
2 150k	*3 4.7M*
1 220k	*1 6.8M*

MISCELLANEOUS
2 14 Pin IC sockets (optional)
Screws, nuts, wire etc.



The printed board, from the copper side, shown full size. While constructors can make their own boards if they wish, commercial versions of this board should be readily available at reasonable prices.

low state. The current from the enter delay network forces the output high and this is latched via the 3.3M resistor. By going high the output also cancels the battery detector, leaving only the 3.3M to latch the mono-stable.

The 100uF capacitor begins to charge, taking over 1.5 minutes for the current in the inverting input to return the circuit to the quiescent state. Re-triggering is now possible via the detector as it is no longer overridden.

8. Relay:

Low power relays or lamps may be driven directly by the LM3900, but the current into the input must be at least 0.1mA. Even so, the IC will only sink around 30mA and for this reason a minimum relay resistance of 500 ohms is recommended.

The relay driver is arranged as a NAND gate where both 150k inverting input resistors must be driven high before the output goes low, energising the relay. Only when the horn mono-stable and the oscillator output are high will the relay operate, and since the oscillator is continually in operation, the relay—and the horn——will pulse at half second intervals while ever the mono-stable is set.

During installation of the alarm, I found the normal operation of the circuit was upset when ever the horn operated. This was overcome by fitting 0.1uF capacitors to the inputs of the horn mono-stable and the input bi-stable. As an additional safeguard the power supply is by-passed with a 22uF capacitor.

Construction is fairly straight forward. Mount the components on the printed board. Observe carefully the polarity of the capacitors, diodes and integrated circuits, check resistors for correct value and, after soldering the components, check all points for dry joints, or for excess solder that may be shorting between tracks.

Where the unit is for use on a negative chassis vehicle, four resistors (marked on the circuit and component layout) need not be fitted to the board.

Bead tantallem capacitors are specified for this unit, standard electrolytic capacitors could be tried but leakage may be a problem in some types.

The finished board is fitted into a sheet metal channel. Four spacers hold the board clear of the channel, while a bracket supports the relay. A cover may be added to give extra protection where the mounting position in the car requires it.

The channel made for the prototype measured 3½in(W) x 8½in(L) x 1in(D). The last dimension may need to be increased, depending on the type of relay used and the space it occupies. Also, check the space into which it is to fit, before settling on final dimensions.

A diagram is given of the wiring between the board relay, and terminal block. Make sure the wiring to the relay contacts is sufficiently large to handle the

expected horn current. Also note a diode is fitted across the relay coil. The polarity must be correct; check before soldering.

There are many relays available. Their suitability for this project will depend in some cases on the horn system they are to drive. The current taken by a single horn will be less than the current requirement of a multiple horn system. If doubt exists as to the current demands of the system consider fitting an automobile horn relay in the engine compartment.

External connections to the alarm are made via a twelve way terminal block, this being fitted to one edge of the channel. Alternately the wiring could go directly to the board but the terminal block simplifies testing and installation.

The completed alarm should be fitted behind the dash panel, well out of sight and not in a position to be damaged by the passenger's feet.

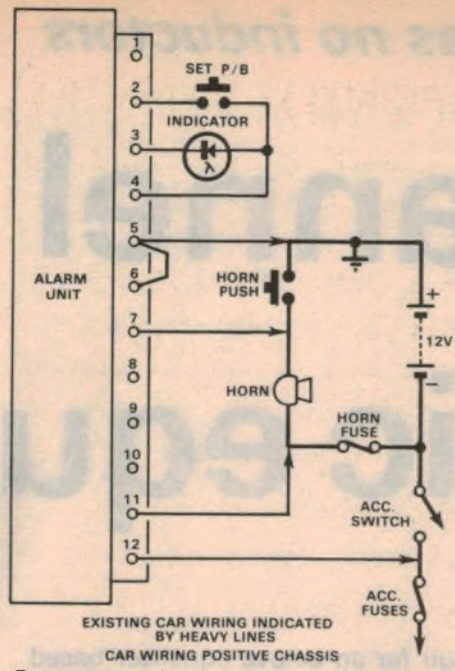
Fit the push button and light emitting diode on the driver's side of the car, either in the dash panel or on a small plate screwed under the dash. For better visibility from outside the vehicle a second LED may be fitted to the passenger's side of the car, wired in series with the original LED.

Car wiring diagrams are given for both the positive and negative chassis versions of the alarm. Note this unit is for 12 volt systems. Six volt operation is no doubt possible but would require component changes that are not within the scope of this article.

Wiring may be summarised as: two wires run to the fuse panel, one to the horn fuse and one to the accessory fuse. A third feeds to the horn and a fourth to chassis. The push button and indicator are wired as shown in the diagram. Note that different inputs are used for the accessory switch in the positive and negative chassis versions.

Testing the unit will involve a run through the alarm sequence outlined at the start of this article. Testing should be carried out after the car wiring is finished, but prior to fitting the alarm behind the dash.

A lamp may be used instead of the horn during the initial stages of testing,



Connections for a positive chassis system. These are the only changes required to cope with car polarities.

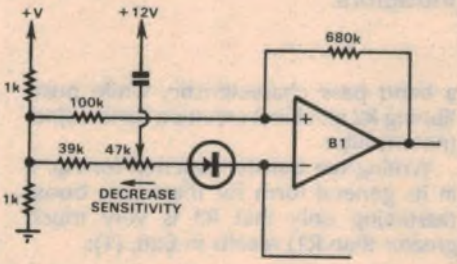


Fig. 2a. A modification to provide variable detector sensitivity, as may be needed to avoid false alarms.

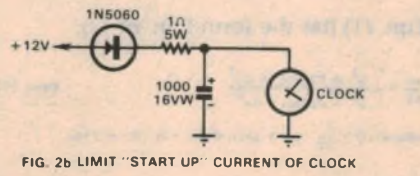


Fig. 2b. A clock, particularly a power wound spring type, may cause false alarms. This circuit, in conjunction with 2a, should solve most problems.

but the horn should be run for a short time to fully check the installation.

Constructors could find that their delay times differ slightly from those quoted in the text. The delay depends on component tolerances (particularly capacitor tolerances) and the times given were taken from the prototype.

Several components are marked on the circuit and board layout with an asterisk. An increase in resistance or capacitance of the marked component will lengthen the associated delay, while a reduction will shorten the delay. Resistance values can safely be doubled, but above this circuit operation cannot be guaranteed.

Since the unit is operated by a momentary drop in battery voltage, it is essential all existing lamps be in working order and further lamps and/or switches be fitted where required.

In vehicles fitted with an electric clock there is a possibility of false alarms. This applies particularly to clocks that are electrically rewound at intervals by a small motor.

Two general approaches may be taken to overcome this problem—reduce the sensitivity of the detector or limit the starting current of the clock—if necessary both cures may be tried.

Fig. 2a shows how the sensitivity of the battery detector may be reduced. It is hoped an adjustment can be found where the alarm is not triggered by the clock but retains sufficient sensitivity for normal use.

Fig. 2b shows a network for inclusion in the active feed to the clock, the component valves are a guide only, in certain instances a series resistor may be found to be all that is required.

The above describes a basic system, but a number of options can be added to it. One is given here; others may suggest themselves to individual readers.

Relays normally have more than one contact set and, as only one pair is needed to operate the horn, an additional pair may be wired across the ignition points as shown in Fig. 3. These contacts prevent the car from starting thereby giving a second line of defence if the horn is faulty or has been disconnected.

This will normally only be effective if it is accompanied by a hidden switch

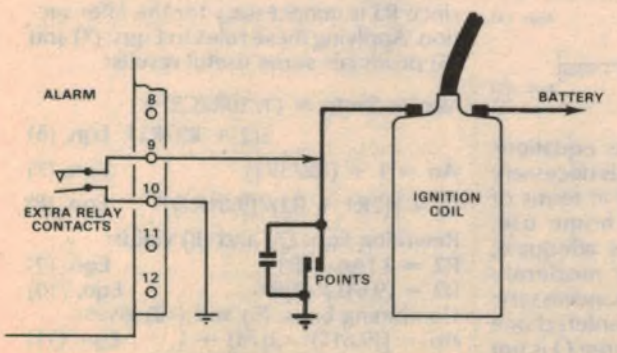


Fig. 3. An extra set of contacts can disable the ignition circuit, as a back up in the event that the horn is disabled. This must be used with the switch in Fig. 4.

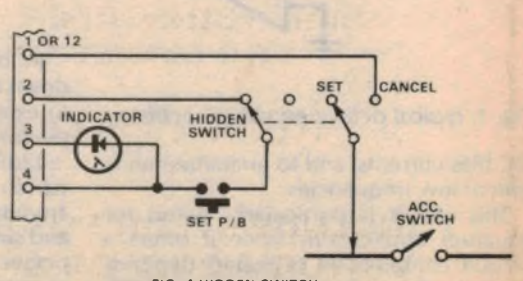


Fig. 4. The hidden switch, to be used with the ignition circuit as in Fig. 3. The extra set of contacts can be used to prevent frivolous operation of the press button.

New IC design has no inductors

10-channel graphic equaliser

This article describes a practical circuit for an octave equaliser based on the new LM349 quad operational amplifier from National Semiconductor Corporation. The circuit requires just 6 ICs for a stereo version, and is unusual in that it employs no inductors.

by DENNIS BOHN

Consumer Application Engineer, National Semiconductor Corporation.

An octave equaliser offers the user several bands of tone control, separated an octave apart in frequency with independent adjustment of each. It is designed to compensate for any unwanted amplitude-frequency or phase-frequency characteristics of an audio system.

A midrange tone control circuit can be used separately to make a convenient ten band octave equaliser. Design equations result from a detailed analysis of Fig. 1, where a typical circuit is shown. Resistors R3 have been added to supply negative DC bias currents, and to guarantee unity gain at low frequencies.

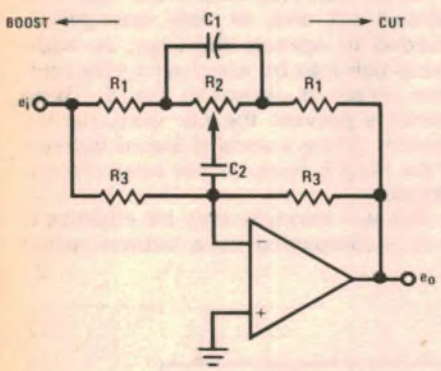


Fig. 1: typical octave equaliser section.

This circuit is particularly suited for equaliser applications since it offers a unique combination of results depending upon the slider position of R2. With R2 in the flat position (i.e., centred) the circuit becomes an all-pass with unity gain. Moving R2 to full boost results in a band pass characteristic, while positioning R2 in full cut creates a band-reject (notch) filter.

Writing the transfer function for Fig. 1 in its general form for maximum boost (assuming only that R3 is very much greater than R1) results in Eqn. (1):

$$\frac{eo}{ei} = -\frac{s^2 + \left[\frac{2R1R2C1 + R3(R1 + R2)C2}{R1R2R3C1C2}\right]s + \frac{2R1 + R2}{R1R2R3C1C2}}{s^2 + \left[\frac{(R1 + R2)C2 + 2R2C1 + R3C2}{R2R3C1C2}\right]s + \frac{2R1 + R2}{R1R2R3C1C2}}$$

Eqn. (1) has the form Eqn. of (2):

$$\frac{eo}{ei} = -\frac{s^2 + K2pWoS + Wo^2}{s^2 + 2pWoS + Wo^2} \qquad \text{Eqn: (2)}$$

where: $Q = \frac{1}{2p}$, Ao = gain @ fo = K, $Wo = 2\pi fo$

Equating coefficients yield Eqns. (3)-(5)

$$Wo = \sqrt{\frac{2R1 + R2}{R1R2R3C1C2}} \qquad \text{Eqn: (3)}$$

$$Ao = -\frac{2R1R2C1 + R3(R1 + R2)C2}{2R1R2C1 + R1(R2 + R3)C2} \qquad \text{Eqn: (4)}$$

$$Q = \sqrt{\frac{2R1 + R2}{R1R2R3C1C2}}\left[\frac{R2R3C1C2}{(R1 + R2)C2 + 2R2C1 + R3C2}\right] \qquad \text{Eqn: (5)}$$

In order to reduce these equations down to something useful, it is necessary to examine what is required in terms of performance. For normal home use, ±12dB of boost and cut is adequate, which means that only a moderate amount of passband gain is necessary; and since the filters will be centered one octave apart in frequency a large Q is not necessary (Q = 1-2 works fine). What is desirable is for the passband ripple when all filters are at maximum to be less than 3dB.

TABLE 1

f_o (Hz)	C_1	C_2
32	0.18μF	0.018μF
64	0.1μF	0.01μF
125	0.047μF	0.0047μF
250	0.022μF	0.0022μF
500	0.012μF	0.0012μF
1k	0.0056μF	560pF
2k	0.0027μF	270pF
4k	0.0015μF	150pF
8k	680pF	68pF
16k	360pF	36pF

Examination of Eqn. (5) in terms of optimising the ratio of C1 and C2 in order to maximise Q shows a good choice is to let C1 = 10C2. A further design rule that is reasonable is to make R3 = 10R2, since R3 is unnecessary for the filter section. Applying these rules to Eqns. (3) and (5) produces some useful results:

$Wo = 2\pi fo = (1/10R2C2) \times (2 + R2/R1)^{\frac{1}{2}}$ Eqn. (6)

$Ao = 1 + (R2/3R1)$ Eqn. (7)

$Q = [(2R1 + R2)/(9.61R1)]^{\frac{1}{2}}$ Eqn. (8)

Rewriting Eqns.(7) and (8) yields:

$R2 = 3(Ao-1)R1$ Eqn. (9)

$R2 = (9.61Q^2-2)R1$ Eqn. (10)

Combining Eqns. (9) and (10) gives:

$Ao = [(9.61Q^2 - 2)/3] + 1$ Eqn. (11)

From Eqn. (11) it is seen that gain and Q are intimately related and that large gains mean large Qs and vice versa. Eqns. (9) and (10) show that R1 and R2 are not

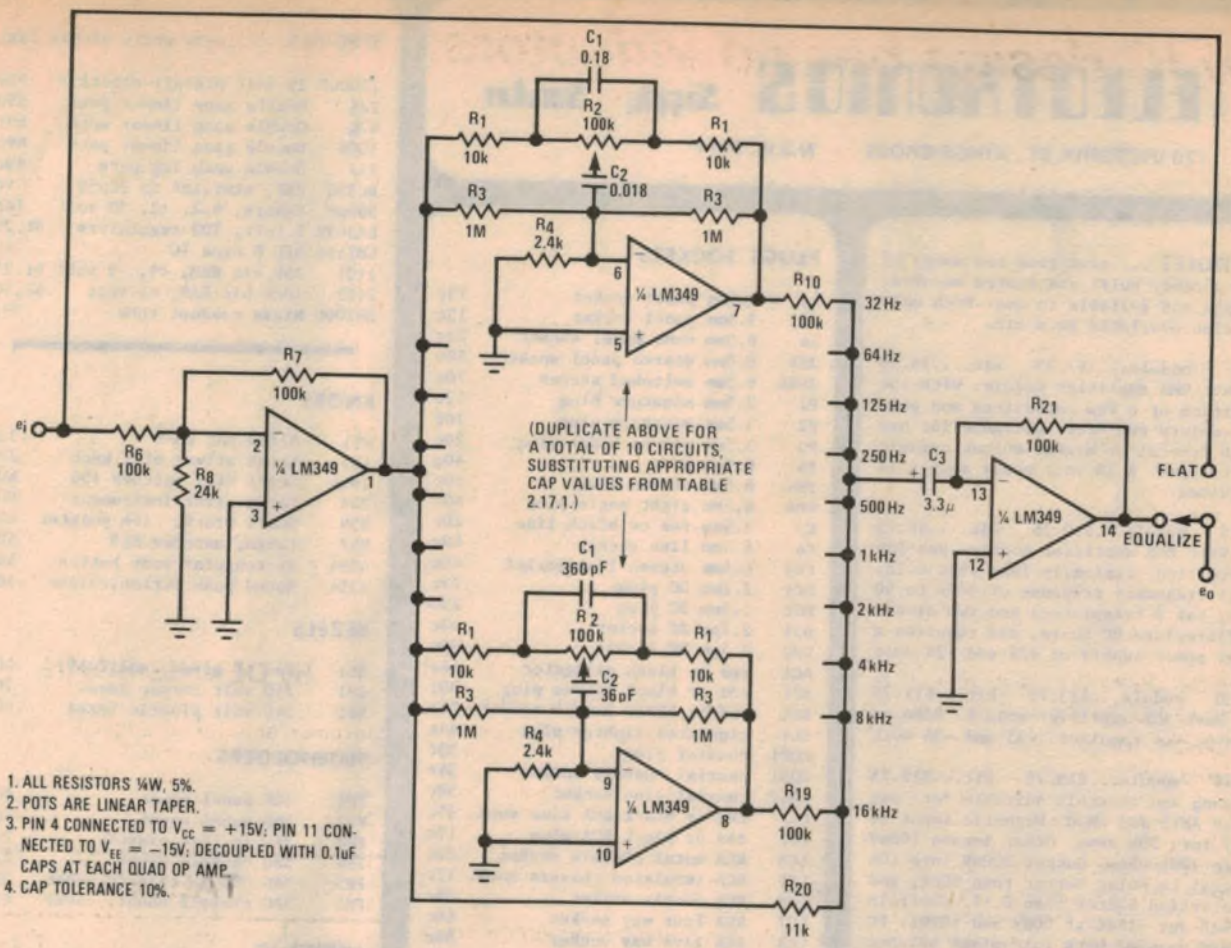


Fig. 2: circuit for a 10-band mono octave equaliser. The circuit is simply duplicated for stereo.

independent, which means that one may be arbitrarily selected and from it (knowing Ao and/or Q) the other is found.

Practical Unit Design

The design of a practical working octave equaliser is set out in the following steps:

- Select R2 = 100k
- R3 = 10R2 = 1 Megohm
- For a gain of 12dB, Ao = 4V/V. From Eqn. (9):
  $R1 = R2/3(Ao - 1) = 100k/3\ (4-1)$
  $= 1.11 \times 10^4$
  Use R1 = 10k
- Check Q from Eqn. (8):
  $Q = [(2(10k) + 100k)/(9.61)(10k)]^{½}$
  Q = 1.12, which is satisfactory.
- Calculate C2 from Eqn. (6) and C1 = 10C2
  $C2 = (1/2\pi fo(10R2))(2 + R2/R1)^{½}$
  $C2 = 5.513 \times 10^{-7}/fo$

A range of standard values for C1 and C2 vs. fo is given in Table (1).

The complete design appears in Fig. (2). While at first sight it may appear complicated, it is really just repetitious. By using quad amplifier ICs, the whole thing consists of just three integrated circuits plus peripheral components.

Fig. (2) is for one channel only, and would be duplicated for a stereo system. The input buffer amplifier guarantees a low source impedance to drive the equaliser, and presents a large input impedance for the preamplifier. Resistor R8 is necessary to stabilise the LM349 while retaining its fast slew rate (2V/us). The output amplifier is a unity gain, inverting summer used to add each equalised octave of frequencies back together again.

One aspect of the summing circuit that may appear odd is that the original signal is subtracted from the sum via R20. (It is subtracted rather than added because each equaliser section inverts the signal relative to the output of the buffer and R20 delivers the original signal without inverting.) The reason this subtraction is necessary is in order to maintain a unity gain system. Without it the output would equal ten times the input; eg., an input of 1V, with all pots flat, would produce 1V at each equaliser output, the sum of which is 10V.

By scaling R20 such that the input signal is multiplied by 9 before the subtraction, the output now becomes 10V – 9V = 1V output, ie., unity gain. The addition of R4 to each section is for stability. Capacitor C3 prevents possible large DC offset voltages from appearing at the output. If the driving source has a DC level then an input capacitor is necessary (0.1uF), and similarly, if the load has a DC level, then an output capacitor is required.

It is possible to generate just about any frequency response imaginable with this ten band octave equaliser. A few possibilities are shown in Fig. (3).

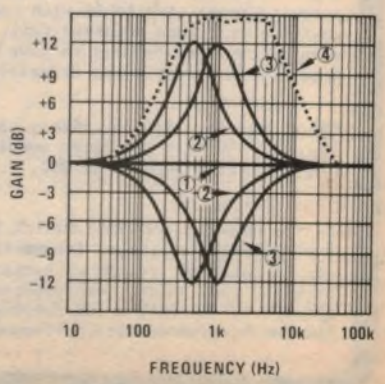


Fig. 3: frequency response curves for several possible control settings.

Sound effects for your Video Ball Game

Since our Video Ball Game was published in the May 1976 issue, we have had many letters and enquiries from readers about possible sound and scoring circuits for the game. We have also had quite a few suggestions from other readers on how to accomplish this. In this article, we present an amalgamation of these ideas.

by DAVID EDWARDS

The basic game as published did not contain any provision for sound or scoring circuits. This was partly intentional, in order to keep the basic kit price as low as possible. However, as quite a few readers have demonstrated, a sound circuit may be implemented fairly easily with the addition of only a few extra devices.

Of course, such sound circuits do not use the sound system of the TV set, but instead use a separate speaker. This is because the addition of a sound carrier to the video modulator is much harder to achieve than the addition of a speaker and appropriate drive circuitry to the game itself.

The addition of scoring facilities is more difficult. Seven segment displays and the associated drive and counting circuitry could be added to the existing circuitry, and provided due regard was taken of the increased battery drain, would probably perform adequately. But because the player's attention is normally directed to the TV screen, the addition of this type of scoring may tend to be distracting.

It is generally regarded as more desirable to have the scores appear on the screen. There are two possible ways of achieving this. Firstly, digital scores could be superimposed on the video for the game, to appear say in the top corners of the screen. In terms of the display circuitry alone, however, this method is quite complicated, and beyond the scope of a simple addition.

The second method is to have a bar graph type of display. This would be much simpler electronically, but would still necessitate fairly extensive modifications to the basic game circuitry.

But the real problem about trying to add on-screen scoring to our video game is that in the near future LSI video game chips will become readily available with these facilities inbuilt. These will supersede not only external sound and scoring circuits, but the whole ball game itself!

In the meantime, however, the Video Ball Game is still capable of providing hours of enjoyment for all the family, and provided it is simple, an add-on sound circuit can be worthwhile.

The add-on sound circuit we are presenting in this article is an amalgamation of our own ideas, and of those interested readers.

Circuits, comments and ideas were received from the following readers: M. Hillman, of North Epping, NSW; L. Collins, of Arncliffe, NSW; D. Hainsworth, of the University of Queensland, St. Lucia, Qld; K. Bolton, Howrah, Tasmania.

The circuit uses a minimum of parts, and gives quite acceptable performance. Sounds are produced when the ball strikes either bat, and when the ball is served. Two different sounds are produced, one when the ball is struck by the left bat, and one when the ball is struck by the right bat.

Only four connections to the main PCB are required: two power supply leads, and two connections to the ball direction flipflop formed by gates 5c and 5d (refer to the diagram on page 39 of the May 1976 issue).

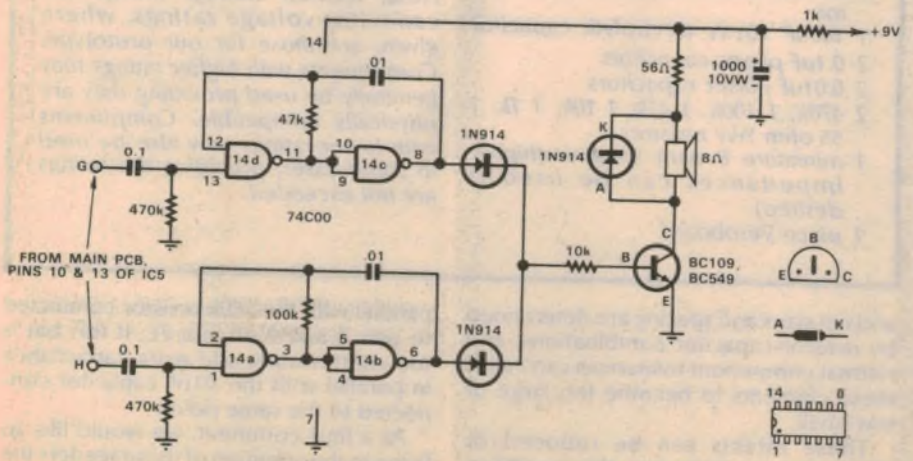
The horizontal direction of the ball is determined by the previously mentioned flipflop. Let us suppose that the ball is moving to the right. Point G, the output of gate 5c will be low, and point H, the output of gate 5d will be high. Pins 1 and 13 of IC14 (the additional gate, numbered sequentially to correspond with the previous system) will be held low by the 470k resistors.

This will prevent the two osciliators formed by gates 14a and 14b, and 14d and 14c from operating, so no sound will be produced by the speaker. This state of affairs will continue until the ball is deflected by the right bat

When this happens, point G will go high, and point H low. Point H going low will only cause gate 14a to remain held off, so that the associated oscillator will not operate. But when point G goes high, gate 14d will be enabled for a short time, and during this period the oscillator will function, causing the speaker, controlled by the transistor, to emit sounds.

The duration of the sound is determined by the time constant of the resistor–capacitor combination. With the values as shown, the sound will last for approximately 1/30th of a second.

This oscillator has an approximate



EA SOUND CIRCUIT FOR VIDEO BALL GAME

3/EG/—

LEFT: This is the circuit diagram for the sound effects module. Only four leads connect to the main PCB.

frequency of 1kHz, and the resulting sound can be described as a "ping". In a similar fashion, the second oscillator is gated on when the ball strikes the left bat, but this time, since the oscillator frequency is lower, a "pong" is produced.

These sounds will also be produced when the ball is served, since serving also toggles the ball the direction flip-flop. A diode OR gate is used to feed the oscillator outputs to the transistor base, to prevent interaction between the oscillators. Speaker current is limited by the 56 ohm resistor. Higher impedance speakers can be used without changes, although lower impedance ones can not. Louder sounds will be produced by higher impedance speakers, and this may be advantageous in some cases.

Supply decoupling is provided by the 100uF/1k capacitor/resistor combination. This prevents the speaker current from modulating the main supply rail, and hence visibly affecting the TV picture.

Construction should present no difficulties, as there is a minimum of parts. We suggest that the circuit be constructed on a small piece of Veroboard, with colour coded hookup wire used to connect the main circuit board. The +9V supply can be obtained from point B (see the PCB overlay on page 41 of the May 1976 issue), and an earth connection at point A.

Points G and H on the circuit diagram (page 39) correspond to points H and D on the PCB overlay (page 41).

The speaker can be mounted behind a group of holes drilled in the top cover (there is no room left on the base of the chassis), with long enough leads to enable the cover to be easily removed for battery replacement. Mount the Vero board on one of the speaker mounting screws.

The usual precautions reguarding CMOS devices should be observed during construction, with the 74COO mounted in a socket if you are at all doubtful of your capabilities. Testing simply consists of trying out the game.

Before concluding, some of the comments made by reader Mr D. W. Hainsworth of the University of Queensland may be of help to other readers. His first suggestion is that a 330k resistor inserted into the link between the emitters of TR1 and TR2 will give an improvement in the dynamics of the ball/bat collision, while still allowing an adequate amount of slice to be imparted to the ball. This overcomes a slight defect caused by offsets in the bat vertical velocity differentiators, gates 6a and 6b.

He also suggests that flicker of the top and bottom lines can be reduced by loosely coupling the horizontal and vertical timebase oscillators. This can be done by connecting a 100k resistor between the two sync outputs.

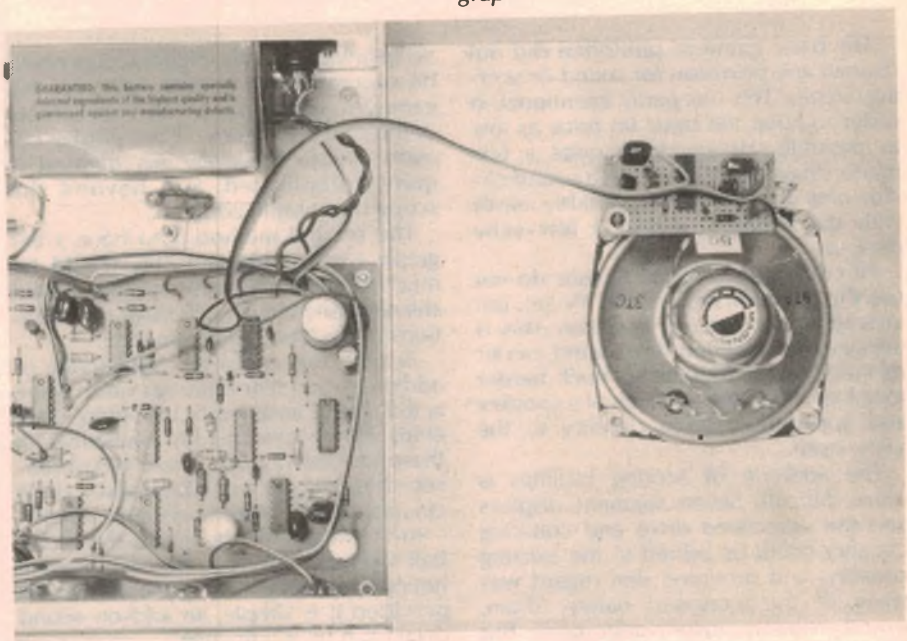
A number of readers have written to ask about the proportions of the court and its various elements. The ball, bat and net sizes and spacing are determined by resistor-capacitor combinations, and normal component tolerances can cause these elements to become too large or too small.

These effects can be reduced or eliminated by trimming the combinations to suit. For example, if the right bat is too long, add extra resistance in parallel with the 150k resistor connected to pins 8 and 9 of gate 7c. If this bat is too short, simply add extra capacitance in parallel with the .01uF capacitor connected to the same point.

As a final comment, we would like to bring to the attention of those readers the notes and errata published in the July 1976 issue.

ABOVE: This photograph shows how the speaker is mounted in the lid of the main chassis.

BELOW: The way in which the Veroboard assembly is held by one of the mounting screws is shown in this photograph.



PARTS LIST

1 74C00 quad NAND gate
3 1N914 silicon diodes
1 BC109, BC549 silicon NPN transistor
1 100uF 10VW electrolytic capacitor
2 0.1uF plastic capacitors
2 0.01uF plastic capacitors
2 470k, 1 100k, 1 47k, 1 10k, 1 1k, 1 56 ohm ½W resistors
1 miniature 8 ohm speaker (higher impedances can be used it desired)
1 piece Veroboard
Solder, hookup wire, machine screws, nuts, washers

Note: Resistor wattage ratings and capacitor voltage ratings, where given, are those for our prototype. Components with higher ratings may generally be used providing they are physically compatible. Components with lower ratings may also be used in some cases, providing the ratings are not exceeded.

DINKI-DI DICK'S DREAM BECOMES A REALITY. . .

. . . or the touching account of how a little Aussie survived among the multi-nationals & cut-price merchants . . .

7 years of steady growth proves it!

In the space of 7 short years, Dick Smith Electronics has grown to the point where it is one of Australia's leading suppliers of electronic components and equipment to the amateur & enthusiast

This would not be possible without the tremendous patronage that you — our customers — have given us. For this we say "Thank You"

It's our seventh birthday this month and for the first time, we have shops interstate. To celebrate this event and to show our gratitude, we thought you might like to read a little about the history of our company.

The best place to start any story is at the beginning; and the beginning of this company was a small car radio installation business in Neutral Bay, Sydney. The time: 1969 . . .

A youthful Dick Smith (age 24) sold his boat for about $1000 and used this money to 'get the show on the road'. The business lasted seven months at Neutral Bay, then moved to the present site of our Gore Hill store in 1970.

Business thrived as a result of some of the crazy antics that Dick got up to for publicity. One remembers an advertisement he ran once in which the copy made absolutely no sense at all — he got a tremendous response. On another occasion Dick managed to procure a pogo-stick powered by a one-cylinder petrol engine. Interest in this gadget was so great that he demonstrated it several times on television.

Apart from the publicity, a lot of hard work was involved and at this stage there were several technicians and car radio installers working for the company. By now Dick's great ambition in life was to earn $200 per week. Nowadays many people in his company earn this — "Too many!" we hear him mumbling.

In 1972 Dick saw the tremendous potential in selling components, tools and equipment to the hobbyist. Not knowing much about this game, he hired a couple of guys and rented a small shop, and started trading.

The potential was there, and there was definitely a need for a dependable supplier of electronics components to the hobbyist. Dick made a decision. He decided to sell the car radio side of the business, and 'jump out of the frying pan into the fire'

The car radio premises at Gore Hill was changed into a shop — a far cry from the one we know today. It was not long before people began to notice the good service from Dick Smith's and the business grew rapidly. This continued through 1973 when plans were made to expand this store as it was becoming impossible to get through the door! The shopfitting was completed quickly and the new shop was operating successfully early in 1974. Then Dick thought: "It's time we had a catalog" SO the first catalog was produced; all 42 pages of it and, compared to the latest effort, really quite crude. It was, however, very successful and the mail order section of the company grew rapidly. It soon became the most important part of the company operation.

Running a company placed heavy demands on a person and it became necessary to continually look for competent people to work for us. In this respect we have been very lucky, but even in today's hard times it is very difficult to get good staff.

By mid-1974, the Bankstown property was purchased to serve the needs of enthusiasts in Sydney's southern and western suburbs. Bankstown was a success right from the start, and continues to be so. Continual improvement to this establishment has ensured this success.

And we continued to produce catalogs, getting bigger and better all the time.

Business was booming, despite the gloomy clouds on the country's economic horizon. 1975 saw great changes and expansion.

Dick now had the size to begin importing his own gear. This is one of the reasons we have been able to hold many lines down to the same prices for over two years. Importing really began in earnest. Now over 80% of products sold by us are also directly imported by us.

This has been extremely important to us as we have control over quality, we get to see new products quickly and also we can negotiate with the factories for the best possible prices. Dick and other staff go overseas regularly to ensure continuity of supply and to make sure that possible problems are eliminated before they start. At the same time, we buy nearly $1 million worth of goods annually from the Aust. electronics industry.

In April 1975 we released our 5th catalog and opened our York Street store. Both were immediate successes. The same pattern of continual improvement at York St has resulted in regular patronage from our city customers.

By June we were bursting at the seams with stock — especially stock that was imported. At that time all inventory was kept in the roof over our Gore Hill store!

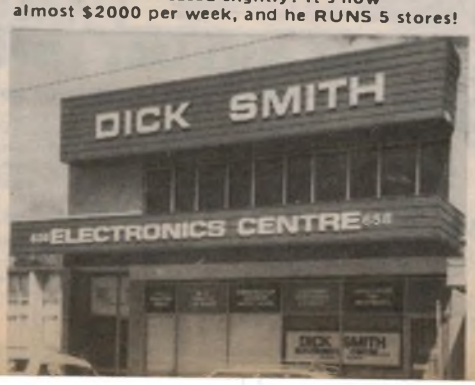
We took the daring step of moving our stock and mail order department into a warehouse about 1km away from our Gore Hill store.

When we first saw this warehouse, 4000 sq ft of it and brand new, we never thought we would see the day when it was full. Five months later — it was full.

There was nowhere to go except out the front door so we decided to move again. This time to our present head office and warehouse in Carlotta Street, Artarmon, still about 1km away from Gore Hill. Again, when we saw this place empty, 27000 sq ft this time, we thought we would never fill it. The walls seem to be closing in on us these days, though . . .

CONTINUED 2 pages over . . .

'Great oaks from little NUTS grow', or something . .. Dick's first 'shop' at Neutral Bay. Rent was $15.00 per week!



The new Melbourne store, in busy Richmond. His rent has increased slightly: It's now almost $2000 per week, and he RUNS 5 stores!

Not forgetting Queensland: here is the Buranda store. It's part of a store and dealer network across Australia.

7 YEARS OF SUCCESSFUL BUSINESS MEANS

DICK HASN'
ANY MI
HE DOES NO
JUST IN

Cat Q-1136 .... $45.00

As reviewed by Electronics Aust

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The Dick Smith Q 1136 is both: a high quality multimeter AND a transistor tester. How's that for convenience? Look at the specs. You'll agree the Q-1136 (also known as the 360TR) is a very handy piece of gear!
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OCV: 0.5 – 1k (100k ohms/V) (3%)
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DCA: 10uA – 10A (250mV) (3%)
ACA: 10A (4%)
RES: 0 – 50 Mohms, 4 ranges (3%)
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Absolutely Identical to the 360TR

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FOR THE TECHNICO'S – OUTPUT IS 5.0mV per CH @ 1,000Hz @ 5cm/sec PV

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6 piece chrome plated screwdriver set in handy plastic pouch. Invaluable value!
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Just tell a builder or handyman about this fantastic gadget – locates any metal object – wires, pipes, reinforcing steel, even nails, inside walls and plaster etc.
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* Penetration, sensitivity control locates metal 6" away
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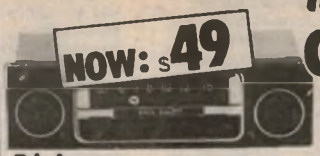

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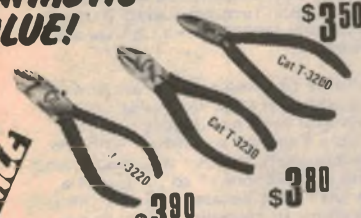

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Dick has lopped $20 off last weeks price. Unit has slider controls for volume, tone & balance; push buttons for instant eject, fast forward & reverse. Healthy 4 watts output. Cat. A-6485 Price does not include speakers.

CAT A-6485

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20Hz – 20kHz
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Dick has carved over $59 off the normal price. 12 volt neg earth operation. Adjustable shafts enable different car installation. 5 watts output per channel into 4 ohms speakers. FM radio is fully multiplexed for stereo reception. Has fast forward and eject buttons. Tremendous value. Cat. A-6480

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SAVE over $59

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GOLDRING ES70S MAGNETIC CARTRIDGE SCOOP!

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Check the spec: Frequency response from 15 to 25kHz. Output is 5mV at 5cm/sec. Tracks at 1 to 2.5gm. Fitted with conical diamond stylus 0.8milligram tip mass and high compliance.
So save $3.00 on this beaut magnetic cartridge. Now it's yours for only

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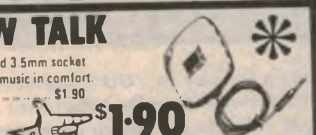

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AND A MATCHING AMP.
Power output 10W RMS, bandwidth 20Hz-20kHz.
You could pay twice as much and do no better.

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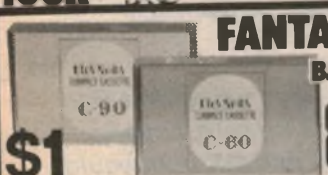

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C60 (Cat C-3346) $0.80
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10 for $15 gives 12V Cat. S-3300

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Made from high impact plastic with overall box dimensions of 114mm wide x 57mm high x 130 mm deep. Large handle and index card slot on each drawer. Boxes have dovetail recess for secure fitting together. Bench or wall mountable.
Cat. H-2584 One drawer type.. .. .. .. $1.00
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$14 pr

WERE $16.

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CAR SPEAKERS

FIT THESE SPEAKERS AS EXTRAS TO THE ABOVE CAR RADIO.
Convertable box type that can also be mounted flush. Has 4 ohm nominal impedance with 8 watts maximum power output. 130 mm Hi-compliance speaker with 90 gm magnet.
Cat. A-6980.. .. .. $14.00 per Pair.

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She's got the lot; easy to read tuning dial, large dynamic speaker, built in ferrite aerial for AM (AM too?) telescopic aerial for the you beaut FM, battery, ear phone and wrist strap to impress ya sheila!
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AM/FM POCKET RADIO

HOLD THAT FUSE!

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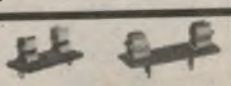
Ideal for automotive or marine work; these fuseholders take the standard 3AG fuses. Held tight with a plated spring and contacts. All plastic, complete with 600mm lead.
Cat S-4277 .. .. $0.40

40¢

CHASSIS OR PCB TYPE



Nice and inexpensive BEFORE Dick dropped the price on these fuse-holders, now they are nice and DIRT CHEAP. He's reduced them 10 cents – that's a whopping 40% discount. 2 sizes, 3AG and 00 fuses.
Cat S-4257 (3AG) $0.15
Cat S-4258 (00) $0.15

15¢

CAR STEREO SPEAKERS

A pair of beautiful 130mm hi-compliance speakers with black padded-cover grilles. 4 ohms impedance.
Cat A-6985 . $16 pr.

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Ideal extention speaker. Handsome complete unit with 4" speaker. Buy now and SAVE well over $2.00
Cat A2457 .. .. $4.50

$4.50

CONTINUED: The true-life adventure story of Little Dick, local NUT made good.

April this year saw our latest and most successful catalog. We were swamped by an absolutely staggering response and at one stage, our famous 24 hour mail order service was 4 weeks behind! At the same time, we began to experience an international component shortage (and we still are, in fact). Many customers gained the impression that our service was failing. Well it was . . . but there was precious little we could do about it. Orders placed 6 and 8 months before were not being delivered to us.

Also this year we were successful in becoming the Australian agent for Midland Communication Equipment. We were very lucky to be appointed, as we believe that Midland CB communication gear is the finest in the world.

Because we had a tremendous number of enquiries from people who wanted to purchase wholesale quantities from us, we decided to establish a wholesaling facility. The program of appointing 'Dick Smith' and 'Midland' dealers throughout the land is proving to be extremely successful. We are always on the lookout for good potential dealers — write to us if you are interested.

Earlier this year we installed an IBM System 32 Computer with the revolutionary hard-goods package for electronic distributors. This machine has virtually taken over stock inventory and control, with humans standing by to carry out orders! As well as being able to give instant stocks of any item from the 3500+ that we carry, the machine can give sales breakdowns through our various stores (to see which one Dick waves the stick at) sales over any particular period (EG immediately after an advertisement has run) and tell us which items are selling and which items are not (thus enabling buying of essential or fast-moving items to be planned with a high degree of accuracy — it's just a pity that our computer cannot control the suppliers, too!) plus a veritable mountain of analyses, breakdowns and projections.

(It will also do the mundane things one would normally expect of a computer, like invoicing, credit control, profit & loss, etc. etc)

If Dick is missing from his office, all employees know where to find him: He's in the computer room, extracting some terribly important and useful information like how many miles of insulation we sold to the Hutt River Province last month . . .

"Just making sure the computer is still working properly . . ."

Which brings us up to now. Brisbane store opened in mid-September; Melbourne a couple of weeks later. Both appear to be as successful as our other ventures.

We now have many 'Dick Smith' & 'Midland' dealers throughout Australia, some of whom are in the most incredible places!

It's a full-time job just keeping track of what's going on here now: 90 employees; $5 million annual turnover; AND FULLY AUSTRALIAN OWNED — a fact we are most proud of!

We still like to think that we are a small company, though. Dick fiddles at home (as a matter of fact, he has just finished making up a Twin 25 Amplifier, which is his pride and joy!). Most of the people who work here are "dabblers" so if there is a problem with a kit we are generally the first to know about it. Usually you never do, because we can rectify it before the kit is put on sale.

Last Christmas, Dick received a present: and he hasn't stopped playing with it yet. No, it wasn't a train set or even a busy builder; it was a $50,000 IBM System 32 Computer. It is shown here with the lovely Dawn who is giving it its morning tea.

All these goodies were on the way to YOU a few weeks ago. This is just a small part of our mail order department (sorry girls, that's MAIL, not MALE). Much of the stock sold by Dick Smith passes through this department.

Where do we go from here?

Good question . . . A lot depends on you, of course. We are anxious to increase our dealer network throughout Australia. Maybe you are interested. If so, write to Gary Johnston in Sydney for details.

Once again, thank you for your patronage. If you feel that we are letting you down in some way or other, write and tell us about it. How are we to know otherwise?

So that's a little about us. We hope you didn't find it boring. It's never boring working here, anyway. Incidentally, speaking of work, perhaps you would like to. For us, we mean. We are continually on the lookout for guys and girls who are dynamic and want to work for a young, growing company. Average age is 21-1/2 — beat that! But you must know something about electronics. Just contact us by 'phone or letter. It will get to the right person here.

DICK SMITH ELECTRONICS GROUP

Head Office: Phone 439 5311. Telex AA20036. Cable 'Diksmit' Sydney.

Mail Orders: P.O. Box 747, Crows Nest, N.S.W., 2065.

N.S.W. Branches: GORE HILL - 162 Pacific Highway, 439 5311.
SYDNEY - 125 York St., 29 1126. BANKSTOWN - 361 Hume Hwy., 709 6600.

Interstate Branches: QLD. - 166 Logan Rd., Buranda, 391 6233.
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The specials shown in this lift—out are available from Dick Smith Stores in Sydney, Brisbane and Melbourne ONLY. However, Dick Smith Dealers across Australia will be running their own specials from time to time.

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BY COMET FREIGHT: THE MINIMUM PACKING AND HANDLING CHARGE IS $1.00. WE DESPATCH "FREIGHT-ON" AND YOU PAY WHEN YOU RECEIVE THE GOODS.

FOR C.O.D. SEND $2.40 EXTRA PLUS $3.00 DEPOSIT.

MINIMUM MAIL ORDER AMOUNT IS $5.

Make a novel door chime with a simple

Proximity Switch

Using only three low cost semiconductors, this simple project will have sure appeal to beginners and old hands alike. Just bring your hand close to the sensor plate, and the circuit will cause a lamp to light or sound a buzzer.

by LEO SIMPSON

The simple proximity switch to be described here has several intriguing uses around the home. It also has possible application in the retail trade, for sales promotions.

Around the home, it may be used as a novel door chime unit, or as a "surprise" gimmick for parties. Imagine the fun if a bell were to ring whenever a guest reaches into the bowl of sweets, or sits down in that unoccupied armchair!

Some of the ideas for sales promotions could be as follows. A sensor plate could be placed behind a shop window. Window shoppers could then trigger the circuit. It might be used to turn on lights over display stands, actuate a slide projector or an endless loop cassette player. It could also be used as an attention alarm on shop counters. In fact, this unit is almost identical to that used on the counter of the former editorial office of "Electronics Australia".

An alternative use on a counter or display stand would be to actuate warning signs. A sign reading "Please do not touch" could thus light up or sound a buzzer when a person disobeyed. Museums could use this device by the dozen!

Total cost of the project is very low at $15 or less, including all hardware and metalwork.

The circuit is very similar to that featured in June 1971 of "Electronics Australia" (File No 2/MS/21). The major difference is that the new circuit employs a lower voltage transformer, which is considerably cheaper and more readily available. As a result the new circuit may not be as sensitive as the original, but it should still be quite sensitive enough for all likely applications.

The semiconductors complement is two SCR devices and one zener diode. Before describing the circuit operation, let us describe the behaviour of these three devices.

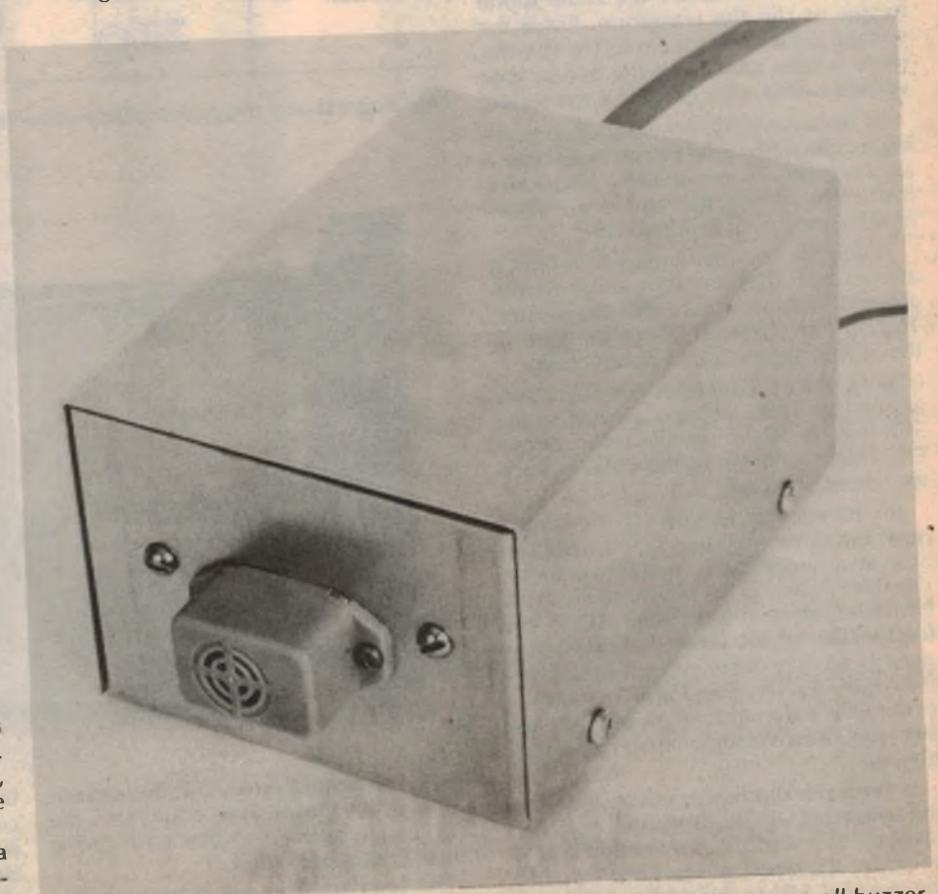
A zener diode can be regarded as a normal diode with a safe reverse breakdown characteristic. With voltage applied in the forward direction, it has a conduction voltage of around 0.6V or more, just like any silicon diode. With voltage applied in the reverse direction, the zener is non-conducting up to a specified voltage. Exceeding this voltage by a small margin causes reverse breakdown with a low dynamic resistance. Limiting resistors must be placed in the circuit to prevent over dissipation in the diode.

Conventional uses of the zener diode are voltage limiting (or waveform clipping) and in regulated voltage sources.

The two SCR devices are a conventional SCR and a complementary or "anode gate" SCR (also known as a programmable unijunction transistor). An alternative device to the complementary SCR is the silicon controlled switch or SCS.

The SCR is one of the family of semiconductor devices known as thyristors. It can be regarded as a special type of recitifier diode which conducts in one direction only. What sets it apart from a normal diode is that when it is forward-baised, it will not conduct until it is triggered into doing so by a small positive voltage applied between its third "gate" electrode and the cathode. With a sine wave voltage applied between anode and cathode, an SCR can be triggered into conduction at any instant during the positive half-cycles. At the end of each positive half-cycle, the SCR turns off as the voltage polarity reverses.

The complementary SCR, is very similar to an SCR, except that it has a gate electrode which is associated with the anode rather than with the cathode. The silicon controlled switch or SCS is virtually a combination of the two, having both an "anode gate" and a "cathode



Housed in an aluminium box, the prototype Proximity Switch drives a small buzzer.

gate". Either can initiate conduction.

Referring now to the circuit diagram, a power transformer with a centre-tapped 12.6V secondary winding is required. The complementary SCR is connected across the whole winding, in series with 6.8k and 1k resistors. The cathode side of the winding is connected to earth (chassis). Note that when an SCS is used, the cathode gate is not connected.

Now for the complementary SCR to switch on during positive half-cycles of the AC waveform, the anode gate must be made negative with respect to the anode. If a person touches or brings their hand close to the sensor plate which is connected to the gate via the look resistor, triggering occurs because of the increase in capacitance between the gate and earth. The increase in capacitance causes the phase lag of the sinusoidal voltage appearing at the gate to increase with respect to the voltage at the anode, until the voltage difference between the anode and anode gate is sufficient to cause triggering.

Because a zener diode with a 10V rating is connected from the anode of the complementary SCR to earth, the voltage appearing at the anode is a clipped, half-wave rectified sine wave with a peak amplitude of 10V.

This means that the phase shift between anode and anode-gate voltages can only cause the anode gate voltage to drop below the anode during that period in the half-cycle before the zener diode begins to clip the waveform. Once the voltage at the anode is limited to 10 volts, there is little chance of the anode gate voltage being reduced below this figure.

So because of the zener diode, triggering produced by gate circuit capacitance always tends to occur early in positive half cycle, giving the circuit an all-or-nothing switching characteristic.

When the complementary SCR fires, it applies a proportion of the zener-diode-clipped voltage across the 1k resistor. This, in turn, forward biases the gate of the SCR to trigger it into conduction.

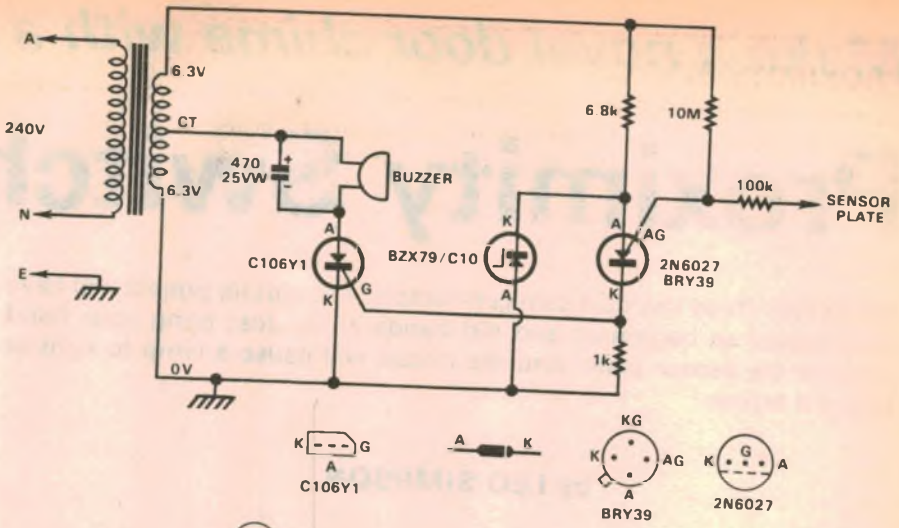
Since the SCR rectifies the 50Hz sine applied to it, the voltage applied to the SCR load needs to be filtered to obtain DC. This is achieved by the 470uF capacitor across the load.

An interesting feature of the circuit now becomes apparent. Normally, an SCR in a circuit such as this would be capable of varying the power to the load. However, since the rectified AC to the load is filtered and since the circuit triggering can only occur early in each positive half cycle, the load voltage is essentially independent of sensor capacitance, once it is sufficient to cause triggering.

If the zener diode was not included in the triggering circuit, both the complementary SCR and the conventional SCR could be triggered at any instant during the positive half-cycles of the 50Hz AC input. This would mean that the capacitance of the sensor plate could vary the DC voltage applied to the load—giving rather erratic operation.

The load used in our prototype is a neat little solid-state buzzer available from Dick Smith Electronics Pty Ltd. It is considerably cheaper than a Sonalert although it is not as loud. The load could alternatively be a small relay.

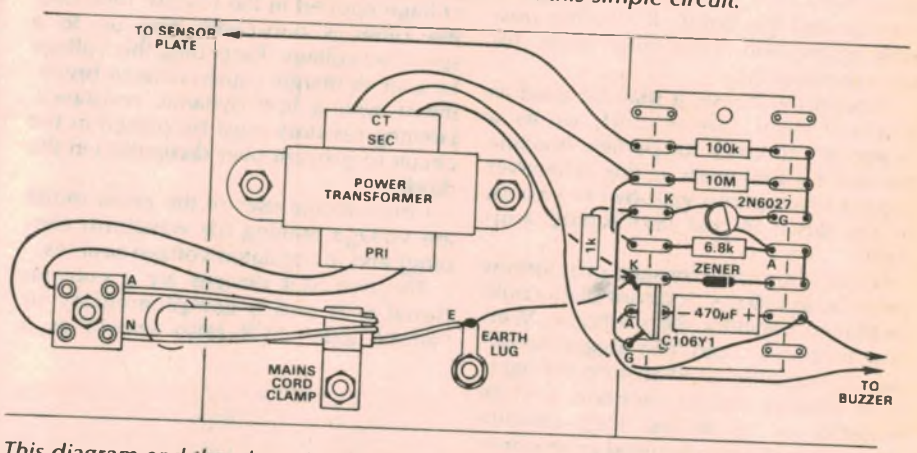
Construction of the proximity switch is straightforward and non-critical in terms



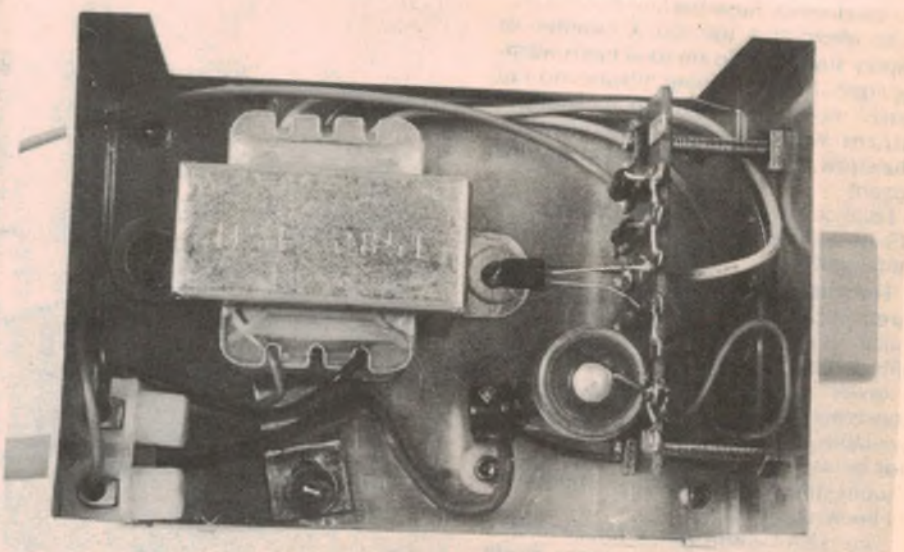
EA PROXIMITY SWITCH

2/MS/-

Only three economy semiconductors are used in this simple circuit.



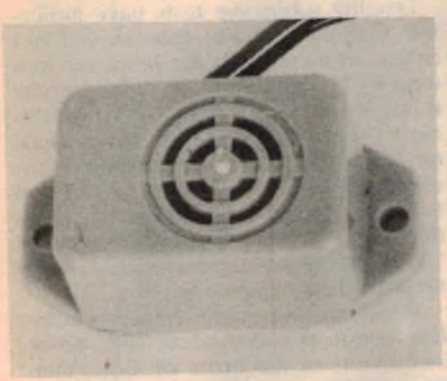
This diagram and the photo below show how to assemble the unit.



of layout. We housed the prototype in a compact aluminium mini-box measuring 104 x 74 x 53 mm.

Since the circuit and the suggested buzzer have a current drain of less than 20 milliamps, almost any 12.6V transformer may be pressed into service. We used a small 2.5VA type, DSE 2851, supplied by Dick Smith Electronics Pty Ltd. Equivalent types are Ferguson PF 2851 and A & R 6474. If buzzers with higher current than about 150mA are used a higher rated transformer will be required. Maximum rating of the SCR specified in the half-wave mode is about 700 milliamps. (No heatsink and at room temperatures).

If the load current is more than about 50 milliamps, the filter capacitor will have be increased accordingly, to obtain satisfactory operation.



This is the buzzer, twice actual size.

All the small circuit components are mounted on an eight-lug length of miniature tagboard. The SCR is soldered directly into circuit and no heatsink is required. If an SCS such as the BRY39 is used, the cathode lead can be clipped short or sleeved to prevent it touching other components and possibly prejudicing the circuit operation.

The buzzer may be attached to the case by small self-tapping screws, or with epoxy adhesive.

Note that the case and circuit must be earthed via the mains cord, otherwise the device will not work. The lead to the sensor plate runs out via small hole in the case. Shielded cable must not be used, otherwise cable capacitance may turn the unit on continuously. Nor should the sensor lead be too long, otherwise stray capacitance will be too high.

The three-core mains cord should be passed through a grommetted hole in the end of the case and anchored with a cord clamp. Terminate the earth conductor to a solder lug on the case. Terminate the active and neutral conductors to a two-way insulated terminal block. Connections to the transformer primary are then made via the terminal block.

A sensitivity control may be added by connecting a 5 megohm pot, wired as a variable resistance, in series with the sensor lead. This will serve to make the unit less sensitive, if need be.

When the unit is complete and ready for installation choose a location which requires a minimum length of lead to the sensor plate. The sensor plate should be kept reasonably far away from earthed metal objects (30cm should be adequate) otherwise sensitivity may be compromised. The sensor plate may be concealed or visible, but it should be at least as large as a male hand (say 150 x 200mm).

Note that the sensor plate may be touched directly. There is no danger of electric shock, due to the low circuit voltage and high values of resistance in the sensor circuit.

PROXIMITY SWITCH PARTS LIST

1 aluminium mini-box, 104 x 74 x 53mm
1 9V buzzer (available from Dick Smith Electronics Pty Ltd)
1 C106Y1 SCR
1 2N6027 complementary SCR (or PUT) or BRY39 SCS
1 BZX79/C10 zener diode
1 470uF/25VW pigtail electrolytic capacitor
1 x 10M, 1 x 100k, 1 x 6.8k, 1 x 1k (¼ or ½W resistors).
1 2-way insulated terminal strip
1 solder lug
1 cable clamp
1 grommet

Three-core mains flex, three-pin mains plug, connecting wire, spaghetti sleeving, screws, nuts, washers, solder.

Note: Capacitors and resistors with higher ratings may be used if physically compatible. Do not use higher rated SCRs, otherwise triggering will be unreliable.

A few checks can be made on the circuit if it does not work. The zener diode may be checked with a multimeter, with the power applied. The voltage reading across the zener, with the circuit untriggered, will be about 3.8V. The SCR can be checked by disconnecting the gate and connecting it to the 12.6V line via 1k resistor. This should apply voltage to the load. If the SCR is okay, the complementary SCR can be checked by connecting the sensor lead directly to the case. This should also apply voltage to the load.

Forum

Conducted by Neville Williams

Who said we can't hear a 2dB change?

Hifi engineers and enthusiasts can debate for hours the "colouration" imparted to reproduced sound by the more subtle peculiarities of amplifiers and transducers. They find it much more difficult, however, to identify positively and to put figures to the effects which they are talking about, and which allegedly compromise the sound quality as heard.

The simpler aspects of the problem are intrinsically technical, having to do with the behaviour of physical devices and electrical circuits. While still perhaps subtle and elusive, it is not unreasonable to believe that such phenomena can ultimately be identified by physical means—including the recent technique of studying transducer behaviour with the aid of a laser beam.

What is much more difficult—and likely to remain so—is the problem of verifying and quantifying what people say they hear. If Joe Bloggs insists that he is conscious of a certain effect which is compromising his enjoyment of reproduced sound, it is very difficult to establish whether he is deluding himself, or is genuine, or is magnifying an effect out of all proportion to its real significance.

And, lest it appear that I am having a shot at Joe Bloggs, Fred Nertz, or whoever, let it be understood that we all share similar subjective propensities. We all find it difficult to admit to not noticing what others profess to perceive. We all "have ourselves on" to some degree. We can all become obsessed with something that our peers feel should be ignored. We can all gain an ego kick from taking a stand as the ultimate perfectionist, no matter how unrealistic that stand might be.

It's all fair game in a subjective way but it does make things difficult for the engineer, enthusiast—or writer—who is trying to be objective!

What triggered this line of thinking was a letter to hand from a reader in Geelong, Victoria, who has this to say:

Dear Sir,

Your mention in the November issue of loudspeaker design involving lasers prompted me to set down some of my own findings about sound colouration.

Hifi standards such as DIN allow for frequency response variations within a 5dB window. Audio literature commonly states that variations of less than 3dB are not normally noticed by the average (?) listener. I am dubious about such figures.

I am the lucky owner of a Nakamichi 700 cassette recorder and the before-after monitoring facility really opened my eyes about the different frequency response of cassette tapes, even within one brand, and the "colouration" this can produce.

As I like to have all may cassettes sound as near as possible to the original, I use a JVC Nivico SEA100 in the input lead to the recorder. The SEA100 allows for reasonably accurate tone control at 60Hz, 250Hz, 1000Hz, 5000Hz and 15,000Hz, the controls being calibrated in dB, and fairly accurate at the nominated frequencies.

Using white noise as a reference signal, not only I but also two young people could notice colouration quite strongly, even though the required correction might be less than 2dB. This applies particularly to the frequencies between 1000Hz and 5000Hz, at least as far as my equipment will tell.

It would be interesting if you could make these same A-B tests, not using a recorder, but with more accurate filters and frequency response measuring gear.

Perhaps the human ear is more capable than we suspect of assessing deviations from linear response. Perhaps even the overall volume is critical.

D.H. (Geelong, Vic)

In defence of the figures which D.H. queries, I think we should repeat what they are meant to convey—particularly as we have been aware of some confusion, of late.

The human ear responds to sound pressure, not in a linear fashion, but logarithmically. This isn't due to some contrary quirk of nature but is, in fact, the very property that allows us to perceive very faint sounds, while still being able to cope with the enormous sound power of a jetplane or a grand organ in the confined space of an auditorium.

It's this same logarithmic quality which tends to upset some of our thinking about amplifier power and loudness. To take an often-repeated situation, manufacturer A brings out an amplifier rated at 20 watts. Not to be outdone, manufacturer B releases one delivering 25 watts and that may impress the buyers as intended; after all, 5 watts of power sounds quite loud on its own and, added to 20 watts, it ought to make quite a noise. That is, until manufacturer C comes up with a 40 watt amplifier—twice as powerful, therefore twice as loud!

Wrong, because such a reaction assumes that our response to changes in loudness level is linear, which it isn't!

To help order their thinking, engineers long ago adopted the concept of the decibel, which is 10 times the logarithm of the power ratio. For a power increase from 20 to 25 watts, the ratio is 1.25. The log of 1.25 is .0969, so that the increment expressed in decibels is .969 or near enough to 1dB.

An increase from 20 to 40 watts represents a power ratio of 2, a log of .3010 and an increment expressed in decibels of 3.

Lengthy subjective tests have indicated that the average listener will not notice an increase in the loudness of a tone by less than 2dB, provided he/she is not alerted to the change by a switching transient. A change of 3dB in loudness is noticeable but certainly not obvious. To achieve a subjective reaction that the intensity of a sound has been doubled (or halved) an increment of 10dB is necessary, representing a power ratio of 10 times, up or down.

Which, of course, renders rather pointless undue preoccupation with power increments of the order of those mentioned earlier. For an increase from 20 to 25 watts, representing 1dB of change, the direct audible result would be virtually nil. Even doubling the power, from 20 to 40 watts would represent a just perceptible increase in potential loudness. To actually double the loudness, in the subjective sense, it would be necessary to bump the power rating from 20 to 200 watts!

This should not be construed as an argument against providing increased power output, where it can be obtained conveniently, because increased power does help the amplifier cope better with transients above the average power level. What the decibels notation does accomplish is to bring our expectations more in line with our sense of hearing.

The concept of 3dB as a barely perceptible change in loudness has been widely accepted for a long time and leads to the common approximation that a piece of equipment can be considered to be "flat", provided the frequency response is within a 3dB tolerance. We must be careful of our terminology, however.

"Within 3dB" can be taken two ways. One is that the discrepancy between the maximum and minimum points on the response curve is not greater than 3dB. The other interpretation is that neither the peaks nor the troughs in the curve

diverge by more than 3dB from a stated or median reference level; this leaves open the possibility, of course, that the discrepancy between maximum and minimum response points could be up to 6dB.

In his letter, D.H. refers to a DIN hifi standard, accepting a 5dB "window", indicating a maximum discrepancy of 5dB between the maximum and minimum response points. It would be equivalent to a maximum deviation of plus and minus 2.5dB from a median reference.

Having in mind the likely response curves of loudspeakers in particular, any system which could offer a response window of 5dB overall should sound very impressive indeed. I would venture to suggest that, if they did not suffer other limitations or peculiarities, any number of such systems would be accepted as top quality by a hifi enthusiast, provided they were heard in isolation.

Why the proviso?

Because I am inclined to go along with D.H's contention that the ear is a lot more sensitive than we may suspect to differences in response curves, when direct comparisons are possible, as in A-B testing.

Earlier in the year, we were involved in quite a lot of listening tests with loudspeaker systems, particularly leading up to the development of our own 3-41L design, and the Philips/Elcoma System 14 and System 16 projects. It involved A-B listening tests between systems, and between variations of the systems. As each was guided towards what we felt was optimum, we became progressively more satisfied with their respective performances, and prepared to give them our enthusiastic endorsement.

But, while they gained that endorsement, and while they sounded a lot more consistent on most program material than the usual groups of showroom speakers, there was no denying the differences on other program material and on broadband noise. And this difference remained, even with variations which produced very similar looking response curves.

I am well aware, of course, that there is a lot more to loudspeaker sound than mere frequency response. What I am saying is that differences which might not be at all evident in separate listening experiences can become startlingly obvious under direct A-B comparison.

I agree also with D.H. that the kind of effect we call "colouration" is most obviously connected with the mid frequency range—hence the vital importance of the mid frequency crossover characteristics or the mid frequency driver, where one is used. I had another very practical illustration of this recently, this time in connection with magnetic cartridges.

A hifi acquaintance was complaining rather bitterly about the dubious quality of many modern discs, on the grounds of vestigial noise, and distortion, and overall balance. As a reviewer, I listen to a fair number of new releases—without having cause to complain anything like as much. So I decided to follow it up by comparing his record player with my own.

As it happened, I had available a number of discs and the equivalent 1:1 copies on cassette from the working masters, as mentioned in our story on page 14 of the last issue. We therefore had the potential not only to compare cartridges playing the disc, but to compare each with a very close cassette copy of the working master, made on a Nakamichi deck.

Without labouring the point, the discs did sound very ordinary, by hifi standards, on my friend's player. They sounded much better—normal, to my ears—on a couple of my own cartridges which I had on hand, a Shure V15 and an Empire 1000ZE. Indeed, it was very difficult to pick any difference between either of the above mentioned cartridges, or between them and the high quality cassette. The problem was obviously not the discs but my friend's cartridge.

The cartridge was supposed to be a real connoisseur's job (adjective, not brand name); but it had enough wrong in its middle register to make good records sound ordinary, ordinary records sound poor, and poor records sound worse!

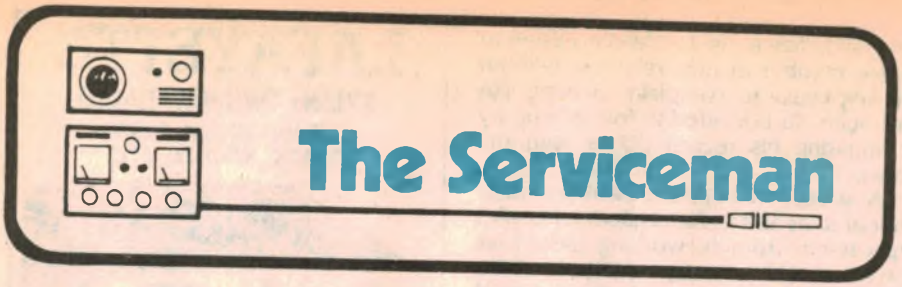
Again, we may not be talking about mere frequency response, but the point emerges that A-B comparisons can highlight differences that would be much less obvious and much more elusive in separate listening situations.

What D.H. is suggesting is that, under A-B conditions, and on the basis of frequency response variations only, keen ears can pick differences in colouration resulting from discrepancies of 2dB or even less. Variations much greater than this will certainly be evident between top quality tapes of different brands, on different machines; even between different batches of the same tape.

D.H. invites us to follow up his observations ourselves but I frankly can't see much hope of so doing for the time being. However, others may like to make their own observations.

But there are just a couple of points worth keeping in mind. Let's say we agree that the ear can pick differences in colouration due to a frequency deviation of 2dB or less; how do we discover which is the least "coloured" version of the two we are comparing? Secondly, if two versions are so similar that we can only pick the difference under A-B conditions, is it really all that important which one we listen to in isolation?

If the difference was a matter of distortion or noise level, evident only from an A-B test, one would logically pick the better of the two. But pure audio "colouration"? It has similar subtle connotations to the colour of "white" on a TV screen—without the availability of a reference standard!



Why are customer complaints ignored?

On many previous occasions I have related stories which emphasise the vast communication gap which often exists between customer and serviceman; a gap which can lead to gross misunderstanding and accusations of dishonesty, which reflect against the trade as a whole. My first story this month is just one more example of such situations.

The story concerns a lady who is a professional musician and who needed a good quality tape recorder to pursue her profession. She subsequently bought a fairly high priced semi-professional type machine with all the potential for first class performance, and which should have been more than adequate for her needs.

In fact, the machine turned out to be completely unsatisfactory right from the start. As a result, she had taken it back to the shop several times, only to be told there was nothing wrong with it. Subsequently, she took it to another audio store, only to be told the same thing.

Now this lady lives nowhere near my suburb, but she is a relative of a very good customer of mine. And it was while she was visiting my customer one day that she poured out the whole sad story. Basically, it seemed that the recorder had always distorted very badly and now it had failed completely.

And my customer—with more confidence in my ability than I might have myself—assured her that I would be able to fix it. And so the recorder suddenly appeared on my counter, with the story I have just recountered. Could I have a look at it and give her some idea of what was wrong if she called in on her way home that afternoon? I said I would see what I could do.

The reason for the complete failure turned out to be a broken microphone cord. That fixed, the recorder worked perfectly and, in fact, turned in a first class performance. So what was this story about distortion? Thoroughly suspicious by now, I decided to wait until the lady returned before delving any deeper.

When she called back I asked her to show me how she operated the recorder. Then the penny dropped. She immediately set the recording level control fully clockwise and spoke her little test piece into the microphone. Then she played it back—and demonstrated very effectively just how badly the machine distorted!

Apparently there had been no instructions with the machine and nobody, in spite of her repeated complaints, had bothered to instruct her, or even investigate whether she knew how to use the machine.

It never ceases to amaze me how such stupid situations are allowed to occur. Surely, when a customer complains and the dealer can find nothing wrong with the equipment, the most elementary common sense suggests that it is time to ask the customer to demonstrate the exact nature of the problem. Such a simple request would eliminate the great majority of dealer/customer misunderstandings which reflect so adversely on the trade as a whole. As far as that goes, the customer would be wise to insist on demonstrating that about which he is complaining; even the most casual shop assistant would find it hard to ignore a complaint when the evidence is right under his nose.

Not that I have any reason to complain over this deal. On the contrary, I am the "white-haired boy" as far as this customer is concerned. Not only was she most profuse in her appreciation, but she phoned me a couple of days later to enquire whether I stocked tapes and accessories and to tell me how much pleasure she is now getting from the recorder. She has since become a very good customer and, who knows, one of these days she may want a colour TV set!

My next story concerns the now ubiquitous pocket calculator. A colleague, who already owns one of the so-called "scientific" versions, decided that one of the simpler versions would make a nice present for his wife, mainly to take some of the drudgery out of balancing the household cheque account.

After some searching he found what he felt was an ideal unit; small and light, it provided the normal four functions, plus percentage, a memory, and even square root—though this last feature was unlikely to get much use. And, since the price was also attractive, he promptly bought it.

His wife was delighted but, unfortunately, her joy was short-lived. She complained to her husband the next day that she had tried to use it total up her cheque butts, whereupon it had suddenly "gone all funny".

More precisely, it had started generating quite meaningless groups of numbers, having no bearing on the calculations under way, and which would change quite randomly every few seconds. At the same time all control via the input buttons was lost.

Naturally, her husband wanted to be shown but, as always, the problem refused to reveal itself. My colleague suggested that she leave it for the present, keep on using the device, and see if it occured again. The unit was under guarantee and he had no doubt that this would be honoured. On the other hand, he had to have something more tangible about which to complain.

For a while, the calculator seemed to behave itself. Then, one night while he was home, his wife was using it for a fairly prolonged series of calculations when it suddenly went berserk again. At first the fact that he had seen it first hand didn't seem to help much, except to dispel any lingering doubts he may have had as to his wife's sanity.

Then he realised that there was a clue. The actual behaviour meant nothing, but he realised that it had happened after the unit had been on for some time; a good ten minutes. He put it aside, let it rest for half an hour, then tried again. It worked perfectly, and kept on working for another ten minutes. Then, without warning, it went berserk again.

Leaving it switched on he hurried down to his workshop, opened the back, and connected a voltmeter across the battery. It was a 9V, 216 type as used in pocket radios. And the best it could deliver under load was 4.5V.

Well, that seemed to be the answer. It was the battery which came with the unit, of Asian origin, and of doubtful age and history, The next morning he took the unit back to the dealer, and explained what happened. Without hesitation the dealer threw the old battery in the rubbish bin and gave him a new one with a local brand.

Unfortunately, his triumph was short lived. The next time his wife tried to carry out some prolonged calculations, exactly the same thing happened. This time, he not only checked the voltage, but also the current and was shocked to discover that, with a full set of digits up, the drain was 60mA plus.

Now my colleague is no expert on batteries, but even he realised that this order of current drain is abnormally high for a battery of this size. The dealer was equally shocked and lost no time in

checking another unit of the same brand, and a similar unit in another brand.

The same brand produced virtually identical figures; 67mA with a full set of "8s" displayed. The alternative brand, on the other hand, needed only 25mA for the same display. By now both the dealer and my colleague were distinctly worried; the dealer because he had sold quite a number of units which would most likely rebound, and my colleague because he seemed to have bought a pup, and as a present into the bargain.

Fortunately, the dealer assured him that he would stand by the deal in some way. If he fancied an alternative unit he would make a swap—and without too much haggling about any price difference.

But my colleague was puzzled. How come a unit of this kind had been marketed if, as it appeared, it was so poorly designed that the prescribed battery was inadequate?

It was at this point that I became involved in the story, in a minor way. My colleague had related the story to me when I happened to receive a call from a friend who is well placed technically in one of our local battery factories. He was in need of a small favour and, having done what I could to help him, I didn't hesitate to seek a quid pro quo.

I briefly outlined the story and then asked him what he thought about that order of current drain from such a small battery.

"Was it", he enquired, "such-and-such a brand calculator?"

"Yes it was", I replied, "why, do you know them?"

"Yes", he answered, "we have already had several complaints about them. And what you suggest is right. This type of battery was never intended to deliver that kind of current for any length of time. It just won't stand up to it."

He went on to suggest that this particular calculator design was probably the result of an attempt to "jump on the bandwaggon" of current low price calculators. In addition, calculators using the 216 type battery were becoming increasingly popular overseas, and tending to displace those using the larger "AA" cells, at least for the simpler types.

He also pointed out that the alkaline cell might be a solution to this particular problem, since it is much more suited to heavy discharge situations, and without this seriously shortening its life. But he agreed it shouldn't be necessary.

So there it is. In addition to all the other decisions one has to make in choosing a calculator, that of current drain must now be considered.

As if life isn't hard enough!

And my colleague's problem? The last I heard he had decided to keep the calculator. Apparently the dealer had made him a very attractive offer involving a nickel-cadmium version of the 216 battery. So, by default, he has probably come out on top.

Where to buy printed boards etc

One of the most frequent requests we receive from readers concerns the availability of printed circuit boards for our projects. To a lesser degree they also enquire about chassis and etched panels.

Some readers imagine that we manufacture and distribute boards. Others appear to believe that these are available only from special sources. We do not manufacture or distribute any of these items, or any other components. But we are concerned that our readers should be able to buy these parts with no more difficulty than the other components used in a project. When a project is ready for publication we distribute drawings of printed boards, chassis, and front panels to a number of manufacturers who have requested that we supply this information.

These manufacturers are then in a position to supply these items to any distributor who requires them or, in some cases, direct to the public. On this basis you should be able to obtain these items from the same distributor who supplies your resistors, capacitors, transistors and other routine components. If he does not have them in stock he should have no difficulty obtaining them to order.

However, for the benefit of those readers who may have difficulty in obtaining these items, for one reason or another, we list below those manufacturers who are currently on our mailing list. If all else fails they should be able to either supply you direct, or advise which distributors are holding stocks.

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241a MacKenzie St,
Toowoomba, Q, 4350

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42c Sydenham Rd,
Brookvale, NSW, 2100

E. H. Earl Ltd,
P.O. Box 834,
Wellington NZ

Jemal Products,
Unit 8, 120 Briggs St,
Welshpool, WA, 6106

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Newmarket, NZ.

Precision Circuits,
P.O. Box 214
Nunawading, Victoria, 3131

Printed Circuits Ltd
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Dorrington, Q. 4046

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P.O. Box 4248
Christchurch, NZ

R.C.S. Radio Pty Ltd,
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Statronics Pty Ltd,
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Welshpool, WA, 6106

Star Delta Co Pty Ltd,
PO Box 31,
Granville, NSW, 2142

As a spin-off from the drawings we prepare for the trade, we can also supply copies for our readers (Price $2.00). Those with access to metal working or etching facilities can take advantage of this to "roll their own".

However, beginners should be aware that this may not always be the most economical approach. To the cost of drawings must be added the cost of raw materials, wastage, etc, plus the disappointment which comes from a job which may fall short of professional standards.

As a general rule it costs very little more to buy the ready made product, saves a lot of time, and results in a much more satisfying end result.

Further thoughts on amateur microwaves Part 3

In the third and final article in this series the author describes typical equipment as used for UHF experiments from 1296MHz to 10GHz. It deals with various methods of frequency multiplication, modulation, and frequency generation, as well as both duplex and simplex systems.

by DES CLIFT VK2AHC

TYPICAL DESIGNS. To illustrate the different approaches possible, block diagrams of representative 1296MHz, 2304MHz, 3.4GHz and 10GHz systems in use at VK2AHC are shown in Figs. 8 to 12.

1296MHz was the first serious attempt at crystal controlled operation above 432MHz. As will be seen, it uses a 432MHz Tx, which has been in constant use, both fixed and /P, for a number of years.

It contains what has proved to be a very versatile FM oscillator circuit. The only faults were an initial shift on switch on and some drift—both have been rectified.

The other feature, in the 2304MHz gear, is use of an R47M15 (RCA) solid state module, as the means of obtaining 12W output with a drive of less than 1W: 12V input, no tuning controls, fully protected and obviously no more expensive than buying the alternative bits and pieces from scratch and spending weeks getting it going.

These devices are for use in 470MHz equipment. They function at 432MHz with about 80% efficiency. The only snag which has been discovered so far has been in a design in which it was fed with the output of a varactor multiplier in which, for space reasons, a minimal amount of output filtering was used.

The device appeared to accept both the drive and idler frequencies, which latter were present due to the small amount of filtering, and promptly oscillated at or near one of these frequencies, taking excessive current. It would therefore appear prudent to drive them only from straight amplifiers. This gives a virtual guarantee of stability and the simplest, most compact arrangement.

In the case of the 1296MHz gear (Fig. 8) the full output of the 432MHz Tx is fed into a varacter trebler, from which 6W is obtained and fed via a coaxial relay to the antenna. It is highly desirable to have some form of reflectometer connected between the 432MHz Tx and the tripler when making the final adjustments. The tuned circuits of the trebler are highly critical to adjust but this becomes easy when tuning for minimum reflected power rather than attempting to tune everything up at once for maximum power output.

The receiving side is independent of the 432MHz Rx. It uses a 60MHz crystal oscillator shown in Fig. 5 of Electronics Australia Nov. '72. This circuit has been adopted as "the standard" for all VHF crystal oscillators where no frequency modulator is required (ie, Rx local oscillators).

The doubled and amplified output at 120MHz (about 700mW) is fed to a 12 times varacter multiplier. The 12th harmonic (1440MHz) at 10 to 20mW is selected by a high Q cavity at 1440MHz and fed to a balanced mixer (per QST Sept. 1973). The only reason for the choice of 1440MHz was that the cavity and multiplier were available from a surplus telemetry transmitter. 1152MHz would have been more suitable had the bits been produced from scratch.

The RF stage compensates for a somewhat lower than normal antenna gain and loss in the the coaxial feed. Its actual operational effect and noise figure has yet to be fully measured.

In common with all the equipment described the mixer is directly coupled to a low noise medium gain 144MHz IF pre-amp; an absolute essential in this business for anything but local contacts. The IF at 144MHz is fed into the station 144MHz Rx which is also used /P and uses a tunable IF of 21MHz-23MHz (144MHz-146MHz). The only power supply necessary is +12V and this also supplies the coaxial relay, a useful option.

Equipment for 2304MHz (Fig. 9) is self-contained except for the 30MHz IF Rx. In this case both crystal oscillators run continuously, the Tx one in an oven at 80°C. Modulation is applied directly to the crystal oscillator. The modified "Butler" oscillator, used with fundamental crystals operating between 12MHz and 20MHz (as in the 2304MHz and 3400MHz equipment) has been adopted

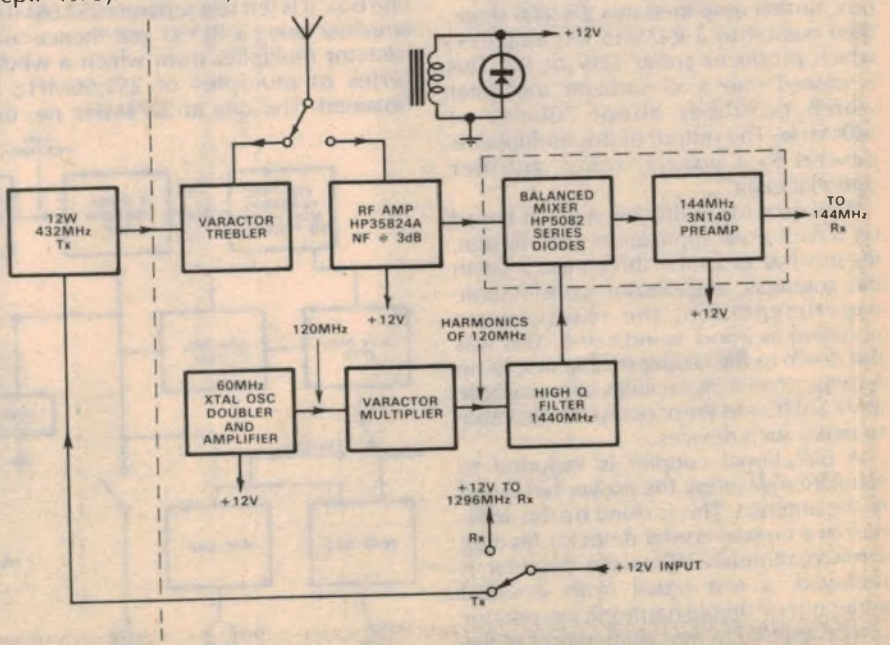

Fig. 8. Block diagram of a typical 1296MHz set-up. The basis of the transmitter is a crystal controlled 432MHz transmitter feeding a varactor trebler. Incoming signals feed a crystal locked converter ahead of a 144MHz receiver.

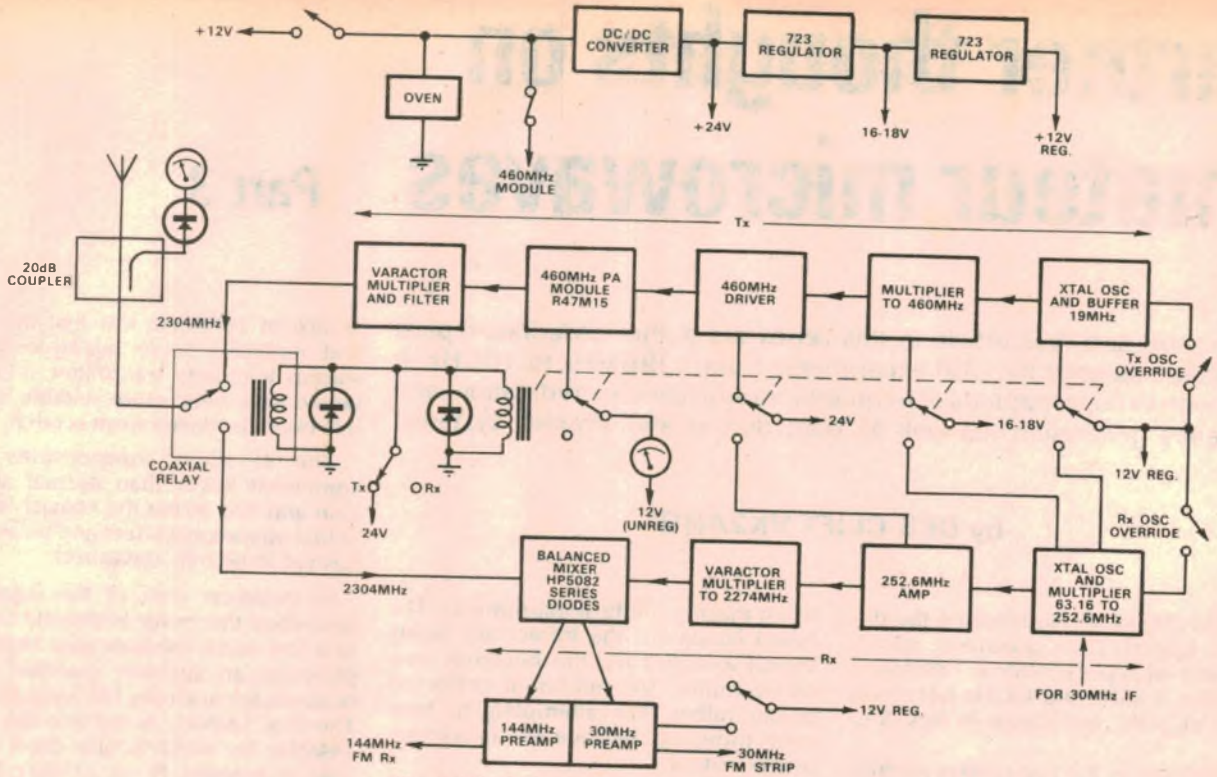

Fig. 9. Block diagram of a 2304MHz system. This is self contained except for a receiver (144 or 30MHz) following the converter. A crystal oven is used for the transmitter. About 12W fed to the varactor at 460MHz becomes 700mW at 2304MHz.

as "the standard" for both narrow and medium wide band frequency modulated operation.

The 19MHz oscillator feeds an MC1550G I/C. This was used as an experiment in this set and was not particularly stable as a straight amplifier and it needed to be heavily loaded. In the 3400MHz circuit this I/C is used as a trebler, fed resistively, and works much better. The crystal oscillator, modulator and I/C buffer are all contained in a cast box. The 19MHz is multiplied to 460MHz in a six stage arrangement, also in a cast box, further amplified in a 2N3866 stage, then passed to a R47M15 I/C amplifier, which produces some 12W of RF. This is passed into a x5 varactor multiplier which produces about 700mW at 2304MHz. The output of this multiplier is passed to a coaxial relay, another optional extra.

The varactor multiplier stage is based on a Motorola application note design, the most successful of three tried. As with the antennas, and despite considerable experimentation, the results were nowhere as good as indicated. This was put down to the cruder mechanics, as no turning or milling facilities are available at VK2AHC and these really are desirable to make such devices.

A directional coupler is included to facilitate measuring the power being fed to the antenna. This is done by the addition of a coaxial crystal detector feeding a microammeter. When the detector is removed, a test signal from a signal generator or simple harmonics generator can be applied to the coupled port of the directional coupler and thence to the Rx.

The Rx consists of a balanced mixer per QST April '74 design, onto which is mounted both a 30MHz and a 144MHz IF preamplifier, using MPF121s. This allows a very short connection to the mixer, a very desirable feature. Only the 30MHz unit has been used so far, the 144MHz unit was put in for future narrow band systems.

The local oscillator chain starts at 63.166 and is multiplied to 252.66MHz in a four stage arrangement. From this, in one box, it is fed to a separate 252.66MHz amplifier using a BLY33 and thence to a varactor multiplier from which a whole series of multiples of 252.66MHz is obtained. The one at 2274MHz (ie, the 9th) is selected by a high Q filter made from an APX6.

It was obvious on inspection of the APX6 that the precision drives and plungers of the three knob tuner could be put to better use. Consequently, one was stripped down and three separate cavities produced using only the original drive mechanism and plunger. One is useful for 1296MHz or to feed a local oscillator chain using either a 30MHz or 144MHz IF. The second tunes 2274MHz quite easily and is used as described. The third was made to tune from 645MHz to 925MHz to fill a space in the test equipment.

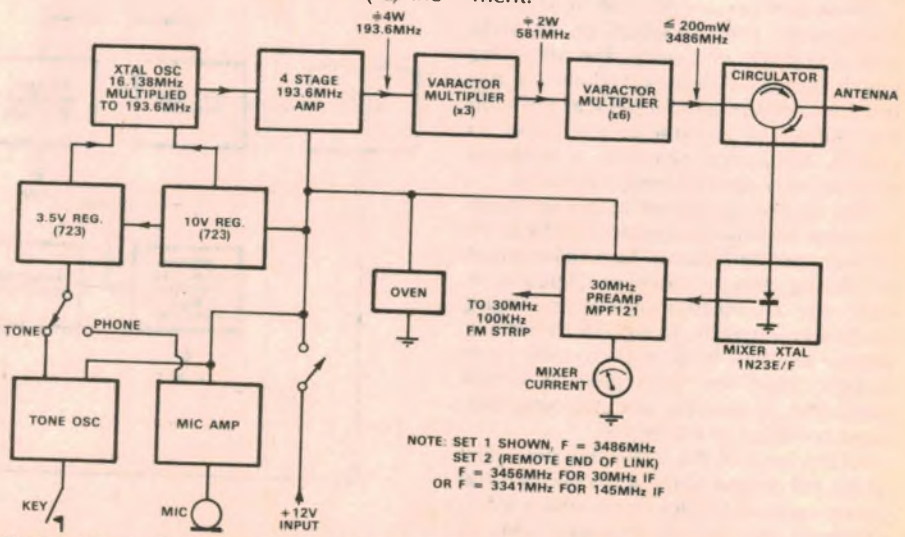

Fig. 10. Block diagram of a 3486MHz system. This is a fully duplex system, the two transmitter frequencies being separated by the receiver IF (30 or 145MHz). It is a wide band FM system (100kHz) compared with the lower frequency systems.

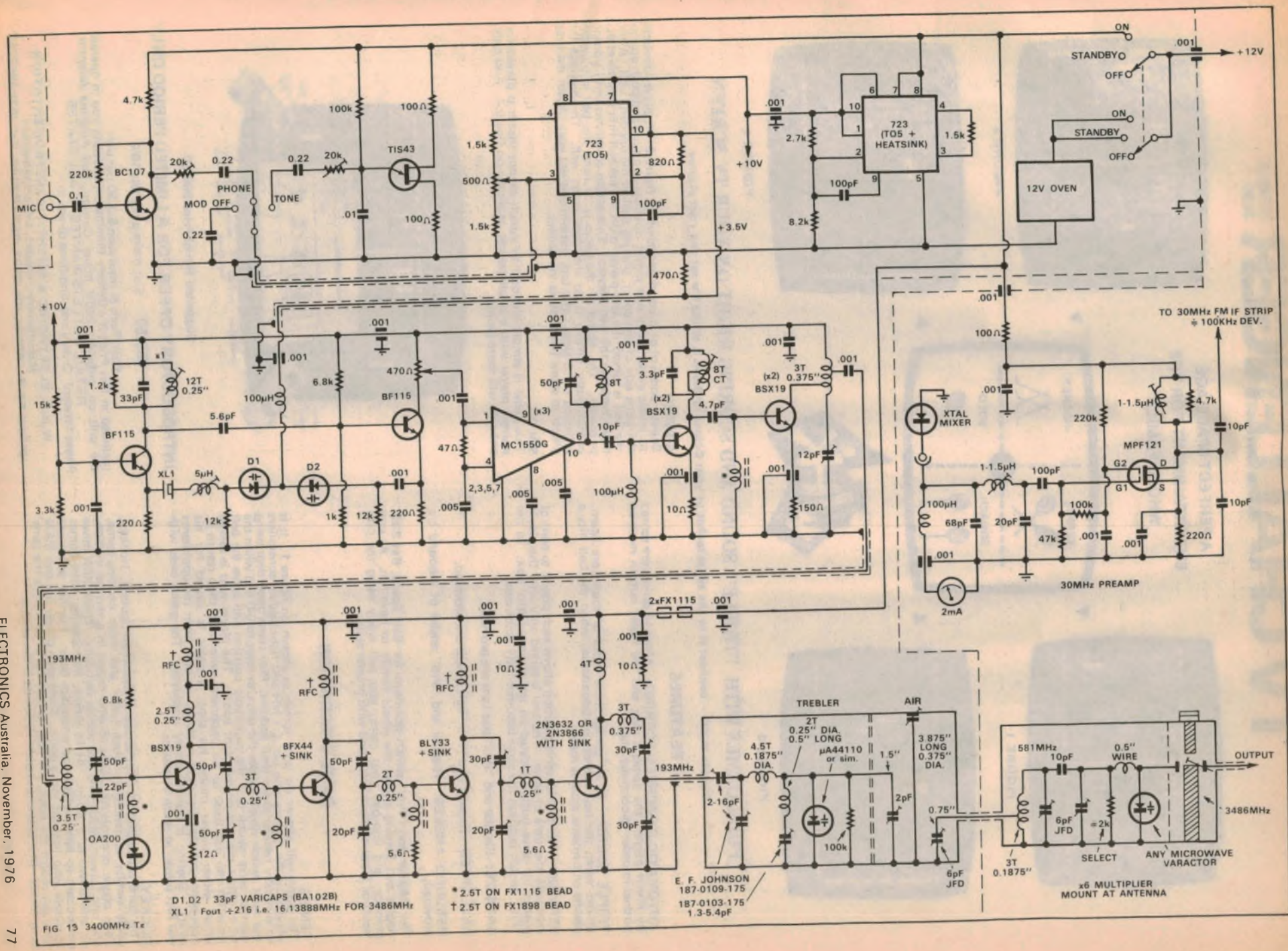

FIG. 13 3400MHz Tx

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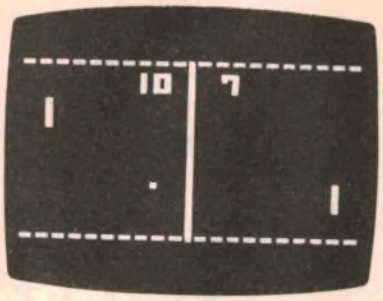


FIGURE 1

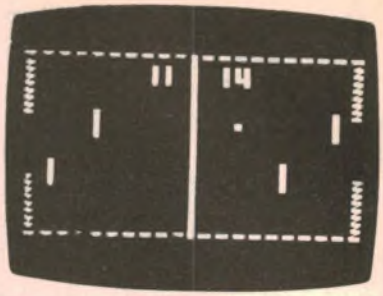
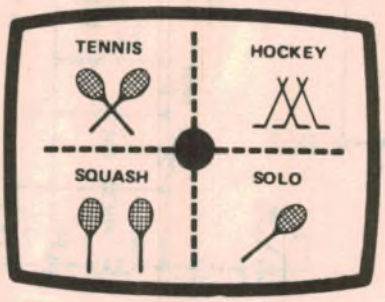


FIGURE 2



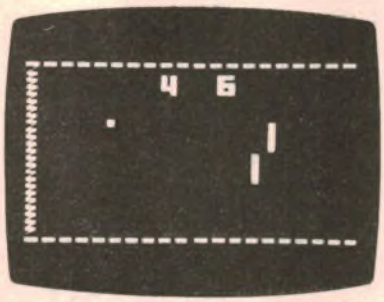


FIGURE 3

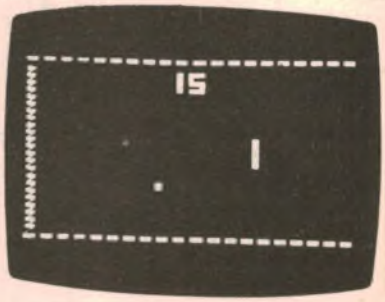


FIGURE 4

FOUR GAMES WITH "TRIPLE" SOUND AND SCORING RIGHT ON YOUR TV SCREEN

Simple to use - connect it to the aerial socket of your Colour or Black & White TV set and start playing

FEATURES

AUTOMATIC ON-SCREEN SCORING: After 15 points are scored by either player, the game is over and the Reset button must be pushed in order to continue play.

TRIPLE SOUND: In all games three types of sound are heard. Sound when the ball reflects of boundaries, when the ball hits a paddle and when a score is made.

SERVING: The regular serve position allows each player to control manually the time of serve. The ball is served only after the player pushes his serve button located on the player control box. In the "Pro" switch position the serve becomes fully automatic.

BAT SIZE: Regular and "Pro" size bats are provided.

BALL SPEED: Regular and "Pro" ball speeds are provided.

REBOUND ANGLES: Regular and "Pro" angles of rebound are provided.

The Regular and "Pro" switch positions for Ball Speed, Bat Size, Angles and Serving allows the whole family to have fun. As you practice, and improve your game, you will enjoy using the professional features more often and with greater skill.

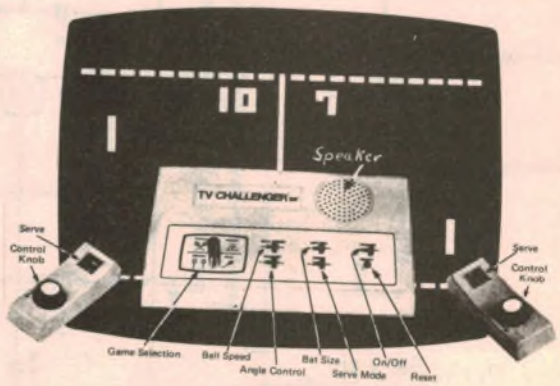
GAME DESCRIPTION

TENNIS
The game will appear on your screen as shown on figure 1. It is played by the players who use the left and right paddle controllers to vertically raise or lower their paddles. Play starts upon depressing the reset switch which causes the score to reset to 0-0 and when the manual serve switch is in the automatic position will serve the ball from either the left or the right court. The player who is served must hit the ball back to his opponent, who must then return it. When either player misses his shot, a point is scored for his opponent and the next ball is served to him from the opponents court. Scoring is automatically displayed. The game ends with the first player to reach 15 points.

HOCKEY
This game will appear on your screen as shown on figure 2. Hockey, while similar to tennis, is much faster and more exciting game. Each player controls his GOALIE who moves in a vertical motion, and one forward MAN who also moves vertically. These MEN move up and down as a group. As in tennis, the opening serve comes cross-court to either player on a random basis. Further serves are to player who has just lost a point. Since each player has two MEN who can return the puck, the play is very fast. Scoring is the same as in tennis - first player to reach 15 points is the winner.

SQUASH
Squash consists of a court as shown in figure 3. It plays identical to tennis except only one player operates at a time and both are on the same side of the court, playing against the opposite wall. After the ball is served the left player must hit the ball first and the alternates between the two players. This action continues until a point is scored. The object of the game is to keep the ball in play by continuously hitting it to the back court wall. The ball can be reflected off 3 sides - the top, bottom and left wall. Again the first player to score 15 points is the winner.

SOLO
This game is almost identical to squash except that it is played by a single player with a single paddle as shown on figure 4. And only one side will score points.



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Approximately 10mW of 2274MHz emerges from the cavity. This is fed through a 3dB attenuator, again an option, to the mixer. A change from zero to 3dB and to 10dB has so far produced no noticeable change in the received signal. This may be noticeable when tests on the 2304MHz beacon of one of the satellites become possible.

The power supply of this equipment is obviously more elaborate than that used at 1296MHz. It was built because it was found impossible to produce either the local oscillator or Tx PA drive requirements using 12V. The 723 regulator has been adopted as standard due to its versatility and ability to supply medium currents without external transistors. A relay performs the Tx and Rx functions and a switched option allows both crystal oscillators to run continuously. The oven is not considered a luxury.

The 2304MHz band appears to be the top limit for narrow band FM and it has been decided to use 100kHz as standard on all higher crystal controlled bands. The reasons are simple. The multiplication factor for 2304MHz, using a 19MHz crystal, is 120 times—this means a 3kHz deviation at the output reduces to 25Hz at the oscillator, which is just about the stability limit to be expected from the oscillator even in its oven, when considering incidental FM from the AC/DC converter and other extraneous sources. In practice, as much deviation as can be handled at the other end has been used—around 5kHz.

At 3400MHz, using a 16MHz crystal, the factor is 216 which would mean 13.8Hz at the oscillator. Obviously, this is too severe a requirement; hence the change to 100kHz, giving a 460Hz crystal deviation.

The same crystal oscillator circuit caters for both deviation requirements, making the equipment sufficiently versatile to permit the wider deviation at 2304MHz. But remember that a reduction in IF bandwidth is equivalent to a large increase in antenna size and obviously the most convenient to concentrate one's efforts on.

The block diagram for 3400MHz (Fig. 10) illustrates the simplicity of this duplex arrangement compared with the simplex of 2304MHz.

Further modification of the basic crystal oscillator has provided by far the best arrangement yet tried. Output is taken from a small resistor in the collector circuit of the second stage. This provides isolation from the oscillator tuned circuit and also assists in making the IC more stable.

The IC is operated as a trebler, followed by two doublers from which about 5mW of 193MHz is obtained. This is amplified in a four stage arrangement to 3W and passed to a varactor trebler, giving 581MHz output. All this is mounted on two sub chassis in a small box and fed by 12V.

Note the method of using a 723 to modulate the oscillator by either voice or tone. This method of modulation has been found to further assist in reducing the drift that was present in the basic design used first for 432MHz. The moral is that a process of evolution of a basically good circuit pays off, rather than continually switching from one circuit to another.

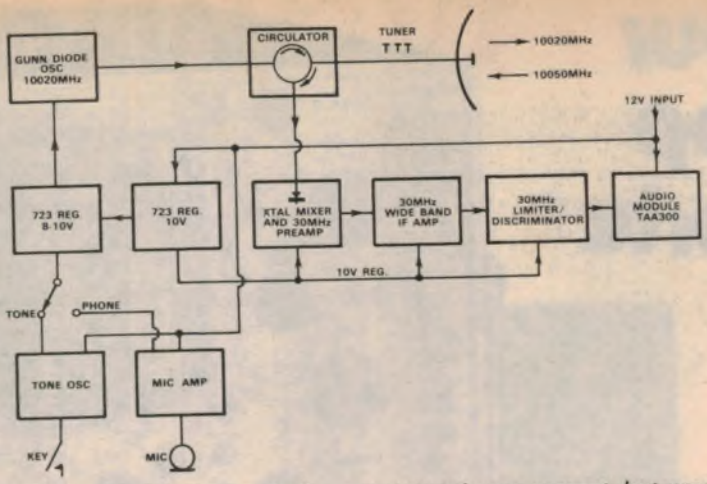

Fig. 11. A 10GHz system. This is a fairly conventional arrangement, but uses a Gunn diode as the RF Generator. It, also, is a duplex system. Note the method of frequency modulating the system via the regulated power supply.

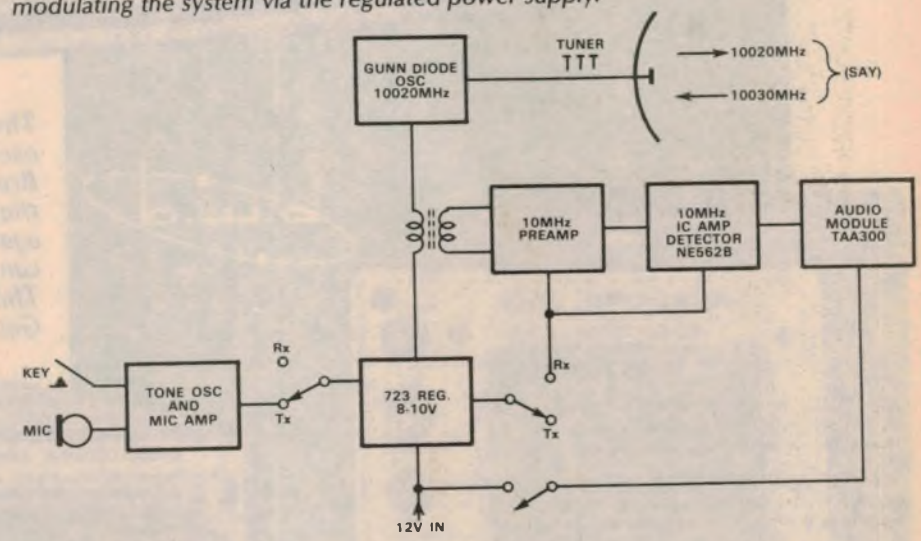

Fig. 12. A simplified 10GHz system. No circulator is used in this arrangement, which provides simplex facilities only. The Gunn diode is coupled to the IF amplifier via an untuned primary winding in series with the supply line.

The 581MHz output is fed to a further varactor multiplier, from which 3486MHz is obtained at a level of 100mW and this is fed to a three port circulator. The output port is fed to the antenna, while the third port feeds the crystal. Since received signals proceed to this port a duplex arrangement results when the other station uses a similar arrangement at 3456MHz (30MHz IF) or 3341MHz (145MHz IF). The latter was chosen in preference to 144MHz to try to get away from the local 5A TV channel which gives trouble when the VK2AHC 2m Rx is run flat out.

Local oscillator drive is provided by reflection of 3486MHz from the antenna. This is a crystal controlled version of the traditional 10GHz equipment and does, of course, require a circulator. If this is not available various simplex arrangements can be resorted to, the simplest being to mechanically change over the antenna from the Tx to the Rx and, by means of a probe, allow sufficient energy to spill into the antenna to produce the correct mixer current.

Either of the two previous systems (Figs 9 or 10) can be used in all the higher frequency bands. Providing the correct final multiplication factor is chosen so that the fequency is between 440 and 470MHz, the arrangement of Fig. 9, using the R47M15 module, would be the obvious one to use.

Fig. 11 shows an updated conventional 10GHz system, which is a simplified version of the equipment described in Electronics Aust. Sept. 1972. Use of a Gunn Diode simplifies the power supply. Radio Commn. May 1974 gives details of simple mounts. An even newer and simpler 10GHz arrangement is shown in Fig. 12 and is based on the Radio Commn. June

continued on page 125

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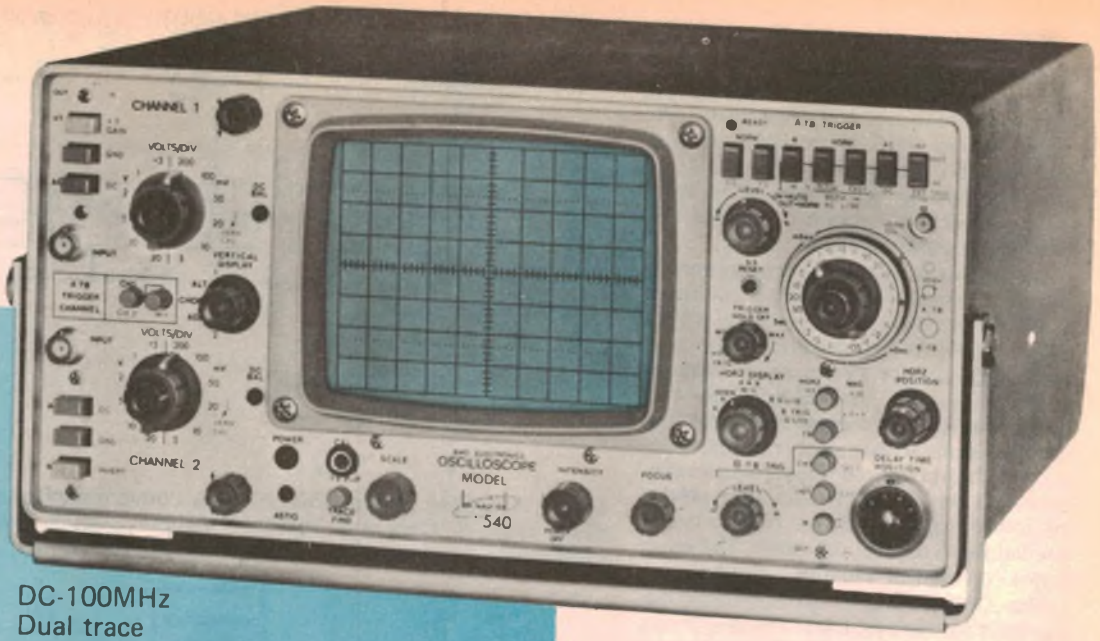

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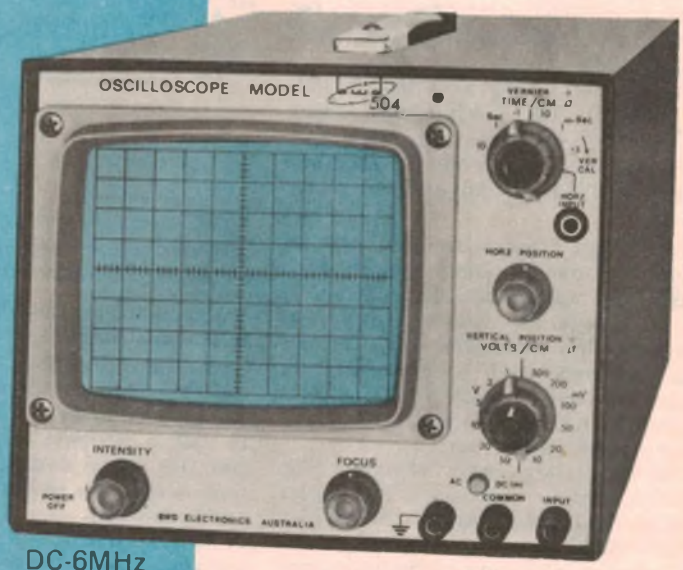

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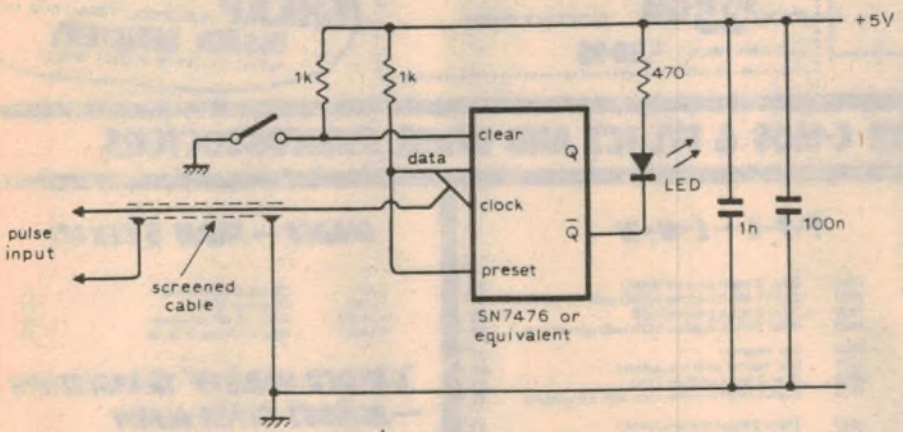
FP376A

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.

Digital pulse detector



The display of digital pulses on an oscilloscope becomes difficult if they are not repetitive.

This circuit provides a simple method for detecting such pulses. Because the D type bistable transfers the information from its data input to the Q output on the positive going edge of the clock pulse, both positive and negative pulses with widths down to approximately 10nS may be detected.

(By P. V. Prior, in "Wireless World".)

Odd job for solar cells

If you need a simple noise generator for test purposes and you have a selenium solar cell handy, try biasing it with a voltage source and then applying the output of the cell to an audio frequency or radio frequency amplifier, suggest Calvin R. Graf. Whether it is forward biased or reverse biased, the solar cell will produce hiss-like white noise with an amplitude that increases directly with the bias voltage applied over the range of a few volts to about 15V. And although it can work in the light, it is better kept in darkness, because an artificial light source, like an incandescent or fluorescent lamp, causes 60Hz (or 50Hz power line hum that overrides the cell's white noise output, especially when the cell is forward biased. Fluorescent lamps, Graf notes darkly, are worse than incandescent.

(From "Electronics".)

Tunable notch filter suppresses hum

Close-tolerance components are not necessary in a hum filter if its rejection frequency can be adjusted to the frequency of the line-current hum. Such a filter is cheap and easy to build.

Notch filters are often designed into audio and instrumentation systems to eliminate unwanted signals or pickup such as 50Hz line-frequency hum. For a given rejection frequency, close tolerance components are usually required to guarantee repeatable design. An inexpensive, reproducible, narrow stop band circuit that can be built with wide tolerance parts and can be tuned from 50Hz to 60Hz with 30dB minimum notch depth satisfies most hum rejection requirements.

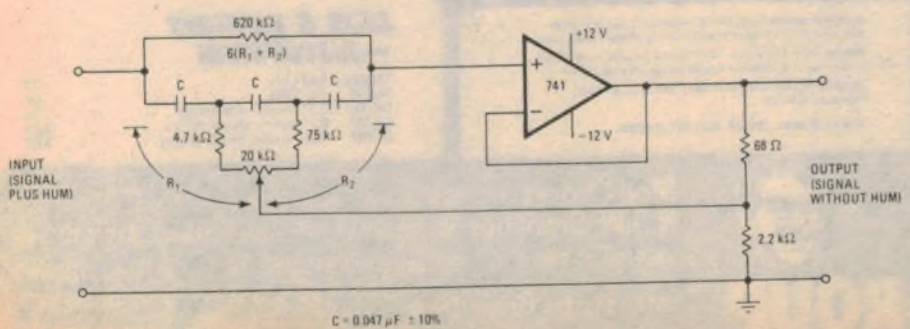
The illustrated circuit employs a bridge-differentiator RC network with active feedback. The notch frequency in Hz is given by:

$$Fo = 1/2\pi C(3R1R2)^{0.5}$$

where C is the farad value of the capacitors in the circuit, R1 is the sum of the 4.7k fixed resistor and the left hand portion of the potentiometer, expressed in ohms, and R2 is the sum of the right hand portion of the potentiometer and the 75k resistor. Although the operational amplifier can be almost any sort, the 741 shown is typical. The notch bandwidth is set by the feedback gain of the non-inverting amplifier, so replacing the 68 ohm resistor with a lower value narrows the rejection band.

With the given component values, this circuit can be turned to reject either 60Hz or 50Hz power line frequency. With 10% tolerance capacitors, the minimum notch depth is 30dB and the total 3dB bandwidth is 14Hz for 50Hz and 18Hz for 60Hz centre frequency. The insertion loss outside the stop band is a negligible fraction of a dB.

(By Peter Lefferson, in "Electronics ".)



Silicon diode crystal set

The circuit shown is a rather unique crystal set using a silicon diode. Tuning is accomplished by varying capacitor C. The ferrite loopstick L, has a low impedance tap. The 1M potentiometer applies a bias voltage across the diode, ranging from 0 to 0.75 volt. Thus, the potentiometer acts as a sensitivity control. At maximum sensitivity (0.7V for-

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4027	Dual J-K flip flop	.90
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4030	Quad exclusive OR	.80
4049	Hex buffer/TTL driver inverter	.80
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4081	Quad 2 input AND	.30
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7403	Quad 2 input positive NOR with o/c outputs	.31
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7405	Hex inverter with o/c outputs	.31
7408	Quad 2 input positive AND	.31
7409	Quad 2 input positive AND with o/c outputs	.31
7410	Triple 3 input positive NAND	.31
7413	Dual NAND Schmitt trigger	.75
7420	Dual 4 input positive NAND	.31
7430	8 input positive NAND	.31
7437	Quad 2 input positive NAND buffer	.55
7440	Dual 4 input positive NAND buffer	.31
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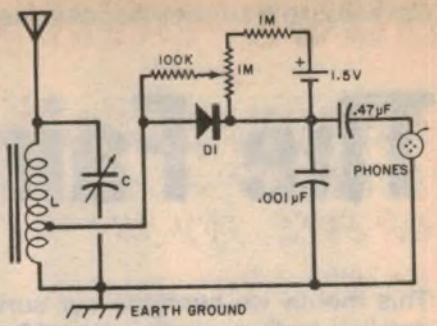
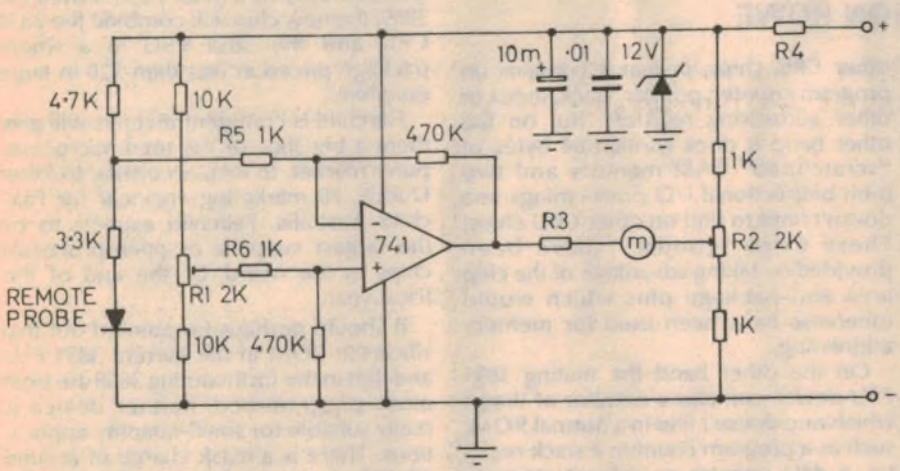


ward bias), very weak signals will be able to ride through the diode. When connected to a good aerial (a long wire or rotatable loop), this little set will deliver a surprising performance.

In operation, you will notice a point where advancing the sensitivity control causes the signal to drop out completely. This happens when the diode turns fully on. Back down slightly for best sensitivity. Use high impedance crystal headphones and a small 1.5V dry cell voltage source. The cell will last for a very long time.

(By John McVeigh, in "Popular Electronics".)

Temperature meter



For some of the work we have been doing lately, we needed to be able to measure variations in the case temperature of some power transistors. Not being able to measure the case temperature led to the needless destruction of some devices, due to over-dissipation.

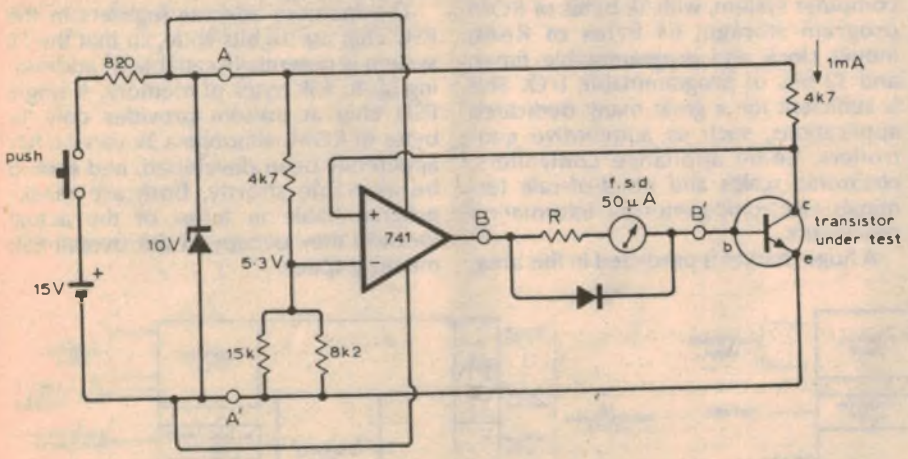
Obviously, we needed some form of surface temperature meter. The accompanying circuit uses a silicon diode as the sensing element in a bridge configuration, feeding a differential amplifier to drive a meter.

Potentiometers R1 and R2 are used to set the lower and upper limits respectively. Resistor R3 depends on the sensitivity of the meter you use. If the system has too much gain for your application, the values of R5 and R6 may be increased but must remain the same value as each other.

The probe diode may be mounted in any convenient holder and should be fed with coaxial cable.

(From "Amateur Radio".)

Direct-reading transistor tester



The op-amp provides base current for the transistor under test, whose action causes equal voltages to occur at the op-amp- input terminals. If Vref is 5.3V, sufficient base current will flow to provide 1mA collector current. Gain of the transistor is then 1mA/base current, and the meter scale is calibrated. Thus, the 50uA point is marked 1000/50 = 20, and so on. A gain value of 400 is marked at the 2.5uA point. Resistor R and the diode protect the meter against overloading which could occur if a zero-gain transistor were tested. Resistance R in series with the meter should total 5k.

For testing PNP devices a switch is fitted to reverse the supply polarity and the meter.

(By A. Rigby, in "Wireless World".)

The Fairchild F8

This month we continue our survey of microprocessors with a more detailed look at the Fairchild F8 chip set. We also look at Fairchild's F8 Design Evaluation Kit, which comes as a fully assembled PC board complete with power supply and teleprinter cables, together with a set of user, programming and applications manuals.

by JAMIESON ROWE

Fairchild Semiconductor's F8 microprocessor is an 8-bit design, like most of the others we have looked at in previous articles. Current devices are of the familiar N-channel MOS type, made using Fairchild's established "Isoplanar" LSI technology.

Despite these superficial similarities, the F8 microprocessor is significantly different from the others we have examined. Designed primarily for high-volume dedicated-use applications, its basic architecture is quite unlike that of a conventional minicomputer. As a result of this, its instruction set also tends to be rather different.

At present, two chips form the heart of any F8 system. One is the 3850, designated the CPU or central processing unit, and the other is the 3851 program storage unit or PSU. In terms of chip area the latter device is primarily a mask-programmed ROM, organised as 1k bytes, which stores the program to run the system.

This may sound conventional enough, but if you look at a block diagram for any F8 system, it shouldn't take long to realise that there is something missing: the usual address bus.

In fact, the designers of the F8 system have avoided altogether the need for conventional address bus, by moving all of the memory addressing registers out of the CPU chip, and into the PSU.

The 3850 chip is therefore unlike most other CPU chips, in that it contains no program counter, pointer, stack, index or other addressing registers. But on the other hand it does contain 64 bytes of "scratchpad" RAM memory and two 8-bit bidirectional I/O ports—things one doesn't tend to find on other CPU chips! These extra "goodies" have been provided by taking advantage of the chip area and package pins which would otherwise have been used for memory addressing.

On the other hand the mating 3851 PSU device contains a number of things which one doesn't find in a normal ROM, such as a program counter, a stack register, a data counter or indirect memory addressing register, and interrupt control logic. Quite apart from these it also provides two further 8-bit bidirectional I/O ports, and a programmable timer.

Block diagrams of the 3850 and 3851 devices are shown below.

What all this means is that the two chips alone provide a fully viable microcomputer system, with 1k bytes of ROM program storage, 64 bytes of RAM, inbuilt clock and programmable timer, and 32 bits of programmable I/O. This is sufficient for a great many dedicated applications, such as automotive controllers, home appliance controllers, electronic scales and point-of-sale terminals, electronic games and information processors.

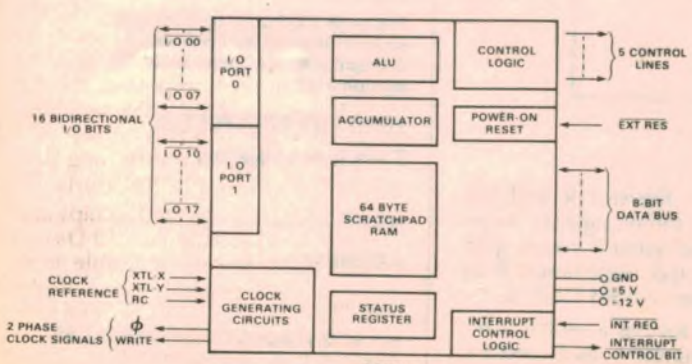
A huge market is predicted in this area, and Fairchild has fairly obviously aimed the F8 system at it in terms of cost-effectiveness. This is evident in the novel architecture adopted for the two basic chips, and also in their recent announcement of a new "single chip F8" to be released early new year. To be called the 3859, the new chip will combine the 3850 CPU and the 3851 PSU in a single package priced at less than $20 in large quantities.

Fairchild is confident that this will give them a big slice of the total microcomputer market. In fact, according to Peter Duddy, F8 marketing engineer for Fairchild Australia, Fairchild expects to be the largest supplier of microprocessor chips in the world, by the end of this fiscal year.

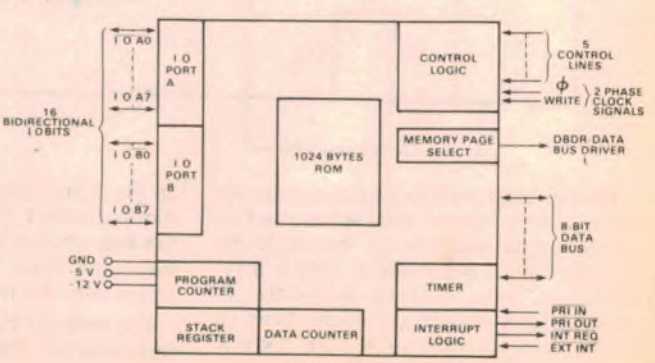
It should perhaps be pointed out that since the ROM in the current 3851 PSU and that in the forthcoming 3859 are both mask-programmed, neither device is really suitable for small-quantity applications. There is a mask charge of around A$1250, and a minimum order quantity of 200 pieces.

Although the F8 system would thus appear to have been designed primarily for dedicated applications requiring a minimal configuration, there is at the same time adequate provision for expansion into more elaborate and memory-intensive systems.

The memory address registers in the PSU chip are 16 bits wide, so that the F8 system is potentially capable of addressing up to 65k bytes of memory. A single PSU chip at present provides only 1k bytes of ROM, although a 3k version has apparently been developed, and should be available shortly. Both are mask-programmable in terms of the actual location they occupy in the overall 65k memory space.



3850
CPU BLOCK DIAGRAM



3851
PSU BLOCK DIAGRAM

This means that multiple PSU chips may be used, to provide whatever amount of program storage is required. Each PSU will have its own program counter and other addressing registers, and all of these will work in tandem. However as the PSU's are mask-programmed to slot into different parts of the overall memory space, only one PSU is ever active during any particular instruction fetch or memory data operation.

RAM memory can of course be added to the system also, although not quite in the usual way. Because there are no address lines available, the RAM chips must be interfaced via special chips which duplicate the program counter and memory addressing registers of a PSU, together with the interfacing control logic.

There are two RAM interfacing chips, one for static memory devices (the 3853), and the other for dynamic memory devices (3852). The latter also provides logic for direct memory interfacing (DMA), in conjunction with a further dedicated DMA chip called the 3854.

There are only three programmable registers in the F8 CPU chip, apart from the 64-byte scratchpad. The three registers comprise an 8-bit primary accumulator, a 6-bit register used for indirect addressing of the scratchpad (called the ISAR), and a 5-bit status register.

To a certain extent the 64-byte scratchpad acts like a bank of 64 secondary 8-bit accumulators. The first 11 scratchpad bytes are directly addressable via some of the F8 instructions, while the rest are accessible through implied addressing via the ISAR register. However, scratchpad addresses 9-15 inclusive (decimal) are dedicated as buffers for the PSU addressing registers, so these will not usually be available for other purposes.

On the software side, the F8 has a repertoire of some 76 instructions, more than half of which use a single byte. Of the rest only three use 3 bytes, and the remainder 2 bytes. This allows some programs to be surprisingly short.

The F8 designers have achieved this economy by relying fairly heavily on implied addressing, where the data to be used in executing an instruction is not specified either directly or indirectly via an instruction operand, but is simply implied by the type of instruction. Most microprocessors use this addressing mode for arithmetic and logic instructions, for example, which normally "imply" that the data concerned is the content of the accumulator.

The F8 carries this considerably further. All eight of the non-branch memory-reference instructions use implied addressing, implying the PSU data counter as an indirect address register. Similarly all 15 of the scratchpad register instructions use implied addressing, implying either the accumulator or the use of the ISAR as an indirect scratchpad address register, or both. Quite a number of other instructions also use implied addressing.

In all there are some 15 accumulator instructions, 12 branch instructions, 8 memory reference instructions, 13 address register instructions (including jump to subroutine and return), 15 scratchpad register instructions, and 13 miscellaneous instructions.

Incidentally all memory reference instructions involve automatic post-incrementing of the PSU data counter, which can be very useful. Many of the scratchpad instructions have optional auto increment or decrement of the lower 3 bits of the ISAR implied indirect addressing register, which again can be useful.

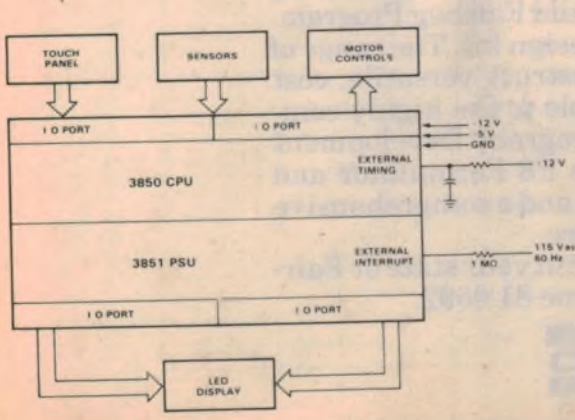
Included in the F8 instruction set are a number of powerful immediate instructions, including ADD, AND, COMPARE (2's complement subtraction), EX-OR, LOAD and OR, together with a "call to subroutine immediate" and a "load data counter immediate". There is also a "short" LOAD immediate instruction, which is only a single byte long, and used to load the accumulator with 4-bit data.

Input/output servicing is normally handled by two separate 2-byte instructions, INPUT and OUTPUT, both of which use the second byte to address one of the IOT ports provided by the CPU chip and the PSU chip or chips. However there are also two "short" IOT instructions, capable of transferring data to and from the lowest 16 IOT ports.

Let us now pass from the F8 chips and their operation to look at the "F8 Design Evaluation Kit" currently available from Fairchild, to allow potential users to get practical experience and undertake simple program development at low cost.

As you can see from the picture, the

As received, the Fairchild F8 evaluation kit comprises an assembled PC board system, an edge connector with cables, and a binder of manuals.



Together the F8 CPU and PSU chips are capable of forming a complete minimal system, suitable for appliance controllers and similar applications.

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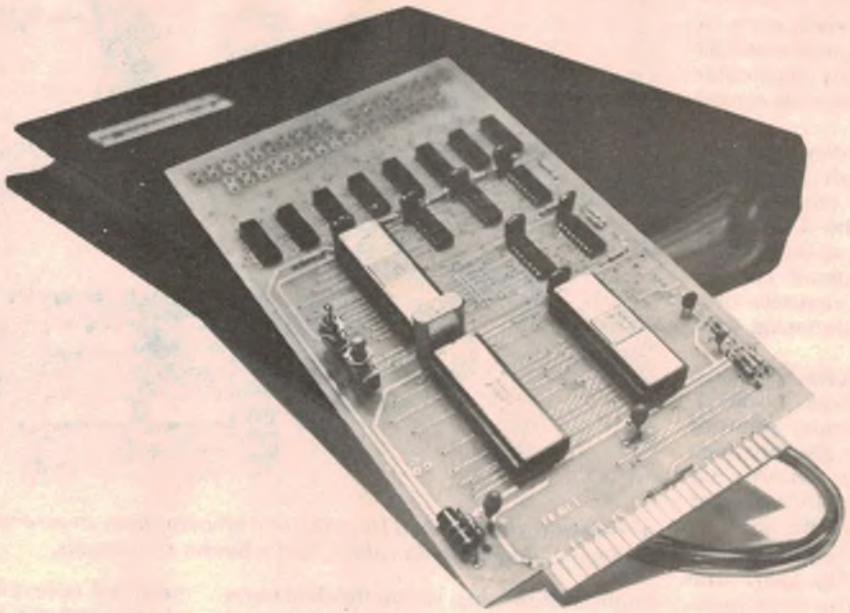

with the Fairchild F8 design kit....

Priced at $166.50 this new low cost microprocessor design kit comes as a fully assembled circuit board with interface and connecting cable for power supply and teletype terminal hookup.

It is a complete microprocessor system with CPU, Debug Program, Memory, 32 I/O BITS, two levels of interrupts and all the necessary control circuits. No assembly or soldering is required.

The fully tested and assembled circuit board includes the Fairchild 3850 F8 CPU circuit, the 3851 Fairbug Program Storage unit circuit, the 3853 Static Memory Interface circuit and eight 2102 static RAMS (1 kilobyte of memory).

Software with the kit includes the F8 Programming Manual, F8 Data Book and the Fairchild Fairbug Program.

F8 goes much further than the design kit. The range of support products enables you to construct versatile, cost effective systems from the most simple to the highly complex. There are the F8 and F8S Program Development Modules, F8 Memory Expander, the F8 Formulator and formulator cable and module options, and a comprehensive range of carefully thought out software.

Contact the Fairchild distributor in your state or Fairchild in Sydney 929 6711, or Melbourne 81 0592.

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kit comes in three parts. There is a fully assembled PC board containing the evaluation system itself, an edge connector fitted with power supply and teleprinter cables, and a large ring binder containing a user manual, programming manuals and various other pieces of useful literature.

The evaluation system on the PCB contains a 3850 CPU, a 3851 PSU and a 3853 static memory interface to which is connected 1k bytes of static RAM. Three of the four IOT ports provided on the 3850 and 3851 chips are available for interfacing to 8-bit parallel peripherals, while the fourth is dedicated to serial interfacing with either a 100-baud teleprinter or a 300-baud terminal, as desired.

The 3850 clock oscillator is implemented using RC components, which must be "tweaked" to give a clock frequency of 2MHz using a CRO or digital counter—not for the F8 system itself, but to ensure the correct baud rates for the serial interfacing.

The edge connector cables provided with the board have banana-type plugs to connect to a power supply, and a Molex 15-way connector which is capable of directly into the "No. 2" socket on the rear right of a standard model ASR-33 or KSR-33 Teletype. The power supply requirements are for +5V at 500mA, and +12V at 100mA.

Resident in the ROM section of the PSU is Fairchild's debug program, which they have dubbed "FAIR-BUG". As with similar programs provided in the other evaluation kits we have examined, this provides basic facilities for the user to develop programs, together with routines for teleprinter IOT servicing. There is also a routine to input a byte of data from one of the parallel IOT ports, something not usually found. All of the IOT routines are available to be called by user programs as subroutines.

The command set recognised by FAIR-BUG permits the user to display and optionally alter memory locations, scratchpad registers, the accumulator, ISAR and status registers or the PSU addressing registers. It also allows the user to punch and load formatted paper tapes, and to execute the user's program. As well as these fairly common functions there is another useful function which is not often provided: a command to punch out the user's program in PROM burning format, as distinct from reloadable format.

Fairchild Australia very kindly made one of the F8 evaluation kits available, so that we could gain some first-hand knowledge and "hands-on" experience. The hardware side of the system turned out to be quite easy to hook up, although I had to remember to adjust the 3850 clock oscillator to 2MHz using a digital counter—to ensure that the timing would be right for the teleprinter interface. With this done the system was soon up and running.

Of course learning to drive a microprocessor's instruction set takes some time, as does the business of becoming fully familiar with the command repertoire of a debugging program. Both of these seemed to present a little more of a challenge with the F8 system than with the other systems I have used, perhaps because both the F8 instruction set and the FAIR-BUG commands are structured somewhat differently. However, after digesting the various manuals and accompanying literature, I was soon doing some tentative program development.

Like some of the other small debugging programs, FAIR-BUG does tend to be rather wasteful in terms of teleprinter paper, by insisting on the use of a carriage return as a command terminator. One tends to use metres of paper, but with characters printed mainly in a narrow column at the left-hand side. The method used to initially keyboard in a program in hexadecimal code using FAIR-BUG also seems a little clumsy, requiring the use of two separate commands per entry.

However, while mildly irritating, neither of these could be construed as major shortcomings.

Out of interest, I tried writing a simple "answer-back" program like those I wrote for the systems we have discussed previously in this survey. By no stretch of the imagination is this a critical "benchmark" program designed to show up the relative capabilities of systems. However, it does provide a modest basis for comparison.

A listing of the program is shown on these pages, and you may find it of interest. As before it uses the teleprinter servicing subroutines in the debug ROM, which are here labelled "TTYI" and "TTYO" respectively. The program calls them by means of immediate addressing "jump to subroutine" instructions, which have the mnemonic "PI".

Note that because the TTYI subroutine does not appear to strip off the incoming parity bit, the exclusive-OR immediate instruction ("XI") used to test for an incoming carriage return tests for a code of 8D hexadecimal, not the correct ASCII code of 0D. Note also that the "FCH" loop used to fetch and deliver the answer does not need to increment a buffer pointer, because the memory reference instruction "OM" causes this to happen automatically. The OM (OR from memory) is used here in preference to an "LM" (load from memory) instruction, because the LM instruction does not affect the status register, and the following BZ (branch on zero) instruction is determined by the status register rather than the actual accumulator content.

All things considered, I found the Fairchild evaluation kit fairly easy to drive, and one which provides a practical and low cost way of becoming familiar with the F8 microprocessor system. It should be of particular interest to those intending to design with the F8, either as an evaluation system or as a low-cost development tool.

Price of the kit is quoted as $166.50, plus tax where applicable. Kits are available from authorised Fairchild distributors in each state.

```
ANSWER-BACK PROGRAM FOR FAIRCHILD F8 EVALUATION KIT
J.ROWE, ELECTRONICS AUSTRALIA 9/9/76

0000 28 83 AD  GO,PI   83AD     /CALL TTYI SUBROUTINE
0003 53           LR   3,A      /STORE CHAR IN R3
0004 28 83 E5     PI   83E5     /CALL TTYO TO ECHO
0007 43           LR   A,3      /RETURN CHAR TO AC
0008 23 8D        XI   '8D'     /CR?
000A 94 F5        BNZ  GO       /LOOP BACK & CONTINUE IF NOT
000C 7A           LIS  '0A'     /YES; LOAD LF
000D 51           LR   1,A      /STORE IN R1
000E 28 83 E5     PI   83E5     /SEND TO TTY VIA TTYO SUBR.
0011 2A 00 1F     DCI  001F     /SET DC TO START OF ANSWER BUFF
0014 70        FCH,CLR          /CLEAR AC
0015 8B           OM           /OR ANSWER CHAR INTO AC,CHECK STATUS
0016 84 E9        BZ   GO       /RETURN TO START IF CHAR IS ZERO
0018 51           LR   1,A      /STORE CHAR IN R1
0019 28 83 E5     PI   83E5     /SEND TO TTY VIA TTYO
001C 90 F7        BR   FCH      /KEEP GOING UNTIL FINISHED
001E 00
001F 47 4F 20                   /START OF ANSWER BUFFER
0022 41 57 41
0025 59 2C 49
0028 27 4D 20
002B 42 55 53
002E 59 21 0D
0031 0A 00                      /ANSWER MUST END WITH A ZERO BYTE
```

Here is the author's novelty answer-back program as implemented for the F8 evaluation kit. It illustrates some of the points discussed.

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Microprogramming module

For those who need to know the "inner mysteries" of microprocessors, including the way they execute instructions, Texas Instruments are producing a series of learning modules. The first of these to be released is the LCM-1001 Microprogrammer, designed to demonstrate the concepts of microprogramming.

by JAMIESON ROWE

Before describing the LCM-1001, it should perhaps be stressed that it is definitely NOT a microprocessor evaluation kit or development system. It is basically a teaching aid, designed primarily to demonstrate specific details of a microprocessor chip's internal operation, and perhaps to serve as a tool for the designers of specialised complex systems.

When the other modules in the TI series become available, it will apparently be possible to interconnect the LCM-1001 with them to produce both a functioning microprocessor, and ultimately a complete microcomputer system. But the resulting systems will be "micro" only in the sense that appropriate LSI chips will be buried within the various modules.

The LCM-1001 module itself is based on a 40-pin LSI device called the SBP-0400, which Texas Instruments describe as a "4-bit expandable parallel binary processor element". It appears to be essentially a 16-function 4-bit arithmetic and logic element (ALU) combined with a register file of eight 4-bit registers, two 4-bit working registers, and a factory programmed logic array capable of controlling the functions of these sections in response to 9-bit instruction words.

The prime use of the SBP 0400 element is in making processors based on "bit-slice" architecture. It provides a 4-bit wide slice of the main part of a processor, so that a number of units may be "stacked" to produce processors of any desired size—8 bits, 12 bits, 16 bits or as large as necessary.

To produce a complete microprocessor, the group of SBP 0400 devices must be supplemented by an algorithm controller. This is because the SBP 0400 is a microprogrammable device, capable of doing only one elementary task at a time. But it may be programmed to do any of the 512 tasks capable of being encoded by its 9-bit instruction word, so that with a suitable algorithm controller a group of SBP 0400 devices form a very flexible processor.

What the algorithm controller does is take the operation code portion of the "machine language" instruction words for the processor, and produce whatever is the correct sequence of elementary "microinstructions" necessary for the SBP 0400 devices to perform the required task. This is the technique of microprogramming—there is virtually a "computer within the computer", or more strictly a controller within the processor.

Many modern microprocessors use the microprogramming technique, which has the advantage that the instruction repertoire of the processor may be changed simply by changing the microinstruction sequences stored in the algorithm controller (usually in a ROM). With processors that are not microprogrammed the instruction repertoire generally cannot be changed without extensive and costly redesign of the processor chip as a whole.

It is basically the technique of microprogramming that the LCM-1001 module is designed to demonstrate, using the SBP 0400 device as an example. Each of the control inputs, data inputs and data outputs of the device are brought out the LED indicators, and all inputs are provided with miniature toggle switches so that the device may be manually programmed. A pushbutton provides the clock signal input.

In addition, all of the SBP 0400 pin connections are brought out to a 40-pin DIL socket for possible future interconnection to other modules. The power for the module comes from an internal rechargeable battery, with a simple rectifier circuit connected to a miniature jack socket to allow for battery charging. An external transformer unit is supplied with the module to provide the required 5.6V AC, but as this unit is designed to plug directly into a 110V outlet, it will not be of much value to Australian buyers.

The manual supplied with the LCM-1001 module is very comprehensive, although it does assume that the reader has a sound grasp of basic microprocessor operation and programming.

All in all, the Texas Instruments LCM-1001 learning module would seem a very effective way of demonstrating the concepts of processor microprogramming. It should find considerable use in universities and colleges, and also in design labs engaged in the development of custom microprogrammed processor systems.

Of course it isn't really necessary to know how a microprocessor executes its instructions in order to use it or program it. So that the majority of people working with microprocessors and microcomputers are unlikely to need the detailed knowledge that the LCM-1001 is designed to teach and demonstrate. In that sense it must be seen as a rather specialised learning tool.

Further information on the module and its planned companions is available from the local distributors for Texas Instruments, Instant Components Service, who have offices in Sydney, Melbourne and Adelaide.

The Texas Instruments LCM-1001 microprogramming learning module, complete with its construction manual. Later modules will deal with other aspects of processors and computer systems.

An Introduction to Digital Electronics—10

Flipflops in counters

Apart from registers, the most common use for flipflops in digital circuits is in counters and frequency dividers. In this chapter we look at the various types of counter circuit, including ripple-carry, synchronous, up-down, ring and Johnson counters.

by JAMIESON ROWE

In many digital systems, there is a need to count the number of pulses which may occur at a given point. Quite a number of different circuits have been developed to perform this job, all of them generally given the title "counter". Nowadays just about all counters are based on flipflops, connected up in various configurations.

Before we look at the most common counter configurations, it is worth noting the difference between counting and two similar but slightly different operations: scaling, and frequency division.

When a circuit is used as a counter, we interpret its "output" as a number—generally a binary or BCD number—which continuously corresponds to the number of input pulses received by the counter input after the circuit has been reset or cleared. We expect to be able to examine the count at any time we choose, to see how many pulses have occurred.

There are times, however, when we don't really need to know the count on a continuous basis. In fact it is sometimes sufficient to have nothing more than a guide to the rate at which input pulses are being received. This can be done by arranging for the circuit to simply deliver an output pulse each time a certain number of input pulses are received—say every 10, every 100 or every 1000. A circuit used in this way is said to be "scaling" rather than counting, and would be described as a "scaler".

If a circuit capable of performing scaling is fed with a regular stream of input pulses—i.e., pulses having a fixed repetition rate—it will deliver output pulses which will also have a fixed repetition rate. But the output rate or frequency will be equal to the input rate or frequency divided by the scaling factor. In other words, the circuit will actually be performing frequency division.

Frequency division is merely a special type of scaling, if you like, where the input and output signals have a fixed repetition rate.

Most of the counter circuits we will be discussing in this chapter are also capable of performing scaling or frequency division, as required.

One more general point. It is usual to classify counter circuits according to the number of input pulses which they are capable of receiving before effectively returning to their initial state. This is known as their "modulo factor". A counter which counts 10 pulses before returning to its initial state is thus described as a "modulo-10" counter, while one which counts to 16 before returning to its initial state is described as a "modulo-16" counter.

Another way of defining the modulo factor of a counter is to say that it describes the number of discrete counting states it provides. So that a modulo-16 counter provides 16 counting states, a modulo-10 counter 10 states, and so on. But note that the "clear" or all-zeros state is regarded as one of these states, and counted if it occurs.

The modulo factor of a circuit when used as a counter is numerically equal to its scaling factor when used as a scaler, and its division ratio when used as a frequency divider. So that a modulo-16 counter may be used as a x16 scaler or a divide-by-16 frequency divider, and so on.

The simplest type of counter circuit is formed by connecting a number of T-type flipflops together as shown in Fig. 1. The input pulses are fed to the clock input of the first flipflop FF1, while the clock input of each successive flipflop is taken from the Q output of the preceding flipflop.

Fairly obviously, FF1 will change state upon the arrival of each input pulse, as they are fed directly to its clock input. However because the clock input of FF2 is fed from the Q output of FF1, it will receive a complete "input pulse" only when FF1 completes a full reset-set-reset sequence. FF2 will therefore change state on every second input pulse.

Similarly because the clock input of FF3 is fed from the Q output of FF2, it will change state only for every fourth input pulse. And FF4 in turn will change state only for every eighth input pulse. The logic levels of the four flipflops for a sequence of input pulses will therefore be as shown in the truth table.

As you can see, the four flipflops effectively count the input pulses in binary fashion, with FF1 counting the units, FF2 the twos, FF3 the fours, and FF4 the eights. As a group the four flipflops are able to count up to 16 pulses before repeating the counting sequence. Hence this simple circuit may be described as a binary modulo-16 counter.

Because a flipflop takes a finite time to change state after being triggered at its clock input, a counting circuit like that shown in Fig. 1 does not respond to an input pulse by immediately adopting the new count. If FF2 is required to change, it cannot do so until FF1 has changed its state; similarly if FF3 is to change, it cannot do so until FF2 has changed; and so on. The changes which take place following the arrival of an input pulse therefore tend to "ripple" down the counting chain, with the last FF tending to change somewhat after the first.

Counters using the simple scheme illus-

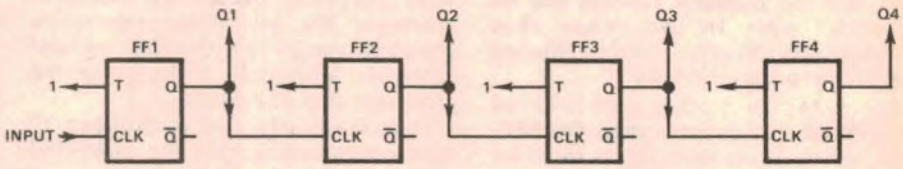


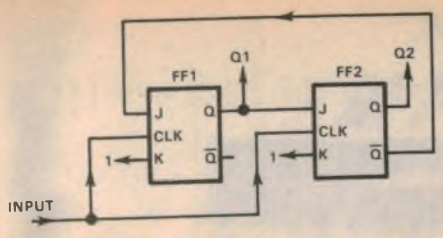
FIG. 1 : RIPPLE-CARRY BINARY COUNTER-MODULO 16

INPUT PULSES	Q1	Q2	Q3	Q4
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1
10	0	1	0	1
11	1	1	0	1
12	0	0	1	1
13	1	0	1	1
14	0	1	1	1
15	1	1	1	1
16	0	0	0	0

trated in Fig. 1 are therefore known as "ripple-carry" counters.

A simple ripple-carry binary counter of this type can be made with any desired number of flipflops, and will count to the corresponding power of 2. In general, a chain of "N" flipflops connected as in Fig. 1 will count up to the Nth power of 2. So that five flipflops will count to 32, six will count to 64, seven will count to 128, and so on.

While simple counters of this type are often used in digital circuits, there are situations where it is required to have a counter with a modulo factor which does not correspond to a power of two. One way of providing such counters is to start with a simple binary counter which has sufficient flipflops to provide the first binary modulo numerically larger than the required modulo. Then some form of feedback or gating is applied, so that the



INPUT PULSES	Q1	Q2
0	0	0
1	1	0
2	0	1
3(0)	0	0

FIG. 2 : MODULO-3 COUNTER

flipflops themselves. This is illustrated by the simple example in Fig. 2, which shows two flipflops connected to form a modulo-3 counter. Note the connection between the Q-bar output of FF2 and the

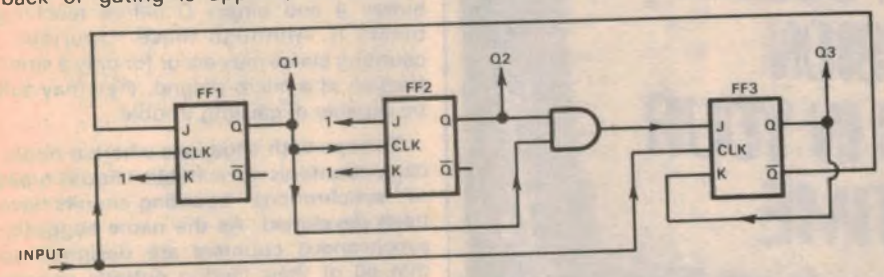


FIG. 3 : MODULO-5 COUNTER

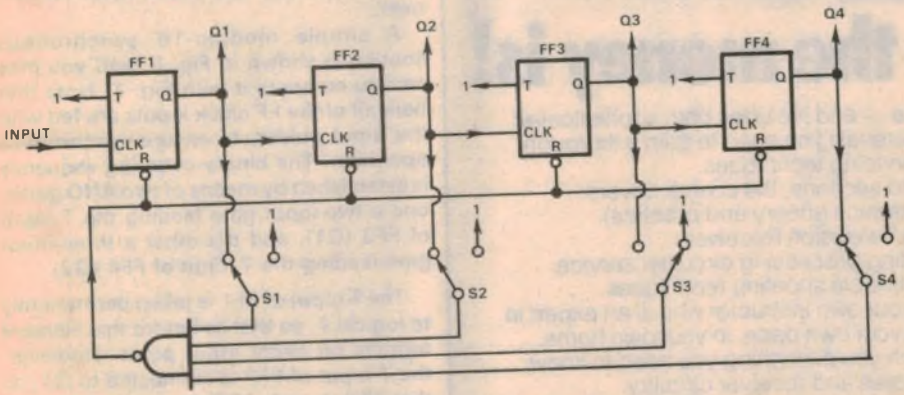


FIG. 4 : ADJUSTABLE-MODULO COUNTER (SET FOR MODULO-11)

counter effectively "skips" some of the normal counting states, to provide the required modulo.

By using JK flipflops, the required gating can often be provided by the

INPUT PULSES	Q1	Q2	Q3	Q4
0	0	0	0	0
1	1	1	1	1
2	0	1	1	1
3	1	0	1	1
4	0	0	1	1
5	1	1	0	1
6	0	1	0	1
7	1	0	0	1
8	0	0	0	1
9	1	1	1	0
10	0	1	1	0
11	1	0	1	0
12	0	0	1	0
13	1	1	0	0
14	0	1	0	0
15	1	0	0	0
16(0)	0	0	0	0

J input of FF1, which forces FF1 to remain reset when FF2 is set.

A further example of the way gating may be used to provide counters with non-binary modulos is shown in Fig. 3. Here three flipflops are used, connected to perform as a modulo-5 counter. The gating used here is a little complex, with a connection from the Q-bar output of FF3 to the J input of FF1, a connection from the Q output of FF3 back to its own K input, and an AND gate at the J input of FF3 whose inputs connect to Q1 and Q2. You might care to draw up your own truth table, to verify that this circuit does in fact have a counting modulo of 5.

It is not always possible to use the J and K inputs to achieve the gating required for a given modulo. With some modulos, the easiest way of making the counter "skip" the required number of states is to arrange for an AND gate to detect when the counter has produced the required maximum count, and then reset all the flipflops via their R inputs.

This approach can be particularly useful where it is desired to be able to "program" a counter to any one of a number of modulo factors. This is illustrated in Fig. 4. As you can see, the output of the 4-input NAND gate connects to the R inputs of the flipflops, and is therefore able to reset the counter whenever all four of its inputs are taken to the true (1) logic level simultaneously. Each of the four gate inputs may be connected to either the output of a FF, or to the 1 level; by setting the switches S1-4 to the appropriate combination the counter may thus be given virtually any modulo between 1 and 15.

With the switches set as shown, for example, the gate resets the counter whenever Q1, Q2 and Q4 are in the 1 state simultaneously. If you refer back to the truth table of Fig. 1, you will see that this combination first occurs immediately after the 11th input pulse. Hence the combination of switches shown effectively turns the circuit into a modulo-11 counter.

So far, we have considered counters which begin counting from zero, and count continuously upward until the maximum count is reached. These are often called "up counters" or incrementing counters. It is also possible to produce counters to do the opposite, jumping from zero to maximum count on the first input pulse, and then counting downwards. Not surprisingly these are called "down counters" or decrementing counters.

A simple ripple-carry down counter may be produced by connecting a chain of flipflops as in Fig. 5. Instead of connecting the clock inputs of the second and later flipflops to the Q outputs of the preceding FF, as before, they are now connected to the Q-bar outputs. This causes each FF to "carry-over" to the next whenever it sets, rather than when it resets.

By using gating, it is possible to produce a counter which may be programmed to count either up or down at will, by means of a control logic level. Not surprisingly, such counters are called "up-down counters".

While ripple-carry counters are adequate for many applications, there are

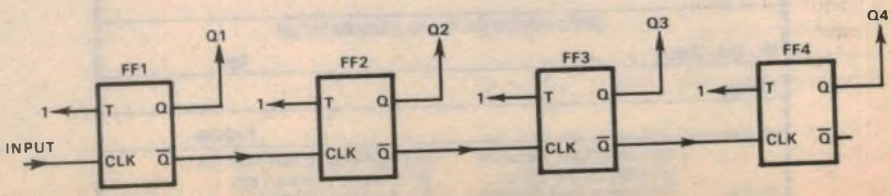


FIG. 5 : RIPPLE-CARRY DOWN COUNTER, MODULO-16

some situations where the progressive response of such a counter to the input pulses can cause problems. Mostly these arise because during the time taken for the changed input to "ripple down" the counter flipflop chain, the overall count present at the FF outputs may pass briefly through many spurious values.

Consider, for example, what happens when the counter of Fig. 1 has received 7 previous pulses, and then receives its 8th pulse. First, FF1 will reset, giving the count "0110" for a brief instant. Then FF2 will reset, changing the count briefly to "0010". Then FF3 will reset, giving a further brief count of "0000" before FF4 finally sets to give the final correct count of "0001", or binary 8.

As you can see, the counter does not change directly from binary 7 to binary 8, but briefly passes through binary 6, binary 4 and binary 0 before reaching binary 8. Although these "spurious" counting states may occur for only a small fraction of a micro-second, they may still be capable of causing trouble.

To cope with situations where a ripple-carry counter is not suitable, various types of "synchronous" counting circuits have been developed. As the name suggests, synchronous counters are designed so that all of their flipflop outputs change simultaneously, from one count to the next.

A simple modulo-16 synchronous counter is shown in Fig. 6, and you may care to compare it with Fig. 1. Note that here all of the FF clock inputs are fed with the input pulses, to ensure synchronous operation. The binary counting sequence is established by means of two AND gates, one a two-input gate feeding the T input of FF3 (G1), and the other a three-input gate feeding the T input of FF4 (G2).

The T input of FF1 is taken permanently to logical 1, so that as before this element toggles on every input pulse. However, the T input of FF2 is connected to Q1, so that FF2 is only able to toggle on every alternate input pulse. Gate G1 then ensures that FF3 is only able to toggle on every fourth input pulse, when both FF1 and FF2 are in the set state. Finally G2 ensures that FF4 is only able to toggle when FF1, FF2 and FF3 are all set, which occurs only once in every eight input pulses.

The circuit of Fig. 6 thus counts in normal binary fashion, with a truth table exactly the same as that shown for Fig. 1. The only difference is that the circuit of Fig. 6 changes cleanly and synchronously between each of the counting states.

Both ripple-carry and synchronous counters may be provided with parallel-load inputs, rather like the registers we looked at in the last chapter. This allows the counter to be preset, so that it effectively starts with a fixed count. A decrementing or down-counter provided with this facility may thus be used to count items in batches, by presetting it each

time with the required batch size, having it count down with the individual items, and ring a bell or otherwise indicate when its count reaches zero.

The counters we have looked at this far have been based on binary counting. There are other types of counters encountered in digital circuits, some of which can offer advantages over binary counters in some situations.

The most well-known counters in this category are the "shift counters", so name because they are based on shift registers. There are two basic types of shift counter: the ring counter, and the twisted-ring or Johnson counter.

Essentially, a ring counter consists of a simple shift-right register whose serial output is looped back and connected to its serial input, to form a ring. A suitable bit pattern is then loaded into the register, which counts by shifting the pattern continuously around the ring.

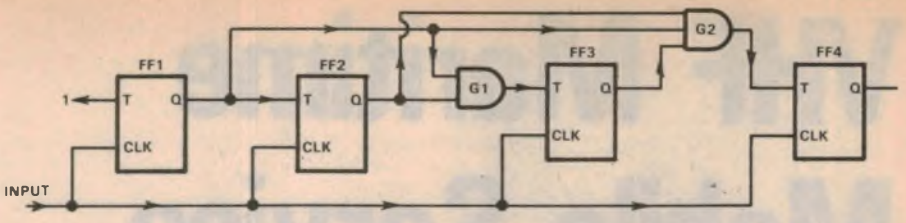


FIG. 6 : SYNCHRONOUS MODULO-16 COUNTER

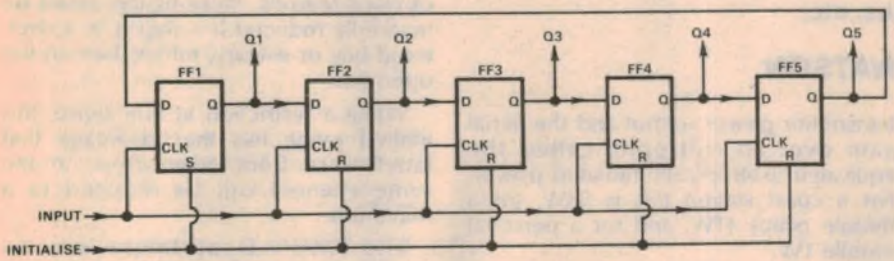


FIG. 7 : MODULO-5 RING COUNTER

INPUT PULSES	Q1	Q2	Q3	Q4	Q5
0	1	0	0	0	0
1	0	1	0	0	0
2	0	0	1	0	0
3	0	0	0	1	0
4	0	0	0	0	1
5(0)	1	0	0	0	0

Usually the bit pattern loaded into the ring is either a single 1, or one less 1 than there are stages in the shift register—to give a single 0, in effect. Both these patterns allow the ring counter to have a counting modulo equal to the number of stages in the ring, whereas other patterns tend to produce a smaller modulo.

Note that there must be at least one 1 and one 0 in the pattern, for the ring counter to work at all. If the "pattern" were all 1's or all 0's (scarcely a pattern in the usual sense of the word!), there would be no way of telling its position in the ring—so the counter would not work.

A simple modulo-5 ring counter using D-type flipflops is shown in Fig. 7. As you can see, it is basically just a 5-stage shift register with Q5 tied back to the D input of FF1. However an "initialise" control line is provided, to set up the required bit pattern prior to counting. In this case the line connects to the S input of FF1 and the R inputs of the remaining stages, so that if the initialise line is taken briefly to logic 1, a single bit is loaded into the ring via FF1.

The truth table shows how the circuit counts, by passing the 1 around the ring.

Ring counters of this type may be produced with virtually any desired modulo, simply by using the same number of flipflops.

The Johnson or "twisted-ring" counter is like the normal ring counter in that it is formed from a simple shift-right register. However, in this case the serial input of the first FF is fed not from the last FF's Q output, but from its Q-bar output. This introduces a logical inversion or "twist" into the ring, because the first FF must always adopt the opposite state from that of the last.

INPUT PULSES	Q1	Q2	Q3	Q4	Q5
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	0

The idea is shown in Fig. 8, which again shows a 5-stage counter. However, if you look at the truth table, you will see that this counter has a modulo of 10—twice the modulo of a normal 5-stage ring counter. This is probably the main feature of Johnson counters: the logical twist gives them a counting modulo equal to double the number of stages in the ring, and hence twice the modulo of a normal ring counter.

Note that like the normal ring counter, the Johnson counter must be initialised, or loaded with a suitable bit pattern before counting begins. The pattern may be any of the combinations which normally occur during its counting sequence, although in most cases it is easiest to make it either all-1's or all-0's. In Fig. 8 the latter is done, by tying all the flipflop R inputs together to form a reset line.

The other main point to note about Johnson counters is that when the counter as a whole is operating at a particular speed, each of the individual flipflop elements is only called upon to toggle at the input speed divided by the modulo factor. If you look at the truth table in Fig. 8, for example, you will see that each of the flipflops only completes a full reset-set-reset cycle once in every ten input pulses.

This means that Johnson counters effectively multiply the speed performance of the flipflops used, so that quite modest devices can be used to count at impressive speeds—considerably higher speeds than those which the same devices normally would be capable of counting, when used in either binary counters or normal ring counters.

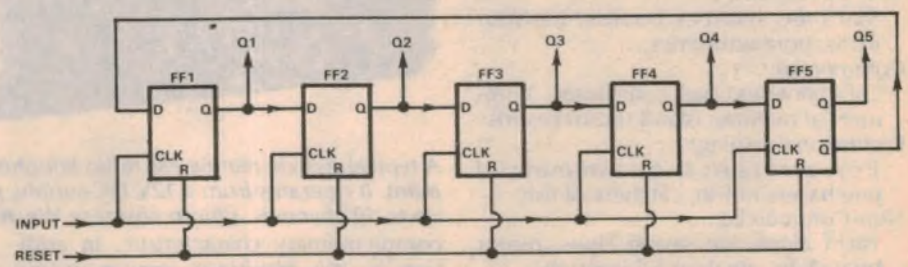


FIG. 8 : JOHNSON OR "TWISTED RING" COUNTER

On the negative side, Johnson counters aren't suitable for counting in an odd modulo. This is because the modulo is twice the number of stages—so that only even modulos are possible, at least with the basic Johnson counter configuration.

VHF Maritime Mobile Service

As mentioned briefly in the "E.A. Year Book", a VHF marine service is now available in Australian waters. It provides a wide range of facilities, ranging from direct connection to the domestic telephone system, through a variety of commercial requirements, to non-commercial channels for boating clubs, life saving clubs, etc.

by PHILIP WATSON

The conditions under which the system operates are controlled by the PMG's Department and the Overseas Telecommunications Commission. The PMG's Department has laid down the technical specifications for the equipment to be used, the channels which are available, and the purpose for which each channel is to be used. OTC is responsible for providing and manning the coastal stations, including a 24 hour watch on the international distress frequency (channel 16).

Frequencies are designated according to internationally agreed channel numbers, and 17 channels have been allocated for the Australian system so far (see table). Of these, 12 are conventional simplex channels (both transmitters on the same frequency), and five are dual frequency channels to permit working into a standard telephone network.

A wide range of craft are entitled to use this service, there being five broad categories, as follows:

Port Operations:
Maritime services boards, harbour trusts, port authorities.

Commercial:
Oil refineries, tug companies, commercial marinas, island tourist resorts.

Professional Fishing:
Processors of fish, commercial purchasers of fish, catchers of fish.

Non-Commercial:
Yacht clubs, life saving clubs, motor boat clubs, amateur fishing clubs.

Public Correspondence:
A telephone service available to all ship stations provided exclusively from government operated stations.

Regardless of how the other channels are allocated, channels 16 (international distress) and 67 (safety channel) are compulsory channels for any VHF marine installation. Similarly, channel 23 is essential before the installation can be licensed to operate into the domestic telephone network.

The permitted radiated power is specified as a combination of the actual transmitter power output and the aerial gain over an isotropic; called the equivalent isotropically radiated power. For a coast station this is 83W, for a mobile (ship) 41W, and for a personal mobile 1W.

Assuming a dipole antenna, or one having a similar order of gain (2.1dB), these figures correspond to an RF output of approximately 50W, 25W, and 0.6W respectively. Whatever aerial is used, it must be vertically polarised and omnidirectional.

Channel spacing is 25kHz and maximum deviation ±5kHz. Transmitter audio response is to be 6dB per octave pre-emphasis from 300 to 3000Hz, and the receiver is required to have a complementary characteristic. In addition to the maximum power output which is permitted, transmitters must also have a reduced power output facility, maximum 1W. This is intended for short-range use to minimise interference to other users.

In certain circumstances aircraft may be licensed to use the specified VHF marine frequencies. Likely uses are in search and rescue activities or where aircraft are used in conjunction with marine activities, e.g., professional fishing. Such installations will be limited to maximum transmitter power 1W, used at a maximum height of 300 metres.

Fairly obviously, a VHF system can never be regarded as a long range one. With all VHF systems, the range is limited to only a little more than line of sight, or the horizon. The power allocated should be adequate for such distances, so that the final performance depends very much on the height of the aerials at each end.

A range of not less than 30km should be expected between a ship and a coast station, possibly extending to 80km under favourable conditions, and even 120km under exceptional conditions. Ship to ship working would normally be less, if only because aerial height is restricted. A range of not less than 15 to 20km should be expected, increasing under favourable conditions. For fairly obvious reasons, these figures could be markedly reduced if a ship is in a sheltered bay or estuary, rather than on the open sea.

While a restriction in one sense, this limited range has the advantage that interference from other users on the same channel will be reduced to a minimum.

The PMG's Department lists six specifications under which equipment may be type approved. Two of these, RB274 and RB275, cover two frequency operation, such as required for the domestic telephone network. The other four, RB297, 273, 274 and 275, cover single frequency (simplex) working only. These specifications are likely to be changed after 31st December 1976 and all new installations will have to meet the new specifications. Equipment already licensed will, in other than exceptional cases, be permitted to remain in operation.

A typical mobile marine FM radio telephone unit as approved by the PMG's Department. It operates from a 12V DC supply, generates 25W RF output, and can provide up to 10 channels. (Photo courtesy Weston Electronics Pty Ltd.)

Commercial equipment which will meet PMG specifications is available from Australian manufacturers, and is expected to fall in the $600 to $800 price range. While this is a good deal more than 27MHz equipment, it is still a lot less than the alternative HF SSB equipment, which typically runs around $1200. In addition, by its very nature, the VHF system should give results, within its range, which are superior to either. Also, it provides for an internationally recognised distress channel, monitored at all times, which is not available in the

27MHz band.

OTC is responsible for the land based stations which provide access to the domestic telephone network (public correspondence), and monitor the distress channel and safety channels. At the moment there is only one such land base. It is at OTC's coastal radio station at La Perouse, and covers the Sydney area. Similar stations are planned for other capital cities and at strategic points along the coast.

As already explained, channel 16 is the international distress channel, and channel 67 has been allocated in Australia as a supplementary safety channel. Channel 16 will be monitored by OTC staff at all times, and they will also issue weather forecasts, navigation warnings, etc., on channel 67 (0803, 1203, 1703 EST daily). Channel 67 will also be used as a working channel after a distress call has been acknowledged on channel 16, to keep the latter as clear as possible for other distress calls.

For the present, channel 26 will be used for public correspondence in the Sydney area, but boats may also fit channel 23 as an option.

The public correspondence service provides direct access to the telephonist via the OTC equipment at La Perouse. Calls may be made to any part of Australia, or overseas. The basic charge for ship to shore or shore to ship calls is $3.00 for the first three minutes or part and $1.00 for each additional minute or part. Trunk line charges or overseas charges would be additional to these.

The system could, conceivably, function in the full duplex mode with both the transmitter and receiver on the ship operating simultaneously. However, this would require either separate aerials for transmitter and receiver, with suitable separation and filters to prevent energy from the transmitter desensitising the receiver, or a single aerial fitted with a suitable duplexer. The alternative arrangement, and the one which will most probably be favoured, is a semi-duplex mode whereby the on-shore party uses the telephone in more or less standard manner, but the ship party retains the conventional press-to-talk technique.

VHF MARINE CHANNELS

Channel	MHz	
6	156.3	
8	156.4	
11	156.55	
12	156.6	
13	156.65	
14	156.7	
16	156.8	(Distress)
23	161.75/157.15	(Public
24	161.8/157.2	
25	161.85/157.25	Correspon-
26	161.0/157.3	
27	161.95/157.35	dence)
67	156.375	(Safety & Working)
70	156.525	
71	156.575	
73	156.675	
74	156.725	

Of particular interest to boating enthusiasts, particularly those with larger boats, is the non-commercial service. This is described in greater detail by the authorities as follows:

"Non-Commercial

"A VHF maritime mobile service between a specific coast station operated by a non-commercial organisation being representative of a readily recognisable group with maritime interests (e.g., a yacht club, life saving club, motor boat club, amateur fishing club or voluntary safety organisation, etc.) and associated ship stations or between ship stations in which messages, other than distress and safety messages, are restricted to those relating to the activities of such organisation and the operational handling and movement of vessels. Public correspondence is excluded from this type of service."

This means that a yacht club or similar organisation can set up its own base station for the benefit of its members and handle traffic relevant to club activities. It would not be allowed to handle third party traffic in any form.

Four channels have been allocated for the non-commercial service, including the mandatory channels 17 and 67. The other two are channels 73 and 70. Channel 73 is for ship to shore, and ship to ship working and is not shared with any other services. Channel 70 is for ship to ship working and is a shared channel.

Classical Recordings

Reviewed by Julian Russell

Berlioz Overtures: "beyond praise"

BERLIOZ OVERTURES—Le Corsaire; Beatrice and Benedict; Le Carnaval Romain; Benvenuto Cellini; Les Francs Juges. London Symphony Orchestra conducted by Andre Previn. EMI compatible quadraphonic/stereo OASD3212.

For many years I have thought Colin Davis to be the world's finest interpreter of Berlioz' music. Now his authority is challenged by readings, different from his, but in my opinion even more in sympathy with the composer's passionate character. First, the sound in this issue is incomparably better than that in most of Davis' earlier recordings. Made for compatible quadraphonic/stereo it retains its superb quality on the stereo equipment on which I played it.

It makes Berlioz' magnificent—and original—orchestration sound even more wondrous. The Corsair takes flight in the very first bars followed by the lovely slow melody played in Previn's most caressing mood. Then comes the calculated recklessness of the pirates' attack, like an eagle circling before its final deadly swoop. You can hear the fierce cries of the engagement and the ultimate climax of victory. Its sense of excitement is quite overwhelming.

No one could desire a better contrast than the overture to Beatrice and Benedict that follows. It is, of course, based on Shakespeare's Much Ado About Nothing, a title which, as the notes point out, if used by Berlioz would have encouraged scornful comments by those unresponsive to his massive genius. It is full of the liveliest wit interrupted by lovers' quarrels and sulks. Yet one is never left in doubt as to the real affection that underlies these brief spats. It reminds one that Berlioz himself was a fervent, if often difficult lover. All this Previn captures unerringly, winning playing beyond praise.

Le Carnaval Romain lives up to its lively title, brimful of incidents, amorous and joyous. Couples flirt in the midst of revelling crowds. And Previn himself revels in all its verve.

Benvenuto Cellini opens rumbustiously in keeping with the character it depicts. After this Previn shows his complete familiarity with Berlioz' style in the following long legato passage played with silken smoothness. The Berlioz' opera of the same name, though seldom played, has much to recommend it, though its best moments are to be found in the overture. Again Previn gives you a reading full of broad contrasts, each brought off without any elbow nudging. If you are acquainted with Cellini's memoirs you will immediately recognise this picturesque renaissance character's fine swagger.

The overture to Les Francs Juges is all that remains of an early unfinished opera. It was numbered by Berlioz Opus 3 but already shows much evidence of the composer's more mature style. Previn gets fine solemnity into the early part, making it sound like a weighty charge read out in court. The music has all the stiffness of court proceedings. Previn goes on to urgency in the following fast, but quiet passage, building it up to a beautifully prepared minor climax. The music then changes into dark threats, and all through the splendour of the recording again allows one to fully enjoy the Berlioz inspired scoring. And he did it all at the age of 23. Very highly recommended.

BRAHMS—Trio in E Flat Major. Rudolf Serkin (piano); Michael Tree (violin); and Myron Bloom (horn).

SCHUMANN—Quintet in E Flat Major for Piano and Strings played by Rudolf Serkin (piano) with the Budapest String Quartet. CBS Stereo SBR 235 770.

Although it is known as the Horn Trio, the piano has just as important a part as the named instrument. In the hands of Rudolf Serkin there need be no worry on that score. Nor is there much to be said in the way of criticism of the other two fine musicians, Michael Tree (violin) and Myron Bloom (horn).

Here is Brahms in his gentlest mood. The Trio was composed while he was staying in his beloved Baden-Baden—a retreat favoured by a much more recent composer, Pierre Boulez. The players capture the meditative mood of the work to perfection. The playing is technically impeccable and well recorded.

The unusual combination of instruments blend admirably, perhaps because of Serkin's unfailing command of dynamics and sonorities. The hypercritical might find a rare off-target intonation on the horn, otherwise the Trio is a fine piece to relax to. There are no worries, no flurries, and even the fast Finale is merry without being pushed.

The Quintet makes a fine contrast to the Trio. Impulsive, generous, spontaneous sounding Schumann has little in common with Brahms, especially in the meditative mood in which you find the latter in the Trio. The Piano Quintet is probably the most popular piece among Schumann's chamber music output, and is probably the most popular piano quintet in the repertoire today.

The original of this reissue is now about 10 years old, but the sound wears very well indeed. And again the whole

Beethoven—Symphony No. 3 in E Flat

BEETHOVEN–Symphony No. 3 in E Flat. (The Eroica). The BBC Symphony Orchestra conducted by Sir John Barbirolli. HMV Stereo Concert Classic SOXLP 30209.

Just what Barbirolli had in mind when he recorded the first movement of this symphony is difficult to imagine. He starts with two hefty chords but then goes on to so suave a reading that it quite reduces the stature of the movement. He is so casual that he seems to take the whole exercise for granted.

This is not to say there is not much fine playing to be heard. It is his interpretation that is so off-putting. But play the rest of the symphony and you will be delighted with everything Barbirolli does. In the second movement, the Funeral March, he conveys a depth of sadness more moving than in any other reading I have heard. Yet he achieves this without any sacrifice of the music's grand dimensions.

The other two movements maintain the same high standard of playing and interpretation. The Scherzo is a peerless example of perfection of judgement of tempos and contrasting dynamics. Though completely different in mood from its predecessor it never sounds trivial.

The Finale starts with magnificently authoritive introductory bars. Its unusual form, a combination of variation and fugue, merge without any signs of a seam and the vitality is extraordinary in the quietest passages. The movement ends on a note of triumphant acclamation.

If only the first movement had been more in rapport with what follows no praise of mine could be high enough to do justice to this remarkable re-issue. It was originally put out some eight years ago and the sound is still fine. My advice is to put up with the disappointment of the first movement and go on to the delights of the other three.

is dominated by Serkin though he, at all times, blends perfectly with the strings. He is audible—and immensely authoritative when necessary, but disappears discreetly when his part calls for single accompaniment. The original Budapest members were at their best when this record was made, their small lapses giving the performance a true air of chamber music—the music of friends. They play so freely that there are occasional ragged ensembles, some roughness in the leader's tone, and occasional off-target intonation. These are however, always minor and I feel churlish even to mention them.

★ ★ ★

WALTON—Symphony No. 2. Variations on a Theme by Hindemith. The Cleveland Orchestra conducted by George Szell. Odyssey Stereo ODA5062.

The late George Szell, with his unique persistence on precision in everything he conducted, was an excellent choice for the Walton Symphony. The Second Symphony is one of my least liked Walton works. I do not think it compares at all favourably with either the First Symphony or the Viola Concerto. I must admit however that it does improve, if only slightly, to repeat performances and I can't imagine it being in better hands than Szell's. It is only rarely that recent music is prepared with the care that Szell makes manifest here. Even if the scores are not familiar to you—and the Hindemith Variations is a very rarely heard piece indeed—here is playing by the then famous Cleveland Orchestra that is peerless in its exactitude. Szell was often accused of demanding this precision at some cost in warmth of interpretation. Surely lack of effusion would have been a more appropriate term. In any case if you feel it necessary to make yourself well acquainted with these two seldom heard works I doubt that you will find better performances than you do here. The engineering is of matching precision.

★ ★ ★

TCHAIKOWSKY—Symphony No. 5 in E Minor. The Cleveland Orchestra conducted by George Szell. Harmony Stereo Cassette HMC543.

George Szell, now dead some three or four years, was in life one of the coldest men I ever met. And this temperament was reflected in his music. Under his 20-odd years martinet regime he brought the Cleveland Orchestra up to a standard of matchless precision. His readings tended to be on the cool side but always of classic proportions.

Frenzy was an emotion quite alien to him.

In Brisbane, during his only visit to Australia at the beginning of the war, he managed to restrain himself in the band room even after a cellist had continued to play an extra bar all by himself at the end of Franck's Symphonic Variations.

Szell's strongest fortissimos were always under the strictest intellectual control. Yet he never failed to present a moving performance of everything he played. I wonder how many readers remember his inimitable recording of Dvorak's New World Symphony issued on 78's back in the middle 1930s. I still recall it with the greatest admiration.

Szell was a connoisseur's conductor and on one occasion, when I heard him conduct the Cleveland in Vienna, every other conductor of note there for the Festival attended and awarded him the same close attention that I did. Over many years CBS tried to "popularise" him but without spectacular success among the record buying public. He remained as reserved as a box at the old Metropolitan.

All the more surprising, then, to find him delivering so passionate a performance of Tchaikovsky's Fifth. By this I don't mean that he used the occasional extravagencies of a Bernstein or a Stokowsky, but he never failed to wring the last grain of emotion from the score. If you listen to this great performance carefully you will find that he brings it all off by an incomparable use of drama. And listening to it with the utmost care I could not find a single bar that failed to preserve the peerless accuracy to which he had trained his orchestra.

This cassette is not Dolbyed but the sound is quite good just the same, with a minimum of background noise. Sometimes Szell's tempos differ from those of most of his competitors but they always sound just right in their context. The slight wiriness of the strings can be balanced against enjoyment of the elegant phrasing. There is excellent stereo separation but no ping ponging.

Szell changes instantly from the utmost forcefulness to the most delicate daintiness without a hint of a jolt. Every bar is as shapely as it is logical, although steely control can be detected underneath it all. Here is complete freedom without license in a glorious performance—the best I can remember.

If you want to sample the cassette try the beginning of the slow (2nd) movement leading to the lovely tone and exquisite shape of the French horn playing, followed by the thin, plangent notes of the oboe. Yet beauty is never sacrificed to sentimentality, for sentimentality was as alien to Szell's music as was cordiality to his social manner. After these few bars of the second movement go on to the delicious slight changes of tempo and dynamics in the Waltz (3rd) movement. And despite the enormous intellectual power of the Finale you will come across no lack of refinement.

In many quarters Szell was perhaps the most consistently underrated conductor of this century while in others his death was an irreparable calamity.

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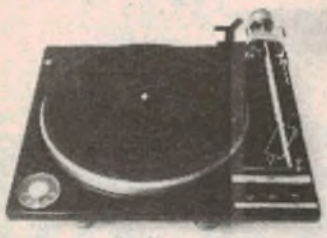

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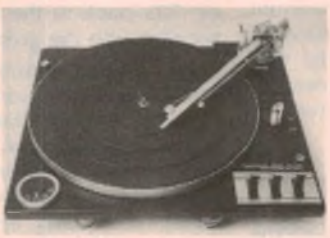

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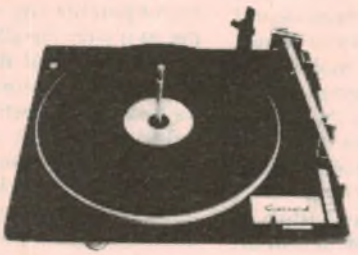
- Tone controls: Bass 50cs ±13dB. Treble 10Kcs 15dB.
- Harmonic distortion: Less than 0.1 percent.
- Loudness control: 50cs 10dB.
- Scratch filter: (high filter) at 10kcs 5 dB.
- Rumble filter: (low filter) at 50cs 5 dB.
- Provision for tape recorder: Record or playback with din plug connector.
- Speaker switching: two sets of speakers can be connected and selected by switch on front panel.
- Headphones: headphone jack is situated on front panel.
- Dimensions: 16½in x 11in. deep x 5in high.
- Weight 16 lbs.
- Power supply: Regulated power supply with switching protection for output transistors.
- Semiconductors: 33 Silicon transistors plus 7 diodes.

Garrard 6-400 Record Changer



$28.50

Recommended retail price $48.00

(POST & PACKING SAME AS M82)

SPECIFICATIONS

Fully automatic turntable plays up to six records automatically and single records automatically or manually as required. 10" turntable. Bias compensation. Cue & pause control with damped action. Record speeds 33⅓, 45 and 78 rev/min. Finished in black with silver trim. Player and changer spindles supplied.

Supplied with high quality Garrard/Sonatone Ceramic Cartridge with Diamond stylus.

Bases in walnut or teak with perspex covers available.

Garrard CC10A Record Changer

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Can be used as an auto changer or manual or auto single play with repeat. Fitted with a Sonatone/Garrard ceramic cartridge, sapphire stylus supplied with template & instructions. Post & Packing: NSW $2.50, Int. $3.50.

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As featured Feb. 1976 issue of Electronics Today

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CLASSIC RADIO

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Lighter Side

Reviews of other recordings

Devotional Records

NEW FRIENDS. Carol Lawrence. Stereo, Word, WST-8689-LP. (From Sacred Productions Aust, 181 Clarence St, Sydney and other capitals).

Carol Lawrence, as pictured on the jacket, is a very personable lass, a talented popular vocalist and one who is warmly commended in the notes by Kurt Kaiser, Pat Boone and others less familiar in this country. Her first number suggests that the program to come will be of the up-tempo variety but the next three tracks are much quieter, revealing other aspects of her talent. Then there's more up-tempo, and some more quiet numbers to round off the program.

The track titles: Someone Who Can—Oh How He Loves You And Me—Clean Before The Lord—All The Time In The World—Friend Of The Father—Lord Send That Morning—Lover Of The Children—Simple Gifts—In The Garden—Lead The Way.

Having listened to the program I was at a loss for appropriate comment. Talented, versatile and experienced, I imagine that Carol Lawrence would have a very strong personal and audience appeal but I'm less sure about the appeal of the record in isolation, to an audience to whom she is just a name. Nor is the impression helped by her interpretation of the one traditional number "In The Garden" complete with a key change that seems as unnatural as it's unnecessary. Maybe the planning has focussed too much on the performer and not enough on the intended audience, I'm not sure. Best you listen for yourselves. (W.N.W.)

★ ★ ★

THAT THE WORLD MAY HEAR. Jimmie McDonald, Stereo, Sacred LPS-4518. (From Sacred Productions Aust, 181 Clarence St, Sydney and other capitals. $4.50.)

If Jimmie McDonald can sustain the performance in this, his first solo album, he'll certainly be making quite a few more. In style, and in his choice of numbers, he is strongly reminiscent of Bev Shea and he will appeal to the same audience who like well established hymns, sung with apparent sincerity and modest ornamentation. Jimmie McDonald also has a powerful baritone voice and some of his phrases sound remarkably like those of Bev Shea but, whereas Shea's voice extends downwards into the bass range, Jimmie McDonald's range is more upward into the operatic tenor sound with (careful) just the faintest trace of stretched pitch on occasional high notes.

Settle back and enjoy these numbers, very well sung: Tell Me The Story Of Jesus—This Is My Father's World—He's Got The Whole World In His Hands—When God Is Near—I Must Tell Jesus—Who Is On The Lord's Side—Lord I Want To Be A Christian—O Love That Will Not Let Me Go—Precious Memories—Unworthy.

The recording is very clean both in terms of surface noise and by its lack of distortion. (W.N.W.)

★ ★ ★

LORD OF THE DANCE. Franciscus Henri. Stereo, Crest CRT-12-SLP-032. (From Sound & Film Enterprises Aust, 122 Chapel St, St Kilda, 3182.)

According to a note from the distributors, this album was prompted by Franciscus Henri's commercials for the Christian Television Association. The credits indicate that he does the vocal solos throughout, plus guitar and percussion when appropriate. Other members of the group are named, with "The Proclaimers" providing choral backing.

The sound could be classed broadly as popular through to soft rock, not too off-putting for traditional ears, but with its most obvious appeal to the rock generations. The lyrics are a mix of Gospel themes, and social and environmental comment: John—Lord Of The Dance—Jesus Is A Soul Man—This Little Light Of Mine—Morning Has Broken—My Father's Mansion—Suzanne—I Knew Jesus, Before He Was A Superstar—A Song For Jenny—Hymn—Tell It All Brothers—He Ain't Heavy, He's My Brother.

The performance is notable for the excellent diction throughout, so that the listener need never be in doubt as to the message behind the titles. Quality is excellent, with the solo voice projected from centre stage. Excellent modern style Gospel. (W.N.W.)

Reviews in this section are by Neville Williams (W.N.W.), Jamieson Rowe (J.R.), Leo Simpson (L.D.S.), Norman Marks (N.J.M.) David Edwards (D.W.E.) and Greg Swain (G.S.).

Educal Video Game

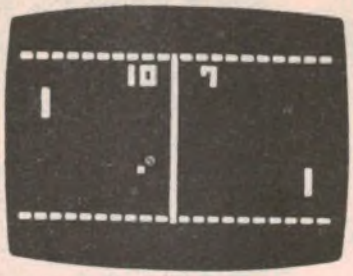


FIGURE 1

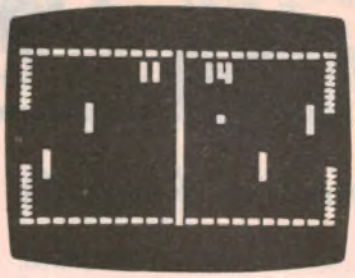
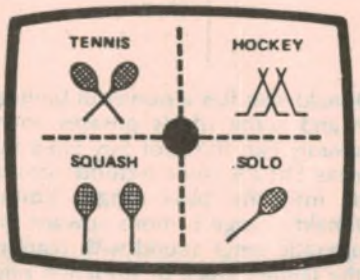


FIGURE 2



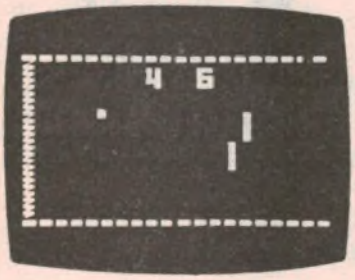


FIGURE 3

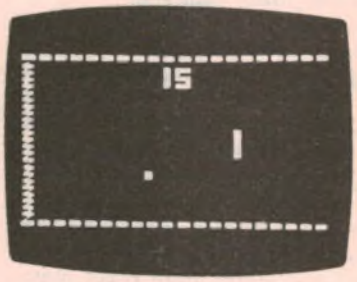


FIGURE 4

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* Selectable Angles.
* Selectable Ball Speed.
* Automatic or Manual Ball Service.
* Realism Sounds.
* Forward Man in Hockey Game.
* Visually defined area for all Games.

GAME DESCRIPTION

TENNIS

The game will appear on your screen as shown on figure 1. It is played by the players who use the left and right paddle controllers to vertically raise or lower their paddles. Play starts upon depressing the reset switch which causes the score to reset to 0 - 0 and when the manual serve switch is in the automatic position will serve the ball from either the left or the right court. The player who is served must hit the ball back to his opponent, who must then return it. When either player misses his shot, a point is scored for his opponent and the next ball is served to him from the opponents court. Scoring is automatically displayed. The game ends with the first player to reach 15 points.

HOCKEY

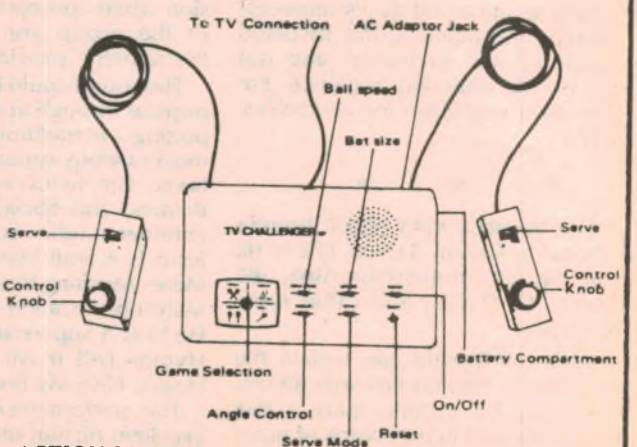
This game will appear on your screen as shown on figure 2. Hockey, while similar to tennis, is a much faster and more exciting game. Each player controls his 'GOALIE who moves in a vertical motion, and one forward MAN who also moves vertically. These MEN move up and down as a group. As in tennis, the opening serve comes cross-court to either player on a random basis. Further serves are to player who has just lost a point. Since each player has two MEN who can return the puck, the play is very fast. Scoring is the same as in tennis - first player to reach 15 points is the winner.

SQUASH

Squash consists of a court as depicted in figure 3. It plays identical to tennis except only one player operates at a time and both are on the same side of the court, playing against the opposite wall. After the ball is served the left player must hit the ball first and then alternates between the two players. This action continues until a point is scored. The object of the game is to keep the ball in play by continuously hitting it to the back court wall. The ball can be reflected off 3 sides - the top, botton, and left wall. Again the first player to score 15 points is the winner

PRACTICE

This game is almost identical to squash exept that it is played by a single player with a single paddle as shown on figure 4. And only one side will score points.



ACTION SOUNDS

In all games three types of sound are heard

a) Sound when the ball reflects of boundaries.
b) When the ball hits a paddle.
c) When a score is made.

Enquiries to:- Educal, 21 Wells Avenue, Boronia, Vic. 3155. Tel:-762-5713.

Instrumental, Vocal and Humour

NUTCRACKER SUITE (TCHAIKOVSKY); PEER GYNT SUITE (Greig). The Boston Pops Orchestra conducted by Arthur Fiedler. Decca Phase 4 stereo PFS 4352.

This album caught me in just the right mood—after a long day in the garden and with nothing of particular interest on television. It was just so easy to get into the spirit of Tchaikovsky's "Nutcracker" and the familar excerpts: Miniature Overture; March; Dance Of The Sugar Plum Fairy; Trepak; Arab Dance; Chinese Dance; Dance Of The Reed Pipes; Waltz Of The Flowers.

Greig's "Peer Gynt Suite" occupies side 2 and starts with that very relaxing "Morning", followed by "The Death Of Ase", "Anitra's Dance", "In The Hall Of The Mountain King", and "Solvejig's Song".

While the melodies will be familiar to most, helpful jacket notes identify and explain the context of each track—still a bonus one gets with discs as distinct from the average pre-recorded cassette.

Technically, the surface is quiet and the frequency response wide but the strings seemed a trifle edgy to my ears. But I still enjoyed listening to it. (W.N.W.)

★ ★ ★

THE WORLD OF SCHUBERT. Decca SPA 426.

This record gives one an excellent insight to the music of Schubert, ranging from his "Unfinished Symphony" to his adaptation of Shakespeare's words in "Who Is Sylvia".

The other tracks are: Little Hedgerose—The Trout Quintet—Whither, from The Fair Maid Of The Mill—Octet in F Major—Moments Musicaux No 3 in F Minor—Swan Song—Ballet music from Rosamunde—Impromptus No 4 in A Major—Piano Sonata No 18 in G Major—Ave Maria.

Some of the artists featured read like a Who's Who of the musical world with such names as Joan Sutherland, Stuart Burrows, John Constable, Clifford Curzon, Tom Krause, Hermann Prey, Vladimir Ashkenazy, The London Philharmonic, The Vienna Octet, The Swiss Romand Orchestra, The Ambrosian Singers and the New Philharmonia.

Except for "The Trout" which is recorded at a low level, and suffers a little from tape hiss, the overall quality is very pleasing. (N.J.M.)

★ ★ ★

STOKOWSKI: TCHAIKOVSKY FANTASIA. Various orchestras. Stereo, Decca Ace of Clubs SDDA-454.

Assembled, presumably, from Decca's library of Stokowski recordings, this budget priced Ace of Clubs album contains a sampling of Tchaikovsky works as under: Overture, Fantasia, Romeo & Juliet (L'Orchestre de la Suisse Romande); Marche Slave (London Symphony Orchestra); Waltz from "Swan Lake"; Waltz from "The Sleeping Beauty", both these by the New Philharmonia Orchestra; 1812 Overture (Royal Philharmonic Orchestra, Welsh National Opera Chorus, The Grenadier Guards Band, the John Aldis Choir.

In all tracks the frequency response is as expected from a Decca ffrr recording but, in some of the tracks at least, the quality is a little on the coarse side. But, after all, it is a budget priced recording and it does contain a sampling of the dynamic conducting of the almost legendary Stokowski. Whether or not you buy it will be a personal decision based on these considerations. (W.N.W.)

★ ★ ★

KARAJAN CONDUCTS TCHAIKOVSKY. Sleeping Beauty, Swan Lake Ballet suites. HMV SOXLP 30200.

This delightful record gives you two of the best known ballet suites plus "The Dances Of The Persian Slaves" from "Khovantschina" by Moussorgsky. Although not the most recent performances, having been recorded in 1959 and 1961, the quality is excellent, with an airy, spacious sound about, particularly in "Swan Lake". I feel the record companies are doing music lovers a service in bringing out records of this nature, often introducing people to some of the best performances on disc that they may have missed in earlier releases.

"Dances Of The Persian Slaves" is a marked contrast to the other music, with it's moody Eastern theme, but it is still a pleasant ending to a thoroughly enjoyable performance by The Philharmonia Orchestra. (N.J.M.)

★ ★ ★

GEORGE GERSHWIN, A Portrait In Music. MCA Coral COPS 7807 Astor release.

This two-record set of Gershwin's best known compositions should be high on the list for anyone with even a passing interest. With performers such as Les Brown, Judy Garland, Percy Faith, Sammy Davis Jr., Artie Shaw, Gertrude Lawrence, Ella Fitzgerald, Jess Stacie, Conley Graves Trio, Carmen McRae, Jerry Lewis, McGuire Sisters, Peggy Lee, First Modern Piano Quartet and Liberace. And tunes like; I Got Rhythm—Swanee—Embraceable You—Oh Lady Be Good—Fascinating Rhythm—Liza—Summertime—Rhapsody In Blue; it's a real feast.

The quality varies from track to track, but with some of the original recordings dating back to 1943 this can be forgiven. (N.J.M.)

★ ★ ★

ROGER WILLIAMS: VIRTUOSO. Stereo, MCA (Astor) MAPS 8327.

Featuring the noted pianist Roger Williams, this excellently recorded album

LIGHTER SIDE

makes for some very pleasant listening indeed. There is sufficient variation in style and pace throughout the album to maintain listener interest, although there was one track that didn't particularly appeal. I refer to the "Theme from Rollerball" which contains some rather "way-out" electronic music.

However, the other nine tracks more than make up for it, the rendition of "Stranger in Paradise" being the most notable.

Tracks featured are: Theme from Rollerball—Could it be Magic—Rock and Roller Bach—Country Concert—Jesu Joy—Stranger in Paradise—Nutrocker—Bolero—I Hear a Symphony—Roger's Bumble Bee. (G.S.)

★ ★ ★

LIVE DANCING IN AL CAPONE'S BALLROOM. MCA MAPS 8197, Astor release.

The basic idea, as conveyed by the title, is novel enough but the gimmick is overdone by the addition of an excessive crowd sounds, compere's voices and so on to what would otherwise be an interesting collection of "oldies".

There are 28 tracks in all, from people such as the Mills Brothers, Louis Armstrong, The Andrews Sisters, Bill Haley and The Comets, Teresa Brewer, the Modernaires, Glen Miller, Count Basie, Ella Fitzgerald, Buddy Holly etc., but they are all cut heavily to make room for machine gun fire, police sirens, etc.

I couldn't help but feel that people genuinely interested in the material would enjoy it better without such a heavy overlay. (N.J.M.)

★ ★ ★

THE SLIPPER AND THE ROSE. EMI EMC 3116 Stereo.

This sound track recording from the recent film based on the Cinderella story features plenty of well known talent with Richard Chamberlain, Edith Evans, Margaret Lockwood and Kenneth More, together with newcomer Gemma Craven in the star role.

Fifteen tracks cover the story from; The

Overture—Why Can't I Be Two People—What Has Love Got To Do With Getting Married—Once I Was Loved—What A Comforting Thing To Know—Protocoligorically Correct—A Bride Finding A Ball—Suddenly It Happens—Waltz Theme—Secret Kingdom—He Danced With Me—She Danced With Me—Position and Positioning—Tell Him Anything—I Can't Forget The Melody—Secret Kingdom.

I haven't seen the film but friends who have say it is a delight; if the soundtrack is any guide I would agree with them. (N.J.M.)

★ ★ ★

LEE HOLDRIDGE CONDUCTS THE MUSIC OF JOHN DENVER. Stereo. RCA Victor BHL1-1366.

I have long been an admirer of the music of John Denver. His songs invariably reflect the simple pleasures of life, all too often forgotten in our bustling cities—the countryside, sunshine, and nature.

The magic of some of these songs is captured here on this disc recorded by a very competent instrumental group under the direction of Lee Holdridge. A wide dynamic range is a feature of some tracks, although the overall mood of the album is one of relaxation.

Track titles are: Rocky Mountain High—Goodbye Again—Late Winter, Early Spring—Annie's Other Song—My Sweet Lady—Sunshine On My Shoulders—Follow Me/Leaving On A Jet Plane—Annie's Song—Calypso—Fly Away—The Eagle And The Hawk.

All in all, a very enjoyable listening experience. Recording quality is excellent. (G.S.)

★ ★ ★

FIRST CUCKOO. Eumir Deodato. MCA Records MAPS 8077. Astor release.

Eumir Deodato and his fellow musicians play a very funky brand of music, based on many varied styles. The title track of the album is an adaptation of Delius' "On Hearing The First Cuckoo In Spring", while at the other end of the range is "Black Dog", a Led Zeppelin number.

The range of instruments used is quite large, and even includes a cow bell! The overall result is very pleasing to the ear, with good solid bass and clean highs. Recording quality is excellent, so if you want a record to put your system through its paces, give this one a try. (D.W.E.)

★ ★ ★

THE WORLD OF MILIZA KORJUS. EMI OXLP 7616 Mono.

Judging by the photos on the jacket, the lady's surname should be spelt Miliza "Gorgeous"; the pictures, by the way, were taken from MGM's "Great Waltz" made in 1938.

The actual recordings that form the content of this disc were made in the period from 1934-1936 so you will have to forgive a certain patchiness in quality. There are fourteen tracks in all, including: Aria Of The Queen Of The Night from The Magic Flute—Elvira's Aria from "Ernani"—Dearest Name from "Rigoletto"—Bolero from Sicilian Vespers—Shadow Song from "Dinorah"—Doll Song from "The Tales Of Hoffman"—Oriental Prayer from "Lakme" together with "The Bell Song" from the same work—Hymn To The Sun from "Coq D'or".

Most of the orchestral backing is provided by the Berlin State Opera Orchestra under various conductors and all the songs are sung in German. Considering the age of the original masters EMI are to be congratulated for an excellent job of remastering. (N.J.M.)

★ ★ ★

BEAUTIFUL NOISE. Neil Diamond. Stereo CBS SPB234777.

Neil Diamond is a singer/songwriter who certainly varies his style—one has only to compare this album with the legendary "Hot August Night" LPs to confirm this fact. But although the style differs, Neil Diamond fans should still find plenty to get enthusiastic about.

The album is, in Neil Diamond's words, "a series of recollections . . . seen through the eyes of a young songwriter making his way through the streets of New York City's tin pan alley in the early 1960s. It is made up of people, places and events . . ."

The best tracks on the album are undoubtedly "Beautiful Noise" and "Stargazer", both of which received plenty of airplay. Other tracks are: Lady-Oh—Don't Think . . . Feel—Surviving the

Scottish Favourites

GOLDEN HOUR OF SCOTTISH FAVOURITES VOL. II. Stereo Musicassette, Astor. GHC-1062.

Hoots mon . . . there are two things about this cassette to please the heart of anyone from north of the border—a full program of Scottish music, and the fact that it plays for a whole hour! But I jest. The hour spent passed very pleasantly for that part of my family group that does hail from the said area. A mixture of instrumental and vocal numbers, there are far too many to list but here are a few of them: The Tartan—Jigs Medley—Forty Shades Of Green (!)—Waggle O'The Kilt—Bonnie Wee Jeannie McCall—Scottish Waltz Medley—Loch Maree Islands—Sing Us A Song Of Bonnie Scotland—Scottish Trilogy.

With a toe-tapping community program like this, one tends not to fuss too much about quality but I certainly didn't notice anything to complain about, even though those responsible for compiling it must have had to tap quite a few sources. How else would they come across "The Muckin' O' Geordie's Byre", for which I had to seek a translation!

If you have a Scottish background, you'll surely enjoy it. (W.N.W.)

LIGHTER SIDE—continued

Life — If You Know What I Mean — Street Life — Home is a Wounded Heart — Jungletime — Signs — Dry Your Eyes.

Recording quality is excellent, with negligible background noise. By the way, the cover on this album must be one of the most expensive ever produced—it's superb. Recommended. (G.S.)

★ ★ ★

CATERINA VALENTE. The Live Concert Album. Astor SPLP 1472.

The live concert atmosphere is well captured in this enjoyable record from Caterina Valente, recorded in London with an orchestra led by her brother, Silvio Francesco.

A pair of medleys take up most of side one, with such titles as: Senza Fine — Arriverderci Roma — More — Mulberry Bush — Girl From Ipanema — One Note Samba — Blame It On The Bossa Nova. Other tracks are: Before The Parade Passes By — Everybody Gets To the Moon — We've Only Just Begun — You've Got A Friend — Scarborough Fair — The Windmills Of Your Mind — Malaguena — Breeze And I — Canto De Ossanha — Leaving On A Jet Plane.

The Orchestra has an excellent big show band sound and could hold their own anywhere. (N.J.M.)

★ ★ ★

THE GOLDEN AGE OF SONG. Vol 4. EMI OXLP 7617.

With a title such as this you could expect a wide variation in quality but the performances, on average, outweigh this shortcoming. Some of the artists and their music are:

Paolo Silveri: Dio Possente — Miliza Korjus: Voices Of Spring — BBC Chorus and Orchestra: Grand March from 'Tannhauser' — Joan Cross: Mimi's Farewell — Jussi Bjorling & Hjordis Schymberg: Lovely Maid In The Moonlight — Jan Kiepura: Tell Me Tonight — Covent Garden Opera Company: Brother Dear And Sister Dear — Jussi Bjorling; La Belle Helene — Maria Cebotari: O Habet Acht — Tito Schipa: Vivere — Luton Girls Choir: My Heart and I, Old Chelsea.

If you are old enough to remember these artists in their prime, this record will bring on an attack of the nostalgias! I guess that is what it is all about. (N.J.M.)

Pleasant background

PIANO AT COCKTAIL TIME. Pietro Dero. Stereo, Astor 3-record set, SF-312.

At $5.75 for a well packaged 3-record set, this has the potential to be very good value indeed. However, its true value to an individual record buyer will depend on the place he/she has in their listening for six sides of "cocktail time" piano.

The multi-fold jacket gives no information whatever about Pietro Dero but his name is curiously reminiscent of Peter Nero (pronounced with sinus) and he would appear to be from a similar physical mould! His style is typically that of an accomplished cocktail lounge pianist: rippling, heavy with ornamentation, pleasant if you want to listen, unobtrusive if you want to talk.

Much of it is done against a background of gentle rhythm — indeed so gentle and so regular that much of it could as easily be coming from an electronic "side man". More than that, many of the tunes are forced into the prevailing rhythm pattern. If you want to know how forced, try playing the traditional "Juanita" in strict waltz time!

As for the titles, there are actually more than double the number suggested by the "30 Hits" on the jacket. They range from old traditionals like "Juanita" and "Greensleeves" through singalong favourites and stage melodies to a whole batch of "plus rhythm" arrangements of classical themes on the last side.

In short, the whole presentation is precisely what it purports to be: "Favourite music for cocktails and conversation". As such, it is quite successful. And technically? With the strictly controlled dynamics of a cocktail performance, the sound is very clean, very smooth. (W.N.W.)

JUNE BRONHILL, At The Opera House. M7 Stereo MLF 118

This lady needs no introduction to anybody, as one of Australia's best known singers, particularly in the field of operetta. This recording made recently at the Sydney Opera House could be regarded as a showcase of her remarkable vocal talent. There are thirteen titles in all, ranging from "Summertime" from "Porgy and Bess" to "Caro Nome" from Verdi's "Rigoletto". Others are the Overture from "Thus Spake Zarathustra" – Chacun Le Sait, Chacun Le Dit – My Hero – Czardas –Mein Herr Marquis – Ah Fors'e Lui Sempre Libera – Send In The Clowns – Love Is Where You Find It – Bless This House – Villia – Shalom.

The recording carries the impression of a live performance very well and the Orchestra under the direction of Tommy Tycho, does an excellent job. (N.J.M.)

★ ★ ★

AT THE SOUND OF A BELL. Pavlov's Dog. Stereo. CBS SBP 234784.

This record is very unusual. First impression is that the lead singer of Pavlov's Dog has a very female sounding voice at first, but after listening to about half the tracks, one tends to forget about it. I guess this is just the conditioning coming out to which we are all subjected. My thoughts about conditioning were sparked off by the names of this album and the group, which were probably chosen for this very reason.

Returning to the record, however, I was quite impressed. All the tracks were composed by Pavlov's Dog, and all the lyrics are included on the album cover, so that you can follow it through. And, even though the instruments have a great deal of presence, at no time are the vocals drowned out.

In short, a very enjoyable record which is technically very good, with a wide range of sounds. The record will be heard best on a good quality system. (D.W.E.)

★ ★ ★

ANGEL. Angel. Casablanca NBLP 7021. Astor release.

Angel is a five man rock band, which I have not heard of before. This record commences with a burst of electronic wailing, which seems to come from all parts of the room at once—and that's only on a stereo system! I imagine that it would be even more spectacular on a four channel setup.

Similar effects seem to be absent from the remainder of the album, however, which is just straight, loud rock and roll. Tracks featured are: Tower—Long Time—Rock & Rollers—Broken Dreams—Mariner—Sunday Morning—On & On—Angel (theme).

I found it difficult to pick out any tracks in preference to the remainder, they are all of a high standard. Technically, the record is O.K., but be warned that, to appreciate it, you need to have strong ears! (D.W.E.)

New Products

NEC Transceiver offers many features

One of the most recent pieces of amateur radio equipment to appear on the Australian market is the NEC all-band HF transceiver Model CQ-110E. The CQ-110E is being handled in Australia by Rank Industries, already well known for their association with Rank Arena TV sets, who are also agents for NEC broadcast transmitters.

This is a very versatile transceiver, offering many features not often found on amateur transceivers. It covers all HF amateur bands from 160 metres to 10 metres and, with one minor exception, the bands are broad enough to accommodate the differences between overseas and Australian amateur bands. The exception is the Australian 11 metre amateur band—26.96 to 27.23MHz—the set covering 27.00 to 27.50MHz. There is also a reception position tuning across 15MHz to cover WWV or other standard frequency stations.

The transceiver can transmit and receive on all bands using upper or lower sideband SSB, AM (single sideband, full carrier), CW, and FSK (RTTY).

Frequency selection is by a large central knob and the readout is a 6-digit LED display. This can be read to the nearest 100Hz at 30MHz. The range of the VFO is approximately 500kHz on each band and it requires approximately 35 turns of the knob to cover this range. (The 10 metre band—28 to 30MHz—is covered in four steps.)

The digital frequency meter readout is to the left of the upper panel, with the VFO/XTAL switch and monitor meter to the right. The lower controls are, L to R, Mode, Rx Gain, Tx Gain, Band, RF Tune, and PTT/VOX, etc.

As well as normal VFO operation, the set has provision for two crystal locked frequencies. Also, it may be used with an external VFO in place of the internal VFO for either the transmit mode only, the receive mode only, or both.

When using the internal VFO for both functions, in the normal way, a receiver fine tune facility is available which can vary the receiver frequency by up to ±5kHz, without altering the transmit frequency. The digital readout indicates either receive or transmit frequency as the set is switched from one mode to the other.

The set has an in-built 100kHz crystal marker. The controls are so arranged that, initially, this marker may be calibrated against a standard frequency station, such as WWV. When so calibrated it may then be used to adjust the digital frequency counter for maximum accuracy.

Transmission may be either press-to-talk controlled, VOX controlled, or held on by a switch position, as may be needed for test and adjustment. The VOX system is also used in the CW mode to provide break-in operation. An anti-VOX (anti-trip) circuit is also provided.

The transceiver is a hybrid unit, as is usual for equipment of this general type. However, as well as using valves in the transmitter, it also uses three valves in the receiver. One is a 6BZ6 RF stage, one a 7360 low-noise beam differential mixer, and the third a 6EJ7 as a local oscillator. The makers claim superior cross modulation characteristics and less spurious heterodynes by using valves in this part of the circuit.

The transmitter uses four valves; a 6EJ7 driving a 6BQ5, which in turn drives two 6SJ6Cs. A cooling fan is provided for the two latter valves.

The equipment may be powered from either the mains of a 12V electrical system as in a car or boat. An inbuilt converter is used in the latter mode and powers the cooling fan as well as the electronics. The required mode is selected by fitting the appropriate power cable.

Continued on page 111

MAJOR SPECIFICATIONS

Frequency stability	Not more than 2kHz during warm-up. Not more than 100Hz after 30 min.
DC input to final	SSB, CW, 280W (240 28MHz) AM, 80W
Carrier suppression	Not less than 50dB
Sideband suppression	Not less than 50dB
Spurious radiation	-40dB or less
3rd order distortion	26dB or more
Receiver selectivity	CW, 0.6kHz (-6dB) 1.6kHz (-60dB) SSB, AM, 2.4kHz (-6dB) 4.5kHz (-60dB)
Sensitivity	SSB, CW, 0.3uV S/N 10dB or more AM, 1uV S/N 6dB or more
IF interference rejection	60dB or better
Image rejection	60dB or better
Internal spurious response	1uV or less
Audio output	3W (10% distortion)
Audio output Z	8 ohms
Power consumption	Receive, 70W or less Transmit, 320W or less
Dimensions	334mm (W) x 322mm (D) x 153mm (H)
Weight	18kg

Arix 360FTR multimeter has 34 ranges

As digital meters have improved in capability and reduced in price, so also have analog meters. This is demonstrated by the Arix FTR-360 which has a large multiscaled meter, many ranges, a facility for checking transistors and a high order of accuracy.

Sensitivity of the Arix 360FTR on DC ranges is 100,000 ohms per volt, while on AC ranges it is 10,000 ohms per volt. Measurement accuracy on DC ranges is claimed to be within ±3% and ±4% on AC ranges. There are six DC voltage ranges, five AC voltage ranges, seven DC current ranges and one AC current range at 10 amps. A fuse protects the meter when used on current ranges.

All told there are 34 ranges on the 360FTR. Most of these are selected by the large rotary switch, while others are brought into play by the two auxiliary switches and by the additional sockets on the control panel.

The three red terminals are placed close together on one corner of the front panel to provide the transistor measurement facility. This is fine when transistors with long leads are to be measured, but is awkward with transistors having leads of length 13mm or less, which is usually the case. A worthwhile refinement would be to add a transistor socket.

Base current in the beta measuring mode is about 25 microamps while maximum collector current is about 10 milliamps. Collector leakage current is checked at 3V, which is the sum of the internal batteries. These conditions are okay for checking most small signal transistors.

A favourable feature of the transistor terminals is that the value of resistors can be measured by connecting them between collector and emitter terminals. This is easier than trying to measure a loose resistor with the meter prods. Of course the meter prods are still the best way of measuring components which are "in circuit".

In spite of the large number of ranges, the meter scales are, for the most part, easy to read. The exception is the Decibel scale, which has the smallest radius and consequently the most cramped calibrations. Also limiting the usefulness of this scale is the fact that the zero calibration is at the lower portion of the scale. Also the AC voltage ranges do not have a preferred sequence of 1:3.16 as normally found on AC millivoltmeters. This latter criticism applies to most multimeters so should not be construed as a particular drawback of this unit.

Accuracy of the unit was found to be particularly good. On the DC voltage ranges it was within 1% of full scale except on the 0.5V and 2.5V ranges,

where it was within 2%. Similarly, on the AC voltage scales, accuracy was within 2% of full scale. Resistance measurements were also within 2% using 500 as FSD. Midscale reading on the ohms scale is 20 so the meter is useful for resistance measurements down to a fraction of an ohm.

Frequency response of the AC ranges was from 10Hz to 100kHz within ±1dB. This is far better than that claimed in the instruction leaflet, to the extent that there must be a mistake in the specification.

Overall, we were impressed with the 360FTR. It is a good all-round meter which is sure to become a work-horse. Price of the unit, complete with batteries and instructions, is $39.90 plus 15% sales tax where applicable.

The Arix 360FTR is available from electronic parts retailers or from the importers, Indeva Pty Ltd, 24 Bellevue Road, Bellevue Hill, NSW 2033. (L.D.S.)

APOLOGY

In the review on the Trio CS-1562 oscilloscope featured in the September issue, the price of $379 plus sales tax refers to the model CS-1562 and not the higher performance model CS-1560. Our apologies to those inconvenienced by this error.

NEW PRODUCTS

Antenna Accessories from Ralmar

Ralmar Agencies Pty Ltd have released a range of antenna accessories for colour TV receivers or FM tuners. They are designed to operate with either 75 ohm coax cable or 300 ohm balanced lines. All are well constructed and attractively priced.

Ten units comprise the complete range. Most are wall-mounting boxes or plates, with concealed screw terminals for 75 ohm coax lines to FM tuners or TV receivers while some have visible thumbscrews for terminating 300 ohm ribbon. Most have integral PC boards which accommodate baluns and/or resistors in networks for low loss and low VSWR.

Each unit is briefly described as follows: WTO-1 is designated as a "Line Wall Tapoff". It is intended for use in home units and large buildings with master antenna and RF masthead amplifiers. WTO-1 is inserted in series with a 75 ohm coax distribution line and has two sets of outputs, 75 ohm coax and 300 ohm ribbon. WTO-2 is similar but is intended to terminate the end of a 75 ohm line.

UV-774 is a "75 ohm 4-way hybrid splitter". As its designation implies, it splits an incoming 75 ohm line into four 75 ohm outputs. A similar unit is the UV-772 which is a "75 ohm 2-way hybrid splitter". UV-732 is a "2-way hybrid splitter" with 75 ohm input and two 300 ohm outputs. UV-332 is a "300 ohm 2-way hybrid splitter" with 300 ohm input and outputs. Somewhat different is the UV-173 Directional Coupler. It has 75 ohm input and output plus a 300 ohm branch output. It provides high isolation between outputs.

BT-2 is a low loss (0.5dB) transformer matching a 75 ohm line to or from a 300 ohm line. BT-1 is a connector plug with inbuilt balun to connect a 300 ohm ribbon to a 75 ohm coax socket. PC-155 is a low loss 75 ohm coax cable 1.8 metres long terminated at each end with a coax connector.

At right are five units in the range of television antenna accessories from Ralmar Agencies Pty Ltd.

We have not tested or actually used any of these accessories but they all appear to be well made and should be entirely suitable for their intended application. Recommended retail prices are as follows: WTO-1 and 2, $8.60 each; UV-774, $7.60; UV-732, UV-332 and UV-173, $4.50 each; UV-772, $4.10; BT-1, $2.80; BT-2, $2.25 and PC-155, $3.10.

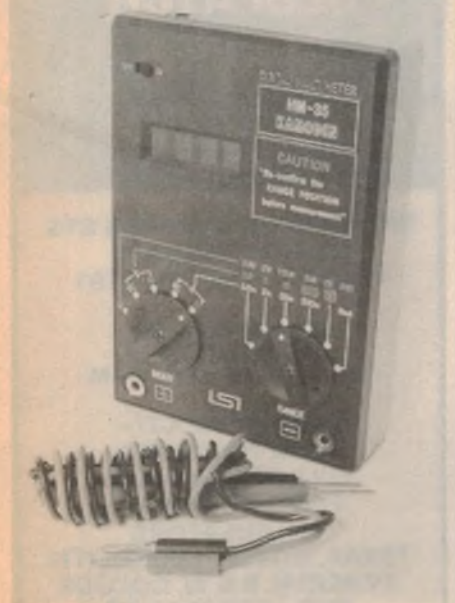
Ralmar accessories are available from parts retailers throughout Australia. Trade enquiries should be directed to Ralmar Agencies Pty Ltd, at their new address, 22 Atchison Street, St. Leonards, NSW 2065 or interstate representatives.

Digital Readout Thermometer

The Comark 3001 is a small hand-held digital thermometer which enables fast, accurate temperature measurements from −50°C to +800°C. It is battery powered and weighs 300 grams.

Further information from Jacoby, Mitchell Ltd, the Crescent, Kingsgrove 2208.

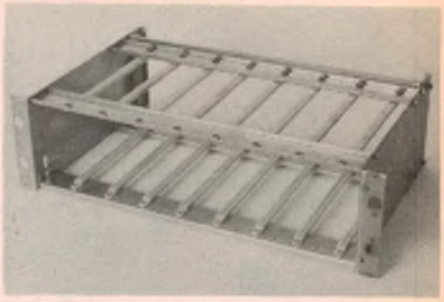
Digital Multimeter



University Graham Instruments Pty Ltd, 106 Belmore Road, Riverwood, NSW have released the Kamoden HM-35 digital multimeter which had 3½ digit readout and 10M input impedance on all ranges. Range switches are similar to those on a conventional meter.

NEW PRODUCTS

Card Frame



A new type of rack-mounting frame for plug-in PCB assemblies is available from Celotek Industries. Designed to mount in a standard 483mm (19-inch) rack, the frame is capable of mounting up to 16 PCB modules on 25mm centres.

The frame is adjustable for card widths in the range 85-101mm, between top and bottom moulded guides. An adjustment is also provided for card length. Card mounting centres are adjustable over a wide range.

The frame is open to allow good air flow around cards for cooling, but rigidity is ensured by all-steel construction. Decorative cover strips are available for the mounting flanges.

Further information is available from Celotek Industries Pty Ltd, 5 Greenfield Street, Botany, NSW 2019.

Simple IC radio kit from Dick Smith

Aimed at the hobby enthusiast, this simple little IC radio is available in kit form from Dick Smith Electronics for just $12.50. The unit is supplied complete with instructions, and can be assembled in about two hours.

Two ICs are employed in a full superheterodyne circuit—an LM1820 in the RF/IF stages, and an LM386 audio amplifier. The LM1820 acts as RF amplifier, mixer-oscillator, AGC detector, and IF amplifier. A zener voltage regulator is also included on the chip.

The amplified IF output signal emerges from pin 6 of the LM1820 and is fed into a further IF stage. From there, the signal passes to a diode detector, and the resulting audio signal fed to the LM386 audio amplifier. Audio output is claimed as 300mW when using the 6V supply specified.

We assembled a sample kit submitted to us by Dick Smith Electronics, and encountered no problems. A single PCB accommodates most of the components and this has been coded for easy assembly. The accompanying construction notes remove any remaining doubts about assembly, and also detail the simple alignment procedure which is performed without the aid of instruments.

An attractive moulded plastic case, complete with a carrying strap, is supplied as part of the kit, as is a crystal earphone piece. In short, an ideal kit for the beginner.

Readers may either purchase the kit from their nearest Dick Smith store, or by mail order from PO Box 747, Crows Nest, NSW 2065. (G.S.)

Transceiver—Continued

Other features include a receiver noise blanker, inbuilt speaker, panel mounted heater switches for both the transmitter and receiver, upper and lower limit warning lights indicating the edge of the 500kHz bandwidth of the VFO, fast and slow AGC response times, automatic level control on transmit, and a panel meter which indicates RF output, modulation level, or the cathode current of the final valves.

From the specifications, and the other data, the reader can correctly assume that this transceiver is aimed at a specialised market; the kind of amateur who wants the best and is prepared to pay for it. And, as also might be imagined, the price tag is somewhat higher than that of the more run-of-the-mill variety. Price, including tax, is $1150.

The specifications, and most of the other information, were taken from a large operating manual, as would normally be supplied with the instrument. However, we feel bound to comment that the manual is a classic example of "Japanese English", having suffered severely in the translation. The result varies from being merely quaint to completely incomprehensible.

Happily the agents assure us that a better manual is currently being prepared.

In the meantime, the existing manual is quite comprehensive. It should enable most amateurs to find their way around the set and perform all the necessary setting up adjustments to ensure optimum performance. It should also help considerably in the event that servicing is required. On the other hand, Rank are providing full service and backup facilities for those who may hesitate to tackle the job themselves.

Further details from Rank Industries Australia Pty Ltd, 12 Barcoo St, East Roseville, NSW 2069.

Books & Literature

Amateur radio

A GUIDE TO AMATEUR RADIO, by Pat Hawker, G3VA, published by Newnes-Butterworths, London, England. Hard cover, 190 mm x 254 mm, 124pp, many tables, drawings and photographs. Recommended retail price $9.00.

This is the sixteenth edition of this very well written and compiled effort by well known Pat Hawker. He is devoted to amateur radio and it is reflected in this publication. As the title implies, this book is intended specifically for people intent on entering the ranks of amateur radio. While it meets this need, it may also be of interest to other radio hobbyists who may not wish to become a transmitting amateur.

This edition includes some new material relating to equipment, with details on the selection of a receiver as well as transceivers and transmitters, etc. There is also quite a bit of material on licensing, although this applies specifically to conditions in the United Kingdom. While the information may be of some interest to Australians, there are may differences which make its usefulness somewhat limited here.

A wide field is covered, which should be of absorbing interest to the intending amateur. There is a certain amount of theory, some constructional articles, together with other tabulated information, all very well presented. I can confidently recommend this book to all those interested in wishing to start in amateur radio.

Our review copy came direct from the Sydney offices of the publishers, Butterworths, 586 Pacific Highway, Chatswood, NSW 2067. (I.L.P.)

. . . and another

NOVICE RADIO GUIDE by Jim Ashe, W1EZT. Published by Communications Technology Inc, Greenville, New Hampshire, USA. Soft covers, 143 pages 288mm x 150mm, illustrated by pictures and diagrams. Australian price $4.75.

While designed for the American novice licence applicant, the title of this book will obviously attract Australian readers interested in the local licence of the same name. So the logical question is, how suitable is the book for the Australian novice scene? It seems to me to be reasonably so.

Chapter 1, Introduction to Amateur Radio, gives the uninitiated a good idea of what amateur radio is all about. It deals almost exclusively with amateur radio as it is today—and perhaps tomorrow—with only a brief reference to its history. This has allowed the author to concentrate on those things which the reader needs to know in order to pass the exams and operate successfully.

Chapter 2, Basic Communications Technology, goes right down to basics, starting with the nature of electricity, simple electrical circuits, ohm's law, AC and AC circuits, and passive components. Chapter 3 then introduces the solid state concept (there is no reference to valves) and, by the end of the chapter is into integrated circuits. In both chapters simple circuits are described to demonstrate the concepts.

The book then takes a more practical turn. Chapter 4 describes how to make a simple (direct-conversion) receiver for the 80 and 40 metre amateur bands, expanding it to 21 and 28MHz with a converter. Construction is at simple breadboard level.

Chapter 5 deals with transmitters. It starts out with an all solid state, crystal controlled 1 watt, CW transmitter for 3.5 and 7MHz. To this can be added a VFO, a 20W valve amplifier (the first reference to valves) followed by a 21 and 28MHz transmitter. There is also a description of dummy loads and tuning procedures. All construction is breadboard style.

Chapter 6 covers antennas; chapter 7, Setting up Your Station; chapter 8, Learning the Morse code; chapter 9, Accessories and Your Radio Lab; and chapter 10, Important Working Materials.

The author has a breezy style, which is easy to read, and lays much emphasis on breaking down the "too hard" barrier which deters many beginners. He sometimes digresses, though not seriously, and sometimes lapses into words and phrases which appear to be well above the level at which the text is pitched.

But these are minor criticisms; a student who is really keen should take them in his stride. A more serious problem arises by reason of the difference between the Australian and American novice standards. The latter provides for CW only, so no part of the book deals with speech modulation in any form. There is also the ever-present problem that components specified in overseas publications may not always be available on the Australian market.

But, in spite of these limitations, the book still represents very good value for money. It would make an excellent Christmas or birthday gift for any youngster who has set his sights on the novice licence.

The review copy came from Dick Smith Electronics Pty Ltd, who list it under catalog number B2280. (P.G.W.)

Colour TV

QUESTIONS AND ANSWERS ON COLOUR TELEVISION by J. A. Reddihough and David Knight. Published by Newnes-Butterworths, London. Hard covers. 134 pages. 165mm x 110mm, illustrated by numerous circuits and diagrams. Suggested price in Australia, $2.50.

This book is clearly aimed at those who have a good knowledge of monochrome TV, but need to upgrade to colour. As such it would provide a very logical first step, being not so deep as to deter anyone who has reached this level in monochrome, yet dealing with the subject in a remarkably comprehensive way. Elementary mathematics is used to explain some processes, including angle diagrams, and some algebra. For the most part, however, the explanations are given in simple word pictures.

The book is divided into four sections: Colour Signals and Transmission, Picture Displays on Colour Tubes, Decoding the Chroma Signal, and Convergance. The book starts off, logically enough, with the pertinent facts on colour—wavelength, the colour triangle, additive and subtractive mixing, etc, leading naturally into the three colour system, dichroic mirrors, filters, etc. The only criticism here is the listing of suntractive primaries as red, yellow, and blue instead of magenta, yellow, and cyan.

The question and answer format may be regarded as something of a gimmick, but is does have the advantage of enabling a particular subject or thought to be introduced with a minimum of preamble. As such it probably contributes to the compact nature of the book.

The book is copiously illustrated with diagrams, explanatory circuits and, in some cases, what look like portions of commercial circuits, though obviously redrawn to maintain style, and not identified.

Quite apart from the modest price, this book seems to provide an extremely good introduction to colour. It would be a logical stepping stone to more involved texts, which are likely to be better understood as a result. Considering the price, it must be regarded as very good value indeed.

Our copy from Butterworths Pty Ltd, 586 Pacific Highway, Chatswood, NSW, 2067. (P.G.W.)

Letters to the editor

Novice licence

In the June 1976 issue you published a letter promoting yet another argument against the limited tenure and non-renewability of Novice licences. In your comments on the letter you state, "It is also true that to date, no one has given a single cogent reason for the two year tenure." In view of this comment and of your apparent editorial stance in opposition to limited tenure for Novice Amateur licences, I would like to advance the following points for your consideration:

Space in the electromagnetic spectrum is limited, and such space as there is, is in great demand: it would be fair to say that there is hardly enough spectrum space to go around. Despite the foregoing, our Government (and governments elsewhere) are prepared to license Amateur operators, and to make available valuable spectrum space to a relatively unimportant service for the purpose of hobby operation. Governments rarely if ever give away something for nothing; why then do they countenance Amateur operation at all? What do they get out of it?

The answer is that they get a very great deal indeed. They get an entire corps of radio operator/technicians that are completely self-trained and self-equipped: operators with their own stations that are available for service in times of national emergency or natural disaster. The training and equipping of these operators takes place at no cost to the Government; its expenses in this connection are quite moderate and consist of the costs involved in examining candidates for the purpose of licensing them, keeping the appropriate administrative records and policing the operation of licensees on the air.

The fact that a Novice class of licence was created at all shows that the Government is not only getting a bargain but that they know it too: the Novice licence is a clear inducement for beginners to start in Amateur Radio, and once having started, to go on and get their full ticket. And this is the crux of the matter—the Novice licence is not intended as some sort of a second-class Amateur licence, but it is rather an inducement, a stepping stone on the way up to the full A.O.C.P. When this is taken into consideration, the two year tenure and the non-renewability of the Novice licence make a great deal of sense indeed.

After all, the Government is interested in procuring radio operator/technicians that are qualified to the standards prescribed for the full Amateur O.C.P.—operators that have a sufficient grounding in communications techniques and radio theory to serve as emergency operators who are capable of repairing their own equipment or if needs be, haywire together an emergency communications link out of whatever happens to be on hand. Allowing an operator to remain at the Novice level indefinitely would hardly accomplish the aims of the Government in creating that class of licence in the first place.

Undoubtedly some of the hypothetical fifty per cent of Novice licensees who fail the A.O.C.P. exam at their first attempt (notional figure from a letter in the June, '76 issue) will turn "pirate"—and so would a good many people who failed the Novice exam itself in the first place—and so would a good many who never bothered to take any exam at all. This is hardly a valid reason for making the Novice licence renewable: making it into a second-class permanent licence would defeat the very purpose for which it was instituted, and insisting that it should have unlimited tenure perhaps betrays a lack of understanding of the rationale behind not only the Novice licence but underlying the whole concept of Amateur Radio.

Perhaps the Radio branch should stand condemned for not spelling out the purpose of the Novice licence more clearly and emphatically; on the other hand they may have considered it to be so obvious as to make explaining unnecessary.

Ivan Botha.
Glen Innes, N.S.W.

COMMENT: To be honest your letter seems more an explanation than a justification. It also appears to assume that Governments hold all rights to natural resources, and that an individual citizen is but a pawn compared with the state. A lot of people would disagree with these assumptions.

FET symbols

Over many years I have been a reader of Electronics Australia, and am now stirred to write to you on the subject of circuit symbols. As there is now an Australian Standard covering these symbols, I think that your publication should use these exclusively.

I refer to the June 1976 edition, page 55, the Sync-a-Slide circuit diagram. The P channel FET symbol is drawn in such a way that there is no way of identifying the Drain and Source. (Or the Collector and Emitter, as the Standard decrees.) The novice constructor could be forgiven for imagining that the top connection is the Drain—but it is not. For the Drain to be negative with respect to Source the Drain would be connected to earth.

Looking at the text to see whether this gave guidance I find the statement: "When the gate voltage goes high, the FET is pinched off. . . . ." A high gate voltage could result in cut-off, but pinch-off is an entirely different matter not caused by gate voltage at all.

As one who is called upon to put pen to paper at times I realize that it is well nigh impossible to write without errors. However, I think that there is really no excuse for those symbols.

N. Jackson
Glen Waverley, Victoria.

COMMENT: Many FET devices are electrically symmetrical, with the labels "drain" and "source" assigned quite arbitrarily. In circuits where such FETs are used purely as controlled resistors, with no direct voltage applied between the ends of the channel, this makes the drain and source connections doubly interchangeable. This applies in the circuit to which you refer, so that the "novice constructor" could in fact connect the device either way. Finally, as the gate-channel depletion layers controlling channel conduction are a function of both gate bias and channel current, pinch-off and cutoff are in fact closely related.

Leaders offend

"Electronics Australia" is a fine technical magazine. I have been a reader for about ten years, but the September issue will be the last for me. As far as I am concerned, Jamieson Rowe's editorials have destroyed the magazine's credibility as anything but a children's hobby magazine. I hope that not too many copies find their way overseas, if it is true that the magazine is Australia's largest selling electronics magazine.

D. W. Davis
Brunswick, Victoria

COMMENT: Well, I did say we could expect to receive some flak! The claim that we are Australia's largest selling electronics magazine is fully supported by audited circulation figures, although as Mr. Davis has opted out he presumably won't be reassured even on this point.

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.

RECEIVERS FOR THE SERIOUS SWL! * *

Yes, the famous Barlow Wadley general coverage receiver with crystal controlled reception of am/lsb/usb/cw now includes the Australian FM band!

BARLOW WADLEY
STANDARD $269 + P&P
WITH FM $298 + P&P

The new Yaesu FRG-7 general coverage receiver features ac/dc operation and the famous Wadley Loop principle with spin tuning and phase-locked synthesiser providing complete coverage from 500 KHz to 30 MHz with an accuracy better than 5 KHz. Please write for further technical details (enclosing SAE)

OUR PRICE **$275** + P&P

ANTENNAS

Listener 1 "V" type antenna. Covers 3-30 MHz with special trap. Ideal for DX reception. $21 + P&P

Listener 3 Long Range wire dipole antenna 3-30 MHz complete with balun, feed wax, VHF plugs, insulators. Ideal for the serious SWL. $42 plus P&P

the COMMUNICATIONS SPECIALISTS!

KENWOOD TS-700A $575

The promise of 2 meter operation...the Kenwood way. The TS-700A operates all modes: SSB (upper & lower) / FM/AM/CW and provides the dependability of solid state circuitry. Has tunable VFO and 4 MHz band coverage (144 to 148 MHz). Automatically switches transmit frequency 600 KHz for repeater operation. AC and DC capability through its built-in power supply. Outstanding frequency stability. Complete with micro phone and built-in speaker.

synthesised SSB $245

27MHz *

This superb rig is the ultimate in quality and sophistication! The CB1000 is synthesised and requires no crystals - accuracy is within 0.001%! There are 69 available modes, 23 AM, 23 LSB, 23 USB at 5 watts AM and 15 watts pep. Runs from 13.8 vdc either positive or negative earth. Controls include squelch, rf gain, clarifier, noise blanker (FR type) and transceiver PA system swich. Front panel meter indicates "s" points or RF output. The rig comes complete with mic, mobile mounting brackets, dc cable and VICOM 90 day warranty. A real bargain!

HF TRAP DIPOLES *

AL48DXN 40 & 80 metres, length 28 metres $ 40
AL24DXN 20 & 40 metres, length metres $ 40
MIDY VN 80 thru 10 metres, length 23 metres $ 48

amateur gear

Ringo Ranger ARX2, three half waves 6 dB gamma loop matched vertical $ 40
AS210BN 2m beam, twin boom 10el each boom, 18 dB gain, F/B 20 dB, length 4m, weight 6.8 Kg $ 99

HF MOBILE ANTENNAS *

AS303A Antenna Set 80 thru 10 metres, centre loaded, incl heavy duty ball mount and spring $105
Quality Hustler Resonators. Precision would with optimum design for each band, adjustable trip rod for lowest swr:
RM80 (80 metres) $26 RM20 (20 metres) $20
RM40 (40 metres) $25 RM11 (11 metres) $24
BM1 Bumper mount $15 RSS-2 spring $12

HY-GAIN HAM ANTENNAS *

14AVQ/WB 40 thru 10 metres trap vertical. True 1/4 wave resonance on all bands $ 76
TH3MK3 3el beam. Outstanding performance at reasonable cost. Separate matched Hy-Q traps for each band $199
TH3JR 3 el beam 10-15-10. Ideal for top performance in limited space $145
TH6DXX 6el super Thunderbird. Impressive coverage 10-15-20 metres. SWR less than 1.5:1 on all bands $245

18AVT/WB The Great Wide Band Vertical Super Performer 80 thru 10 Meters! $98

Superb omnidirectional capabilities. Automatic band switching. Beefed-up Hy-Q traps. Top loading coil. True 1/4 wave resonance on all bands. SWR 2:1 or less at band edges. Outstanding low radiation pattern. Entirely self-supporting.

ANTENNA COUPLERS *

CL66, 500 watts, 80 thru 10 metres, quality construction with 4 position coax switch $112
CL666, 2.5 kW, 80 thru 10 metres, heavy duty $235
CL99, 200 watts for 144-148 MHz $ 54
CSW216 ALL-IN-ONE incorporates swr/pwr meter and antenna coupler. Covers 3.5-28 MHz up to 500w. SWR measurment 1.8 to 150 MHz to 200 watts. A real bargain $162

$ 598 uniden

The fabulous Uniden 2020 phase-locked-loop transceiver offers separate usb/lsb/cw 8-pole crystal filters as standard and 6146B's in the final with screen voltage stabilisation for minimum distortion products. Features plug-in pcb's and even the front panel can be swung out for easy servicing. A full spares catalogue is available together with change-over pcb's. Compare the Uniden 2020 with other HF transceivers and you'll be quickly convinced that it offers the best value!

DELUX AM TRANSCEIVER

BUILT-IN SWR BRIDGE!

NEW $140 *

COUGAR 23 B AM DELUX TRANSCEIVER

Delux mobile 23 channel (synthesised) for the quality conscious Novice. The Cougar features built-in swr meter, noise blanker, delta tune, rf gain control, mic gain control, built-in modulation meter, separate PA switch. Circuitary consists of 1 IC, 20 transistors, 18 diodes. RECEIVER: dual conversion, sensitivity 0.5 uV for 10 dB S+N/N, selectivity 6 dB bandwidth 5 kHZ, PA audio power 5 watts. TRANSMITTER: 5w input, spurious harmonic suppression better than 55 dB. Comes complete with mic, mobile bracket, dc cable and manual. *

MODEL M1 27 MHz MOBILE WHIP Base loaded stainless-steel mobile whip, 40.5 inches, 50 ohm impedance, vswr less than 1.5. Includes roof-top mount, optional boot lid mount, spring and coax with PL259 plug. Tensile strength 260,000

MODEL G2 AS ABOVE WITH GUTTER CLAMP $24.50

27 MHz MOBILE ANTENNAS $22 *

ICOM

.... where quality counts!

SYNTHESISED! NO CRYSTALS

IC22S $220

NEW *

The new IC22S transceiver is a PLL synthesised rig with programmable ROM for any frequency multiple of 25 KHz from 144 to 148 MHz. Simplex, duplex or reverse achieved by a flick of a switch on the front panel. This fabulous new rig features ceramic discriminator, IDC, electronic Tx/Rx relay, full swr protection and VICOM 90 day warranty. Circuitary includes 34 transistors, 7 FETs, 13 ICs and up to 128 diodes. Receiver sensitivity better than 0.4 uV for 20 dB quieting. Your new IC22S comes complete with mic, mobile mounting bracket, plugs, cables, spare diodes for programmable matrix and English Instruction Manual.

IC215 HANDY FM PORTABLE

This is ICOM's first FM portable, and it puts good times on the go. Change vehicles, walk through the park, climb a hill, the ICOM quality FM communications go right along with you. Long lasting internal batteries make portable FM really protable, while accessible features make conversion to external power fast and easy!

- Fully collapsible antenna
- 15 channels (12 on dial + 3 priority)
- Dual power 3 watts/40 mW
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- Crystals same as IC22 series

Your new IC215 comes complete with 3 popular channels, mic, shoulder strap, connectors, batteries, English Manual and VICOM 90 day warranty.

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The famous IC202 handy portable runs 3 watts pep with VXO control 144-146 MHz. Features noise blanker, RIT, lighted dial and meter, telescopic antenna and of course that ICOM quality! Comes complete with mic, carrystrap, dry cells, English manual and 90 day warranty.

IC502 $175 IC202 $185

Six metres SSB using the IC502 can be great fun! This handy portable runs 3 watts pep ssb 52-53 MHz. Featuring VFO control, switchcable noise blanker, RIT and provision for external power and speaker. 9 long-life C batteries, English manual and 90 day warranty.

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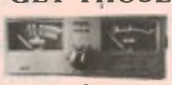
Why take the gamble? All rig sold by VICOM are given a thorough pre-delivery checkout supported by technical expertise and well equipped workshops. Spare parts are available too!

3 watt lighted dummy load fitting into UHF (PL259) plug. Glows when transmitter is on - making this handy accessory ideal for transmitter tuning and testing. $2.50

GET THOSE EXTRA "S" POINTS! *



Popular VC2 swr/pwr meter operates 3-150 MHz with power measurement 12/120 watts. Will handle up to 1000 watts. 50 ohms impedance, twin meters. A bargain! $29.80

SWR/PWR METER $29.80 * *

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3' coax jumper lead with PL259s	$2.20
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RG58A/U 52 ohm coax - 45c/metre	
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Brisbane	Elite Electronics, 69 Wardell St, Dorrington. Phone 38 4480
Canberra	Daicom, 32 Kalgoorlie Crs, Fisher. Phone 88 4899
Perth	Netronics, 388 Huntriss Ave, Woodlands. Phone 46 3232

Prices and specifications subject to change without notice. Prices include Sales Tax but exclude freight and Insurance. Allow 50c per $100, minimum $1

The Amateur Bands

by Pierce Healy, VK2APQ

Threats to amateur radio

The mighty dollar, public demands, commercial black boxes, national apathy, expansion of commercial frequencies. The referee—The World Administrative Radio Conference, 1979.

Those words are used to illustrate some areas from which potential threats to the amateur service could come during the next two years.

To try to forestall that possibility, answers to some pertinent questions must be sought. Such as:

—where does the future of amateur radio lie?

—where is amateur radio heading?

—are the future trends in amateur radio readily decernable?

—do amateurs comprehend the changed attitudes towards radio communication?

With the advent of the commercial black box era the habits and attitudes of amateurs have changed. One of these is that the emphasis seems to be communication rather than experimentation. This has not only affected operation on all frequency allocations but has also created a fertile field for the mighty dollar investors.

The black box industry, nourished by the introduction of miniaturised components, printed circuits and solid state devices, has developed a flourishing market for hand held personalised communication units.

While black boxes for amateur consumption is now big business, the possible market for the personalised hand held units is infinitely greater, plus a much higher content due to the repair-by-replacement attitude of the public in general.

These units are proving very popular among the non-technical members of the general public. The old affliction known as "mike fright" seems to have disappeared and the ability to use a microphone seems almost a natural habit. The ease with which it is now possible to listen and communicate via a small black box, not relying on interconnecting wires and eliminating charges (as in the case of telephones) has caught the imagination of young and old, stay at home and traveller alike. This is the phenomenon classified as "public right"; by its exponents and exploited by commercial opportunists.

It is an extension of the ancient "smoke signal" technique of conversing with unseen friends or neighbours. It has about the same degree of privacy. But it is likely to be a major factor in determining the overall form amateur radio will take in the future.

Apathy towards amateur radio unfortunately exists in several members of the International Telecommunication Union. Although most prevalent in the so-called developing nations, it is also evident in others where bureaucracy pays only lip service to amateur requirements.

Only the efforts of amateurs, individually within their own community or at government level through their national society, can overcome or alleviate some of the handicaps that can arise from those national attitudes.

It is a fact that where a strong active national amateur organisation exists, close cooperation between themselves and administrative authority is possible.

However, the most destructive factor is apathy on the part of the amateur himself towards the threats from outside sources. All major amateur radio societies are endeavouring to alert their members not to lapse into an apathetic attitude towards WARC 1979.

The claim for additional frequency assignments from all types of commercial services is a never ending process. Unfortunately, as has happened in the past, the amateur service allocations are looked upon as fair game by commercial interests.

Use the band or lose them. This is still a sound watchword and is, in fact, a basic requirement if the present allocations are to be retained.

In the USA the American Radio Relay League has commenced a program to increase its membership by 60,000 by 1979. It is hoped to achieve this by an aggressive program to expand training through affiliated clubs, the production of new publications and training materials, and efforts to reduce the drop out rate among novice licensees.

In Australia, the WIA has set a target of increasing its membership to 8000 by 1979. There are similar activities in other national societies.

The International Amateur Radio Union is also active. On the second weekend of September 1976, Region III directors met in Singapore and a few days later IARU regional representatives met in Geneva to advance IARU strategy in preparation for WARC 1979.

For those who have just joined the amateur ranks and those who are not members of their national society, it would be wise to reflect that amateur radio today is the result of efforts by older generations of amateurs and national societies, going back to the 1959 WARC and beyond.

To raise, or at least maintain, the status of the amateur service, it is now their turn to help influence the sole referee in frequency assignments and overall policies—WARC 1979.

HUNTER BRANCH FIELD DAY

The annual Hunter Branch Field Day will be held on Sunday 7th November, 1976 at Rathmines Park on the western shore of Lake Macquarie just south of Toronto.

Program: Registrations commence at 9.00 am.

0900-0930—HF and VHF mobile scramble. Use of repeaters not permitted.

1000-1030—Pedestrian hidden transmitter hunt on 27.125MHz.

1045-1115—144MHz hidden transmitter hunt for mobiles.

1130-1215—7MHz hidden transmitter hunt for mobiles.

1230-1330—Lunch—Note: Meals or barbeque facilities not provided.

1330-1430—Blindfolded sniffer hunts on 144MHz and 27.125MHz.

1445-1515—Talk-in transmitter hunt on 144MHz.

1530-1615—Transmitter hunt for mobiles on 144MHz, two transmitters will be in operation.

1630—Prize presentation.

Registration fee—$1.00 for family or adult single. $0.50 for students.

The event has been organised by the WIA Hunter Branch, and the Westlakes Radio Club.

BLUE MOUNTAINS FIELD DAY

The Blue Mountains Branch, NSW Division WIA field day will be on Sunday 21st November, 1976, at Springwood.

The program was not to hand when these notes were compiled. Listen to VK2AWI news broadcasts on 7146MHz Sunday mornings at 11.00 am for information.

DXCC COUNTRIES

Australian novice licensees will no doubt be interested in working DX countries. It will be interesting to see how long it will take before an Australian novice licensee applies for the DXCC award.

Country lists are readily available, but little publicity is given to the criteria that validate a country for the DXCC award.

There are four points in the present criteria. The first deals with government and administration.

—An area, by reason of government or a distinctly separate administration, constitutes a separate country.

The second point deals with islands and separation by water.

—An island or group of islands, not having its own government or distinctly separate administration, is considered as a separate country under the following conditions:

(a) Islands situated offshore from their government or administrative area must be geographically separated by a minimum of 362 kilometres of open water. This point is concerned with islands off shore from the mainland only. This point is not concerned with islands which are part of an island group or are geographically adjacent to an island group.

(b) Islands forming part of an island group or which are located adjacent to an island, or island group, which have common government or administration, will be considered as separate entities provided that there is at least 805 kilometres of open water separation between the two areas in question.

The third point deals with separation by foreign land.

—In the case of a country, such as that covered in point 1, which has a common government or administration but which is geographically separated by land which is foreign to that country, if there is complete separation of the country in question by a minimum of 121 kilometres of foreign land, the country is considered as two separate entities. This 121 kilometres of land is a requirement which is applicable to land areas only. In cases of areas made up of a chain of islands, there is no minimum requirement concerned with the separation by foreign land.

The final point refers to unadministrated areas.

—Any area which is unadministrated will not be eligible for consideration as a separate country.

There are a number of inconsistencies in the countries list if based on these criteria. The list has been in existence for many years dating back prior to World War II. Political changes following that war created problems but since then the criteria have been updated to overcome the broadness of the original rules.

The subject was treated at some length in "QST" October, 1972 and "CQ" March, 1976.

OVERSEAS NEWS SNIPPETS

The Canadian division of the ARRL has supported a novice licence proposal. The licence would be for Morse code only on 3700kHz-3725kHz, 7100kHz-7150kHz, 21.1MHz-21.2MHz, and 28.1MHz-28.2MHz. Power limited to 150 watts input.

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 colums. Photographs will be published when of sufficient general interest, and where space permits. All material should be sent to Pierce Healy at 69 Taylor Street, Bankstown 2200.

AMATEUR BANDS

The licence would be for two years and require a 5 word per minute code test, knowledge of regulations, and knowledge of adjustment, operation and care of radio apparatus. The test would be administered by two advanced class licensees not related to the applicant.

In 1975 the Canadian Department of Communications (DOC) commenced introducing significant changes to amateur examinations and updating the content to reflect the state-of-the-art in a more streamlined manner.

The multiple choice examination has been in use since January, 1976 and reports indicate that it is working quite well and has generally gained acceptance. The pass mark is 70% and 10 words per minute Morse code.

RADIO CLUB NEWS

GOLD COAST RADIO CLUB: AOCP classes are now held in the Old Surfers Paradise state school. Six members sat for the August, 1976, examinations. Three novice call signs on the Gold Coast have resulted from the examination in March, 1976. These are—VK4NEV, Kev Hymus, VK4NKS, Ken Stewart and VK4NRT, Athol Roberts-Thomson.

The first official contact through OSCAR VII satellite from the GCRC club station, VK4WIG, was made on 3rd August, 1976, during orbit number 7852. Contact was made through the 70cm uplink and 144MHz downlink with ZL1TFA and VK5EU.

Quite a number of GCRC members are operating and listening through OSCAR VII.

ELIZABETH AMATUER RADIO CLUB: The annual general meeting of the EARC was held on the 4th September, 1976. The following office bearers were elected:—

President—Ted Cooling, VK5ZE; Secretary—Steve Mahoney, VK5ZIM; Treasurer—Jim Zinkler; Committee—Steve Dench, VK5ZSD; Paul Philbrook, VK5ZPP; Bill Thomas, VK5VE.

Following the business of the meeting, an informative talk and demonstration on VHF antennas was given by Steve Mahoney, VK5ZIM.

The EARC meets on the first Saturday in each month at 8.00pm in the Elizabeth Grove Methodist Church Hall, Fairfield Road, Elizabeth Grove, S. Aust. A welcome is extended to prospective members and visitors.

In conjunction with the WIA and the Elizabeth Technical College the EARC is arranging courses in amateur radio theory and Morse code for 1977.

Further details from the Secretary, EARC, PO Box 8, Elizabeth, S. Aust. 5112, or by telephone from the president, Ted Cooling, on 255 2249 or 255 7586, or the publicity officer, Bill Thomas on 258 6070.

MOORABBIN AND DISTRICT RADIO CLUB: From the September, 1976, issue of the MDRC newsletter "APC" it was reported that the president and treasurer had received their full licence call signs. John Emery, (VK3YDC) is now VK3UA and Bruce Wodetzki (VK3ZKR), is now VK3BIW.

These two calls will make it that much easier for DX stations to obtain honorary membership of the MDRC.

This award may be obtained by working five MDRC member stations. For VK stations it is neccessary to work 14 club members.

Intending members and visitors are welcome to the new club rooms at 33 Turner Road, Highett, Melbourne, Vic. Meetings are held on the third Friday in each month at 8.00pm.

GEELONG AMATEUR RADIO & TV CLUB: About 40 members, wives and friends attended the GARC annual dinner on Saturday 28th August, 1976. The venue was the Seafarer restaurant in Queenscliff. The event was voted as being very successful by all who attended.

An historical note appeared in the September, 1976, issue of the GARC newsletter. It recalls the part amateur radio played in the early days of broadcasting.

First established in 1925, an amateur station was operated by Fred Feldman in Forest Street, South

Geelong, call sign A3QH, later VK3QH. It was a popular station, broadcasting recordings and live recitals by the Geelong Mouth Organ Band.

The equipment was home made, including transformers, and the microphone. This was a Reis type, laboriously carved out of a block of marble, with gold plated electrodes and a mica diaphragm.

The transmitter was a master oscillator and a power amplifier using Heising modulation. The PA valve was a UX210 Radiotron. The modulator used four UV102As and the rectifiers were UV281s.

Rack and panel construction was used, the transmitter and power supply being in separate racks.

The antenna was a cage type inverted "L" 15 metres high. The input was 10 watts, the maximum allowed in those days.

Fred was also interested in DX, making many contacts on 40 and 80 metres.

CENTRAL COAST AMATEUR RADIO CLUB: A lecture, Logic Principles, was given at the club meeting on 20th August, 1976, by Ross Mudie, VK2ZRQ. This was televised live on ATV.

The broadcast was made from the club rooms at Kariong and relayed through a UHF repeater by Phil Levenspiel, VK2TX, at Wyong. Reports show that good signals were received in Newcastle. A video recording was also made.

The equipment was supplied and operated at the club rooms by Bob Carr, VK2ZUJ, Don Cruicher, VK2ZCZ, John Tanner, VK2ZXQ and Ray Wells, VK2ZSX.

In addition to ICs and logic used in the VK2RAG repeater control circuits, Ross gave detailed explanations of popular series of ICs and typical arrangements of ICs and their functions in devices such as frequency counters, call sign generators, clocks and associated control circuitry.

The CCARC is finalising the program for the 1977 field day on Sunday 20th February, 1977. Remember to keep that day free for a family outing at Gosford.

ILLAWARRA AMATEUR RADIO SOCIETY: The inaugural monthly IARS news broadcast was made on Sunday evening the 8th August, 1976 by John Hodkinson, VK2BHO. This service will be conducted on the second Sunday of the month at 7.15pm through the Wollongong channel 5 repeater.

Members of the Illawarra WICEN group, Jim Thyrd, VK2BBC, Jim Giblin, VK2YCH, and Richard Wilson, VK2ZVX, participated with other organisations in an exercise on the 15th August, 1976 by the Illawarra Section of the State Emergency Service.

It was reported that, from a communications point of view, the exercise was extremely successful and the amateurs participated very well in the overall plan.

Moonbounce tests were carried out in late August but a transmitter power supply problem prevented contact with USA stations. W4ZXI was heard at "M" copy. After Lyle Patison, VK2ALU, had worked on the power supply—and removed a nest of mice—tests were conducted with European stations. Contact with F2TU was prevented by heavy QRM from another French station.

A QSL card was received from SM5LE for the first Australia—Sweden 432MHz contact, on 30th July, 1976.

WESTLAKES RADIO CLUB: Club activities are becoming more noticeable in the Newcastle area. During August there was an increase of 20 members, bringing the membership to 162. A large percentage of new members are attending the YRS classes each Saturday afternoon.

Nine of the 13 candidates who sat for the August, 1976 AOCP examination, held at Newcastle, were WRC members.

In reply to a query by the WRC, concerning amateur station operation by incapacitated persons, the following was received from the Post and Telecommunications Superintendent in Sydney.

"Although each application is considered on its individual merits the Department's general policy is to examine all persons who desire to become amateur radio station operators and to make special arrangements for persons unable to undertake the examination for an operator's certificate in the normal manner. These include the examination of blind persons.

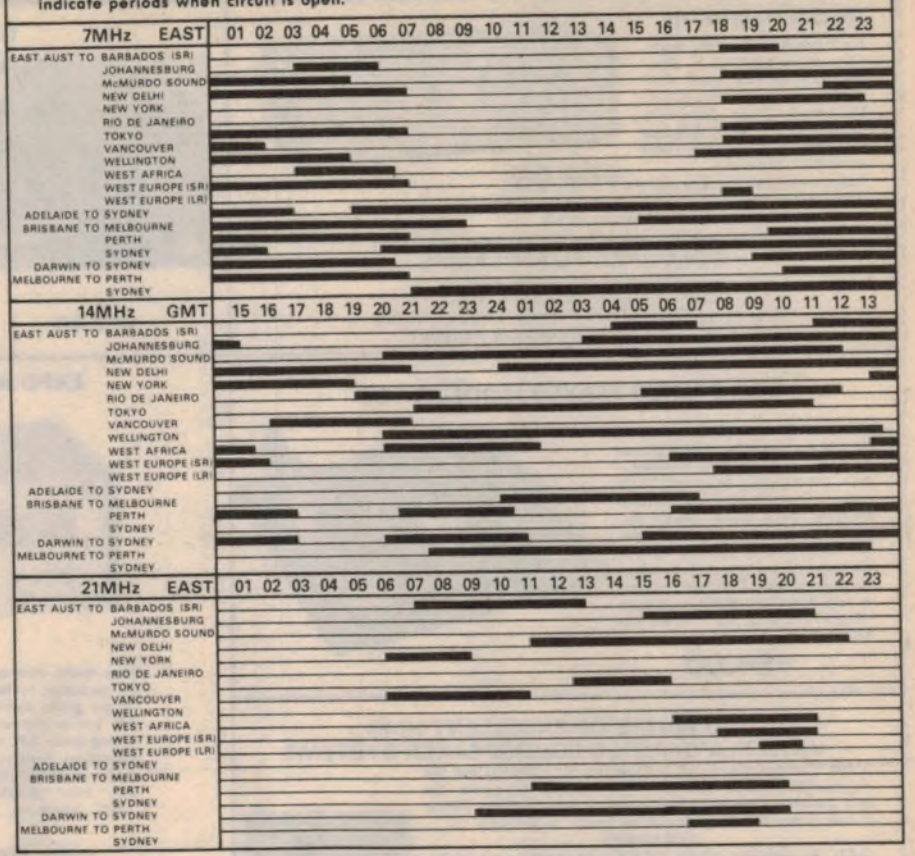
"When an incapacitated person satisfies the Department at a special examination that he is able to operate an amateur radio station in a responsible and capable manner he is advised that he may apply for an amateur station licence. An AOCP, however, is not issued in these cases.

"Where the Department feels that it is in the interests of the licensee, special conditions regarding the safety of the station equipment may be required. These conditions may also restrict access to parts of the equipment or require the station to operate in the presence of another amateur radio operator".

IONOSPHERIC PREDICTIONS FOR NOVEMBER

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.

11.76



YRCS NEWS

The January, 1977 issue of these notes will review the WIA Youth Radio Club Scheme. Should club leaders wish to publicise their club with a report or a photograph please send details to the address given on page 117 by the 15th December, 1976.

The Black Forest Scout group in Adelaide, S.A. has a very active club which recently raised funds to purchase an FT200 transmitter. Steve Daff and Geoff Taylor, VK5TY, are concentrating on a radio operating course for club members.

Other clubs in South Australia include the Sacred Heart College club in Adelaide, which has 14 members. Membership is not restricted to members of the School.

Two students from the YMCA club sat for the novice licence examination, John Gazzard has two theory and one Morse code instructors assisting him. An active club meets each Tuesday evening at Port Augusta which is guided by Lloyd Douglas assisted by a former student.

In New South Wales there are at least 29 clubs registered with the NSW division of the YRCS.

John Stroud of the Blue Mountains Radio Club has been accepted as a trainee radio technician by the RAAF. His older brother Michael joined the RAAF in a similar trade earlier in the year. In both cases the RAAF selection board expressed satisfaction at the production of their YRS certificates.

At a radio camp at Wiseman's Ferry, organised by Reverend Bro Cyril Quinlan of the Eastwood Marist Brothers High School Radio Club, eight boys qualified for YRS certificates.

Two Blue Mountains Radio Club members have been successful in a recent amateur examination. Peter Griva, gained the AOCP and Henry Lepke the AOLCP. A recent "on the air" night used a transmitter built by one of the members to the design published in the January and February, 1976 issue of "Electronics Australia". The transmitter worked like a charm and several contacts were made.

Classes in electronics are conducted by the BMRC at the Springwood primary school every Friday night at 8.00pm. Meetings are held in the Blaxland primary school on the first Monday of each month.

Enquiries should be directed to the publicity officer, Geoffrey Swift, 21 Hodgson Road, Glenbrook, 2773, telephone 39 1144.

Shortwave Scene

by Arthur Cushen, MBE

An increase in the frequencies allocated to short-wave broadcasting has been forecast. Current plans call for a doubling of the spectrum allocated to short-wave broadcasters and, if adopted, will reduce the interference currently experienced by listeners on the now crowded bands.

According to Jim Vastenhoud of Radio Nederland the plans for the expansion of short-wave bands would increase their present frequency range from 250kHz to roughly 500kHz. He indicated that the short-wave broadcasting bands are now so overloaded that an end to the power race in short-wave transmitters can only be achieved if the 1979 World Administrative Conference decides upon a marked extension of short-wave broadcasting bands. Many short-wave broadcasters think that the shift of traffic from fixed bands to satellite will provide a chance to double the spectrum allocated to short-wave broadcasters. Broadcasters also hope to make use of the 7MHz band world-wide and to inaugurate a new short-wave broadcasting band for regional broadcasting in the 4 or 5MHz range.

LA VOZ DE GALAPAGOS

Signals from the Galapagos Islands off the coast of Ecuador continue to be received on 4810kHz from opening at 1215GMT. The station is now verifying reception with an attractive card from the Station Director, Reverende Padre Edgar Raul Pinte. Galapagos lies off the coast of Ecuador and consists of 12 large islands and several hundred small islands. The largest town, San Cristobal, is the site of La Voz De Galapagos. The station has a call sign HCVG6 and operates on 4810kHz 1215-1430 and 2300-0400GMT. According to the New Zealand DX Times, Galapagos time is 6 hours behind GMT. The station is operated by the Franciscan Mission and has an affiliate station on Santa Cruz Island on 1410KHz medium-wave.

NEW VOA BASE

According to the BBC Monitoring Service, the Voice of America could establish another relay base in Portugal. Radio Difusao Portuguesa, Lisbon has quoted a report from the Portuguese community press in Massachusetts that the United States authorities are expected to approach the Lisbon Government with the view to establishing a transmitting base in Portugal for "Voice of America" broadcasts to Europe and North Africa.

At the present time the Voice of America, as well as operating five transmitting sites in the United States, also has relay stations in Thailand, Sri Lanka, Greece, Ryukyu Islands, Philippines, Morocco, Liberia and England.

The Voice of America recently discontinued typing the location of the transmitter on the verification card and also deleted the announcement of the transmitter location in the station announcement. This has been brought to the attention of the American Senate, which has reversed the policy somewhat. Sites will continue to be listed in the VOA'S Frequency Schedule. This schedule will be sent to anyone requesting a copy. After ascertaining the correct site from the Frequency Schedule, include the site on your report, along with a request for verification of this specific site. If readers follow this policy they will then receive a verification giving complete details of date, time and the frequency and location of the transmitter.

Notes from readers should be sent to Arthur Cushen, 212 Earn Street, Invercargill, NZ. All times are GMT, add 9 hours for West Aust. Summertime, 11 hours for East Aust. Summer time and 13 hours for NZ Summer time.

NEW TWR STATION

Trans World Radio, which already operates gospel stations at Bonaire, Swaziland and in Monte Carlo, has recently opened a medium-wave transmitter in Guam on 770kHz. Now comes the news of a new 400kW transmitter to operate from Sri Lanka on 890kHz to serve the South Asian area. In a release from TWR it is pointed out that the station will be located in Northern Sri Lanka, just 20 miles from the southern tip of India. TWR expects to have a dominant signal that will be not only easy to find but almost impossible to ignore. TWR expects to cover Afghanistan, Pakistan, Bangladesh, Burma, Nepal, and Thailand—a total population of 839 million people.

VATICAN'S HIGHER POWER

The installation of a new 500kW transmitter for Vatican Radio is expected to be completed next month and put into service. As well the station is to have a tall rotatable aerial system to take advantage of the power boost. This increase in power over the present 100kW transmitters will enable it to be heard throughout the world with more reliable signals. The rotatable aerial, which consists of two towers each 79 metres high, will allow the signal to be beamed at any point in the world, doing away with the many masts and arrays formerly necessary.

The Vatican Radio broadcasts in English to Australia and New Zealand daily from 2210-2225GMT on 7235, 9615 and 11705kHz.

PAPUA NEW GUINEA STATIONS

The next station to open in Papua New Guinea, according to John Campbell reporting in the WRH Newsletter, is Radio West Sepik, Vanimo 2kW, which has been assigned 3205kHz. Later Radio Enga at Waba will be built, but there are no plans as yet announced for this new station. West Sepik and Enga are the only two Papua New Guinea provinces which have no radio service of their own. These two stations would complete the radio development plan.

RECENT VERIFICATIONS

MOZAMBIQUE: Radio Mozambique at Maputo, formerly Lourenco Marques, confirmed reception with a card as well as a letter and schedule. The card shows a map of the world with Mozambique marked. According to the schedule enclosed the 'A' program is broadcast 3210kHz 0400-0600 and 1700-2200GMT; 4925kHz 0400-0630 and 1615-2200; 6115kHz 0400-2200; 9620kHz 0500-1700; 11820kHz 0500-1700; and 15295kHz 0700-1500GMT.

ECUADOR: Radio 'Centinela Del Sur' Loja verifies with a letter. The callsign is HCER5, and the station broadcasts on 4890kHz. As well as the letter, a pennant was enclosed. The verification signer is Hernan Coronel.

MEDIUM WAVE NEWS

AUSTRALIA: 2GN Goulburn, NSW, recently made a frequency change from 1380 to 1370kHz to avoid interference from 3MP, which is now on 1380kHz. According to a verification letter from the Chief Engineer of 3MP, they operate 24 hours a day using 5kW and feeding a directional antenna system with protective mills toward Lithgow and New Zealand. 3MP also sent a verification card, as well as the covering letter. The address of the station is Mornington Peninsula Broadcasting Ltd, Bayside Shopping Centre, Beach Street, Frankston 3199.

Station 2LT Lithgow, which formerly operated on 1370kHz, had moved to 1380kHz instead of the previously announced 1390kHz.

Last year it was announced that 3 medium-wave and 9FM stations would be licenced for Universities and Technical Institutes. One of these, operated by the National University at Canberra, has been heard by Chris Martin of Sydney. According to the DX Post Adelaide 2XX is a new community station located in the nation's capital. The Australian National University is running 2XX with a power of 300W on 1010kHz. Hours of transmission are 2000-1500GMT. Postal address is PO Box 4, Australian National University, Canberra 2600 ACT. The other two stations for medium-wave operation are to be operated by the Darling Downs Research Institute at Toowoomba and the West Australian Institute of Technology.

LISTENING BRIEFS

EUROPE

DENMARK: Radio Denmark at Copenhagen has recently installed a rotable antenna and is now being heard on 15165kHz 0730-0815GMT, while a further transmission on the same frequency has been noted at 2030GMT. Some other transmissions observed are 0900-0945, 1730-1815 and 1900-1945GMT.

SWEDEN: Radio Sweden continues to operate a test transmission to Australia and New Zealand with a relay of the Swedish Home Program. Recently the frequency was moved from 11705kHz to 9605kHz, although the transmission is still broadcast 0630-0800GMT.

EAST GERMANY: Radio Berlin international broadcast in English to South Asia 0645-0715 on 15240 and 17800; 1200-1230 on 11965, 15125 and 21540; and 1400-1430GMT on 15125 and 21540kHz.

ANDORRA: Information from the World Radio Handbook Newsletter indicates that Radio Andorra is again on short-wave on 6230kHz. The station broadcasts weekdays 0600-1500GMT with a relay of the home program in both French and Spanish, with French being broadcast 0600-0700GMT. At weekends they are broadcasting in English and Dutch 0900-1400GMT. The experimental broadcasts are for a three month trial period and IRC's should be enclosed with a reception report to receive the special verification card.

FRANCE: The English transmission to Africa has been retimed to 1600-1700GMT and is now broadcast on 15200, 15210, 15300, 15360, 15425, 17720, 17800, 17850, 17860 and 21580kHz.

HUNGARY: Radio Budapest has a daily transmission in English to the Far East 1030-1100GMT on 7155, 9585, 11910, 15160, 17715 and 21525kHz. A further transmission 1200-1240GMT is broadcast Monday to Friday on 6150, 7155, 9585, 11910, 15160, and 17785kHz.

BELGIUM: The Belgium Radio has a daily broadcast in English 0015-0045GMT on 9735kHz. Relays of the home program are also broadcast and reception in this area is generally good 0430-0615GMT on 9650-11790kHz. A further transmission 1000-1130GMT is on 17740 and 21475kHz.

AFRICA

BENIN: According to Sweden calling DXers two transmitters are being supplied from Germany, one of 20kW for medium-wave and one of 50kW for short-wave, with a rotatable aerial for transmission to Europe, Asia and later North America. For the time being ORTB, Cotonou, broadcasts on weekdays 0515-0830 and 1615-2300GMT on 4870kHz, and 1130-1330GMT on 7190kHz. On Saturday and Sunday the transmission is 0600-2300GMT, with the morning and evening transmissions on 4870kHz and the midday session on 7190kHz.

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Brand new in original packing cases—unopened complete with 240 volt power supply. Charts, etc. $90 each—cartage to rail $1. Freight payable at nearest attended railway station.

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INFORMATION CENTRE

PLAYMASTER TWIN 25: The .0022uF capacitor on each power amplifier of the Twin 25 is wrongly placed on the PCB. According to the circuit the .0022uF is between the collector of T10 and the OV line. The .0022uF is in fact between the OV line and the collector of T9. Dick Smith's staff assure me the thing works regardless. However, I have a mangled BC640 and a 39 ohm resistor to prove it doesn't. Moreover, BC640's are hard to get in Canberra. Can you advise substitute types? (B.W., Kambah, ACT.)

● There is an apparent anomaly between the PCB and circuit but the PCB is a direct equivalent to the circuit, as far as AC signals are concerned. This is because of the signal bypassing effect of the shunt 0.1uF capacitor across T15. The circuit does work. Your damaged components are likely to be due to incorrect insertion of the BC640. Notice that the leadout diagram for the BC639/640's is different from the other transistors in the circuit. At this stage, we cannot nominate available substitutes for these transistors, apart from the more expensive BD139/140 types.

THIRD METHOD SSB: I wonder if a constructional article could be produced by your magazine for an SSB exciter based on the "third method" of generation, using CMOS technology. Readers such as myself have such limited recourses, that a project could better be done by someone with more experience in the field, hence my request directed to Electronics Australia. The idea is not new but I have never seen a project published along these lines. I feel that the advantages of the "third method" are considerable, with particular regard to the matter of adjustments and I also feel that many other readers would be interested in a project of this nature. (A. E. A. Nelson, NZ.)

● Thank you for your suggestion regarding the SSB transmitter using the "third method" of generation. We have already given the matter some thought, and we will certainly be giving it some further serious thought in the near future. This does not constitute a promise of a project, but we will present one if circumstances permit.

COLOUR PRINTING: I was interested in your discussion of the Colorvision CCS in the June issue. It occurred to me that it might be used for slide presentation and, by simple electronic reversal, viewing of colour negatives would be possible. My main interest in this would be to determine the filter requirements to produce a balanced print from a colour negative.

In this regard a test print could be obtained by trial and error and, by knowing the filter factors used, and adjusting the machine to produce an identical picture on a colour TV set, it would be possible to solve the problem of colour reproduction. (M. K., Russell Lea, N.S.W.)

● This idea is not new. We published a brief description of such a system some years ago, as developed by an American firm. It was intended for making enlarged prints, but we have heard little about it since. On the other hand the idea is well established in the motion picture film processing industry and it is used by at least one large processing laboratory in Sydney. It is generally regarded as an

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L.E. CHAPMAN

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Ferrite Rods 6 inch 50, 9 x ½ 75 cents.
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8 x 4 8 or 15 ohm	$4.50
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MSP 12 inch 12 UAX x 8 ohm. 20 Watt RMS	$17.50
MSP 4 inch 120 ohm	$3.50
4 inch 120 ohm	$4.50
2¾ inch 33 ohm	$2.00

ideal solution to the basic problem.

While the idea is simple, the hardware and calibration are quite complex and we seriously doubt whether it would be within the scope of the home constructor. As far as the Colorvision unit is concerned it is suitable only for 8mm film.

DRILL SPEED CONTROLLER: I have a complaint to lodge about your Mark II drill speed controller. (July 1976, 2/PC/22). With the potentiometer turned up full there is an output of about 15 volts. The circuitry has been checked over and all double soldered. If you could suggest some fault that could be in it, I would be very happy. (H. H., Condobolin, NSW.)

● There could be any number of faults. You will have to trouble-shoot the unit using your multimeter. Check the resistors for correct value. Check the diodes for low resistance in one direction and high resistance in the other. The ST4 should show high resistance in both directions. The SCR (or Triac) can be checked in the following way: Disconnect the gate and connect it via a 1k resistor to the Anode (or A2 in the case of a Triac). Now connect a drill and switch on. The drill should run at a high speed, but not its maximum. If the drill runs slowly, or not at all, replace the SCR. If the SCR checks out, then the ST4 is the other possible faulty component.

NOTES & ERRATA

AM SYNCHRODYNE RECEIVER (June 1976, File No 2/TU/41): Readers have reported difficulty in obtaining the BA163 varicap diode. The author has suggested an alternative. Substitute a BB105G varicap as used in the Playmaster FM tuner and increase the series 47pF capacitor (C24) to 0.01uF.

3.5MHz SOLID STATE TRANSMITTER (September 1976, File No 2/TR/60): On the circuit diagram, the 270pF and .0012uF capacitors in the tuned circuit of TR2 should be reversed.

MUSICOLOUR Mk III (September 1976, 2/PC/23): To ensure reliable operation with all 555 IC's, the 10k and 33k resistors at the output of the bridge rectifier should be changed to 330 ohms and 1k respectively.

Car Burglar Alarm . . . from p. 57

since, in most car electrical systems, bypassing the ignition switch, as a thief would normally do, will cancel the alarm in the same way as operating the switch itself.

Fig. 4a shows how a double pole switch is wired in series with the accessory switch and push button. With this fitted the thief has not only to bypass the accessory or ignition contacts, but also find and disable the second switch.

The purpose of the switch in the push button circuit is to prevent children—or curious adults—setting the alarm when the car is parked with the ignition switch in the off position.

Amateur Microwaves . . . from p. 79

1975 article. This arrangement is the obvious one to use on 5.8GHz and work is proceeding in that band at VK2AHC.

Fig. 13 shows the complete circuit of my 3400MHz equipment. It illustrates the FM crystal oscillator circuit and the use of 723 regulators, VHF amplifiers and varactor multipliers.

CONCLUSION. It is hoped that this may serve to help the newcomer to amateur UHF and microwave. Current programs at VK2AHC are aimed at investigating super refraction effects at 5.8GHz and 10GHz and keep abreast of techniques used in the rest of the world, particularly in the UK where activity at this time is extremely high.

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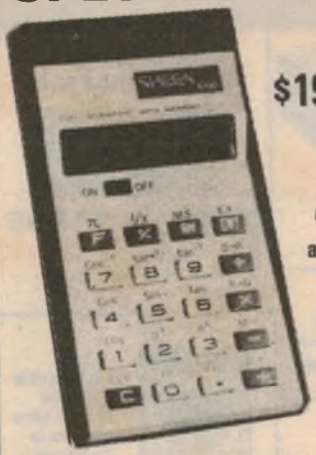

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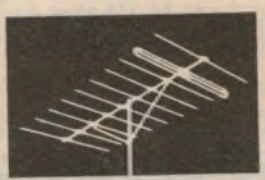

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Hartland WH89 Copper Braid	3.3 dB	100 metre	36.92
Hartland WH87 Copper Braid	6.0 dB	100 metre	26.65
Hartland WH86 Copper Braid	6.5 dB	100 metre	19.25
300 ohm Feeder Cable	1.8 dB	100 metre	8.80
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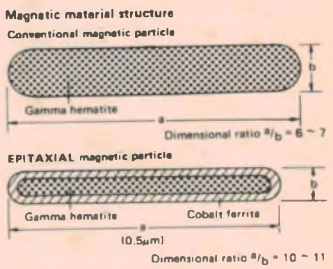
UD XL

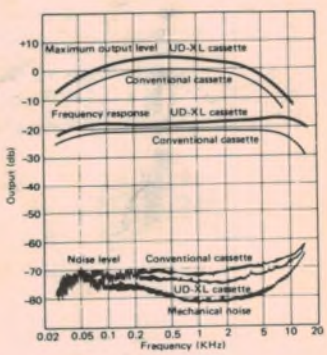
Developed by MAXELL this completely new EPITAXIAL magnetic material combines the advantages of the two materials (gamma-hematite and cobalt-ferrite): the high sensitivity and reliable output of the gamma-hematite in the low and mid-frequency ranges and the excellent performance of the cobalt-ferrite in the high-frequency range. The result is excellent high-frequency response plus wide dynamic range over the entire audio frequency spectrum.

Compared to chrome tape, sensitivity has been improved by more than 3.5dB. Because EPITAXIAL is non-abrasive, it extends to the life of the head. Consequently, the UD-XL delivers smooth, distortion-free performance during live recording with high input. When using UD-XL it is recommended that tape selector be in the NORMAL position.

Fidelity is also ensured by a precision-manufactured cassette shell with a special anti-jamming rib that provides smooth tape travel and helps eliminate wow and flutter.

Another good idea of the UD-XL cassette is a replaceable self-index label. Simply peel off the old label and put on a new one when you change the recording contents. No more mess on the label.





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