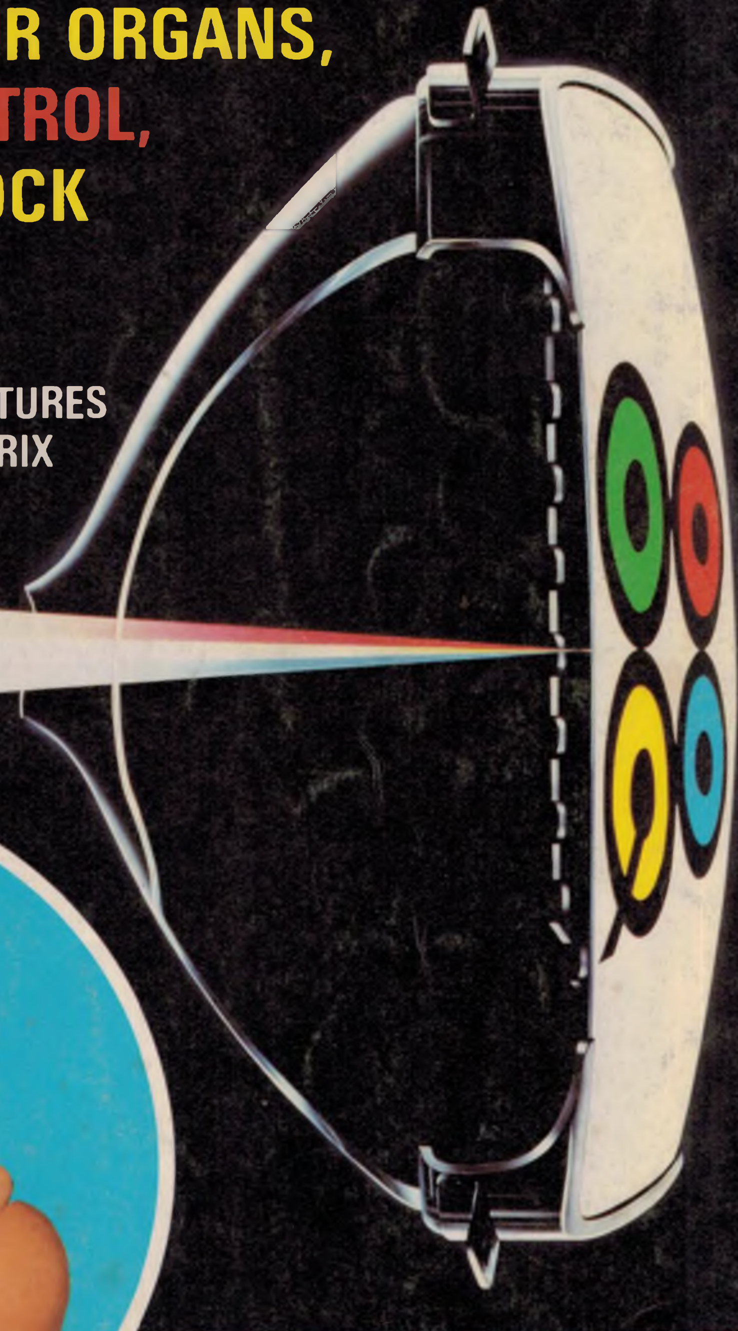
ELECTRONICS Australia

HIFI NEWS

JULY, 1976
AUST $1.00* NZ $1.20

BASS SPEAKER FOR ORGANS, DRILL SPEED CONTROL, DIGITAL WALL CLOCK



BRIGHTER, SHARPER PICTURES WITH NATIONAL'S QUINTRIX

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The case for cassettes...

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Consider: Wow and flutter less than 0.07%; Frequency response 20Hz to 20kHz; Signal to noise of 55dB (and even better with Dolby on). All that and cassette convenience!

Sony did it by combining its proven closed-loop dual capstan drive with a number of remarkable new cassette deck developments. First, the TC-177SD has three heads for separate erase, record and replay. This ingenious design avoids the compromise between record/playback head design and permits A/B monitoring of sources and just recorded signals for instant checking.

Second, the TC-177SD is unique in providing Bias/Equalisation switching so that Sony's fantastic new Ferri-Chrome and the normal chrome dioxide tapes can be "tuned" for ideal balance in recording. Naturally Dolby noise reduction is inbuilt. But with a typically Sony difference; four Dolby circuits provide such super features as Dolby monitoring, there's a Dolby oscillator for optimising the particular tape in use, and for Dolby-encoded broadcast FM.

Functions, too, are up to the highest reel standard: feather touch control buttons; FM multiplex filter; full mixing for microphone and line inputs; peak level indicators are LED to complement the Limiter and 2 large VU meters; a memory counter for auto location of desired part, and there's an auto shut-off.

Everything you've wanted for easy, professional-quality cassette recording is now together in the fabulous Sony TC-177SD.

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Sony TC-177SD puts 3 heads together

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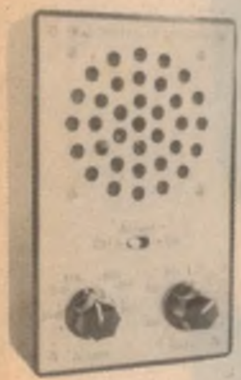
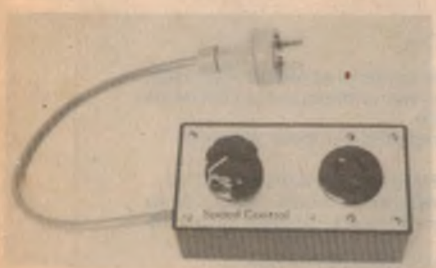
VOLUME 38 No 4



Developed in our laboratory, this digital metronome should be just the thing for music students. It is based on modern CMOS ICs, features accented beat, and is easy to construct. Details on page 40.



This simple unit will allow an electric drill to be used over a wide range of speeds while still maintaining good torque characteristics. Two alternative circuits are presented on page 62.

On the cover

The main theme on this month's front cover is a stylised view of the new National "Quintrix" colour TV picture tube, showing the placement of the additional pre-focus lens. The pre-focus lens is used to give a smaller diameter spot, resulting in a brighter, sharper picture. Our story on page 29 has all the details. Inset, an attractive model displays some unusual "jewellery"—bandolier packed metal glaze resistors produced at the IRH plant at Kingsgrove in Sydney for export to Japan. IRH's success story is on page 24.

CONTENTS—JULY, 1976

world of electronics and hi-fi

projects and technical

regular features

You can build this 12" three-way imported Philips speaker system

— all it takes is a couple of hours and a screwdriver

This new addition to the Philips series of assemble-it-yourself professional quality speaker systems introduces an altogether higher standard of performance.
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Editorial Viewpoint

The broadcasting inquiry

By the time you read this, the public servants who conducted the recent inquiry into broadcasting for the Minister of Posts and Telegraphs should be busy preparing their report. To my mind it is a great pity that the inquiry was not fully public, and that it was not conducted by a panel or committee of completely independent people. It also seems to me to have been conducted with undue haste, when one considers the future ramifications of any decisions made upon its recommendations.

Despite these qualifications, it will nevertheless be a good thing if we can have at least some resolution of the current confusion, doubt and lack of confidence which is everywhere evident in the broadcasting industry. In December last the Editor-in-Chief noted that the ABC, the commercial broadcasters and the aspiring community broadcasters were all stumbling along, shackled by lack of adequate planning and cohesive administration.

Frankly, I believe the answer will be to bring all areas of broadcasting administration under a single authority. But I also believe we should go further than that, and give the same authority full responsibility for non-broadcasting usage of the electromagnetic spectrum. Only by creating an authority of this type, fashioned perhaps on the American Federal Communications Commission, will we really be in a position to ensure planned and co-ordinated use of the spectrum for the future.

I can only hope that when the Federal Government considers the report of the inquiry, they give due consideration to this possibility, and not preclude it by a hasty decision based on political expedience.

Microprocessors

On a happier note, it is good to see that microprocessors, those exciting new devices which seem destined to change the whole nature of electronics, are now becoming available in Australia in quantities and at prices which bring them right down into the sphere of schools and individual hobbyists.

Whether you're an engineer, a technician or a hobbyist, you'll probably have to adjust to these intriguing devices, and learn how to use and drive them. Here at EA we are planning to do our best to help you do this. In the coming months, we plan to publish as much down-to-earth material on the subject as we can. We're starting the ball rolling in next month's issue with a special introductory supplement, so make sure to get your copy.

Too much of a good thing

Talking of supplements, the Dick Smith Electronics catalog we ran in the April issue has apparently brought that firm so much mail order business that they are literally submerged in paperwork. Dick Smith rang me the other day to ask if I could apologise on his behalf to any readers whose orders seem unduly delayed. He asks your indulgence, and has given us an assurance that all orders will be processed as soon as they can.

Apparently one of the problems is that Dick and his staff have to knock off every so often, to eat and sleep!

—Jamieson Rowe

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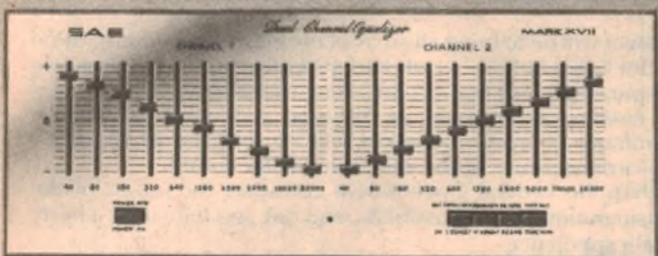
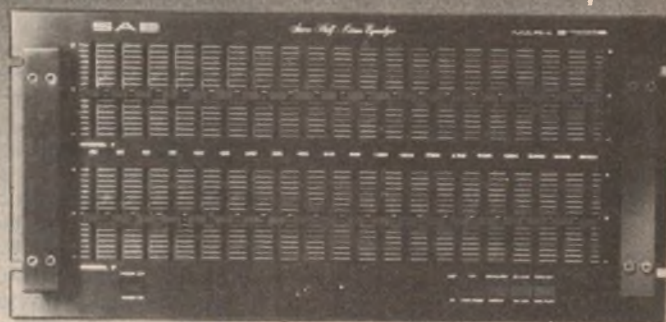
some are more equalizer than others

• MARK XVII octave equalizer



• MARK 2700B half octave equalizer



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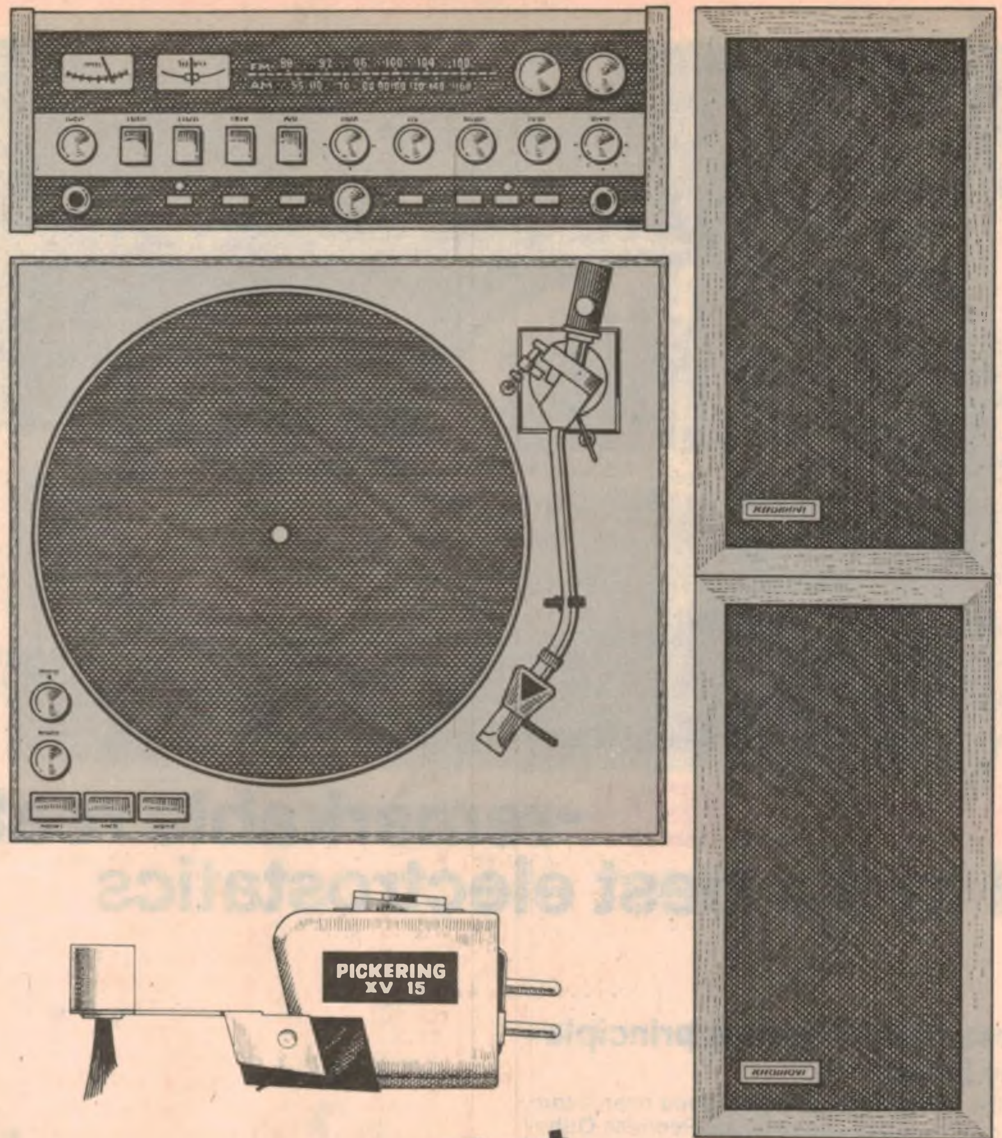

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Hi Fi News

Linear phase: "Everybody's doin' it . . ."

It seems that, whichever way one turns these days in the world of hifi, one is faced with the term "linear phase", or one of its many possible variations. What does it all mean and, more importantly, what does it add up to in terms of the audible end result?

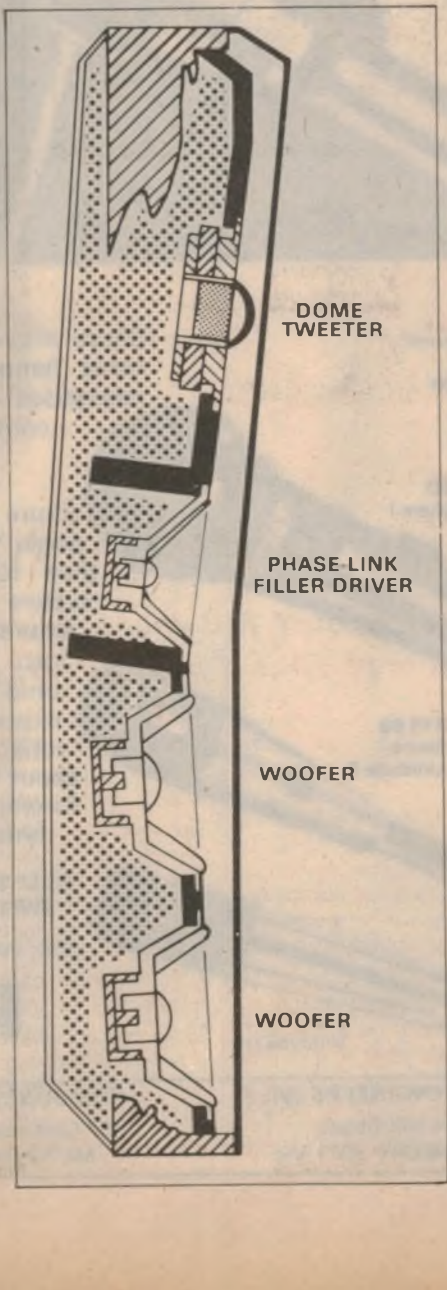
by NEVILLE WILLIAMS

To date, most of the emphasis on phase in stereo systems has been to make sure that the bass drivers in the respective stereo channels are in phase with each other. If they are not, so that one cone is trying to compress the air in the room, while the other is trying to do the reverse, the end effect is an apparent loss in the bass response of the overall system.

As far as the middle and upper frequencies are concerned, it is normal to stipulate that the drivers that produce them should be connected the same way in both channels to ensure a symmetrical phase characteristic. At these frequencies it is not so much a question of energy being cancelled, but of optimising the definition of the stereo image. The greater the symmetry between the left and right channels, the more precise will be the apparent location of dispersed sound sources, particularly those between the two loudspeakers. At least that's what the good books say!

Not that the good books are all that sacred; the whole concept of a hard stereo image has taken a beating in recent years with the emphasis on multi-directional loudspeaker systems. These deliberately diffuse the sound sources by bouncing a large proportion of their output off adjacent walls. The case made for this approach is that it fills the listening room more naturally than if the sound comes from a narrow imaginary horizontal rectangle between the two speakers.

To counter the criticism of excessive diffusion, multi-directional loudspeaker systems usually position one driver on the side directly facing the listening position, to establish a directional reference. Even so, it is difficult to escape the conviction that the designers are more concerned with the total subjective effect rather than the theoretical niceties of phase and stereo imaging.



And one has to concede that total subjective effect has an essential relevance when the objective is pleasing, natural sound!

However, despite the almost evangelistic fervour of the proponents of multi-directional systems, very strong support has continued for forward-facing drivers, in some cases with a renewed emphasis: the design of each integral loudspeaker system should minimise phase shift between the various drivers (bass, middle, treble) as evident at the listener's ears. The argument runs something like this:

Conventional testing procedures using sine waves only do not adequately probe the performance of a loudspeaker system. Testing with square waves can reveal a great deal more about phase and transient behaviour. There is good reason to assume that, if a system can do justice to square waves, it will do justice to any likely musical signal.

When a loudspeaker system is called upon to reproduce a square wave, it falls largely to the tweeter to produce the abrupt changes in pressure—the near vertical changes from one pressure to the other. The mid-range driver has to maintain the pressure at the new level until the woofer has time to "catch up" and hold the pressure for the duration of the "flat" portions of the wave.

If the respective drivers (treble, mid and bass) get out of step because of phase leads and lags, then the various components would seemingly fail to assemble a true squarewave of pressure at the the listener's ears. Presumably, the sound will have undergone a quality change that (again presumably) will be for the worse.

To demonstrate the effect, researchers have set up microphones in front of various loudspeaker systems and looked at the received waveform on an oscilloscope. While all such waveforms show some deterioration from their journey through air and two transducer functions, it is possible to design systems which tend to produce better looking waveforms than average. Whether they sound any better is another matter.

We shall say more about this later.

It seems likely that the current concern about phase within an integral system stemmed first from calculations surround -ing the design of cross-over networks. Whereas, in earlier years, it was a problem enough to attain the appropriate input frequency and power to each

Bang & Olufsen are currently offering a complete range of what they describe as "Uni-Phase" loudspeaker systems: the M70 free standing system (70W RMS), three shelf models at 30, 45, and 60W RMS, and two wall mounting units rated at 30 and 45W. As illustrated at left, the wall units have a modestly concave front, presumably intended to equalise the effective distances between the respective drivers and a typical listening position.

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driver, today's computer equipped mathematicians can do it all with much less sweat, and plot phase and its possible implications as part of the operation. And what they now know about, they can also argue about!

The use of multiple drivers has itself been the subject of interminable debate but most loudspeaker designers now seem to agree that, for the present, the best approach is to use multiple drivers, each designed for optimum performance over an assigned portion of the audio spectrum. Crossover networks must therefore be included, somewhere in the amplifier chain, to ensure that frequency components in the total signal are assigned predominantly to the appropriate driver.

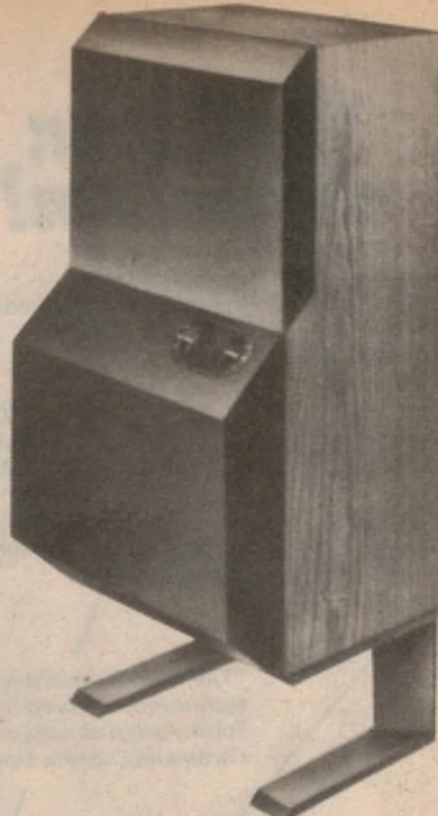
As far as phase is concerned, there is no great hassle if the divider networks are of the simplest type, using just an inductor to block the highs and just a capacitor to block the lows, each looking into its own resistive termination. The attenuation slopes approximate 6dB/octave and the phase angles either side of crossover are smooth and complementary. So energised, the complementary drivers can ideally produce a pressure resultant in space which shows no discontinuity in either amplitude or phase. Theoretically, they should be able to contribute to an accurate square wave (or other transient) in space.

The problem is, however, that 6dB/octave filters do not assign frequencies sharply enough to take best advantage of the specialised drivers. The woofer gets too large a proportion of the middle register which should be going only to the mid-range driver. The reverse is also true, and the problem is repeated between the mid-range driver and tweeter. As a result, much attention has been paid to the derivation of more elaborate (and more expensive) networks capable of giving an attenuation slope between drivers of 12dB/octave, or even 18dB per octave.

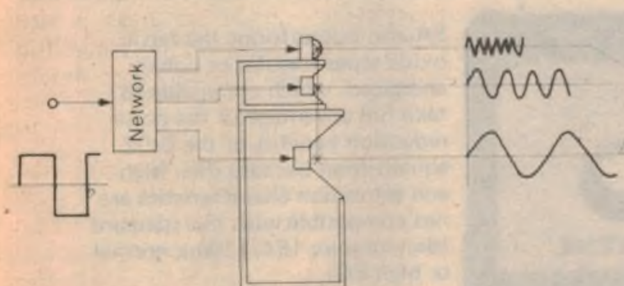
Unfortunately, while achieving one objective, these steeper networks run into another problem. Using both L and C in each leg, they produce the sharp phase discontinuities which tend to characterise resonant circuits. Thus, while a plot of the voltage to each driver may suggest a smooth and symmetrical crossover, the respective voltages may turn out to be 180 degrees out of phase at the crossover point, and produce a deep pressure null in space due to cancellation. This can be partially corrected by reversing the connections to one driver, but what are the other implications of so doing?

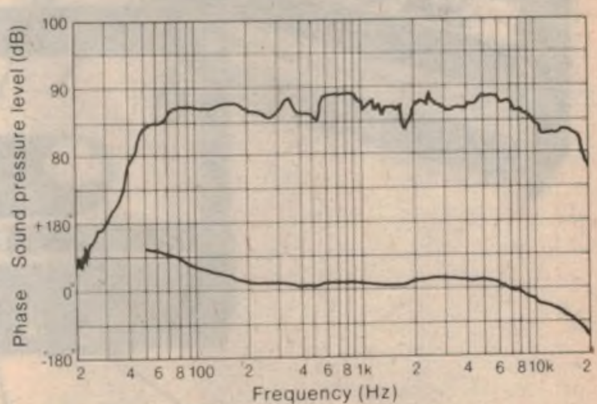
It is largely because of these considerations that engineers in Australia and elsewhere have recently published learned papers examining the behaviour of frequency crossover networks. Most such papers are well above the heads of the average hifi enthusiast and it may well be that the resulting practical networks, with more ambitious specifications, will also be above a good many pockets!

It is sufficient to say that the implication of linear phase response starts right inside the enclosure, in the crossover network. The curious alternatives would appear to be a step back to greater simplicity, or forward to greater com-

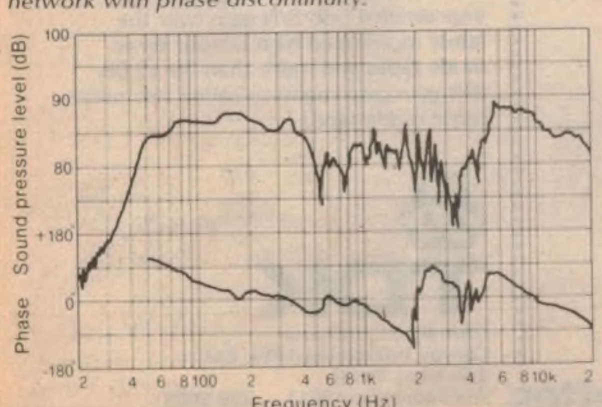


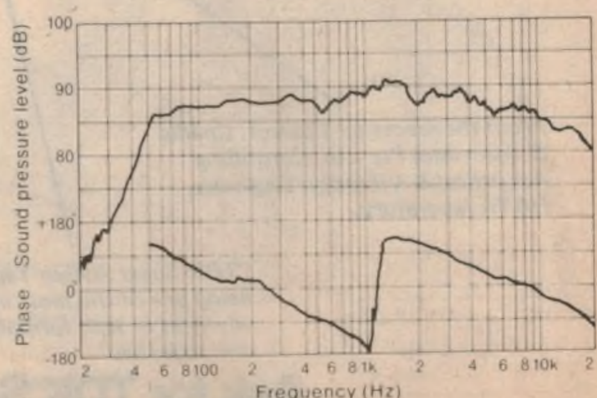
Advertised as "Britain's first linear phase speaker system", the B&W DM6 is also one of the most aggressively linear in styling! The woofer, operating into its own internal chamber, is mounted behind the lower frontal panel. The mid-range, behind the upper grille, is further back, while the tweeter is on a third terrace. The controls permit overall balance to be varied as desired.





From Technics literature, the above diagram illustrates their SB-7000 "Flat-Phase" system and, at right, a plot of frequency response and phase. Below: the same system but without vertical alignment. Bottom right: correct driver alignment but fed through a conventional divider network with phase discontinuity.





plexity!

A natural corollary of all this has been an examination of the physical placement of the loudspeakers themselves in relation to the listening position. Superficially, there would seem to be little point in ensuring that the multiple cones move in a close phase relationship if their physical distances to the listeners' ears are sufficiently different to produce a significant time (and therefore phase) differential in space.

Whether or not the time difference is "significant", the obvious fact remains that the respective drivers are at varous distances from the listeners' ears, even in systems using a common front baffle. The woofer cone is invariably set at the bottom and, considering its considerable depth, its effective distance from (and below) the listening position is greater than that of the higher placed and shallower mid-range cone. The tweeter is usually closer again.

With this in mind, a number of manufacturers have released models in which the distances to an anticipated listening position have been equalised: by tilting the enclosure as a whole, by angling the front of the enclosure, or "terracing" it to create multiple planes on which the drivers mount. If such treatments look unusual, they are also potential selling points to buyers who may be a little weary of the conventional.

Almost as a matter of course, one can foresee a rash of imitators offering budget priced look-alike boxes with sound-ordinary works, but our concern is not with them. It would certainly seem that the reputable manufacturers have done their sums—the big problem being whether the answer can be heard as readily as it can be displayed!

So much for the background story. What has been the reaction of other speaker manufacturers and of those who have listened at length to these new linear phase systems?

At the "boffin" level, there has been plenty of argument, with some branding the whole thing as a technical exercise that has been turned into a marketing gimmick of no real significance to the hifi buyer.

They claim that experiments over many years have shown that the human ear is not nearly as sensitive to relative phase as has been claimed; that the ear breaks a complex wave into its component frequencies anyway and judges the sound by its components, not by the shape they happen to add up to on an oscilloscope screen. The microphone/CRO set-up may be an interesting visual exercise but one from which quite unjustified acoustic parallels are being drawn. And what of the precise microphone position and the effect of reverberant energy in a typical room?

Proponents of the approach do, indeed, rely heavily on the oscilloscope display to justify their case but they maintain, with varying degrees of fervour, that their listening tests confirm the visual display. But in any case, it would seem wise to design for a deliberate phase relationship in the direct listening area, rather than leave it entirely to chance.

What has been listener reaction so far?

Leaving aside those who have a vested interest in the various systems, listener reaction has been cautiously favourable, but without any apparent conviction that the linear phase treatment has opened up a whole new world of sound. Some have been more definite when they have been able to listen to signals which have been recorded right through with a meticulous attention to phase.

But have they been reacting to phase or to the "meticulous attention"?

Ortofon also are stressing reduced phase distortion but their emphasis is different from other manufacturers. The drivers protrude to a greater or lesser degree but the systems look conventional with the front grille in position. Very little is said about the crossover network but Ortofon say that their wooter is something special, with a non-magnetic, low-resistance cap over the end of the inner pole piece. By giving a 10:1 boost to the voice coil acceleration on transients, the woofer is better able to follow the higher frequency drivers without phase lag.

More ambitious than the usual integrated amplifier, the new 3200/140 complement by Marantz nevertheless avoids the cost penalties of super-power designs. The model 3200 preamplifier (top) offers "ruler flat" response from 20Hz to 20kHz (± 0.5dB) with less than .05% harmonic distortion. Tone controls are detented sliders for bass, middle and treble, with selectable turnover. It will accommodate two tape decks for dubbing, &c. The power amplifier model 140 offers 75W RMS per channel minimum into 8 ohms at no more than 0.1% distortion. (Details from Auriema (A'Asia) Pty Ltd, P.O. Box 604, Brookvale, NSW 2100).

Toshiba's new SA220L receiver/amplifier is designed for the user who needs all the usual hifi receiver/amplifier facilities without having to pay for jumbo-sized power output; the receiver provides for L.W., M.W. and FM-stereo reception, connection to phono, "aux" or tape input (with tape monitor facilities) and 11W RMS per channel into 8 ohms. A companion model SA320L offers somewhat more ambitious specifications and 15W per channel, while the SA420 goes one better again with a 2x 25W output. (For further details: Toshiba-EMI (Australia) Pty Ltd, 301 Castlereagh St, Sydney 2000.)

Others have suggested that a comparison with comparable systems has shown a perceptible firming of the stereo image.

In short, while the linear phase concept may be a contribution to hifi loudspeaker thinking, there is nothing at present to suggest that it is of overwhelming importance or likely to render existing systems obsolete.

Linear phase or not, the overall balance will still depend on the response and matching of the individual drivers; the presence or absence of colouration will be a function of their smoothness; the general quality will be a function of their linearity; the quality and quantity of bass will depend on the enclosure details.

By all means, read what the manufacturers have to say about linear phase, and regard it as a possible plus. But then listen critically to whatever rival systems may be claiming your attention, whether by the same manufacturer or another.

If there's one that especially pleases and suits you, that's still the one to buy—whether it's phase linear or phase something else.

VENTURI LOUDSPEAKERS

In the meantime a letter recently to hand from Mr V. M. Ross, Operations Manager of International Dynamics (Agencies) Pty Ltd, refers to an intriguing item in Audio Times, January 15th, 1976:

"WESTBURY, N.Y. — British Industries' Venturi speaker systems have been found worthy of a patent, number 3,892,288, recently granted by the US government. The patent covers a principle of cabinet design employed in reproducing bass response in which useful energy generated inside the enclosure is substantially increased through acoustic transformer action. B.I.C. vice-president and Venturi division manager Larry Epstein claims the principle enables Venturi speakers to deliver more and cleaner output in the low bass range. He added that the principle, used by B.I.C. for the first time in acoustics with the Venturi line, has been used in carburettors, missiles, steam engines, fluidics and other areas."

AM/STEREO ABILITY

Station 3MP—Melbourne's 7th commercial licence and the first for the city in more than 40 years, plans to be broadcasting in the current month. It has a full, 5 kilowatt signal and will be transmitting on 1380kHz. Its 29 year-old Chief Engineer, Murray Korff, spent seven years with Perth's top rating 6PM, the last three years as Chief Engineer.

Two fully imported RCA BTL 5L-2 "Ampliphase" transmitters are being installed—the first such units to be used by a metropolitan station in Australia. The pair will have AM/Stereo capability. Their "state of the art" technology will allow modulation without use of a modulation transformer. Performance will approach that of FM. (See "Electronics Australia", August 1975, page 7.)

The studio/production consoles are being made in West Australia by Poul Kirk Electronics. The station is stressing a new approach in studio construction, in that the overall design is coming from the desk of the Chief Engineer. In keeping with this philosophy, the consoles are being made to 3MP specifications. They will compare with any in this country.

The antennae are directional and, again, a local product. The system was developed in Australia; in fact the patent is held locally. Their height, 280 feet, is lower than originally planned, but multi-loading will be utilised to give an effective 0.52 wave length at the station's frequency, 1380kHz. It will be the first time the multi-loading technique has been used by a metropolitan station in Australia.

How a GI souvenir began the US tape industry

It is almost a legend that the American tape recording industry virtually began in July 1945, when a US soldier in occupied Germany happened to hear a recording played back on one of the "magnetophon" recorders which had been developed during the war by German engineers. Here is the story of that fateful discovery, and the events which followed—told by that former US soldier himself.

by JOHN T. MULLIN

In 1944—like thousands of other GIs just before D Day—I was in England. Because of my background in electronics, I was assigned to the Signal Corps, troubleshooting a problem the Army was having with radio receivers that were picking up severe interference from the radar installations that blanketed Britain.

I became so intrigued with what I was doing that I would work until two or three in the morning. I wanted music while I worked. The BBC broadcasts filled the bill until midnight, when they left the air. Then, fishing around the dial in search of further entertainment, I soon discovered that the German stations apparently were on the air twenty-four hours a day. They broadcast symphony concerts in the middle of the night—music that was very well played, and obviously by very large orchestras.

I had some experience with broadcast music and knew what "canned" music sounded like. The American networks wouldn't permit the use of recordings in the early 1940s, because they claimed the quality was inferior. You could always spot the surface noise and the relatively short playing time of commercial 78-rpm discs. Even transcriptions had some needle scratch and a limited frequency response. There was none of this in the music coming from Germany. The frequency response was comparable to that of a live broadcast, and a selection might continue for a quarter of an hour or more without interruption.

In Germany at that stage, of course, Hitler could have anything he wanted. If he wanted a full symphony orchestra to play all night long, he could get it. Still, it didn't seem very likely that even a madman would insist on live concerts night after night. There had to be another answer, and I was curious to know what it was.

As the Allied armies moved on Berlin, my unit was reassigned to Paris and lodged in a building that had been a maharajah's palace. It was quite something. Each of us had a big room of his own, with lots of space to store equipment in. We were given the job of rooting out technological developments—particularly those with military applications—that the Germans had made in electronics during the war. That meant taking trips into Germany from time to time.

On those trips, I kept finding battery-operated portable magnetic recorders: about a foot long and eight inches wide with tiny reels. All of them used DC bias, which meant fairly poor signal-to-noise ratio, limited frequency response, and distortion in the high frequencies. But that didn't matter, because they were intended for dictation in the field; bare intelligibility was the prime criterion. We found so many of these recorders that we started dumping them in the maharajah's courtyard. When I left Paris there was quite a pile of electronic hardware out there, rusting in the rain.

In July 1945, a Lt. Spickelmeyer and I were sent to Germany to look into reports that the Germans had been experimenting with high-frequency energy as a means to jam airplane engines in flight. Our mission was to investigate a tower atop a mountain north of Frankfurt. There, in an enormous basement room, were two gigantic diesel engines and generators, apparently designed to pump out high-frequency energy to resonate the ignition systems of enemy planes. Nothing ever came of it.

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A Magnetophon from the wartime Frankfurt radio station, similar to those sent home by the author. Machines such as these were the source of the strange night-time broadcasts heard by Mullin when he was a GI in England during the war.

While we were poking around I met a British army officer who was there on the same mission. The subject of music and recording came up, and he asked if I had heard the machine they had at Radio Frankfurt. When he told me it was a Magnetophon—the term that Germans used for all tape machines—I assumed it was similar to the recorders we had been junking in Paris. He raved about the musical quality of this recorder and urged me to listen to it, but I thought he simply didn't have a very good ear.

On the way back to my unit, we came to the proverbial fork in the road. I could turn right and drive straight back to Paris or turn left to Frankfurt. I chose to turn left. It was the greatest decision of my life.

The radio station actually was in Bad Nauheim, a health resort forty-five miles north of Frankfurt. The station had been moved into a castle there to escape the bombing of Frankfurt, and it was then being operated by the Armed Forces Radio Service. In response to my request for a demonstration of their Magnetophon the sergeant spoke in German to an assistant, who clicked his heels and ran off for a roll of tape. When he put the tape on the machine, I really flipped; I couldn't tell from the sound whether it was live or playback. There simply was no background noise.

The Magnetophon had been used at Radio Frankfurt and at other radio stations in occupied Germany by the time I stumbled onto it, but there was no official word that such a thing existed. The people who were using it to prepare radio programs apparently were unaware of its significance. For me, it was the answer to my question about where all of that beautiful night-music had come from.

Lt. Spickelmeyer and I went to work photographing all the manuals and schematics. I saw to it that the Signal Corps got two Magnetophons. When we came upon more, I kept two for myself. During my last few months in the Army, I took these machines apart and sent them home to San Francisco in pieces. Regulations specified that a war souvenir had to fit inside a mailbag in Paris or it couldn't be sent. I made little wooden boxes for the motors, shipping each one separately. In all, it came to thirty-five separate items. Any one of those boxes could have been lost or damaged, but all of them arrived safely. Reassembly, early in 1946, must have taken me three or four months, including the assembly of the electronics, which I wired anew with American parts.

John T. Mullin, centre at Magnetophon, give the first demonstration of professional-quality tape recording in America for the San Francisco chapter of the Institute of Radio Engineers, May 16, 1946. The unusual doughnut-shaped folded horn speaker in the four-foot-square enclosure was made by Western Electric.

Mullin, with Bing Crosby, listens to a tape-edited show played back via the Magnetophon.

Once I got the units together, I started showing them to audio professionals. The chairman of what was then the Institute of Radio Engineers (now the Institute of Electrical and Electronics Engineers) heard about them and asked me to give a demonstration at the May, 1946 IRE meeting in San Francisco. With Bill Palmer, my business partner in those days, I had recorded some music at NBC and at station KFRC in San Francisco. The station had a pipe organ, which was particularly effective for showing off the Magnetophons.

In the audience for the first San Francisco demonstration was Harold Lindsay, who, a few months later, was retained by Ampex. That company had been making aircraft motors during the war but was now looking for a new product, preferably in professional sound. The tape recorder seemed to be a natural.

In June, 1947, before Ampex really got involved, I was invited to give another demonstration—this time for Bing Crosby. He had been with NBC until 1944, doing the Kraft Music Hall live. He's a very casual person, and he resented the regimentation imposed by live broadcasts. Some weeks he wasn't in the mood and hated doing a broadcast. At other times he was ready to do two or three at a crack. He didn't like having to keep an eye on the clock and being directed to speed things up or draw them out.

The obvious solution was to record the shows. But NBC had told Crosby flatly that it wouldn't air a recorded show on the network. It never had, and it wasn't about to start. So Crosby took a year off, and when he returned it was with Philco on the new ABC network. ABC and Philco had agreed to let him record.

But because the process involved recording and re-recording on transcription discs, quality did suffer—at times to the point where the sponsor threatened to cancel the show because, during that first year at ABC, the audience rating was falling off. Philco blamed the poor audio. Crosby's voice didn't always sound very good after two or three transfers.

During the 1946-47 season ABC's engineers recorded each show in its entirety on 16-inch transcription discs at 33 rpm. If everything went perfectly there was no problem—they simply would air it as transcribed—but that seldom happened. Almost invariably, there was editing to be done. That meant copying some discs onto new ones, making adjustments as they went, maybe substituting a song that had gone better in rehearsal for the final take. Since they recorded everything in rehearsal as well as what took place before the audience, there were plenty of bits and pieces to work with.

Sometimes it was necessary to make what were called predubs. Say they wanted to use three cuts from three different discs, all within a matter of a few seconds. That didn't allow enough time to get each one cued up during re-

recording. So they would make little pre-transfers, or predubs, making copies until all the cuts were added. The final record, therefore, might be two or three generations removed from the original.

Bill Palmer and I had been using tape for soundtrack work (he already had a going business in the film industry before we joined forces), where magnetic recordings were far better in quality and more easily edited than the optical tracks that were standard for films at that time. We were introduced to Murdo McKenzie, the technical producer of the Crosby Show, through our Hollywood contacts. And after our demonstration we were invited back to record the first show of the 1947-48 season. Crosby's people didn't say, "You have the job". They only wanted to see how tape would compete with the disc system they had been using. When I taped that first broadcast, they asked me to stay right there after the show and edit the tape, to see if I could make a program out of it. I did, and they seemed to like what they heard.

Once the Crosby people bought the idea, they had to find a place for me to work. The American Broadcasting Company had been the Blue Network of NBC until, a short time before this, the government ordered NBC to sell it. NBC and ABC were still in the same building at Sunset and Vine in Hollywood. Crosby broadcast from what had been one of the major NBC studios.

Prior to the breakup, there had been what they called a standby studio, scarcely larger than a hotel room, with two little control rooms at one end. One was the Blue control room, the other was the NBC Red Network. There was nothing in the studio but a piano, a table, and two microphones. If one of the networks lost its feed from the East, as they did once in a while, somebody could dash into the standby studio to play the piano. An engineer would run into the control room for whichever network was out, and it was on the air again with local programming.

Once the networks split and ABC had adopted the principle of using recordings on the air, there was no need for the standby studio. So that's where they set me up. I installed my machines, moved in a sofa and a couple of chairs, and it became a little living room. It was a delightful place to work.

Crosby's taping schedule was determined by two factors: when he was available, and when Bill Morrow, the writer, could come up with the material. Sometimes we went right up to the wire. At other times we would be two months in advance. We might do three shows in a row—one a day—particularly if we were in San Francisco, where Crosby liked to work because of the audiences.

Murdo McKenzie was a very meticulous man. It was his responsibility to make sure that a studio was available, that the musicians would be there, and that Morrow would have the script. After the show was recorded, it was Murdo's responsibility to satisfy Bill that his script had been handled properly. And if there was anything at all that indicated where I had made a cut, I would have to rework it until it was inaudible—either that or abandon it. Sometimes it would take me a whole week to put a show together after Bing had performed it.

I had two recorders and fifty rolls of tape to work with—just what I sent home from Paris. With those fifty rolls I was able to do twenty-six Crosby shows—splicing, erasing, and recording over the splices.

There were no textbooks on tape editing in 1947, so I had to develop my own techniques. There was no such thing as actual splicing tape, as we have it now. I began with a cement very similar to that used in film editing. The problem with it was that you could hear the splice—a sort of thump—if there wasn't complete silence where it occurred. I then switched to ordinary Scotch mending tape, along with a pair of scissors and a can of talcum powder. Mending tape was fine for the first day or so, but before long the adhesive would begin to bleed, sticking one turn of tape to next. Then tape would break, and we would have a real mess. Before I used a roll, I always went through it and rubbed powder on the back of every one of those splices. That would get me by for a while, but soon they would be sticky again.

When the show was finally assembled on tape, it had to be transferred to disc because nobody—including me—had confidence that this newfangled thing could be relied on to feed the full network. When someone asked me what would happen if the tape were to break, I didn't have an answer. Since each roll ran twenty-two minutes (at 30ips), a half-hour show took two rolls and required the use of both machines. I would have no back-up if the machine that was on the air failed.

We continued to record all of the material from the afternoon rehearsals. Crosby didn't always know his songs very well, and he might start one and blow it. John Scott Trotter, the music director, would play the tune on the piano. When Bing got it, we would record two or three takes.

In the evening, Crosby did the whole show before an audience. If he muffed a song then, the audience loved it—thought it was very funny—but we would have to take out the show version and put in one of the rehearsal takes. Sometimes, if Crosby was having fun with a song and not really working at it, we had to make it up of two or three parts. This ad-lib way of working is commonplace in recording studios today, but it was all new to us. The BASF tape I was using had the iron particles imbedded in plastic instead of coated onto it, and since the tapes were not of a consistent thickness the sound quality and volume would change from one roll to another. The thicker the tape, the louder the low frequencies. So, having put together a show with various rolls, it was necessary for me to take them apart again afterward and sort the pieces by thickness. I didn't dare throw away an inch of that German tape, because I didn't know where I could get any more.

The salvaging of the tape is a story in itself. Many a night I stayed in my studio doing just that. In those days, the building was supposed to be closed after hours. The guard would try to throw me out, but unless I stood my ground there would be no tape for the next day's recording session.

In order to get some sleep, I made use of the Buzz Bomb Effect. In England during the war, if a buzz bomb came our way, we woke up. But if it created a Doppler effect, that meant that the bomb was going over to one side, and we stayed asleep. That kind of sensitivity will develop after a while. So I would put a low-frequency tone onto the tape, with the machine set down to monitor this tone and lie down on the couch for a little sleep. When the level of tone changed, I'd wake up, stop the machine, take the tape apart, sort out the new piece onto the correct roll, and go back to sleep.

The first two Ampexes (modeled on the Magnetophon) finally appeared in April 1948 and were followed immediately by twelve more for ABC. The ABC order had, in fact, made possible the final financing of the first two—Ampex Model 200, serial numbers 1 and 2, which were presented to me. They went into service on the twenty-seventh Crosby show of 1947-48. Still, ABC insisted on broadcasting from discs until its technical people were sure of their backup capacity and of the reliability of tape. But we retired my Magnetophons, which were getting pretty tired by that time.

Mullin in 1950 with two "portable" Model 200 Ampex tape recorders and the first Model 300 to leave the factory. With these machines, Mullin had available a full range of advanced editing techniques.

As we became more familiar with tape, and as blank tape became available from 3M and others, we found that we could do all sorts of things that weren't possible on disc. One time Bob Burns, the hillbilly comic, was on the show, and he threw in a few of his folksy farm stories, which of course were not in Bill Morrow's script. Today they wouldn't seem very off-colour, but things were different on radio then. They got enormous laughs, which just went on and on. We couldn't use the jokes, but Bill asked us to save the laughs. A couple of weeks later he had a show that wasn't very funny, and he insisted that we put in the salvaged laughs. Thus the laugh-track was born. It brought letters, because those big guffaws sounded ridiculous after the corny jokes.

We considered the ability to splice in laughs a technical achievement. We had to trim carefully so that, where we went into or came out of a laugh, the levels would be the same as those on the laugh we were replacing. It was pretty tricky; we had no way of fading in or out.

About two years later, Chesterfields had replaced Philco as sponsor of Crosby's show. One night Bing had a cold. While doing a commercial with announcer Ken Carpenter, Bing said, "If you like smoking (cough)"—and blew it right there. The audience laughed. As soon as the show was over, the ad-agency men were in my control room. In the end, we had to re-record the commercial.

Then there was the time that Crosby was ad-libbing with Bob Hope. Hope loved to take the script that Morrow had written and throw it out into the audience, saying, "Let's go on from here without a script". Crosby didn't like that very much, but they would make a good show of it. On this particular occasion, Hope said, "It's a lucky thing for you that ..." Before the show was over the people from Chesterfields were in demanding, "What can you do about it?" I didn't know what they were talking about. "That reference to Lucky Strike," they explained. We had to replay the tape, find the offending word, and assure the sponsors that it could be removed.

Much of what we did—things like making up a song out of several takes, "inventing" canned laughter, tight editing to take out offending material—has become commonplace. But I had to learn for myself. It was part of a process of discovery—sometimes serendipitous—that began at that fork in the road outside Frankfurt. Sometimes I wonder what would have happened had I turned toward Paris. Perhaps, for the tape recorder, the story would have had much the same outcome; for me it would have been quite different.

At left, the Bing Crosby show's cadre: writer-producer Bill Morrow, with bow tie; music director John Scott Trotter (centre); and technical producer Murdo McKenzie.

Quad 405 "current-dumping" Power Amplifier

As hifi fans now realise, "current dumping" is not East Anglia's answer to the black pudding, nor the solution to a grape surplus. Current dumping is the name given to the circuit principle employed in the new Quad 405 stereo power amplifier.

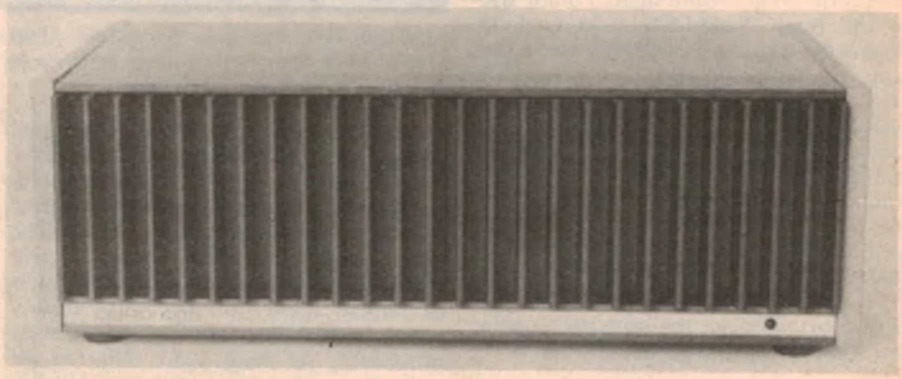
While most people tend to think of their amplifiers as operating in the class-B mode, the Quad 405 is probably one of the few units that actually does operate in pure class-B. The output stages draw no current at all when no signal is present. It manages to overcome the usual problems of crossover distortion by the new principle mentioned above. Instead of having a low-power class-A amplifier in series with a higher power class-AB amplifier (as in all other modern stereo amplifiers), the Quad 405 has a low power class-A amplifier effectively in parallel with a high-power class-B amplifier. Naturally, the class-B amplifier is fairly non-linear, especially in the cross-over region, but the class-A amplifier is arranged so that it compensates very closely for any errors introduced by the class-B stage.

A lengthier discussion of the principle was presented in the hifi pages of the January 1976 issue of "Electronics Australia". The major advantage accruing from the new principle is the elimination of quiescent current from the output stage.

This means that the usual quiescent current monitoring circuitry with its attendant adjustment problems can be omitted. It also means that the basic transfer characteristic is essentially linear and constant over the whole signal cycle, rather than subject to an inherent cross-over discontinuity which is in itself subject to operating conditions, as in the normal class AB amplifier.

Construction of the amplifier might be termed "heavy-set". While relatively compact with dimensions of 340 × 115 × 200mm (W × H × D) it is also quite heavy for its volume, with a mass of 9kg. The front of the amplifier is taken up almost completely by the large heatsink and the LED pilot light completes the decoration. No one could accuse Quad of having "busy" styling. By comparison, the rear panel is positively stimulating with a DIN input socket, a pair of spring loaded loudspeaker terminals, three-pin mains inputs socket, voltage selector and fuseholder.

Inside, the most impressive component is the large potted transformer with its seeming multitude of connections all tied together in a neat cable form to the voltage selector. Filter capacitors for the balanced supply rails are 10000uF.



Staid appearance of the Quad 405 belies its high performance.

Each power amplifier is accommodated on a PC board of modest size. The output power transistors are mounted on a sub-heatsink and soldered directly to the PC board. Thus, the PC board and sub-heatsink assembly can be easily detached from the main heatsink by removing four screws.

In the meantime, the Quad 405 may be matched to the Quad 33 or any other control unit with an output signal voltage of 0.5V RMS or more. Since the amplifier input impedance is 20k in parallel with 50pF, the output impedance of the preamplifier would ideally be less than 1k.

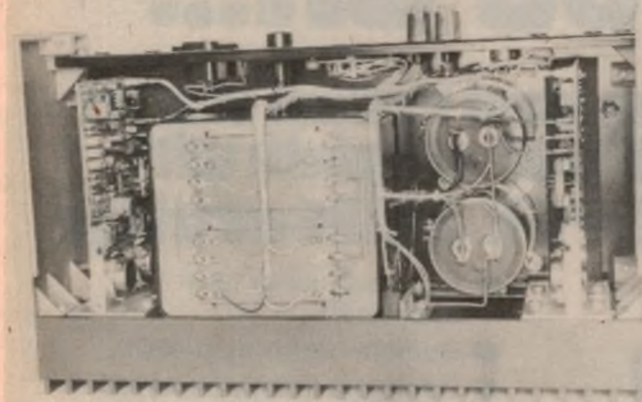
In view of the advanced specification of the new 405 it seems likely that a companion preamplifier/control unit could be introduced to provide the facilities traditionally lacking from earlier Quad combinations. In the well-written handbook Quad discuss how facilities for headphone connections and loudspeaker switching may be added. However it would be a better commercial approach for Quad to provide all these user conveniences in a comprehensive control unit.

Protection of the amplifier and external loudspeakers is provided by fuses in the supply lines, and circuitry which monitors the voltage and current in the output transistors and removes the signal of these conditions become excessive. This circuitry will protect the amplifier against excessive loading and short circuits for short time intervals (say a few minutes). But short circuits of longer duration would cause overheating and ultimately, damage to the circuitry.

Apart from the fuses, there is no protection to the loudspeakers in the case of an amplifier malfunction. Here the amplifier suffers by comparison with imported amplifiers which features relay protection for the loudspeakers as well as fuses. Considering the price range of loudspeakers with which this amplifier is likely to be teamed with, the addition of relay protection would be very worthwhile.

In some ways measurement of this amplifier was disappointing. For example, we were unable to measure the harmonic distortion of the unit since it appears to be well below the residual capacity of our existing equipment! This could be expected from the specifications.

Other specifications such as power output, frequency response, sensitivity, separation between channels and so on were all easily confirmed. The frequency response specification follows recent trends in amplifier design in that it is 3dB down at 50kHz rather than somewhere up in the RF region. At the same time recommended input slew rate limit is 0.1V/uS to minimise the possibility of transient intermodulations distortion. This maximum signal frequency limit would be automatically provided by the Quad 33 control unit but if other high performance control units were used it might be necessary to interpose a low-pass filter network. At the other end of the audio spectrum, a high-pass filter rolls off signal frequencies below 20Hz at a rate of 12dB/octave. This is a good feature as it prevents extraneous low frequency signals being delivered to the loudspeakers.



Power output was just slightly in excess of 100 watts RMS per channel into 8-ohm loads with both channels driven. Slightly more power was available when only one channel was driven. We were surprised to find that the power into 4-ohm loads was considerably less than for the 8-ohm condition. Reference to the owners manual indicates that maximum power into 4-ohm loads is limited to about 75 watts RMS by the protection circuitry referred to above. We found that the actual output power before current limiting occurred depended on the operating temperature of the amplifier. When the amplifier was very hot the power into 4 ohm loads dropped to around 50 watts. At normal operating temperatures the power output was close 75 watts into 4 ohms (with both channels driven). This temperature sensitivity can be expected from the type of current monitoring circuitry used—it basically depends upon the base-emitter voltages of two transistors. Maximum power is delivered into resistances of between 5 and 6 ohms (about 140 watts RMS) so 8-ohm loudspeakers with minimum impedances of 5 or 6 ohms should present no problems. However, the limitation with 4-ohm loads means that less power will be available if the user wishes to use two sets of 8-ohm loudspeakers in parallel, especially if these units had minimum impedances of 6 ohms or less.

We were unable to fault the 405 in other respects of performance. It is unconditionally stable as claimed, and very quiet. Signal-to-noise ratio is 90dB relative to 100 watts which means that the residual noise is determined by the control unit. When teamed with the Quad 33 a very quiet combination is obtained. In fact it is probably unlikely that a quieter 100 watt per channel system can be obtained.

Like most high performance equipment, the Quad 405 is not inexpensive. Recommended retail price is $496, including sales tax. Further information and demonstration can be obtained from hifi retailers or from the Australian distributors for Quad equipment, British Merchandising Pty Ltd, 49-51 York Street, Sydney, NSW 2000. (L.D.S.)

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Richard Allan Academy 3-way Loudspeaker System

While many of our younger readers may not recognise the name, older readers will remember Richard Allan Radio Ltd as a respected British manufacturer of loudspeakers. They are still producing a quality product, as demonstrated by their Academy system. It is a large three-way system with generous power handling capacity.

The Academy system will certainly appeal to those enthusiasts still of the opinion that the only way to obtain optimum performance is to use large and massive loudspeakers. Well, the 300mm bass loudspeaker is certainly large and massive—voice coil diameter is no less than 53mm, and a large magnet is used to obtain a high flux density in the gap. The heavy Bextrene cone has a generous roll surround to allow long excursions.

The tweeter has a transparent plastic dome of 20mm diameter. Frequency response of the tweeter is quoted as 3kHz to 25kHz (no tolerance limits) and power rating is 70 watts when used with a suitable crossover network.

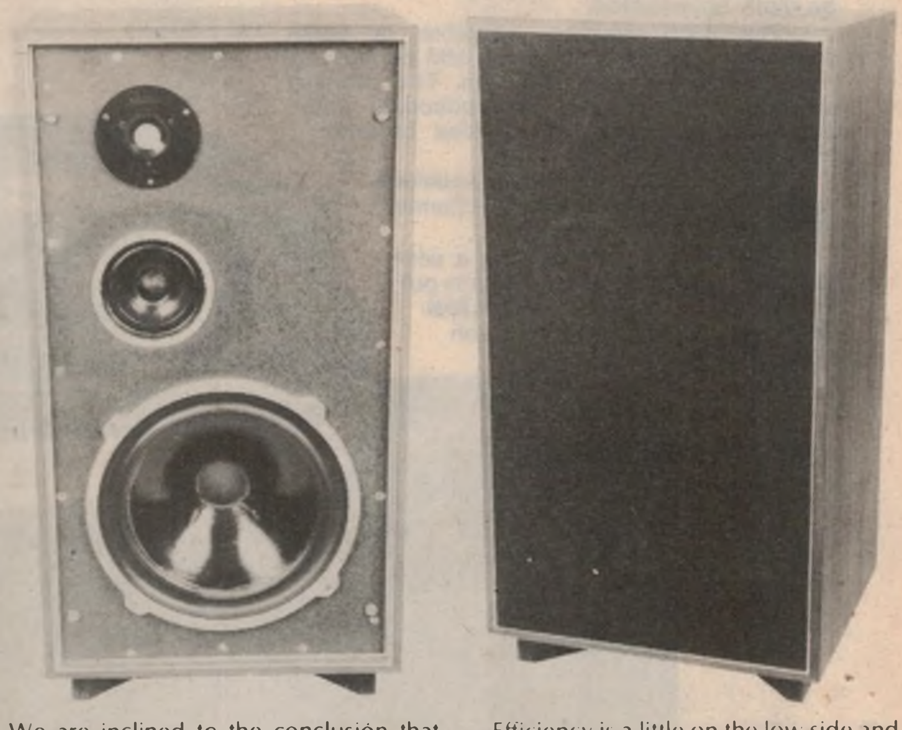
By comparison with the woofer, the midrange unit looks almost puny. It has an effective cone diameter of 90mm and also has a roll surround. It has its own cabinet within the main enclosure, to isolate the rear of the cone from the bass energy generated by the woofer.

According to the literature, the crossover network consists of a "half-section 12dB/octave network operating at 700Hz using air cored coils and low loss capacitors for low distortion and insertion loss, particularly at the higher power levels. The treble circuits are capacitively fed using metallised polyester components and operate at 7kHz". This seems a little vague and ambiguous but we were unwilling to dismantle the well-sealed cabinet to investigate further. It seems more likely that 12dB/octave networks are used to drive the woofer and midrange units while a simple capacitor network couples the tweeter with a rolloff of 6dB/octave below 7kHz.

Dimensions of the enclosure are 800 × 413 × 343mm, which includes the slightly projected grille-cloth frame and plinth. Mass is approximately 27kg. Cabinet finish is in Teak or Walnut veneer.

One practical criticism we can make concerns the terminals on the rear of the enclosure. These are conventional plastic thumbscrew terminals, which are quite adequate normally. But here they are housed in a minuscule recess which renders it almost impossible to make connections. This could be easily fixed by the manufacturer.

Impedance of the system is quoted as 8 or 15 ohms. Whether or not the manufacturer actually makes the system in 8 or 15 ohm versions we are not sure.



We are inclined to the conclusion that only the one system impedance is provided and this is intended as a compromise between the two. Measurements confirmed this. The median value of the measured impedance (modules) was 12 ohms, while the minimum value was 7.3 ohms at 7kHz. There was another impedance dip to 8 ohms at 700Hz. These two frequencies are actually the crossover points for the three-way system.

The enclosure is completely sealed and the main system resonance is at 40Hz. This is very well damped, to the extent that the acoustic output appears to begin rolloff at about 60Hz. We wonder if better results might not have been obtained by matching one of Richard Allan's smaller but equally good woofers to an enclosure of similar dimensions and perhaps of the bass-reflex type. This approach has been shown to give very good results in recent times.

Still, the conservative approach gives good results. The overall system response was quite smooth and extended to beyond the limits of audibility. While the tweeter output was perhaps not quite as well maintained to the upper limit as some other designs, it represents a good compromise in this system.

Efficiency is a little on the low side and Richard Allan recommended an amplifier of more than 25 watts per channel. We found the system well-matched to a 100 watt per channel amplifier. That makes it very loud.

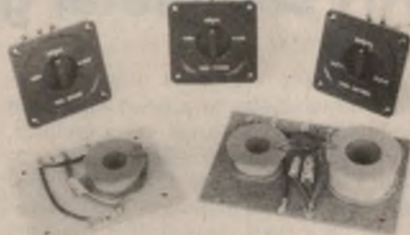
On music, the system performs very satisfactorily and it certainly has no faults to set the listener's ears on edge. We found that it did sound cleaner if raised off the floor by about 30cm and kept well away from the corners of the listening room.

For those in favour of larger systems it represents good value at $468 per pair. Further information can be obtained from the Australian distributors, Radio Parts Group, 562 Spencer Street, West Melbourne, Victoria, 3003. (L.D.S.)

HIFI REVIEWS

Large Range of Audio Accessories from Ralmar Agencies Pty Ltd

Ralmar Agencies Pty Ltd have recently released their comprehensive 1976 catalogue of electronic hardware and audio accessories. Pictured here is just part of their large range. Equipment not shown includes headphones, tone arms and cartridges.



No less than nine loudspeakers are included in the Ralmar range, from a 300mm woofer to a 25mm dome tweeter. As well, there is a range of economy loudspeaker systems for use in the home and another range for use in cars, boats and caravans. Also pictured is part of the range of crossover networks and attenuators.

Of particular interest to tape recording enthusiasts is the range of microphones. There are sixteen in all, budget and high performance units in electret condenser, dynamic and crystal types. There are three dynamic microphones particularly intended for use with cassette decks. They have low impedance and a stop/start switch.

In both the electret condenser and dynamic microphone range there are low, high and dual impedance models with uni-directional or omni-directional characteristics. The electret models are powered from a single penlight cell which gives up to 10,000 hours use.

Further information can be obtained from audio retailers, while trade enquiries should be directed to Ralmar Agencies Pty Ltd, 71-73 Chandos Street, St Leonards, NSW 2065, or interstate representatives.

News Highlights

IRH sell metal glaze resistors to Japan

While many segments of Australia's electronics industry have been wiped out by cheap imports, local manufacturer, IRH, has succeeded in selling resistors to Japan. Under an initial 12 months contract, won against Japanese manufacturers on their own ground, IRH resistors will be used in IBM computers and business machines worldwide.

IRH, a member of the Kemtron group, negotiated the sale to IBM Japan through the Procurement Office of IBM Australia Ltd. The order has since been augmented by a second contract from Honeywell-Bull to supply resistors for Honeywell computer products produced at a plant in Angers, France.

In all, the two contracts call for the supply of some 5.5 million resistors over the next 12 months. Dollar value is said to be in the region of $200,000.

While the dollar worth of the contracts is not great, the sales are significant as they show that Australia's depressed electronics industry is able to win orders for locally manufactured components in the tough international atmosphere. Mr, Frank Tennant, IRH General Manager of Marketing, said that Australia had as much know-how in resistor manufacture as any other country in the world. Only four other companies in Europe, Britain and Japan hold licences to manufacture the high-technology metal-glaze resistors developed by TRW Inc, USA.

Mr Tennant said that the Australian market was "just too small" for manufacturing economy, and IRH planned to export half its production by 1978. IRH is now talking to several other major overseas companies in the computer and telecommunications fields. This export drive is concentrated solely on the close-tolerance professional-grade resistor market.

The IRH factory at Kingsgrove, NSW, has been in operation since 1935, and recently underwent complete reorganisation. Some 250 people are employed at the Kingsgrove plant which houses the modern machinery used to produce the metal-glaze resistors. Much of the equipment was built by IRH engineers, the capital investment in new equipment exceeding $350,000.

The recent sales to IBM and Honeywell follow encouragement from Australian Government departments to maintain a resistor manufacturing facility here. They are also regarded as a success for the offshoots of IBM and Honeywell in Australia, as both companies have been anxious to procure local components for their international products in order to meet crucial offset requirements.

Metal glaze resistor production at Kingsgrove: at top, finished resistors are bandolier packaged for shipment to Japan; above shows banks of automatic "spirallers" which helix the resistance elements to desired values.

24hr TV programming —on a single disc

A high density video recording technique which combines laser and conventional optical technologies has been announced by RCA. The new technique makes possible the storage of as many as 50,000 TV pictures on a single 30cm disc and, according to RCA, could bring about drastic changes in TV station studio operations.

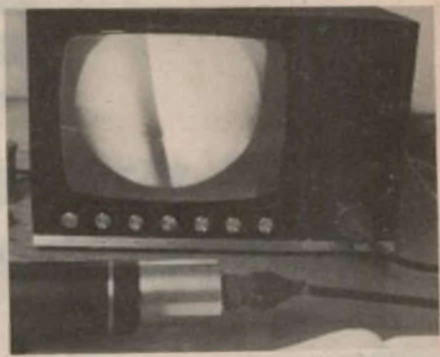
Although still at the developmental stage, the equipment is currently capable of storing a single frame of TV information on an area no greater than three thousandths of a square inch. This figure represents an improvement in packing density of about 300 times when compared with current techniques. Expressed in figures of another kind, it is thought that a TV station could ultimately broadcast an entire day's programming from recordings on such discs.

A small medium-powered laser is used for recording and replay. Information is recorded by directing a modulated beam onto a sensitized coating applied to the disc surface. On replay this information is scanned by the laser beam, with the reflected and modulated signal fed to signal processing circuits.

A small dedicated computer is used to control high speed information retrieval. Stored pictures can be accessed and displayed in a fraction of a second by employing a random search mode.

It appears that the system is broadly similar to the optical video disc replay system developed by Philips and MCA for the home consumer market. The latter, of course, has no record capability. The new system is completely distinct from the home video disc system developed by RCA.

TV camera examines aircraft engines



Damage to leading edge of an aircraft engine turbine blade is displayed on a television screen, having been discovered with the use of a new 'Low Light' miniature television camera and attached endoscope.

Intended for use at light levels below that of moonlight and entirely automatic in operation, the camera is controlled from a monitor or a separate control box. The entirely new system allows a television picture to be panned or tilted without physical movement of the camera body. This eliminates the use of a motor driven mount and enables the camera to be used in severe environmental conditions.

Electronic zooming takes place within the camera, using a standard fixed focal length lens. The unit has been specially designed for use in confined spaces and in situations where stripping down a component—such as an aircraft engine—would be time consuming and costly.

Ultrasonic test unit detects foetal heartbeat

In use by a doctor during a pre-natal examination is the Pocket Sonicaid, a compact low-cost unit capable of providing an immediate indication of foetal life and well-being during pregnancy. The Unit has gained one of Britain's 1976 Design Council Awards.

The Sonicaid is an ultrasonic Doppler instrument which will detect the presence of a viable foetus as early as the 12th week of pregnancy and give an audible representation of foetal heartbeat. A continuous ultrasonic wave at 2MHz is directed in a narrow beam over the foetus heart site from the transmitting crystal of a transducer.

Ultrasonic reflection from any moving tissue or fluid is picked up by the receiving crystal and processed.

Powerful, stand-alone desktop computer from IBM

The increasing trend towards powerful stand-alone desk-top computers is dramatically illustrated by the recently announced IBM 5100 Portable Computer. Designed for use in most office, laboratory and manufacturing environments, the 5100 places problem-solving computer capabilities at the fingertips of the engineer, financial analyst, statistician, planner and other professional problem-solvers.

Highlights of the 5100 include a combination typewriter-like keyboard and a 10-key calculator pad for data entry; function and program command keys; a 1024-character screen for display of keyboard input, output and user guidance; a processing unit with 16k, 32k, 48k or 64k positions of main storage; a tape cartridge capability for storing programs and/or data; and an adapter for attaching black and white TV monitors.

Models of the 5100 Portable Computer are available with either APL or BASIC or both programming languages. APL is a general purpose language capable of handling complex mathematical relations, tables or arrays. BASIC is an English-like, widely used language. Both are interactive programming languages that are easy to learn and can be used in any problem-solving environment such as business, mathematical and engineering.

Three Problem-Solver Libraries, contained in magnetic tape cartridges, are available for use with the IBM 5100, providing more than 100 interactive routines applicable to mathematical problems, statistical techniques and financial analysis.

In addition to serving the needs of the problem-solver in a stand-alone operation, an optical communications adapter allows the 5100 Portable Computer to communicate with a remote System/370 computer. Two other desktop input-output optional devices, the IBM 5103 printer and the IBM 5106 auxiliary tape unit, are also available.

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The comparison with conventional tape: An amazing gain in maximum output of 4.5dB at 400Hz and 7dB at 12.5kHz!

Ideal for use with all Sony tape and cassette players with "Fe-Cr" positions, this new tape will still give remarkably improved response through any high quality tape player which has "SLH," "Special" or "Low-Noise" tape positions.

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Then try Sony's remarkable "Chrome" and double-coated "Ferri-Chrome" tapes soon.

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NEWS HIGHLIGHTS

Inauguration of Singapore Chapter of IREE

Professor John Ratcliffe, IREE Australia President, is pictured speaking at the inauguration of the Singapore Chapter of the IREE Australia. Seated behind him are (left to right): IREE Aust. Assistant General Secretary, Don Miller; General Secretary, Keith Finney; Vice-President, Les Free; Professors J. Chen and Y. Huen of Singapore University; and Mr T. Gwee, the Singapore Government's Director of Industrial Training. The Australian IREE's first off-shore International Electronics Convention will be held in Singapore in 1978.

NASA space probes for Venus weather study

NASA will send both an orbiter and a multiprobe spacecraft to Venus in 1978 to conduct a detailed scientific examination of the planet's atmosphere and weather. The information they gather may help us learn more about the forces that drive the weather on our own planet.

The orbiter will be launched in May and inserted into Venusian orbit in December; the multiprobe spacecraft will be launched in August and the probes will enter the Venusian atmosphere six days after arrival of the orbiter.

The spin-stabilized multiprobe spacecraft consists of a bus, a large probe, and three identical small probes, each carrying a complement of scientific instruments. The probes will be released from the bus 20 days prior to arrival at Venus.

The large probe will conduct a detailed sounding of the lower atmosphere, obtaining measurements of the clouds, the atmospheric structure, and the atmostpheric composition. Primary emphasis is on the planet's energy balance and clouds. Wind speed will also be measured during the descent.

The three small probes, entering at points widely separated from each other, will provide information on the general circulation pattern of the lower atmosphere. Since the important motions are believed to be global, only a few observations are required. The probe bus will provide data on the Venusian upper atmosphere and ionosphere down to an altitude of about 120 kilometres (75 miles) where it will burn up.

The orbiter mission is designed to globally map the Venusian atmosphere by remote sensing and radio occultation, and directly measure the upper atmosphere, ionosphere, and the solar wind/ionosphere interaction.

In addition, the orbiter will study the planetary surface by remote sensing, utilizing radar mapping techniques. This should provide important information on Venus cratering and surface structure and an estimate of global shape.

Aust. misses Indonesian telecom contracts

ATDA chairman accuses Federal Government

During 1975 contracts to the value of US$1,000 million were awarded in Indonesia by Perumtel, the Indonesian national telecommunications authority —US$700 million for equipment and the balance for capital works—and not one cent in orders came to Australia.

This was stated recently by Mr T. E. Hodgkinson, Chairman of the Australian Telecommunications Association (ATDA). Mr Hodgkinson said the lack of orders for the Australian telecommunications manufacturing industry was directly attributable to the attitude of this and preceding Federal Governments in Australia.

"No Federal Government will back us up in the way that overseas companies are backed up by their national governments", said Mr Hodgkinson, "we simply cannot get official underwriting of loans and other financial arrangements."

"The situation in Indonesia is that a company cannot tender for telecommunications orders without guaranteeing finance—and here in Australia we cannot get Government finance until approved contracts are produced. So we have a classic chicken-and-the-egg situation."

The Indonesian contracts awarded last year were for a major planned step in the provision of an Indonesian telecommunications network and included advanced computer-controlled exchanges from Philips, Holland; ITT, Belgium; and Siemens, Germany; each with orders greater than US$100 million.

Additionally, large orders for satellites and ground stations were placed with the American companies Hughes, ITT and Philco Ford; for a cable network with BICC; for telex exchanges and teleprinters with Siemens, Germany; and with the French companies, TRT, CIT and Thompson C & F for microwave and coaxial systems and trunk and transit exchanges.

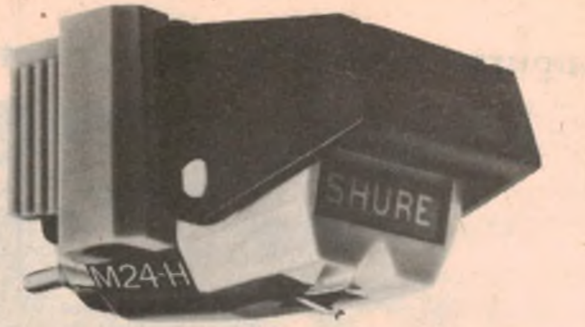
Mr Hodgkinson said that the fact that Australia received no orders was surprising to many people, particularly in view of the fact that Australia maintained a government technical mission—ATM (Australian Telecommunications Mission)—in Indonesia which was paid for by the Australian taxpayer and which had made a significant contribution to the planning of Indonesia's telecommunications network.

Most contracts awarded to foreign companies were negotiated by bankers rather than the companies themselves, with the relevant governments underwriting high percentages of the values and supporting highly competitive financial arrangements. In doing this the governments were supporting their domestic telecommunications industries and assuring high employment for these industries.

Mr Hodgkinson said that some of the Indonesian orders were extremely large and beyond the resources of any one Australian manufacturer.

"However, with proper governmental support, and with a combined effort from banks, industry associations, trade unions and Telecom Australia, an impressive proposal could have been produced. Instead of that we have nothing," said Mr Hodgkinson.

2+4!!



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We call it "2+4": *a totally different concept in a phono cartridge* that combines Shure's traditional pre-eminence in *stereo* and state-of-the-art *quad* technology. It's the first such cartridge that doesn't sacrifice stereo for quad capability!

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The M24H does not compete with the V-15 Type III or M95 Cartridge. The M24H is for those who want excellent stereo and quad without having to change cartridges every time they change records.

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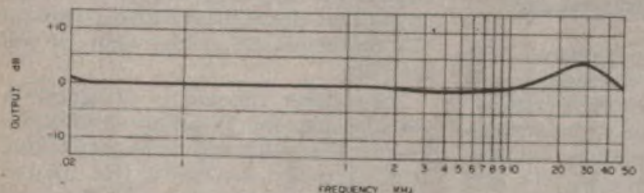

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* Total capacitance includes the capacitances of the tone arm wiring, phono cables, and the amplifier input circuit.

Tracking Force Optimum: 1¼ grams.

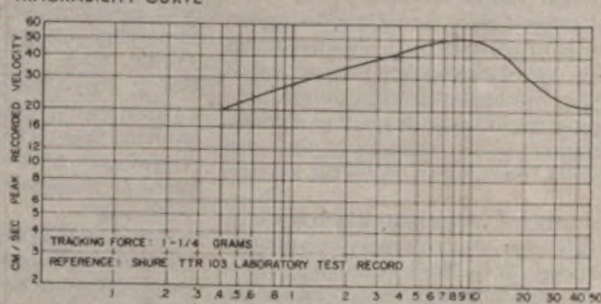
Trackability

400 Hz	20 cm/sec*
1,000 Hz	28 cm/sec*
5,000 Hz	47 cm/sec*
10,000 Hz	50 cm/sec*

* Peak recorded velocity

(Measurements made using a Shure/SME Tone Arm.)

TRACKABILITY CURVE



Stylus Model N24H: 8 x 18 microns (.0003 x .0007 in.) hyperbolic diamond tip.

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AE106/FP

"Quintrix"—Improved Colour Tube

Our front cover this month shows a stylised view of the new National Quintrix colour tube, with emphasis on a major feature of this tube: an improved gun structure which it is claimed results in a sharper and brighter picture, together with reduced beam current.

The National Quintrix tube is made by the Matsushita Electrical Industrial Co, Ltd, of Japan, and handled in Australia by Matsushita Electric Co (Australia) Pty Ltd. In greater detail the makers describe the new gun structure as employing an additional electronic lens, ca'led a "prefocus" lens.

Most conventional tubes use two focusing lens. One, called the auxiliary lens, is nearest the cathode and the other, the main lens, further down the neck of the tube. In the Quintrix tube the prefocus lens is located between the main and auxiliary lenses, and close to the latter.

In simple terms the prefocus lens reduces the width of the electron beam before it reaches the main lens. The end result is that the main lens can then focus the beam to a smaller spot at the shadow mask.

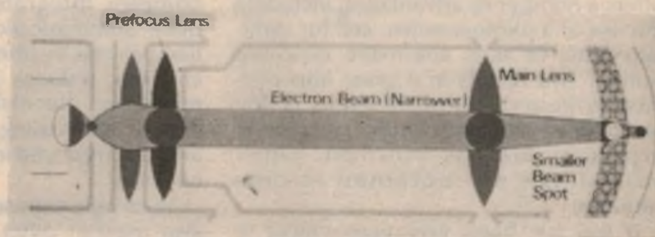
The most obvious advantage of a smaller spot is a sharper picture, at least within the limitations of the TV system as a whole. But, in a shadow mask tube; a smaller spot also means a brighter picture. The reason for this may not be immediately obvious, but it involves what might be called the shadow mask efficiency: the ratio of shadow mask area within the spot diameter.

In this regard the shadow mask tube behaves quite differently from a monochrome tube. In the latter case, reducing the size of the spot will increase the spot brightness—per unit area—but the total of light generated will remain the same, the increased spot brightness being offset by the smaller area.

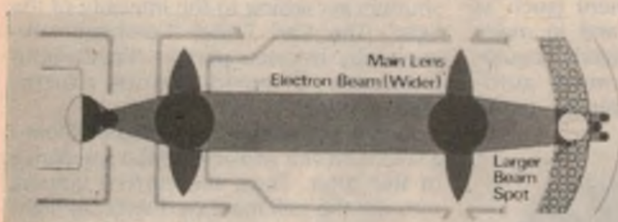
This simple relationship does not hold for a shadow mask tube. It can be shown, for example, that in a simplified case where an electron spot just encompasses six holes, decreasing the spot size to encompass only three holes reduces the area of the spot by a factor of three, with a proportional increase in electron density. At the same time, the loss due to the reduced number of holes is only a factor of two; hence a brighter picture.

The important point is that the brightness increase achieved in this way does not involve any increase in beam current. In fact, in the Quintrix tube the beam current is actually reduced from around 1.3mA in a conventional tube to 0.9mA in the Quintrix tube. And this in spite of an increase in EHT from a typical 26kV to 27kV (27.5kV max.) which makes a further small contribution to picture brightness.

In short, the improved gun structure not only produces a sharper and brighter picture; it does so while reducing the beam current—something which would not normally be expected.



Right: "Quintrix" tubes employ three lenses, the extra "pre-focus" lens producing a much narrower beam and smaller spot.



Left: a conventional colour tube using only two lenses. Note the broad beam and large spot which results.

Another significant improvement in the Quintrix tube involves the method of making the shadow mask to suit the now almost universal black matrix type screen. To date the "post etching" technique has been almost universal but Matsushita have replaced this with the "direct exposure" technique, which offers significant advantages.

To understand the direct exposure technique it is necessary to consider tube design before the advent of black matrix. In those days the phosphor dot was always marginally larger than the hole in the shadow mask; an arrangement which ensured that all the electrons passing through a hole would land on the dot, even assuming some minor misalignment.

The major objection to this was that the portion of the phosphor which was not energised served no good purpose but, on the other hand, helped to reflect ambient light from the screen and degrade contrast under high ambient light conditions.

The black matrix philosophy was to eliminate this waste phosphor area, reducing the dot size to what had been its active area only. Then the space between the spots was filled with black compound to reduce light reflection. And, to ensure that all the spot was energised, in spite of minor alignment problems, the hole in the mask was made larger than the spot.

But, since the holes in the mask are used to lay down the dots, it seemed that the only way to implement this idea was to process the mask after the dots were laid down. This, in fact, was what was done, the mask being put through an etching bath which enlarged the holes. This is the post-etching technique.

One of the objections to this method is simply that it involves several additional processing stages which adds to the cost structure. Another is that the etching tends to produce a ragged hole rather than a neat circular one, with the risk that the electron stream passing through it could strike adjacent phosphor dots of a different colour.

The direct exposure technique solves this problem. It allows the holes in the mask to be made the full size initially, smaller dots being produced from it by purely optical means.

This optical process is quite ingenious. Normally, the light used to expose the photoresist through the holes in the mask is quite small but, in this process, is a relatively large evenly illuminated circle.

This produces two concentric spots of light on the photoresist, one of relatively low intensity and which is larger than the mask hole, and one of much higher intensity which is smaller than the hole.

Since it is the smaller light spot only which is wanted, the larger spot is ignored by very precise exposure of the photoresist, such that it responds only to the brighter light.

Finally, there is the advantage of the black matrix technique. Matsushita make no claim for anything new in this regard, but it is worth considering how this supplements the brighter picture, particularly under high ambient light.

Continued on p.125

New direction for consumer electronics . . .

The focus is now on

Electronic circuits are now being used in a range of consumer product applications that would have been considered impractical just a few years ago. Witness, for example, the explosive growth of the electronic calculator industry in the last two years or, more recently, the appearance of digital electronic watches for the consumer market. This article examines yet another application that is becoming increasingly prevalent—the role of electronics in modern camera designs.

It has been estimated that approximately 40% of cameras being designed at the present time employ electronic shutter timing. The use of an electronic circuit for this purpose instead of the conventional mechanically timed shutter offers a number of advantages, including the use of a photosensitive cell for semi-automatic or fully automatic exposure setting. This results in a great improvement in the accuracy of the shutter timing and the convenience with which long exposures may be obtained. Other advantages are obtained in cine cameras.

It has not been very economical to include complex circuits in cameras in the past, since the labour changes involved in connecting up many transistors and other components are extremely high. However, the development of integrated circuits especially designed for use in particular cameras during the past few years has made the inclusion of very complex circuits economically feasible. The numerous connections inside a complex integrated circuit are made quite automatically during the production process by photographic techniques and this reduces labour charges to a minimum. Nevertheless, simple electronic circuits using discrete components are still employed in some of the cheaper cameras.

Electronic exposure timing circuits are also used in other equipment (such as photocopying machines) and in many types of research and industrial equipment. Exposures can be made automatically after an electronically timed delay. It is also possible for the film to be wound on automatically after each exposure and for a succession of exposures to be made at any desired preset intervals; this is ideal for time lapse photography.

History: The widespread use of electronics in commercial camera shutters is a relatively recent development, but the basic idea is by no means a new one. Indeed, as long ago as 1902, Carl Eisner was granted the German Patent No. 136898, the title of which may be translated 'A mechanism for the automatic regulation of exposure time in mid-lens shutters according to the intensity of the light'. The Carl Eisner Company subsequently became part of the Compur Company, a world famous shutter manufacturer.

In Carl Eisner's circuit the light fell onto a selenium cell and altered the resistance of the latter. Thus, the current flowing through the cell increased with the light intensity. This current drove an electric motor which rotated the shutter blade; the blade therefore revolved more quickly at high light intensities and gave the required short exposure.

Eisner even appreciated the need for a mechanism which would provide information to the electronic circuit about the maximum aperture of the interchangeable lenses, but it seems probable that he never constructed a practical shutter of this design. Nevertheless, it is rather remarkable that modern developments in electronically controlled automatic shutters were foreseen so long ago.

Although a few types of shutters driven by electromagnets were produced in the 1930's they required relatively large amounts of power and were quite unsuitable for use in portable cameras. It was impossible for much further progress to be made until modern semiconductor devices became available at reasonable prices.

The Yashica Electro 35 GT camera has fully automatic electronic exposure control.

electronic camera control

by BRIAN DANCE, M.Sc.

PART 1

The Yashica Electro 8 fully automatic cine camera.

Shutter types: Electronically timed camera shutters can be divided into two main classes, namely semi-automatic shutters and fully automatic shutters.

In semi-automatic exposure control systems, the light intensity is measured and indicated by a meter which is normally situated at the edge of the field of view in the view-finder. As the lens aperture and/or the shutter speed is adjusted, a scale moves past the meter needle to show whether the exposure is satisfactory.

In semi-automatic systems, the lens aperture or the shutter speed must be adjusted manually, but they are far more convenient to use than cameras which employ an exposure meter quite separate from the shutter and lens aperture controls. In both semi-automatic and in automatic systems, information on the speed of response of the film must be fed into the circuit by means of a potentiometer adjustment whenever a film of a different type is employed. Semi-automatic exposure systems may employ either mechanical or electronically timed shutters. They help to eliminate operator errors and can be operated more quickly than the older type of cameras.

In cameras with fully automatic shutter speed control, the correct exposure is set automatically according to the intensity of the incident light. A light sensor feeds information about the light level (as an electric current) to the electronic circuit which controls the speed of operation of the mechanical shutter. In some cameras the operator can over-ride the electronic timing.

Fully automatic exposure control systems can provide very accurate exposure times at widely different light intensities. The exposure time is normally continuously variable up to a certain maximum value which may be one minute. Amateur cameras employing automatic exposure control are very simple to operate and no time is wasted in making adjustments before the exposure.

Batteries: All cameras employing electronic shutters and almost all of those employing semi-automatic mechanical shutter timing require at least one battery. One or more mercury cells are normally specified, since their voltage remains virtually constant throughout their useful life and this assists reproducibility of the exposure times.

If a battery fails, cameras with semi-automatic systems using a mechanical shutter can still be operated, but without the special exposure indicator. Some types of automatic cameras with electronically timed shutters can be operated without a battery, but the exposure time is then usually the shortest one available from that model of camera.

Light detectors: In the past selenium cells have been widely used in exposure meters. They have the advantage that they convert the energy of the incident light into an electric current which can be used to deflect a meter; no battery is required when a selenium cell is used, since the energy from the light itself provides the current.

Nowadays, however, the use of cadmium sulphide photoconductive cells is much more common than selenium cells, although selenium cells are often employed in separate exposure meters. Although cadmium sulphide cells must be used with a battery, they have the advantage that they can operate at lower light levels than selenium cells.

Photosensitive cells used in exposure systems must have a spectral response fairly similar to that of most photographic emulsions. It is for this reason that selenium or cadmium sulphide cells are always employed in normal photographic applications.

Silicon photodiodes and phototransistors are quite unsuitable, since their

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response is mainly in the red and infrared regions of the spectrum, whilst germanium devices have a response which extends much farther into the intra-red and a correspondingly smaller response to blue light.

The cadmium sulphide photoconductive cells used in cameras are the conventional type with an interleaved electrode structure, as found in similar cells used in other applications. One of the disadvantages of cadmium sulphide cells is their relatively long response time when a large change of light intensity occurs. This type of photocell can take some 5 seconds to reach its equilibrium resistance if the light intensity is suddenly reduced by a factor of some hundred times. However, in practice such large changes seldom occur suddenly.

TTL: Most modern camera exposure systems employ cadmium sulphide cells which measure the amount of light entering the camera through the lens. The acronym 'TTL' is often used for 'through the lens', but this must not be confused with its more common use in electronics for 'Transistor-Transistor-Logic'.

Many single lens reflex cameras employ semi-automatic exposure systems. The mirror of the reflex camera may be only partially silvered, the light which passes through this mirror falling onto the cadmium sulphide cell which is placed somewhere behind the mirror.

The light intensity is measured with the camera lens wide open over a fairly narrow angle near the centre of the field of view, typically about 10 degrees. The mirror may be raised during the actual exposure, but the exposure time has been set before the mirror is moved.

Electronic Timing: In cameras available at the present time, an electronic circuit can be used to control the operation of a mechanical shutter. The device which provides the connection between the electronic and mechanical systems is an electromagnet. Electromagnets can exert an appreciable force only over a relatively short distance. It is therefore normal practice to employ an electromagnet to hold open the blade which closes the shutter after the exposure time. When the electronic circuit cuts off the current to the magnet, a spring pulls the blade so that it moves very rapidly and closes the shutter.

The timing in the electronic circuit depends on the time taken by a capacitor to charge through a resistor to a certain voltage. This voltage across the capacitor is applied to a sensitive trigger circuit which cuts off the current to the electromagnet at the required time. Naturally, many variations of this type of circuit have been developed for use in commercially available cameras. Suitable variable resistors are included in the circuit to account for the lens aperture to be employed and the film speed; they affect the rate of charge of the capacitor.

Exposure systems of this type provide exposure times accurate to within a few percent; the exposure times remain very constant with time, unlike mechanical shutters in which the time varies as springs become stretched somewhat. In electronic shutters, the longest time can be calibrated with a stop watch and all of the other times will then be almost exactly correct.

Circuits: One of the most commonly employed circuits in the relatively more economical cameras is a Schmitt trigger circuit. An example is the circuit used in the automatic Vitessa 500AE camera, for an exposure time range of 1/500 to 10 seconds; this circuit is shown in Fig. 1.

When switch S1 is closed, the photoconductive cell P passes a current through meter M which varies according to the light intensity falling on the cell. However, when the shutter is operated, switch S2 is actuated so that the current passing through P is diverted to charge C1, S3 being opened.

TR1 and TR2 form a Schmitt trigger which switches when the voltage across C1 reaches the threshold voltage. The current through TR2 is thus reduced to a very low value and TR3 is switched off. Current therefore ceases to flow through the electromagnet which releases the blade to close the shutter.

It should be noted that the exposure reading is no longer indicated on the meter in the view-finder when the shutter

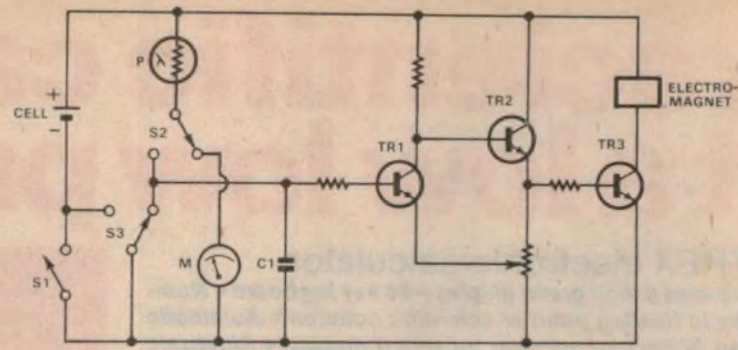


FIG. 1

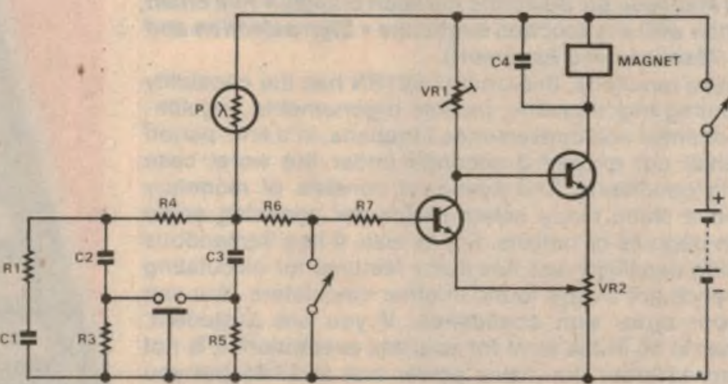
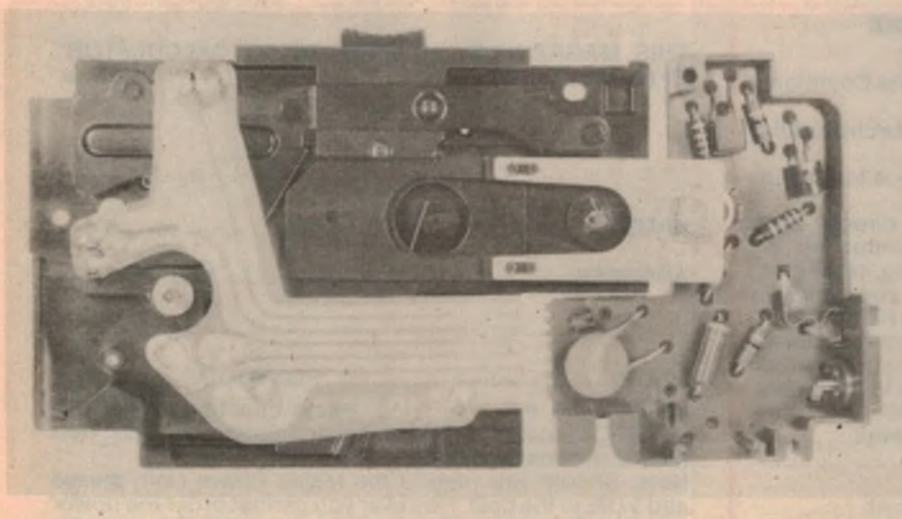


FIG. 2



Part of the circuit used in the Polaroid M330 camera showing the two transistors and some of the metal shutter blade.

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is actuated. S3 closes after the end of the exposure so that the charge on the capacitor is shorted out ready for the next exposure.

Polaroid cameras: The special techniques developed by the Polaroid Company enable a fully developed black and white positive photograph to be obtained about 15 to 30 seconds after the exposure, whilst colour photographs can be obtained about one minute after the exposure. Many types of Polaroid cameras employ metal plate shutters between the lenses or near to the lens, the timing of the movement of the blade which closes the shutter being controlled electronically.

A cadmium sulphide photoconductive cell controls the charging time of a capacitor connected across the input of a Schmitt trigger circuit and the latter controls the electromagnet in the way discussed previously. The circuit of the Polaroid 340 and 350 Land Cameras is shown in Fig. 2.

The Polaroid "Super Swinger" Land Camera incorporates semi-automatic exposure control. The word "Yes" is shown in the viewfinder when the exposure setting is suitable, black and white photographs being produced some 30 seconds after exposure.

The Polaroid model 350 camera has an electronic circuit for timing the development of the photographs immediately after exposure. Two integrated circuits are employed in this timer. A potentiometer on the back of the camera is used to set the required development time; when the exposed film is pulled out of the back of the camera, the timing is started automatically. A lamp is illuminated during the development, but is extinguished after the required delay and an audible warning tone is emitted so that the user removes the film.

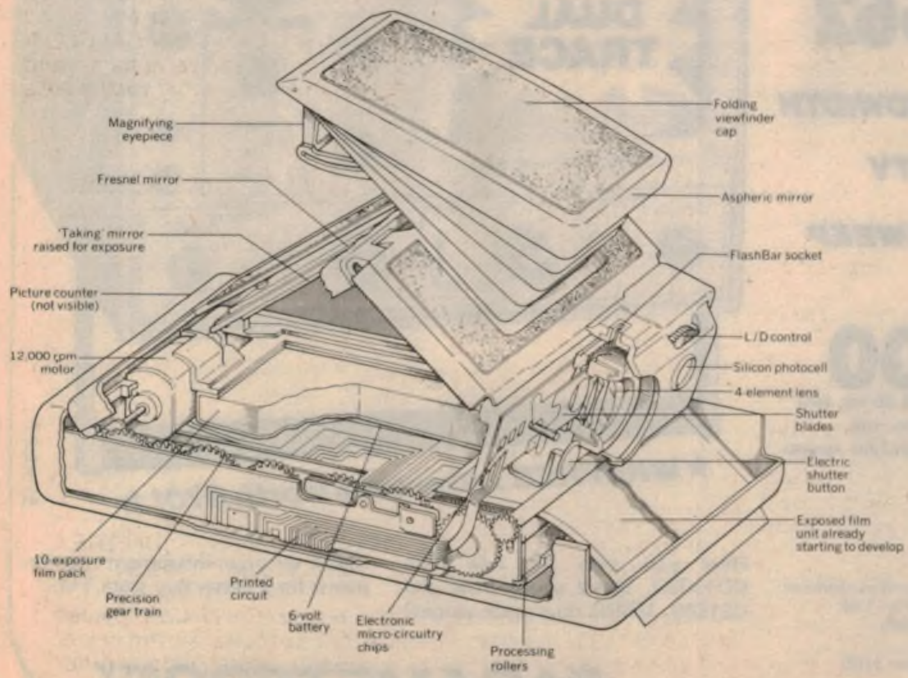
The SX-70: The new Polaroid SX-70 camera operates on somewhat different principles. It produces a developing colour picture (which is quite dry) 1.5 seconds after the exposure. The picture develops outside the camera, even in the brightest light, and the development process need not be timed. An internal view of this camera, which measures 2.5 x 17.5 x 10cm, is shown in Fig. 3.

The film pack itself contains a wafer-thin battery so that each new film-pack provides a new power source to the whole camera. The operation of the camera is controlled by integrated circuits which contain the equivalent of several hundred transistors. An electric motor automatically drives the film unit out of the camera after the exposure has been made.

As the exposed film emerges, the rollers rupture a small pod of chemical reagent, spreading the latter between the bonded negative and positive sheets. Opacifying dyes in the reagent form a kind of chemical curtain to shield the negative's still sensitive layers from any further exposure to light. This chemical curtain is so effective that it can block millions of times the amount of light used to take the photograph.

The picture in its stiff, protective plastic cover is at first invisible, the whole of the area appearing uniformly turquoise. However, within seconds the colour image begins to appear. Migrating dyes from the negative push through the reagent to form a colour picture on the inner surface of the transparent positive sheet. As the picture materialises, the opacifying dyes become quite colourless and a brilliant image is seen against the highly reflective layer of white pigment. The protective structure around this type of photograph enables it to be handled fairly roughly or dipped into water without damage.

The electronic shutter in this new camera controls exposures over a very wide range of lighting conditions, exposures of up to 14 seconds being available. A new type of flash unit clips into the camera shutter housing and automatically engages the follow-focus mechanism. The flash unit has ten small flash bulbs and the electronic circuitry bypasses used bulbs and automatically selects the next good one. The circuitry automatically prevents the bulbs from flashing when a new film pack is being loaded or when the camera is empty.



Exploded view of the Polaroid SX-70 Land Camera showing the working parts.

(To be continued)

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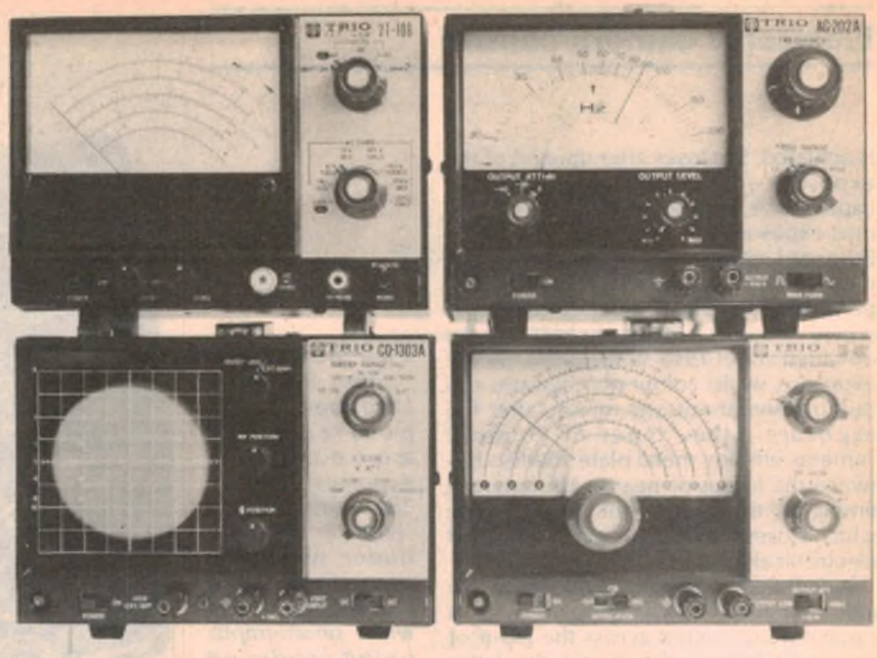

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Computer command system for British police force

Faced with the realities of crime in today's urban environment, police forces in many countries have responded with the introduction of up-to-date computer equipment to increase operational efficiency. A new computerised command and control system installed by Strathclyde Police in Glasgow will enable Britain's second largest police force to react quickly and effectively to any given situation, and will streamline administration.

by BILL KNOX

Strathclyde Police, Britain's second biggest force with an establishment strength of 10,000, now occupies a new £2 million headquarters in Glasgow city centre. This ultra-modern complex, said to be the most advanced in Europe and probably in the world, serves a force that is next in size to metropolitan London's.

Created earlier this year under local government reorganisation, the Strathclyde force incorporates several Scottish forces and covers an area of some 14,000 sq km with a population of more than 2½ million.

To match this role, the headquarters building contains a computerised on-line command and control system. The £500,000 system aids in the management and deployment of the police resources in Glasgow, Scotland's largest urban centre.

It offers on-line control of resource deployment, backed up with a management information system for overall planning. The system also feeds, by daily magnetic tape delivery, the Greater Glasgow Authority Computer Centre to facilitate statistical analysis work.

The system is only the second to be installed in Britain and was supplied by the Military Systems Division of Ferranti following close consultation in design with the Police Scientific Development Branch of the Home Office, Strathclyde Police and the Department of Design Research of the Royal College of Art.

The system consists of two Argus 500 computers, printers, and associated visual display terminals. Each controller in the central control room is equipped with two terminals. One is a standard visual display unit on which the details of each incident reported to the police are entered to form the basis of the incident log.

The second terminal is a rear port device, which automatically displays on its screen a map of the area when the address of an incident is keyed-in. This is taken from a cassette of slides, all streets in the city having been divided into 100 metre units. Overlaid on this is electronically generated information on the nearest available police resources and their status.

Each police mobile unit in the city is equipped with a small data entry terminal through which location and status codes can be updated into the computer system.

The radio system involved is the Burndept Consort multi-station multi-operator radio telephone control system. This also includes a pulse code modulated selective-calling system providing communication between headquarters and each divisional office.

Remote site and headquarters radio equipment is linked by dual 1,500MHz radio terminals complete with 24-channel multiplex equipment, sub-equipped for 12 channels. At headquarters, routed from each operating position through the Consort common equipment, an audio feed leads to a multi-channel tape recorder containing 24-hour tapes. Tape decks can be switched to either continuous operation or voice triggered start-stop, giving a record of all radio messages and obvious security advantages.

The Ferranti command control system's management information subsystem utilises operational information obtained from the computer generated incident log. This, apart from day to day management, will facilitate the planning of amendments to deployment patterns and show whether police patrol patterns are correct for any particular area.

The system deals with 800 incidents and 300 crime reports a day within Glasgow. Police authorities in many parts of the world have expressed considerable interest in its operational capabilities, and forces in Iran, Australia, Hong Kong and Malaysia have sent officers to see the equipment in use.

The computerised on-line command and control centre at the Strathclyde Police headquarters in Glascow, Scotland. The console units were supplied by Ferranti.

Letter from America

The Winter Consumer Electronics Show was held in Chicago a few months back but George W. Tillett, a Florida resident and Contributing Editor to "Audio" and "Stereo Guide", decided not to go because "it is pretty cold in Chicago this time of the year". Instead, among other things, he wrote this letter to "Electronics Australia" on some other interesting happenings in the United States.

Microwave Power Transmission

The transmission of electrical power through the air without wires has long been the dream of many engineers (and science fiction writers!), and I well remember the excitement of reading about the Tesla experiments years ago. But now the dream is becoming a reality as a team of engineers in California's Mojave desert are regularly sending power through the air by microwaves. They are from the California Institute of Technology and Raytheon's Microwave division and the work is being sponsored by NASA.

The main reason for the experiments is to develop equipment capable of transmitting power from satellites equipped with solar energy collectors to receiving stations on earth. At present, distance covered is a little over 1 mile with a power of 30kW DC, but results are steadily improving as more knowledge of this new technique is gained.

The transmitting equipment now used consists of a klystron with a maximum output of 450kW at 2.388GHz, an 85ft dish antenna, and a 100ft collimation tower. An array of Schottky GaAs diodes are used for rectification and these are spaced one-half wavelength apart. Efficiency is currently 82%, but it is expected that figures up to 90% will soon be attained. Said Peter Glaser of the Arthur D. Little company, the project consultants, "A typical satellite using a microwave beam at a 10cm wavelength could provide 10,000MW, and a network of such satellites could generate enough power to meet a significant portion of the foreseeable US demands".

Newspaper Production via Satellite

Last November, the first newspaper production operation in the world to be controlled through a communications satellite was officially inaugurated by Dow Jones & Co, publishers of the prestigious Wall Street Journal. The journal is set in type in Chicopee, Massachusetts, and facsimiles of full size pages are sent via the Westar 1 satellite to another plant in Orlando, Florida, about 1200 miles away. The reproduction proofs are individually wrapped around a transmitting drum which scans the page at 800 lines per inch, converting the print to electrical impulses. Transmission rate is 150,000 bits per second to Westar, 22,300 miles over the equator, which relays the information to Orlando.

The receiving unit then converts the impulses back into light which exposes the image on page size (26 x15in) sheets of film in an average time of 3 minutes. The developed film is laid over a sheet of treated aluminum and the image transferred, resulting in a lithographic plate. This is attached to the printing press which can turn out 70,000 copies in an hour!

The earth stations use 33ft diameter antennas and the company responsible, the American Satellite Corporation, has supplied a number of similar satellite links to the US government.

Consumer sales and CB radio

In 1975, nearly 11 million television sets and over 31 million radio receivers of all kinds were sold in America. Although it sounds a lot, it was about 18% below last year's figures. High fidelity equipment did quite well—so did calculators and there are now dozens of different models to choose from ranging in price from below $US8 to $US300 or more for scientific instruments. One model is in the form of a pen and there are several combined with digital watches—including a solid gold creation costing over $US3000!

But the most amazing thing about the last few months is the almost unbelievable boom in CB radio. There are already more than 6 million sets in use and another 2.5 million will almost certainly be sold this year, although some estimates would even double this figure! The majority are installed in cars but a growing number are home based, with about 5% small hand held models.

One of the most interesting is the JS and A PocketCom which measures only 5¼ x 1¼ x ¾ in and costs less than $40 with one crystal. Features include beep tone paging, 60dB AGC range, LED battery indicator, and two-channel switching. It uses an LSI (large-scale IC) chip and the RF power output is 100

The 33-foot diameter antenna and the press control room at the Wall Street Journal's printing plant in Orlando, Florida.

The PocketCom miniature CB transceiver, shown about two-thirds actual size. It offers beep tone paging and 100mW output.

milliwatts—which means no licence is required. Sensitivity is quoted as "less than 1 microvolt" but no noise figures are given.

Who uses CB? The simple answer is anyone who is over 18 and can afford the $150 or so. The boom probably started with the long distance truck drivers who found it useful for getting information about police speed traps and finding out where to buy gasoline during the fuel shortage. Now all kinds of people use CB: security patrols, salesmen reporting to the office, workers on construction sites, housewives, students and any number of would-be hams. There is in fact, a 10 code based on Ham radio procedure: 10-4 means yes, 10-30 means danger and 10-33 is help me quick!

Much of on-the-air vocabulary owes a lot to the earthy but expressive language of the truckers. For instance, "Wall-to-wall Bears" means lots of police, "Bear Cave" is a police station, a "Seat Cover" is a passenger, usually female, and a "Pregnant Rollerskater" is—you've guessed it—a Volkswagen!

Music students — build this

Digital Metronome with accented beat

Here is a project that music students should welcome—a new solid state metronome with an accented beat. Based on modern integrated circuit technology, our new Digital Metronome is simple to construct, and should prove reliable in use.

by DAVID EDWARDS

It is almost ten years since we last described an electronic metronome: in the May 1967 issue, to be precise. This unit was based on a unijunction transistor oscillator. The accented beat was produced by developing a "staircase" waveform, which was then used to trigger a second unijunction transistor which provided the accent. Interested readers are referred to this article for a more complete explanation of the circuit operation, and also for some background information on metronomes in general.

Before discussing our new metronome in detail, we will first give a short summary of the features and facilities which are desirable in a metronome. First and foremost, the rate at which its output clicks occur should be constant and repeatable. In other words, the clicks should come at regular intervals, and it should be possible to set the unit to operate at a particular rate with a good degree of certainty.

Secondly, the clicks produced must be of the right intensity, and they must not be "musical" in character at all. This is most important. Thirdly, the basic rate must be adjustable within the normal musical tempos, which range from about 40 beats per minute (bpm) to about 160 bpm.

An accent feature, if provided, should be easily set to the normal musical requirement, such as one beat in every two, one in three, and so on. The accented beat should occur at the time when the normal beat would have occurred; i.e., it should not be delayed at all.

Having in mind the specifications as outlined above, and spurred on by a reader's query concerning the previous metronome, we set about designing a modern replacement. Our first idea was simply to replace the unijunction transistors with 555 type integrated circuit timing modules, generating the accented beat by means of a staircase waveform as before.

This approach, however, proved to have several disadvantages. While the basic oscillator was satisfactory in terms of stability, the output pulse did not seem to produce the right type of click. If the oscillator was adjusted so that a very narrow pulse was produced, the resultant click was too soft, and could not be clearly heard. Lengthening the output pulse with the idea of giving it more energy meant that we now heard two separate, but closely spaced clicks.

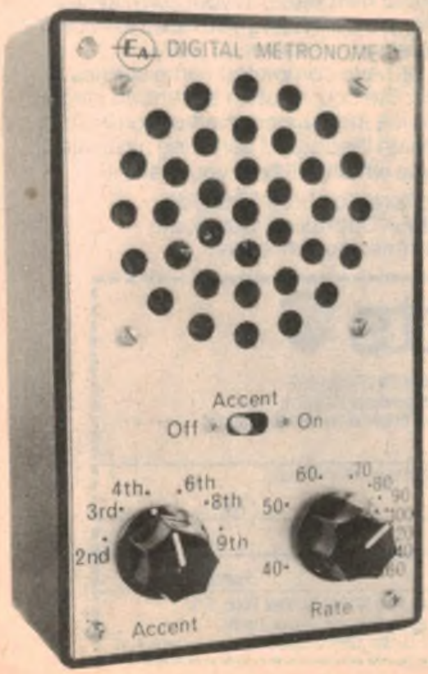
Our thoughts then turned towards using the pulse to gate on some type of oscillator or noise source. This presented its own difficulties, however, as we now discovered that the accented pulse did not start till part way through the normal pulse, giving an effect which we can represent graphically(or is it textually?) as "accENT", rather than "ACCENT".

It was this problem that led us to the present unit, which uses digital logic chips to generate an accented pulse starting at the correct time, as well as a digital noise source. We have retained the 555 type oscillator as the basic drive unit.

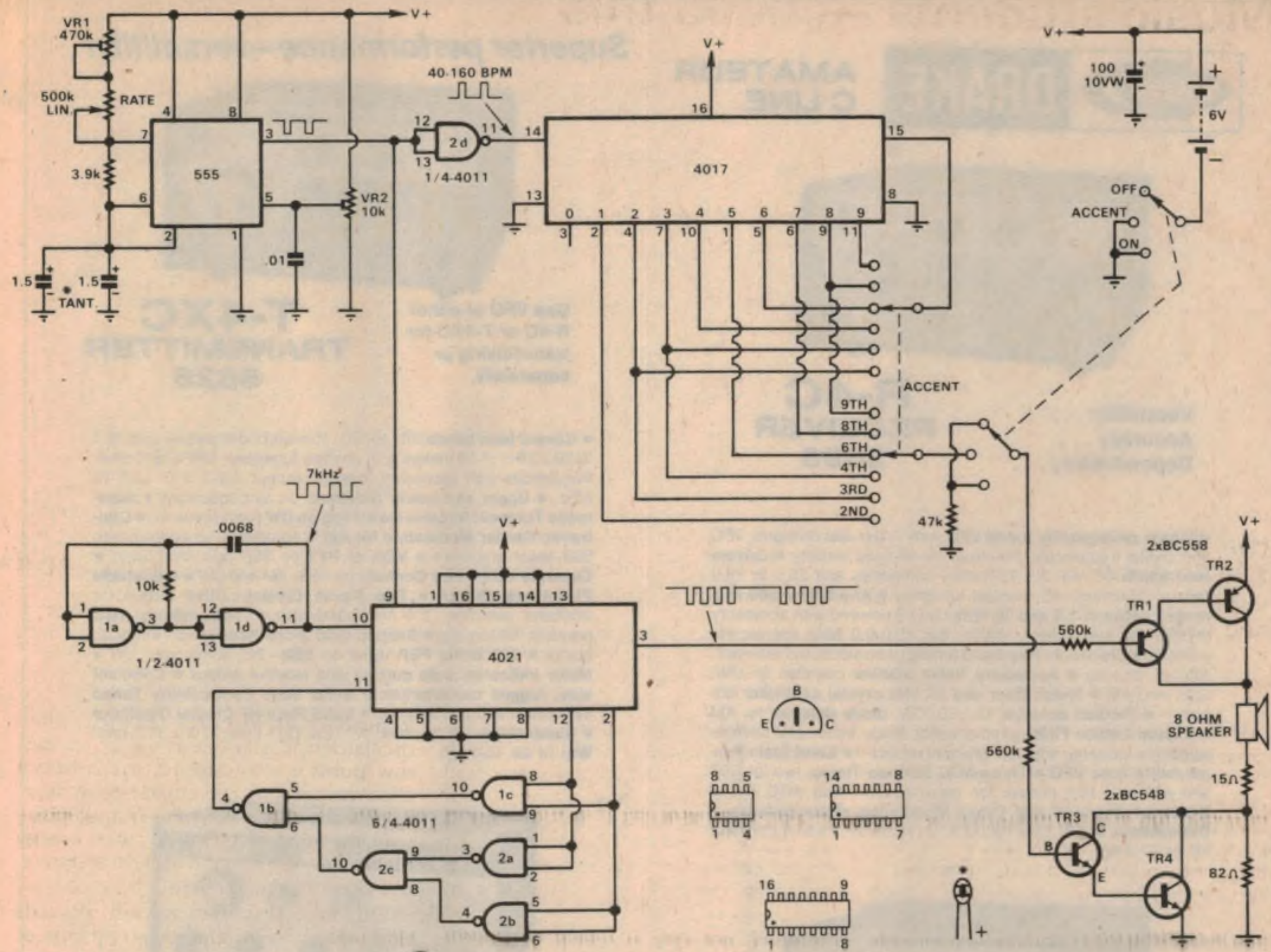
Turning now to the circuit diagram, we can follow its operation step by step. Power is supplied by four AA cells in series, giving a 6V rail. This is shunted by a 100uF electrolytic capacitor.

The 555 is connected as a conventional astable oscillator. The width of the negative going output pulses is determined by the 3.9k and 3uF resistor-capacitor combination, while the spacing between pulses is determined by the 500k rate control and the 470k preset pot. The operating frequency can be trimmed by varying VR2, a 10k preset pot.

CMOS gates 1a and 1d are connected as a free-running oscillator, with a frequency of about 7kHz. This is connected to the clock input of a 4021 type 8-stage static shift register, which is used



At left is a photograph of the completed metronome. Note the calibrated scale, which is reproduced elsewhere in the article.



DIGITAL METRONOME WITH ACCENTED BEAT

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as a seven stage pseudo-random noise generator, with the last stage serving solely as a buffer. We used a seven stage generator rather than an eight stage, because the required feedback gating is much simpler.

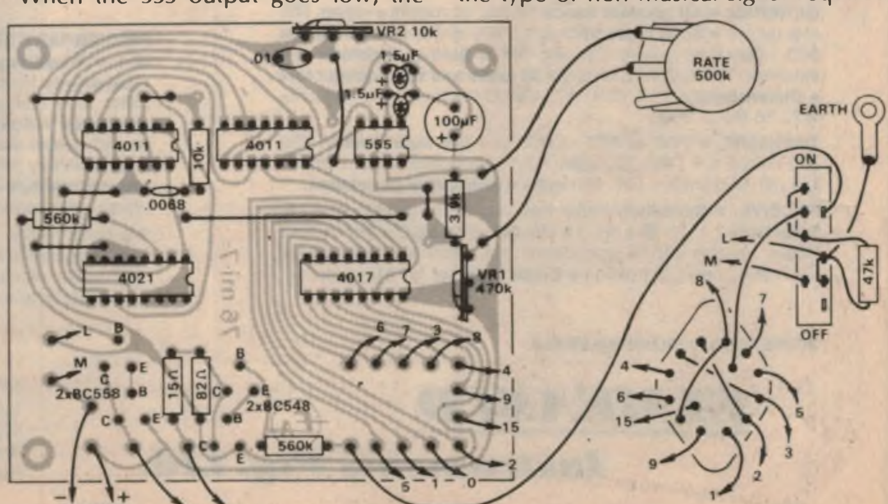
Feedback to the input, pin 11, is generated by gates 1b, 1c, 2a, 2b and 2c, which perform the exclusive nor function on the outputs from the sixth and seventh stages. This causes the register to cycle through 127 different patterns, before it repeats, and gives a pseudo-random stream of high and low pulses from the last stage.

This stream of "noise" is gated on and off by applying the output pulses from the 555 to the parallel load enable input of the 4021, pin 9. When the 555 output is in the high state (between pulses), the register is asynchronously loaded with the data presented at the parallel inputs. At the same time, the clock input is disabled, so the register does not shift.

The number that is loaded into the register has been chosen as follows: Firstly, it must not be 00000001 or 00000000, as this will cause the register to lock into this sequence. The eighth stage must be loaded with a 1, so that the PNP Darlington pair controlling the speaker is held off. Keeping these two requirements in mind, the actual number chosen was 00001111, which minimises interconnections on the printed circuit board.

When the 555 output goes low, the register commences to shift, and the noise signal so generated switches the speaker on and off via the PNP Darlington pair TR1-TR2. It is necessary to use a Darlington pair to prevent excessive loading on the CMOS output stage. The speaker current, and hence sound intensity, is limited by the 15 and 82 ohm resistors.

The resulting burst of noise is exactly the type of non-musical signal required



This combined component overlay and wiring diagram will aid construction. Use rainbow cable to make the numbered connections.

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R-4C RECEIVER $695

• **Linear permeability tuned VFO** with 1 kHz dial divisions. VFO and crystal frequencies pre-mixed for all-band stability • **Covers ham bands** 80, 40, 20, 15 meters completely and 28.5 to 29.0 MHz of 10 meters with crystals furnished • **Any fifteen 500 kHz ranges between 1.5 and 30 MHz** can be covered with accessory crystals for 160 meters, MARS, etc. (5.0-6.0 MHz not recommended) • **Electronic Passband tuning** gives sideboard selection, without retuning • **Accessory Noise blanker** operates on CW, SSB, and AM • **Notch filter and 25 kHz crystal calibrator** are built-in • **Product detector** for SSB/CW, **diode detector** for AM • **Crystal Lattice Filter** gives superior shape factor and ultimate selectivity for better adjacent channel rejection • **Solid State Permeability Tune VFO** • **Three AGC Release Times,** two for SSB and AM plus fast release for break-in CW. Also AGC off. • **Excellent Overload and Cross Modulation characteristics** • **Dimensions:** 5½"H, 10¾"W, 12¼"D (14.0 x 27.3 x 31.1 cm). **wt.:** 16 lbs. (7.3 kg).

Use VFO of either R-4C or T-4XC for transceiving or separately.

T-4XC TRANSMITTER $625

• **Covers ham bands** 80, 40, 20, 15 meters completely and 28.5 to 29.0 MHz of 10 meters with crystals furnished; MARS and other frequencies with accessory crystals, except 2.3-3, 5-6, 10.5-12 MHz. • **Upper and Lower Sideband** on all frequencies • **Automatic Transmit Receive Switching on CW** (semi break-in) • **Controlled Carrier Modulation for AM** is completely compatible with SSB linear amplifiers • **VOX or PTT** on SSB and AM built-in • **Separate VOX Delay Controls** for SSB/AM and CW • **Adjustable Pi-Network Output** • **Two 8-pole Crystal-Lattice Filters** for sideband selection, 2.4 kHz bandwidth • **Transmitting AGC** prevents flat topping • **Shaped Grid Block Keying** with side tone output • **200 Watts PEP Input on SSB**—200 watts input CW • **Meter indicates plate current and relative output** • **Compact size; rugged construction** • **Solid State Permeability Tuned VFO** with 1 kHz dial divisions • **Solid State HF Crystal Oscillator** • **Dimensions:** 5½"H, 10¾"W, 12¼"D (14.0 x 27.3 x 31.1 cm). **Wt.:** 14 lbs. (6.4 kg).

TR-4C SIDEBAND TRANSCEIVER $630

GENERAL: • **All amateur bands** 10 thru 80 meters in seven 600 kHz ranges • **Solid State VFO** with 1 kHz dial divisions • **Modes** SSB Upper and Lower, CW and AM • **Built-in Sidetone** and automatic T/R switching on CW • **30 tubes and semi-conductors** • **Dimensions:** 5½"H, 10¾"W, 14⅜" D (14.0 x 27.3 x 36.5 cm). **WT.:** 16 lbs. (7.3 kg).

TRANSMIT: • **VOX or PTT** on SSB or AM • **Input Power:** SSB 300 watts P.E.P.; AM, 260 watts P.E.P. controlled carrier compatible with SSB linears; CW, 260 watts • **Adjustable pi-network.**

RECEIVE: • **Sensitivity** better than ½ μV for 10 dB S/N • **I.F. Selectivity** 2.1 kHz @ 6 dB, 3.6 kHz @ 6 dB • **AGC** full on receive modes, variable with RF gain control, fast attack and slow release with noise pulse suppression • **Diode Detector** for **AM** reception

SSR-1 COMMUNICATIONS RECEIVER $290

• **Synthesized** • **General Coverage**
• **Low Cost** • **All Solid State** • **Built-in AC Power Supply** • **Selectable Sidebands**
• **Excellent Performance**

PRELIMINARY SPECIFICATIONS: • **Coverage:** 500 kHz to 30 MHz • **Frequency** can be read accurately to better than 5 kHz • **Sensitivity** typically 0.5 microvolts for 10 dB S + N/N SSB and better than 2 microvolts for 10 dB S + N/N AM • **Selectable sidebands** • **Built-in power supply:** 117/234 VAC ± 20% • **If the AC power source fails** the unit switches automatically to an internal battery pack which uses eight D-cells (not supplied) • **For reduced current drain** on DC operation the dials do not light up unless a red pushbutton on the front panel is depressed.

The performance, versatility, size and low cost of the SSR-1 make it ideal for use as a stand-by amateur or novice-amateur receiver, short wave receiver, CB monitor receiver, or general purpose laboratory receiver

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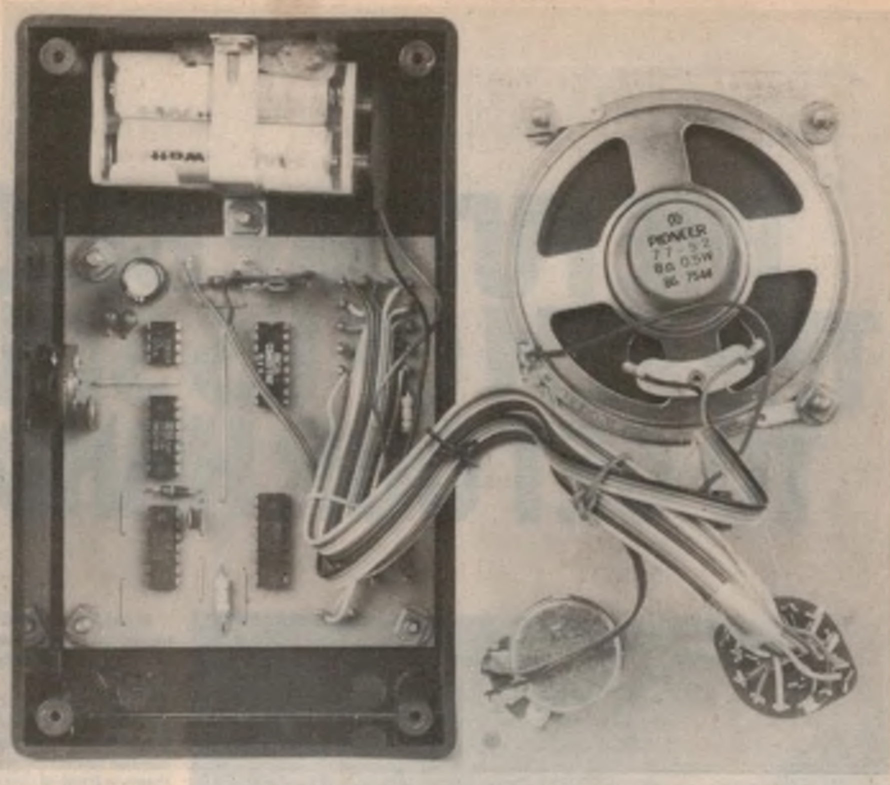
for a metronome. It can be clearly heard over typical musical sounds, yet does not itself conflict.

We have not used the MM5837 digital noise source IC (as featured in the 1975 Yearbook) to generate this noise because of the cost involved in the purchase of the IC, and also because of the dual power supply which this chip requires. Our alternative solution, while not as elegant, is quite satisfactory in this role, and is considerably cheaper.

The accented beat is generated by a second CMOS chip, a 4017 type divide-by-ten counter/divider with ten decoded outputs. Gate 2d is used to invert the pulse from the 555, which then clocks the counter. A two-pole six-position switch is used to connect the appropriate output pulse to the reset line, thus resetting the counter. The second pole of the switch is used to select the required output pulse.

We have used a six position switch as this is the largest commonly available rotary type, so that our metronome can only accent six beat patterns. We have chosen these to be the 2nd, 3rd, 4th, 6th, 8th and 9th, as we felt that these would be the most useful. If required, a larger switch could be used, and the remaining beats accented.

The signal from the accent switch then passes to one pole of the power switch, which is a three position miniature slide type. In the centre position, the signal is connected to the NPN Darlington pair TR3-TR4, which then shorts out the 82 ohm resistor for certain beats, thus providing the accents.



This photograph shows the internal layout of the metronome. VR1 is at the top of the PCB, while VR2 is at the extreme left. Note the battery clamp. PC stakes have been used to facilitate the external connections to the PCB.

In the second "on" position of the slide switch, the base of the NPN Darlington pair is connected to ground, thus disabling the accent. The 47k resistor wired across the switch prevents the 4017 outputs from being shorted to ground as the power switch is operated.

After completing our prototype, testing showed that the device was suitable in all but one respect. We had not calibrated it. This was easily achieved, however, and required only the addition of two trimpots and the use of a stopwatch. We were then able to fit a calculated scale, and adjust the metronome to agree with it. The exact technique required is explained later in the artcle.

Construction of the Digital Metronome should be within the capabilities of most readers. With the exception of the switches, controls and speaker, all components are mounted on a small printed circuit board, coded 76mi7, and measuring 86 x 94mm.

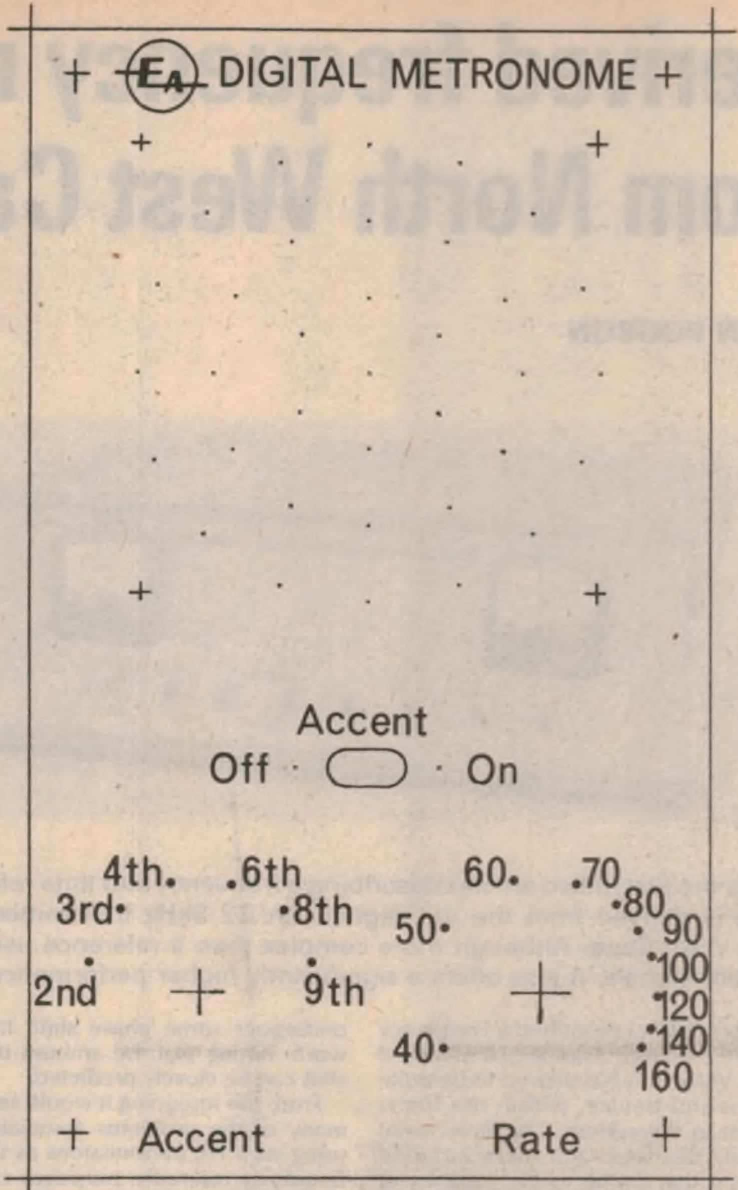
We mounted the components in a small plastic utility box measuring 150 x 90 x 50mm. The aluminium lid is used as a front panel, with suitable labels applied using stick-on lettering. The batteries are held in a holder, and clamped to the bottom using a small scrap of aluminium. Mount the speaker behind the front panel, and drill a suitable pattern of holes. A cloth can be clamped between the speaker and the panel, to keep dust out.

Commence construction by mounting all components except the CMOS ICs on the PCB. The connections to the switches and other components not mounted on the PCB are made using "rainbow" cable

This is a full sized reproduction of the PCB pattern, shown from the copper side, which can be traced if desired.

Metronome

This full sized copy of the front panel can be used directly, or it can be copied. It is the correct size for the UB1 box.



and PCB pins. Use the component overlay diagram and wiring diagram to help you. The 47k resistor is mounted on the back of the slide switch, as shown.

The CMOS devices should only be mounted on the PCB when all other construction is finished. Make sure that your soldering iron tip is connected to the "earth" line of the copper pattern. Remove the ICs from their protective wrapping, and insert them in the board with a minimum of handling. The first pins to be soldered should be the power supply pins, which are at diagonal extremes of the chips (pins 8 & 16 or 7 & 14). If you are not confident of completing this successfully, good quality IC sockets may be used.

With the power switch in the off position, connect the battery, and then switch to the accent position. The speaker should start to click at a rate set by the rate control, and the accent should occur as set by the accent switch. Check that operation is correct in all positions of this switch. Any faults will most likely be due to faulty wiring at the switch. Check also that in the second on position, no accent occurs.

Calibration of the metronome can now commence. This requires a scale similar to that on our prototype. This can be copied from the full-sized photograph shown elsewhere in this article, or from a positive or negative dyeline obtainable from our Information Service for $2.00. Once you have copied the scale onto the front panel, fix the knob so that it can rotate equally past the 40 and 160 marks. There should be about 30 degrees of movement past both marks.

Now set the pointer to the 160 mark, and adjust VR2 so that the metronome produces 160 bpm. If you have access to a frequency counter, this can be used. Otherwise, it will be necessary to use a stopwatch or wristwatch with a sweep second hand.

You will find it easier to check this rate if you set the accent switch to accent every fourth pulse, and only count these accented ones.

Then set the pointer to the 40 mark, and adjust VR1 to obtain 40 bpm. Return the pointer to the 160 mark, and re-adjust VR2 for 160 bpm. Alternate between the two adjustments until both are correct. As a final check, set the pointer to 90, and see if the metronome produces 90 bpm.

Your Digital Metronome is now complete. Replace the batteries when the calibration is no longer accurate. After installing the new batteries, check the calibration, and adjust as necessary.

PARTS LIST

SEMICONDUCTORS

1 CD4017C divide-by-10 counter/divider
1 CD4021C 8 stage static shift register
2 CD4011C quad 2-input gates
1 555 timer IC
2 BC548 NPN transistors, or equivalent
2 BC558 PNP transistors, or equivalent

CAPACITORS

1 0.0068uF plastic
1 0.01uF plastic
2 1.5uF tantalum
1 100uF 10VW PCB mounting electrolytic

RESISTORS (all ½W)

1 15 ohm, 1 82 ohm, 1 3.9k, 1 10k, 1 47k, 2 470k 1 500k linear pot, 1 10k trimpot, 1 470k trimpot.

MISCELLANEOUS

1 2 pole 6 position rotary switch
1 2 pole 3 position slide switch
1 plastic utility box, 150 × 90 × 50mm, type UBI or similar
2 knobs
1 miniature 8 ohm speaker, 76mm dia max
1 printed circuit board, 86× 94mm, coded 76mi7
4 AA cells, holder and clip to suit
Scrap aluminium, solder, hook-up wire, machine screws and nuts, circuit board pins

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.

Derived frequency reference from North West Cape

by IAN POGSON **PART 1**

Here is the first of two articles describing a frequency and time reference which is derived from the VLF signals on 22.3kHz transmitted from North West Cape. Although more complex than a reference using HF standard signals, it also offers a significantly higher performance.

In April, 1975, I described a Frequency Reference derived from the HF standard station VNG. This has proved to be quite a successful device, within the limits inherent in the system. The limits were generally discussed and these included the point that owing to the vagaries of short wave propagation, reception of VNG was not always available and because of fading and interference with the transmitted signal, the order of accuracy of the received signal suffers some degradation when compared with that transmitted.

The point was also mentioned that some investigation had already been made into the possibility of using the VLF signal of 22.3kHz from North West Cape in Western Australia. As I understand it, this station is used by the United States Navy for communications purposes. The carrier frequency is referred to a Caesium Beam frequency standard and the order of accuracy of the transmitted signal is quoted as being ± 0.5 parts in 10^{10}. The radiated carrier power is estimated at 1000kW.

Propagation of such high power VLF signals covers a very wide area, so that they tend to be available over the full 24 hours of each day. VLF signals suffer very little degrading of accuracy during propagation except for about one hour around sunrise and again for about one hour around sunset, where the signal undergoes some phase shift. It is also worth noting that the amount of phase shift can be closely predicted.

From the foregoing it would seem that many of the problems associated with using such HF transmissions as VNG for frequency reference purposes could be avoided by making use of a suitable transmission in the VLF range. The North West Cape transmissions are the closest available to us in Australia and possibly New Zealand.

By using the signal from North West Cape, we have a signal potentially available for 24 hours each day. Also, the accuracy as stated before, is much better as received when compared with the HF transmissions.

It would seem that this arrangement leaves little to be desired and with some reservations, this is so. Firstly, it is true that the transmissions are available for almost 24 hours of each day, but there are short breaks in transmission from time to time each day, lasting for periods up to three minutes or so. Also, for maintenance purposes, the station goes off the air just before 1000 hours EAST each Wednesday and may be off for about four hours before resuming constant transmission.

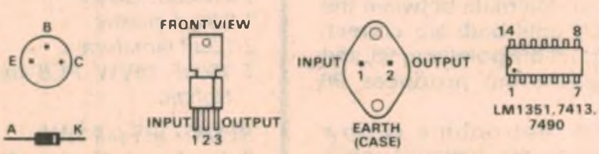
A second consideration is the type of modulation used. In the main it is narrow band FSK, shifting from 22.30kHz to 22.35kHz for teletype. The FSK feature makes for some problems to be solved in order to make use of one or other of the two frequencies, to the exclusion of the other.

Just how these problems should be solved will depend upon what the frequency reference is to be used for. In any case, one satisfactory method is to introduce a quartz crystal oscillator into the system and to use the received stable frequency to phase lock the crystal. I would hasten to mention that it may be obvious to readers that the crystal oscillator will only be phase locked to the received signal when it is on the air! This is of course very much so and use can only be made of the reference when the signal is being received and so controlling the crystal oscillator.

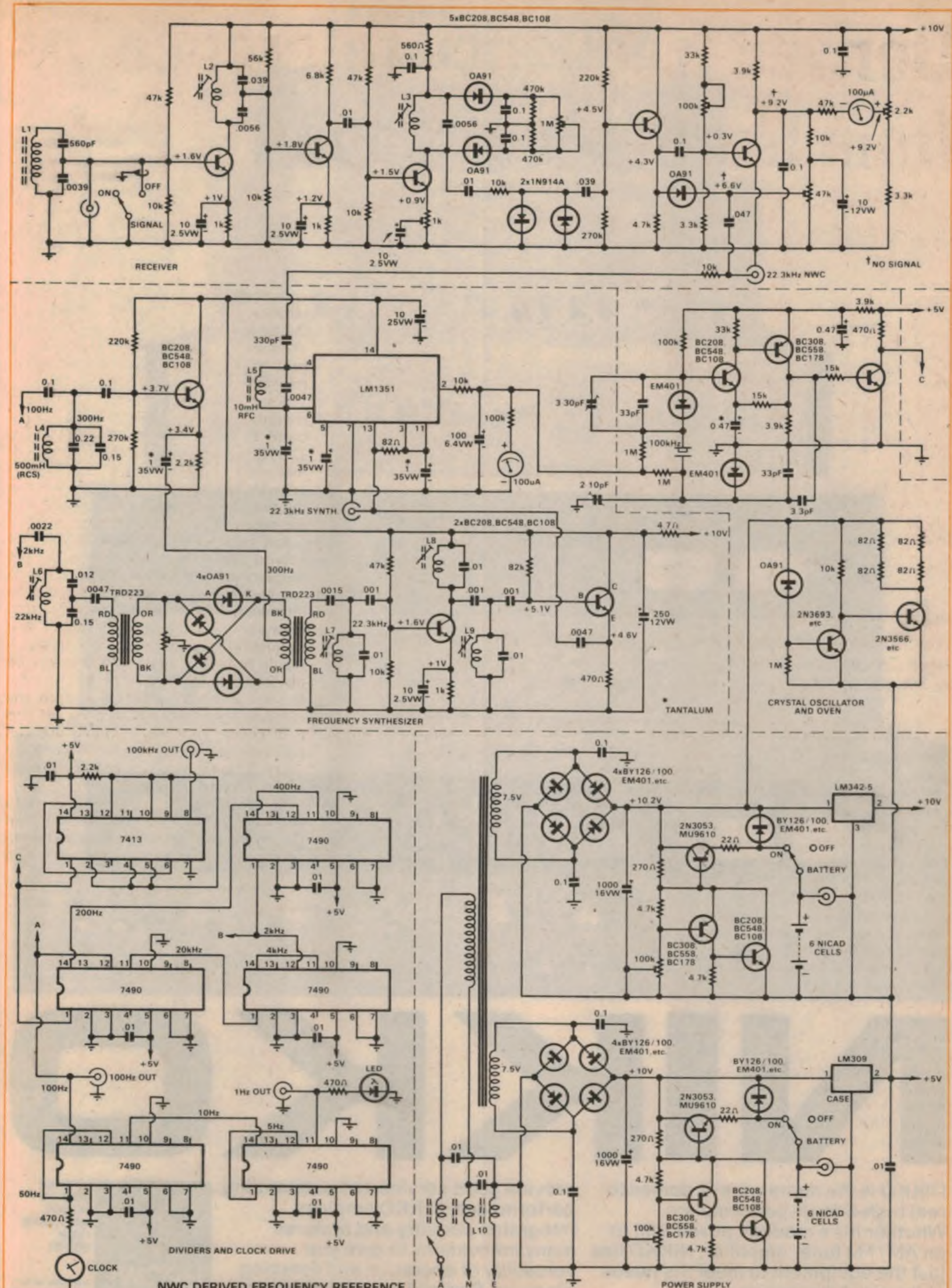
Where the frequency reference is to be used as a clock for timekeeping, then the crystal oscillator must be relied upon to tide the system over the periods when the signal is not available.

The following is an account of how I went about making use of the NWC VLF transmission, both for use as a frequency reference and a highly accurate clock. My aim was to achieve as successful a device as possible but with a minimum of complexity and cost. There are many ways of solving the problem and I would hasten to say that there may be other and better ways than that set forth. However, it appears to be quite satisfactory and it should have many applications as a frequency reference and clock.

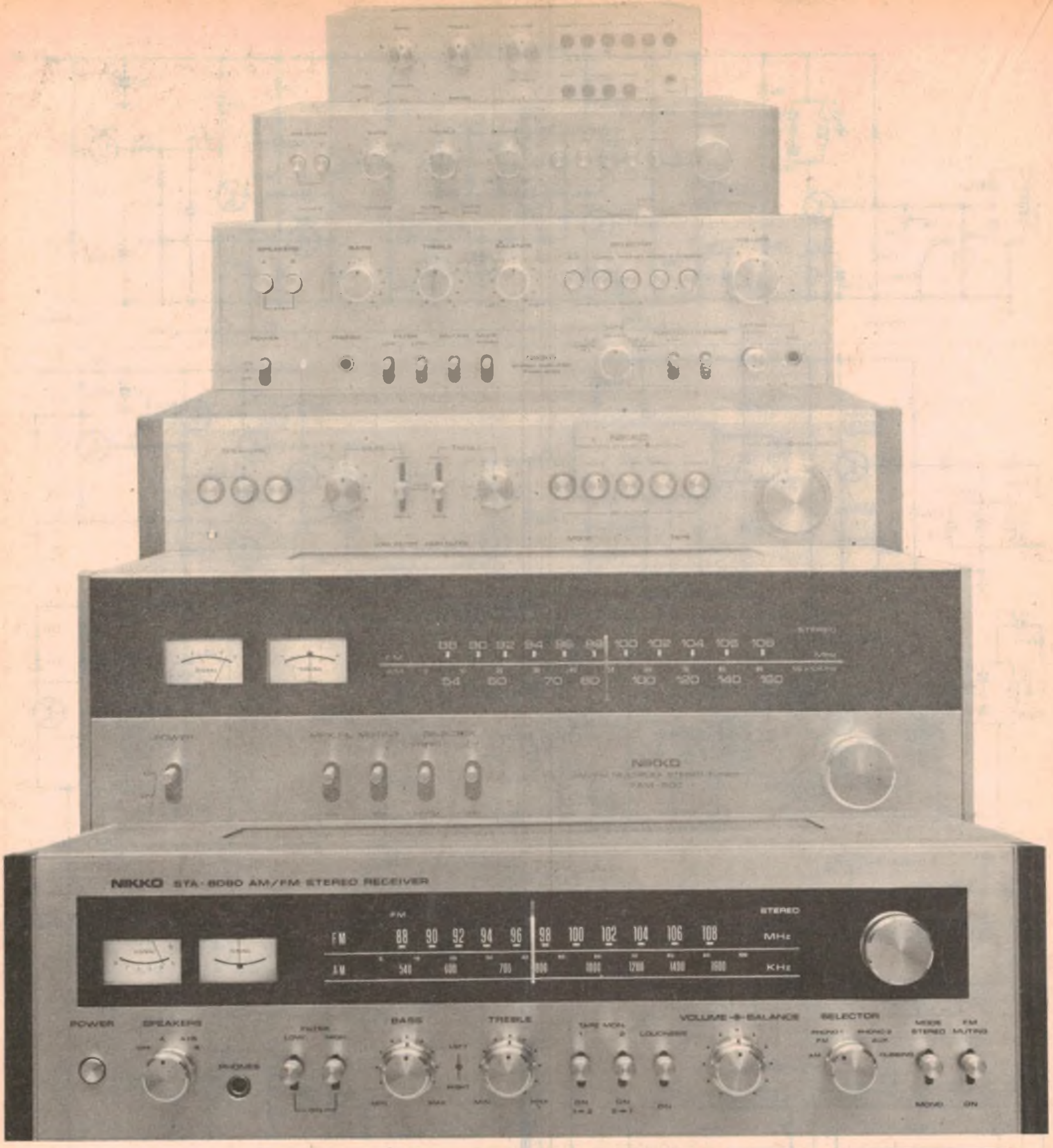
The unit may be considered as being divided into four sections: 100kHz crystal



Above are the connections for the solid state devices used in the circuit. The circuit at right has been modified in some details and these will be given when the second part of the article is presented.



NWC DERIVED FREQUENCY REFERENCE



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oscillator and divider chain, down to 1Hz; a receiver on 22.3kHz; a synthesiser to generate 22.3kHz from the 100kHz crystal; and a power supply. A look at the circuit will show each of these sections in detail.

You will see that the crystal oscillator is fitted into a small and simple oven. My first effort was to operate the crystal and the oscillator circuit at ambient temperature but I very soon found that this was just not a proposition considering the order of accuracy which was being contemplated. Then the crystal was tried in a temporary oven but this did not help much. The change of oscillator circuit component parameters with temperature played havoc with the frequency stability and so the whole oscillator was then included in the oven.

The crystal oscillator circuit is one which I have used on a number of occasions previously, modified to suit the particular purpose. Two EM401 silicon power diodes are used as variable capacitance diodes for frequency control purposes.

The oven heating circuit is about as simple as it could be. The sensing device is a germanium diode, making use of its effective change in reverse resistance with temperature. The diode is in the first transistor base divider and when cold, the resistance is high and so the first transistor is not conducting. The same transistor has a 10k resistor in its collector which is directly coupled to the base of the following transistor. Under these conditions, the second transistor is saturated and draws full collector current. The collector load is four 82 ohm ½ watt resistors in series. Under these conditions, most of the power is dissipated by the four collector resistors.

By virture of the heat dissipation and consequent temperature rise, the germanium diode reverse resistance falls and bias is increased on the first transistor, causing it to start conducting. This results in a voltage drop at the collector and so there is less drive at the base of the second transistor, thereby reducing its collector current and heat dissipation. This process continues until equilibrium is reached. Actually, the circuit settles down to a value of collector current for the second transistor, according to losses mainly directed by the ambient temperature conditions.

I found that with the arrangment which I finished up with, that the oven temperature settled down to about 40°C. This should be about right for many situations but may be altered to suit individual needs by a change in some of the circuit constants.

Output from the 100kHz crystal oscillator is fed via a driver stage into a series of five type 7490 decade dividers to give 20kHz, 4kHz, 2kHz, 400Hz, 200Hz, 100Hz, 50Hz, 10Hz, 5Hz and 1Hz. Of course, any of these frequencies may be used as desired. In point of fact, I used the 50Hz to drive a clock movement and the 1Hz to drive a flashing LED on the front panel. More about these later on.

Output from the 100kHz crystal oscillator is also fed into a 7413 dual Schmitt trigger IC. Both sections are used, being connected in series so that the maximum isolation may be achieved between the crystal oscillator and the usable output. This appears to work out quite well in practice.

The receiver is a simple fixed tuned TRF unit with five stages in all. The first three stages are RF amplifiers involving three tuned circuits, including the aerial loopstick. The fourth stage is an emitter-follower, after which the signal is split, one part going to a discriminator and the other to a fifth stage used to actuate a signal strength meter.

The tuned circuit in the collector of the third RF amplifier has a noise limiter circuit across it. This is effective in reducing noise, but there is also a clipper circuit following immediately, using a pair of silicon diodes in series with a 10k resistor. These two circuits combined are very effective in reducing the noise problem to a point where it has little effect on the wanted signal.

Due to the fact that the transmitter is off the air from time to time, there appeared to be a potential problem of noise then causing ringing of the tuned circuits and so upsetting the otherwise stable operation of the crystal running alone. To avoid this possibility, I have added a diode gate between the emitter-follower and discriminator. The diode is reverse biased indirectly from the collector of the fifth stage operating the meter. When a signal reaches the base of the fifth stage, the collector voltage falls and this allows the diode to conduct under received signal conditions. The diode closes when the signal disappears or drops to a very low value.

In order to bring the 100kHz crystal under the control of the 22.3kHz as transmitted by NWC, 22.3kHz must be synthesised from the 100kHz crystal and the two 22.3kHz components compared in a discriminator. As there are many frequencies available from the frequency divider chain, all square waves rich in odd harmonics, the task of synthesising 22.3kHz is not as difficult as one might at first suppose.

By taking the 2kHz square wave and feeding it into a high Q circuit resonant at 11 times 2kHz, we get damped wave trains in the tuned circuit output at 22kHz. Similarly, by feeding the 100Hz square wave into a similar circuit tuned to the third harmonic, we get damped waves at 300Hz at the output. Both the 22kHz and 300Hz components are then fed into a balanced ring mixer and the sum, 22.3kHz can be picked off the output of the mixer by circuits resonating at the wanted frequency. It will be seen that there are three tuned circuits resonant at 22.3kHz. This number is necessary to get a clean signal, with unwanted components filtered out.

There are three transistors associated with the synthesiser circuits, two emitter-followers for impedance matching and one an amplifier at 22.3kHz. Two iron-cored transistor driver audio transformers are used as input and output for the ring mixer.

Outputs from the receiver and synthesiser at 22.3kHz are fed into pins 4 and 13 respectively, of a type LM1351 IC. This consists of a limiting amplifier, synchronous detector and buffer stages. Any difference in phase relationship between the two signals causes a change in DC level at pin 2. This is filtered with a 10k resistor and a 100uF electolytic capacitor. The filtered DC is used to vary the capacitance of two diodes in the crystal circuit thus keeping the 100kHz crystal under the control of the received signal.

The filtered DC voltage just referred to is also metered with a 100uA meter fed via a 100k resistor. This makes the meter effectively a 0-10V meter and this is useful to monitor the performance of the control voltage.

The power supply could conceivably be modified quite a bit from that which I found to be that which met my particular requirements. As my primary interest is to use the device to drive a clock movement, some sort of battery backup must be provided in order to avoid breaks due to possible mains supply interruptions. I was fortunate in being able to obtain a set of nickel-cadmium cells which have been arranged to do this job quite nicely. The cells are normally left on float charge and when required, can keep the unit running for three hours or so. When the mains supply returns after a break, the batteries are recharged ready for next time.

A small line filter is incorporated in the transformer primary circuit. It was found that switching transients on the line could find their way into the system and so upset the counting system. The filter consists of a trifilar winding on a ferrite toroid, together with two .01uF 2kV ceramic capacitors.

The mains transformer secondary is rated at 7.5V AC at 1A for each of the two windings, although half this current rating would be adequate. Each winding feeds a separate bridge rectifier and a 1000uF filter. The output of one feeds an LM3099 5V IC regulator, for the high current supply at 5V. The second output feeds a smaller 5V IC regulator, type LM342-5.0. This second 5V supply is stacked on top of the first one and supplies the receiver and discriminator

Parts List For Derived Frequency Reference

CRYSTAL OSCILLATOR & DIVIDERS PARTS LIST

1 Metal case, 12in (305mm) wide x 4in (102mm) high x 8in (204mm) deep, Horwood type H84/12 or similar
4 Rubber feet for case
2 EA Multi-Dip boards (single width)
1 Metal bracket to fix Multi-Dip boards
1 Clock movement, optional (see text)
1 Oven box with insulation (see text)
1 Crystal, 100kHz, 30pF, ambient, HC-13/U (see text)
2 Transistors, BC208, BC548, BC108
1 Transistor, BC308, BC558, BC178
1 Transistor, 2N3693 or similar
1 Transistor, 2N3566 or similar
5 ICs, 7490 14-pin DIL
1 IC, 7413 14-pin DIL
6 Sockets 14-pin DIL
2 Silicon diodes, EM401
1 Germanium diode, OA91
1 Light emitting diode, red, bush mounting
2 RCA type sockets, bush monitoring

Resistors (½W)
4 82 ohms
3 470 ohms
1 2.2k
2 3.9k
1 10k
2 15k
1 33k
1 100k
3 1M

Capacitors
1 3.3pF NPO ceramic
1 2-10pF trimmer, ceramic panel mounting
1 3-30pF trimmer, preferably Philips "beehive" or similar
2 33pF 100V polystyrene
6 .01uF 100V greencap

POWER SUPPLY PARTS LIST

(As individual requirements may vary considerably, the parts list is presented as a guide only and the text should be studied for further details and comments.)
1 Power transformer, prim 240V, sec 2 x 7.5V 1A
10 Silicon power diodes, BY126/100, EM401 etc
2 Transistors, 2N3053, MU9610 etc
2 Transistors, BC208, BC548, BC108 etc
2 Transistors, BC308, BC558, BC178 etc
1 IC, LM342-5.0
1 IC, LM309
2 Tagboards, each with 12 prs tags
1 Ferrite toroidal core, Philips 4322 020 36570, or similar
1 4-way mains terminal strip
1 DPDT toggle switch
1 SPDT toggle switch
12 Nickel-cadmium cells, 1.0Ah, Short C
1 Box for cells
1 3-core power cord with plug
1 Power cord clamp
4 Spacers, ½in long tapped ⅛in Whitworth

Resistors (½W unless stated otherwise)
2 22 ohms
2 270 ohms
4 4.7k
2 100k trimpots

Capacitors
1 .01uF 63V ceramic
2 0.1uF 2kV ceramic
4 0.1UF 100V greencaps
2 1000uF 16VW electrolytics

RECEIVER PARTS LIST

1 Tagboard with 24 prs tags
2 Spacers, ⅝in long tapped ⅛in Whitworth
1 Ferrite aerial rod, 8in (200mm) long x ½in (12mm) diameter (Radio Despatch)
4 Potcore halves, Philips 4322 020 21510 P18 3H1
2 2-section formers, Philips 4322 021 30280 P18
1 Meter, 100uA FSD, 45mm x 42mm
2 RCA type sockets, bush mounting
5 Transistors, BC208, BC548, BC108
3 Germanium diodes, OA91 or similar
2 Silicon diodes, 1N914A or similar
1 Toggle switch, SPDT

Resistors (½W unless stated otherwise)
1 560 ohms
2 1k
1 1k trimpot
1 2.2k trimpot
2 3.3k
1 3.9k
1 4.7k
1 6.8k
6 10k
1 33k
3 47k
1 47k trimpot
1 56k
1 100k trimpot
1 220k
1 270k
1 470k
1 1M trimpot

Capacitors
1 560pF 630V polystyrene
1 .0039uF 400V polystyrene
2 .0056uF 100V greencap
2 .01uF 100V greencap
2 .039uF 100V greencap
1 .047uF 100V greencap
6 0.1uF 100V greencap
3 10uF 2.5VW electrolytic
1 10uF 12VW electrolytic

SYNTHESISER PARTS LIST

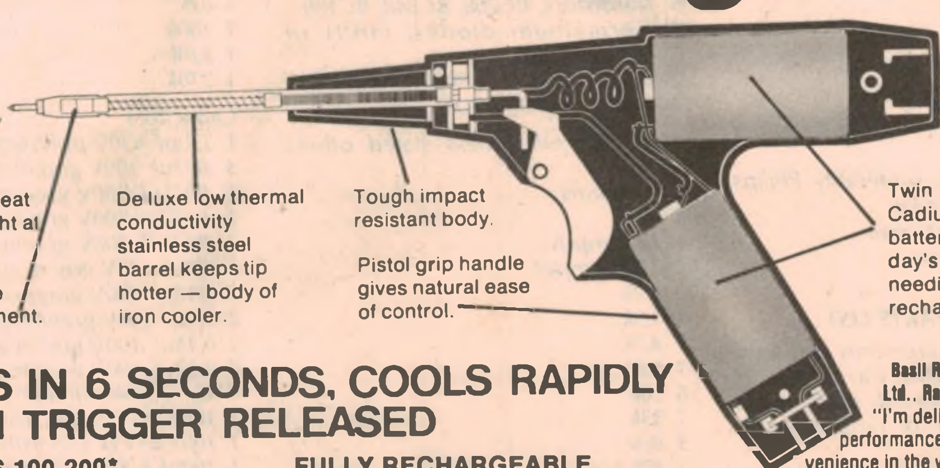
2 Tagboards, each with 20 prs tags
1 500mH potcore inductor (R.C.S. Radio)
1 10mH single pi RF choke
8 Potcore halves, Philips 4322 020 21510 P18 3H1
4 2-section formers, Philips 4322 021 30280 P18
2 Transistor audio driver transformers, Ferguson TRD223 or similar
1 IC, LM1351 14-pin DIL
1 Socket 14-pin DIL
3 Transistors, BC208, BC548, BC108
4 Diodes, OA91 or similar
1 Meter, 100uA FSD, 45mm × 42mm
1 RCA type socket, bush mounting
2 Spacers, ½in long tapped ⅛in Whitworth
2 Spacers, ⅜in long tapped ⅛in Whitworth

Resistors (½W unless stated otherwise)
1 4.7 ohms
1 47 ohms
1 1k
1 82 ohms
1 2.2k
1 2.2k trimpot
2 10k
1 47k
1 82k
1 100k
1 220k
1 270k

Capacitors
1 330pF 630V polystyrene
3 .001uF 100V greencap
1 .0015uF 100V greencap
1 .0022uF 100V greencap
3 .0047uF 100V greencap
3 .01uF 100V greencap
1 .012uF 100V greencap
2 0.1uF 100V greencap
2 0.15uF 100V greencap
1 0.22uF 100V greencap
4 1uF 35VW tantalum
1 10uF 2.5VW electrolytic
1 10uF 25VW electrolytic
1 100uF 6.4VW electrolytic
1 250uF 12VW electrolytic

Miscellaneous
Light coaxial cable, hookup wire, solder, solder lugs, screws, nuts.
Note: Resistor wattage ratings and capacitor voltage ratings are those used on the 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 if available, providing ratings are not exceeded.

Scope Cordless 60w Soldering Tool



HEATS IN 6 SECONDS, COOLS RAPIDLY WHEN TRIGGER RELEASED

SOLDERS 100-200* TYPICAL JOINTS BEFORE RECHARGING
*Light electrical connections. Capacity will vary for lighter or heavier joints.

PISTOL GRIP DESIGN balances weight of cells for comfort and tip control.

FULLY RECHARGEABLE OVERNIGHT, from car, power-point or Scope Transformer.

ABSOLUTE SAFETY
No earth leakage currents. Solder anywhere with total personal and component protection.

Basil Rogers & Co. Pty. Ltd., Radio & T.V. Repairs.
"I'm delighted with its performance and sheer convenience in the workshop or in the field. It's light, fits easily in your hand and you can solder even with the set on."

Kevin Ball, T.V. Technician.
"In my job I work mainly on circuit boards and I'm rapt with Scope Cordless. I've never reached a point where the gun can't handle a day's soldering. I like the feel of it; tremendous balance."

SCOPE

Distributors to the Electrical Trade:
NATRONICS PTY. LTD. The Crescent, Kingsgrove, N.S.W. 2208

Manufactured by: SCOPE LABORATORIES, MELBOURNE.

circuits. It will also be noticed that there are four 0.1uF capacitors, one on each side of each of the 7.5V transformer windings. These are used to aid in combating the switching transients mentioned earlier.

Two sets of six nickel cadmium cells are charged from the two filtered DC outputs, via a 2N3053 or MU9610 regulator transistor with a "variable zener" consisting of a BC308 and a BC208 (or similar) in the base circuit of the regulator transistor. The voltage is set by the 100k potentiometer to give the right charging current characteristic. The 22 ohm resistors in series are current limiters. Output from each of the batteries is automatically available via the series silicon diodes. Supply of about 10V DC unregulated is taken from the second supply to feed the oven heater circuit.

If a backup supply is required but the use of nickel cadmium batteries is not desired, then the charging circuits could be dispensed with and dry batteries substituted. The series diodes should be retained to effect the automatic changeover when required.

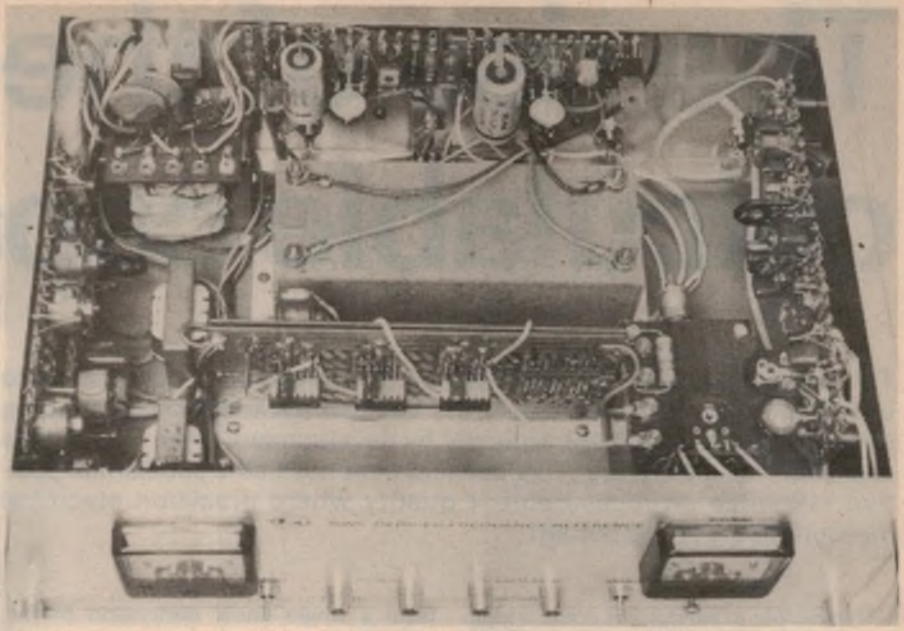
The components which I used are readily available, with a couple of possible exceptions. In these cases substitutes are available and no troubles should be had in this respect. Perhaps a few comments on some of the components may be helpful.

The case in which the unit is built is a very nice unit made in Melbourne by Horwood and is normally available through trade outlets. The type number of the case is H84/12. They are available in plain aluminium, or vinyl covered steel, with aluminium back and front panels. I used the vinyl version.

Meters, basic components such as transistors and most of the ICs should all be readily available. The two power supply regulator ICs are by Motorola and these should also be available through outlets dealing in Motorola products. The types of diodes which I have specified should also be readily available. The LED is not critical and should preferably be a bush mounting type so that it can be easily fixed to the front panel.

The crystal which I am using was supplied by Bright Star Crystals Pty Ltd, 35 Eileen Road, Clayton, Victoria. If you intend to follow the crystal oven construction, then it will be necessary to use a crystal in the same HC13/U holder. If you already have a crystal in some other type of holder which you would like to use, then the question of a suitable oven will have to be considered.

The two transformers used for the ring mixer are made by Ferguson Transformers. Type No TRD223 is one of the few remaining transistor driver transformers on the market. However, if difficulty is experienced in obtaining this particular



This inside picture shows the location of the sub-assemblies. The power supply is at the back, with the batteries immediately in front. Nearer the camera are the printed boards, the crystal oscillator oven immediately right. Far right is the receiver and far left are the synthesiser circuits.

transformer, then a similar type with a ratio of primary to secondary of about 2.5/1 + 1 should do the job nicely.

I took the liberty of using a power transformer which is no longer listed in the Ferguson range. It is a multi-ratio type PF2155 and by splitting the 7.5V tap I was able to obtain two separate 7.5V AC secondaries, rated at 1A maximum each. This suited my purpose very well, both electrically and physically. As mentioned earlier, the power supply may well be modified to suit individual requirements and the particular transformer type which I used may not then be suitable.

While some other manufacturers may be able to offer a suitable power transformer, Ferguson offer at least two possible alternatives. If the load requirements are not too high—say without battery charging—then the very small 5VA rated line may be suitable. I would suggest under these conditions that PL18/5VA would be a possibility. As the regulation is rather poor, instead of starting with a 7.5V secondary the above type has a nominal 9V secondary and this should do the job, short of battery charging. On the other hand, Ferguson type PL15/20VA would be adequate for full load conditions. The physical shape would necessitate some rearranging of components around the particular corner of the case.

The ferrite toroid which I used for the line filter is no longer available but almost any type should do the job satisfactorily. One suggestion is a Philips toroid type 4322 020 36570. This one is about the same size as the one which I used and should be available without any problems, as this has been specified in some of our projects in the past.

The ferrite aerial rod which I used is one of the larger types and it is to be preferred to smaller ones. Stocks of the type which I used are currently available from Radio Despatch Service, 869 George Street, Sydney. The rod is actually part of a ready wound aerial coil. The winding should be removed and the new winding may then be put on the former which is ideal for the job.

The nickel cadmium cells which I used are a disposals item but I understand them to be brand new. These are also available from Radio Despatch Service for a very modest price. It is also just possible that there may be other sources of low priced nickel cadmium cells. Alternatively, they are always available through the normal channels in the usual well known brands.

If you wish to use a more or less conventional clock movement for a time readout, there are many such movements which can be synchronised with the pulses available from the divider chain. The transistor switched single cell operated clocks readily available from stores may be run from the 50Hz outlet. I am doing this with a "Vedette" movement available from Australian Time Equipment Pty Ltd, 192 Princes Highway, Arncliffe, NSW. It is possible to run this type of movement from lower frequencies, which are multiples of five, down to 5Hz but I doubt whether it would be possible to get satisfactory operation above 50Hz.

There are also some alternative movements which use a vibrating reed. I have used one which operates at 100Hz and it synchronises nicely when fed from a frequency of 100Hz. One other comes to mind and which operates at 300Hz. This should also be suitable when fed from 300Hz but I have not tried them.

(To be continued)

The rise of the calculable capacitor

The US National Bureau of Standards has contributed significantly to one of the quieter revolutions of the last two decades—the upgrading of electricial measurement accuracy by development of the "calculable capacitor" as a standard. This development has had a substantial positive influence on measurement quality where precision electrical measurements are important.

The electric capacitor has come a long way in the science of measurement. Twenty years ago discussions of basic electric standards scarcely mentioned it. Today the SI or metric unit of capacitance, the farad, is the most accurately realizable of the electric units.

More impressive still, capacitance standards can now be used to measure the resistance in ohms of standard resistors. And the National Bureau of Standards (NBS) is setting up a regular program for monitoring the US legal ohm standard by comparing it periodically with the capacitance standard.

The capacitor's march to metrological glory began back in 1956 when A. M. Thompson and D. G. Lampard of the Australian National Measurement Laboratory (NML), then the National Standards Laboratory of Australia, discovered a new theorem in electrostatics. They uncovered a whole new class of designs, the "cross capacitors," whose capacitances can be calculated with unusual accuracy—in electrostatic units—from a single linear dimension of the capacitor.

However, to calculate a capacitance in SI units (farads)—which is indispensable for most practical applications of capacitors—it is necessary to know the speed of light. (The capacitance formula contains the factor, ϵ_0, the "permittivity of space," which in turn depends on c^2, the square of the speed of light). Hence any uncertainty in the speed of light will reappear (multiplied by 2, because the square of c is involved) in the uncertainty of the capacitance. This difficulty was soon eliminated by progress in measuring the speed of light at NBS Boulder Laboratories. The uncertainty is now below 0.01 part per million (ppm).

An apparently more formidable obstacle in the path of the calculable capacitor was the extreme minuteness of a picofarad (pF). Its usefulness would therefore have been severely limited unless a way could be found to accurately compare such small capacitors with the more frequently used larger ones.

Capacitance and the speed of light

To those not deeply immersed in electrical matters, it may seem more than a little far-fetched that the speed of light pops up in the calculation of a capacitance.

The paradox is at least partially resolved by recalling that light, after all, is an electromagnetic wave and its speed depends on basic characteristics of electric and magnetic fields.

In a little more detail, one notes that an electric charge can manifest itself in two ways:

- It is repelled by like charges and attracted by opposite ones.
- A moving charge is, in addition, acted on by other moving charges through the forces we call magnetic. It turns out that the speed of light depends on the relative strength of these two effects—electrostatic attraction or repulsion on the one hand, and magnetic forces due to moving charges on the other.

And capacitance—in farads—depends on the same two effects:

1) Capacitance in farads is the number of coulombs needed to raise the p.d. of the capacitor to 1 volt. But the coulomb is the charge delivered by a current of 1 ampere in 1 second, and the ampere is defined in terms of magnetic forces between moving charges.

2) The p.d. is a measure of the energy per coulomb (1 volt = 1 joule per coulomb) stored in the capacitor—energy that depends solely on the electrostatic attraction between the charges on the capacitor's two plates.

This difficulty was overcome when scientists at the Australian NML and at NBS succeeded in designing circuits (transformer comparator bridges) that can compare capacitors of only a fraction of a picofarad with capacitors well over 100,000,000 times larger. And they do this without noticeably increasing the uncertainty of the result—a measurement feat that is believed unique to the field of electricity. (For a comparable achievement in measuring length, one would have to measure a distance equal to that between New York and San Francisco by means of a measuring rod only 2 cm long, and do it without making any detectable error in the measurement process itself.)

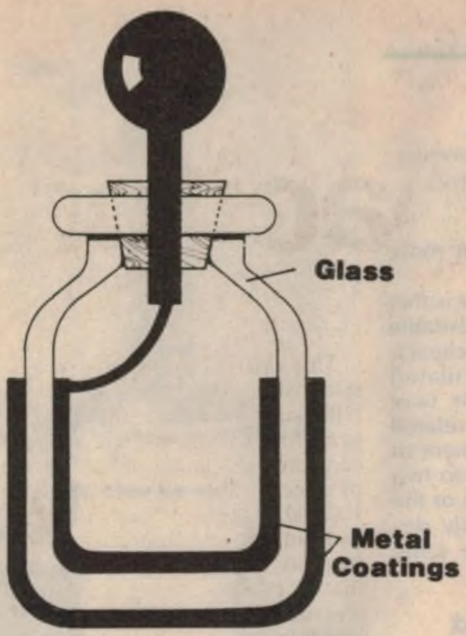
The intercomparisons are made in a series of 10-to-1 stages: for example, a 10pF capacitor is measured against a 1pF capacitor, then a 100pF capacitor is compared with the 10pF one, and so on up the scale. This same technique has since been adapted to comparing standards of the volt and the ohm.

Better Farads, Ohms & Amperes

Thanks to the calculable capacitor, the US legal farad is believed to conform to the definition of the SI farad to within 0.02ppm. (This, like other accuracy figures in this article, given in ppm, are estimated at the 95 percent confidence level.)

Capacitors are critical components in all sorts of electronic circuits—amplifiers, oscillators, filters, pulse generators, and a hundred others. Tuning a radio or TV set, for example, is usually done by adjusting a variable capacitor. Considerably greater demands on accuracy are made in such applications as aircraft fuel gauges and operational amplifiers for analog computers and control devices. The higher accuracy of the new capacitance standards makes quality control a lot easier for those who make precision capacitors and the instrumentation for measuring them.

The calculable capacitor is leading to more accurate standards of electrical resistance (the ohm) where high accuracy is in even greater demand. The ohm formerly was determined by comparison with a calculable inductor. One either calculated the inductance of a carefully designed coil from its dimensions and number of turns, or the mutual

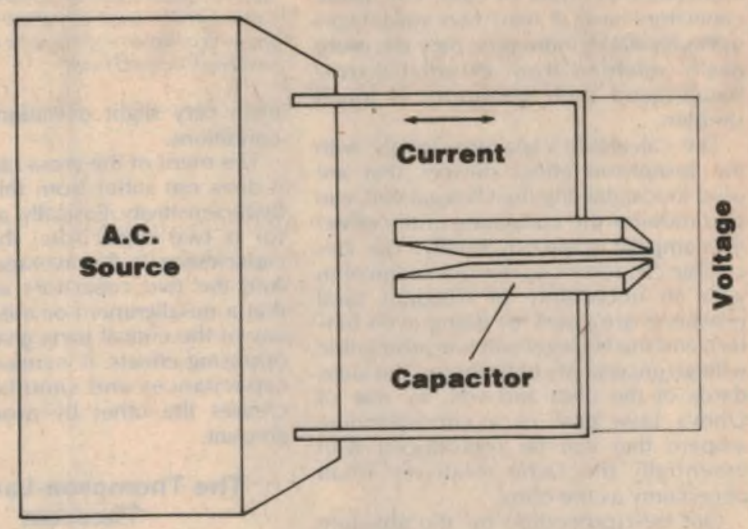


SOME BASICS ON CAPACITORS AND CAPACITANCE . . .

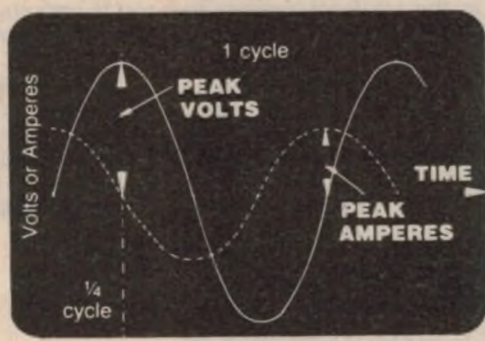
Any two conductors, with a nonconductor (the 'dielectric') between, can store electric charge.

A capacitor is a pair of conductors specially designed to store appreciable amounts of charge (like a millionth of a coulomb)—its two conductors come close to each other over a fairly large area . . . as can be seen in the first capacitors, the 'Leyden jars' of the 18th century, one type of which is shown here in cross section. Glass is the dielectric; tin foil or silver leaf formed the conducting layers.

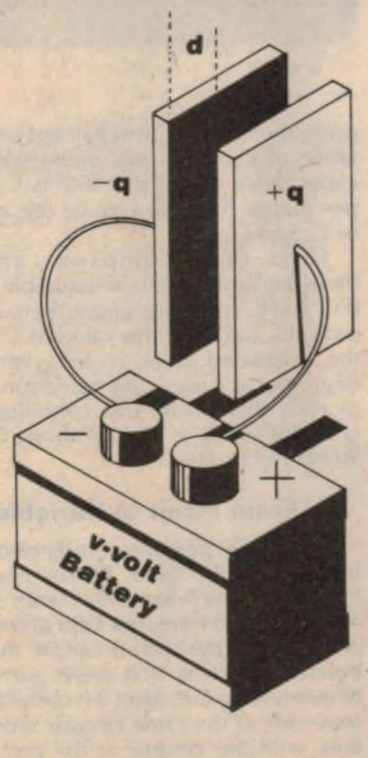
Another way to describe a capacitor is by its behavior when an alternating voltage is applied across its terminals.



This behavior is summarized in the graphs below (which might be displayed on an oscilloscope screen), showing how the current through a capacitor (dotted graph) and the voltage across it (solid graph) vary with time.



It is characteristic of a pure capacitor that the current wave is one-quarter cycle ahead of the voltage wave. The peak voltage divided by the peak current is the impedance of the capacitor. The impedance depends on the capacitance C (in farads) and on the frequency f (in hertz) of the alternating voltage: impedance of capacitor $= 1/2\pi fC$ *ohms.*



The capacitance C, in farads, is the number of coulombs stored on each conductor per volt of potential difference between them. In this parallel-plate capacitor, where the conductors are metal plates, $C = q/v$*. This capacitance can also be calculated (approximately) by the formula:* $C = \kappa\varepsilon_0 A/d$.

A is the area (sq meters) of each plate.
d is the distance (meters) between plates.
κ *is the dielectric constant (nearly 1 for air, exactly 1 for vacuum, 7 or more for flint glass).*
ε_0 *is the 'permittivity of vacuum', it is equal to* $10^7/4\pi c^2$
where c is the speed of light.

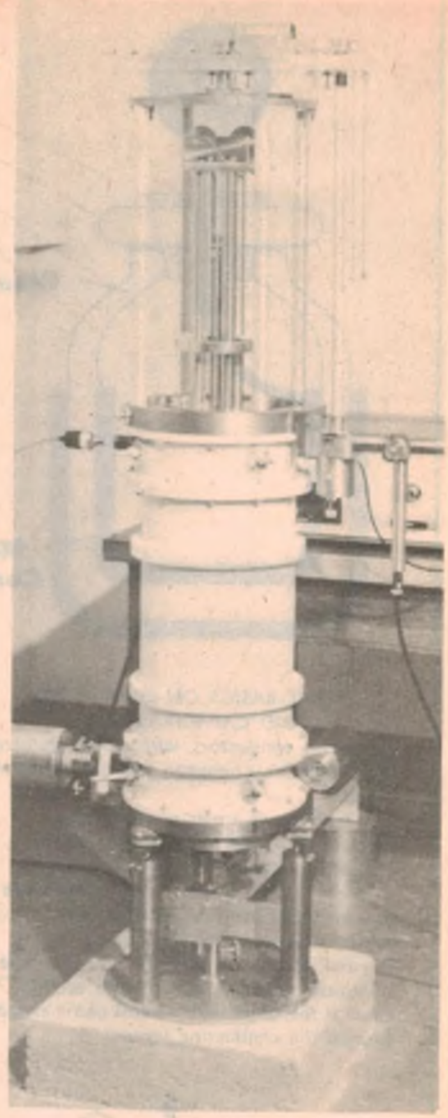
The closer the plates are together and the larger their area, the more accurate the formula becomes.

inductance of a pair of coils. Calculable capacitors have at least two advantages over calculable inductors: they are more easily shielded from external disturbances and their geometry is much simpler.

The calculable capacitor, jointly with the Josephson effect devices that are used in maintaining the US legal volt, can also monitor the constancy of the effective ampere standard. Briefly: the calculable capacitor can reproduce the ohm with an uncertainty of 0.06ppm (and prospects are good for doing even better); and the US legal volt is reproducible with an uncertainty of 0.08ppm. But standards of the ohm and volt, by way of Ohm's Law, give us a corresponding ampere that can be reproduced with essentially the same relatively small uncertainty as the ohm.

Our best procedure for the absolute determination of the ampere, which uses a current balance, has an uncertainty of about 15ppm. Thus, although the ampere standard could conceivably vary, from one absolute determination to another, by as much as 15ppm, scientists can nevertheless (through the ohm and volt standards) narrow the range of possible fluctuations in the US legal ampere to less than 1/200 of that amount.

There were calculable capacitors before 1956, but achieving the required accuracy was so difficult that it discouraged their use as standards. Almost any physics textbook tells how to calculate the capacitance of a "parallel plate" capacitor—two equal metal discs, parallel to one another and separated by air or some other nonconductor. Unfortunately, the calculation is exact only under certain ideal conditions, and the capacitance is extremely sensitive to even very slight deviations from those conditions.



NBS calculable capacitor (variable cross capacitor) with upper cylindrical cover removed, showing pulley arrangement for raising and lowering the shield hood

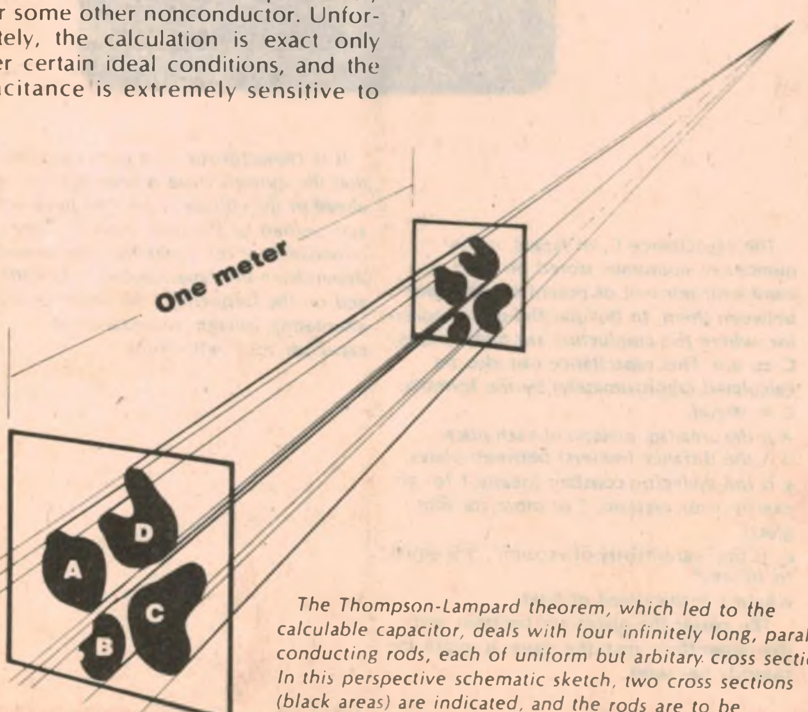
The merit of the cross capacitor is that it does not suffer from this undesirable hypersensitivity. Basically, a cross capacitor is two capacitors; the calculated capacitance is the average of the two. And the two capacitors are so related that a misalignment or misplacement of any of the critical parts gives rise to two opposing effects: it increases one of the capacitances and simultaneously decreases the other by nearly the same amount.

The Thompson-Lampard Theorem

The kind of situation considered in the Thompson-Lampard theorem, on which the calculable capacitor is based, is not difficult to describe: a set of four metal rods—call them A, B, C and D—of indefinite length and placed parallel and close to one another, as suggested in the illustration. The cross section of any one rod is uniform along its length, but different rods can have different cross sections.

Now any two conductors, say portions of rods A and C, separated by a non conductor (air, for example) constitute a capacitor. But because the rods are "indefinite" in length, we can only speak of their capacitance per unit length. Suppose, then, the A-C rod pair has a capacitance of C_1 farads per metre while the capacitance of rod pair B-D is C_2 farads per metre. Also, let Cav be the average of C_1 and C_2.

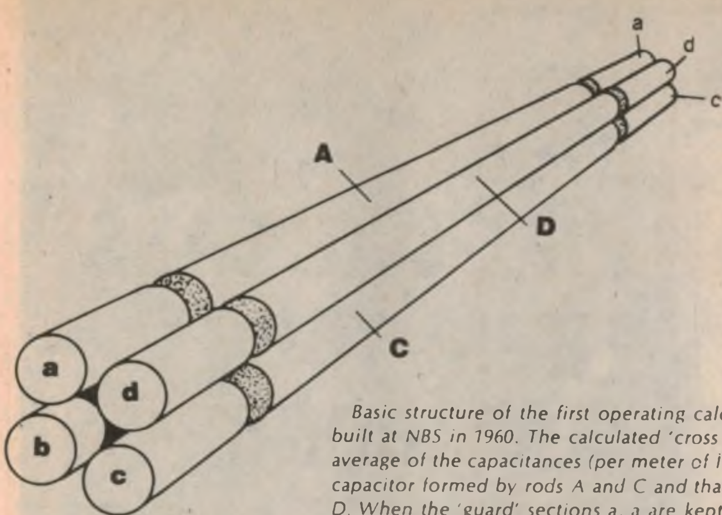
Then the Thompson-Lampard theorem leads to this remarkable result: If C_1 and C_2 are nearly equal, then we cannot only calculate the value of Cav, but the calculated value is—to a very high degree of accuracy—the same for all sets of rods that satisfy this condition. This constant value of Cav is about 2 picofarads per metre.



The Thompson-Lampard theorem, which led to the calculable capacitor, deals with four infinitely long, parallel conducting rods, each of uniform but arbitary cross section. In this perspective schematic sketch, two cross sections (black areas) are indicated, and the rods are to be thought of as continuing indefinitely to the front and rear.

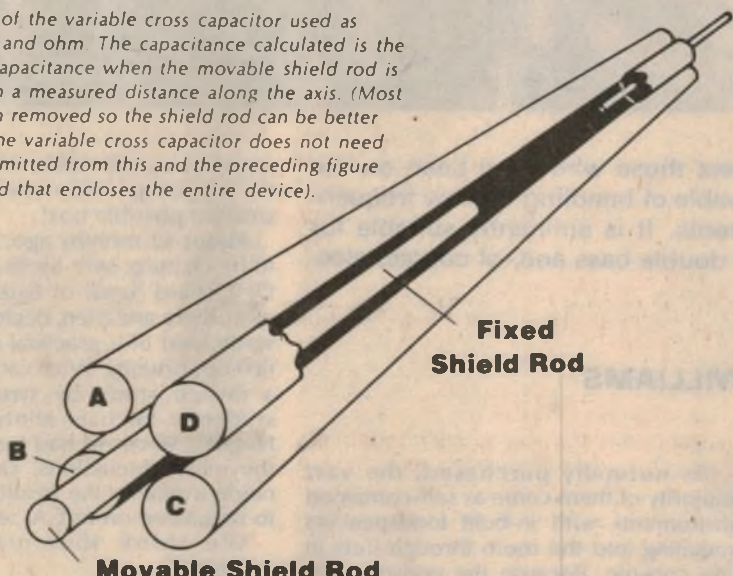
From Fixed to Variable

In practice, of course, rods of definite length must be used. But by placing a "guard section" near either end of each rod (insulated from, but kept at the same potential as, the rod) it can be made to behave much as if it were part of an infinitely long rod. Also, it is easiest to use four rods of the same circular cross section, with the centres at the corners of a square. A "grounded" metal cylinder, enclosing the entire cross capacitor, is



Basic structure of the first operating calculable capacitor, built at NBS in 1960. The calculated 'cross capacitance' is the average of the capacitances (per meter of length) of the capacitor formed by rods A and C and that formed by B and D. When the 'guard' sections a, a are kept at the same voltage as A, b, b at the same voltage as B, etc., then A, B, C and D act very nearly as if parts of infinitely long rods.

Basic structure of the variable cross capacitor used as standard of farad and ohm. The capacitance calculated is the change in cross capacitance when the movable shield rod is displaced through a measured distance along the axis. (Most of rod D has been removed so the shield rod can be better seen. Note that the variable cross capacitor does not need guard sections. Omitted from this and the preceding figure is the metal shield that encloses the entire device).



employed to shield it from electrostatic fields between itself and conductors in the vicinity.

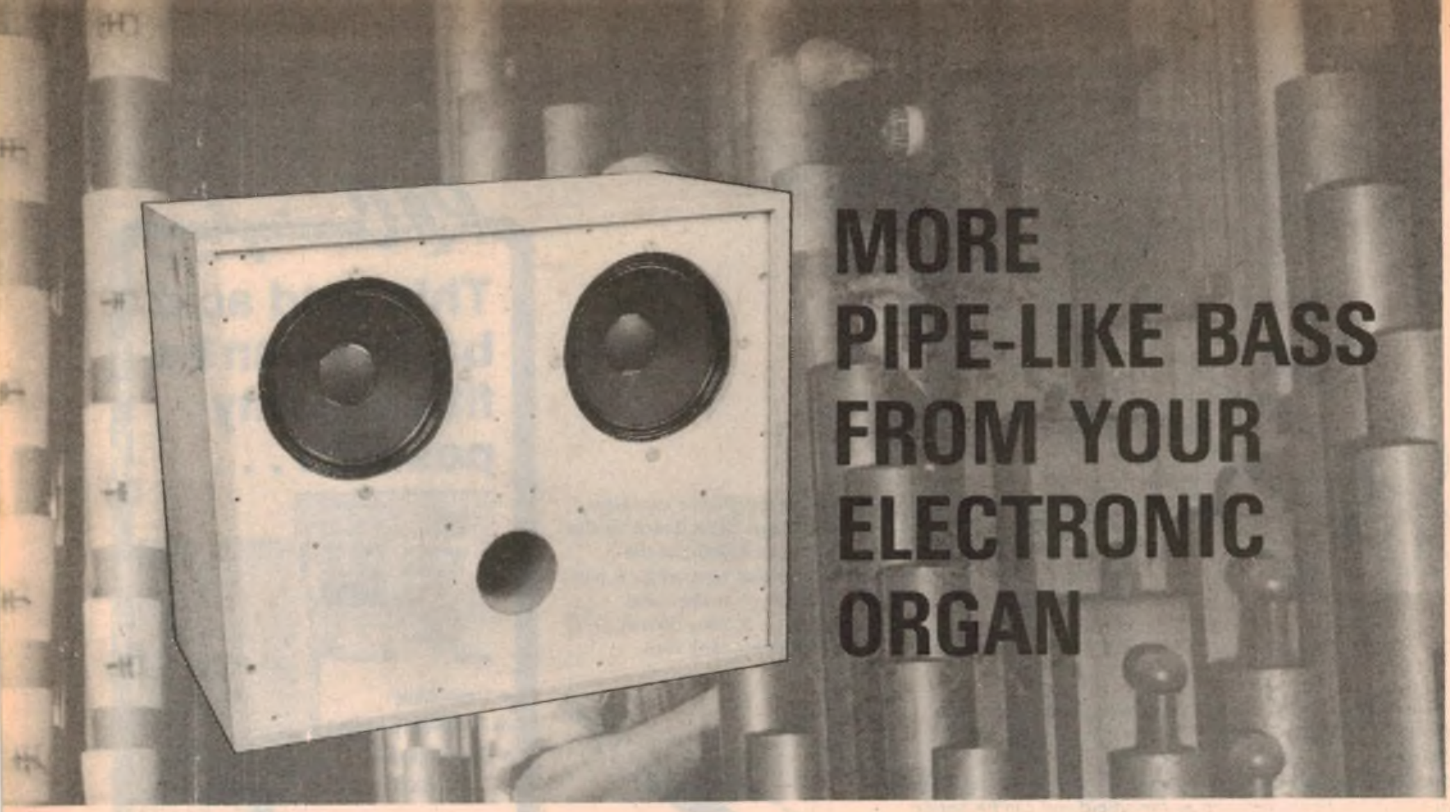
The first operating calculable capacitor of this kind was built in 1960 by Robert D. Cutkosky at NBS. Its electrodes (rods) were precision gauge blocks, and it was used to calibrate an ohm standard to 6 ppm. Cutkosky also extended the theory to allow for nonconducting films on the electrodes.

An important change came in 1964 when Thompson and Lampard, working with W. K. Clothier, made the cross capacitor variable. They did this by inserting a grounded rod down along the central axis of the device. This acts as a shield between opposite rods, reducing C_1 and C_2 effectively to zero over the distance the shield rod has been inserted. The A-C and B-D capacitances are again restored as the movable rod is withdrawn. Leaving out the complicated details, if the rod is pulled out through a distance L, the cross capacitance increases by LC. Clothier built an instrument of this design in 1964. Its accuracy was limited to about 0.5ppm by the then existing uncertainty in the speed of light.

The second cross capacitor at NBS was of this variable kind. It was built by Cutkosky in 1974 and is the one used by him to determine the farad to 0.02ppm and the ohm to 0.06ppm. Besides the advantages inherent in the variable cross capacitor, plus some refinements worked out at NBS, this cross capacitor has the major advantage arising from the use of a stabilized laser for the interferometric measurement of the displacement L.

Thus in less than twenty years the calculable capacitor has become one of the two pillars of the electrical measurement system (the other is the AC Josephson effect) that are primarily responsible for the accuracy and stability of that system.

Reprinted from "Dimensions", by arrangement with the US National Bureau of Standards.



MORE PIPE-LIKE BASS FROM YOUR ELECTRONIC ORGAN

Here is a design which should interest those who have been on the look-out for a loudspeaker system capable of handling the low frequencies from electronic musical instruments. It is eminently suitable for use with electronic guitars, amplified double bass and, of course, electronic organs of all shapes and sizes.

by NEVILLE WILLIAMS

Perhaps we should qualify the above introduction by emphasising that there is no such thing as a completely universal music nstrument loudspeaker, even if one is thinking only in terms of a bass-end reproducer.

The kind of bass driver which might be selected by a specialist guitar player in a high-power pop group would be far too ambitious and expensive for someone entertaining at an amateur level in a more limited environment.

For organ work, there tends to be a special emphasis on response in the 30-40Hz region, but still with a diversity in power handling capability according to the situation in which the instrument is to be used. And a big, powerful, bass-rich system, which might be appropriate for a church organ, would bring no delight to a pop group guitarist: it simply wouldn't fit into his car or wagon—even if he could lift it!

Yet, given all this in, there obviously is a place for a bass loudspeaker system which can meet the needs of the many musicians who want something better than they already have, but who can neither afford nor accommodate a big, pretentious system.

Take for example, the scene we know best at E.A.—that to do with electronic organs.

As normally purchased, the vast majority of them come as self-contained instruments with in-built loudspeakers radiating into the room through frets in the console. Because the console also houses the organ "works", it cannot provide a proper acoustic chamber to enclose the rear of the bass driver, which therefore has to operate in a virtual open baffle mode.

Under these conditions, there is no way that it can do full justice to the 16ft pedal notes, which involve fundamentals down to 32Hz. Pedal notes will be heard, of course, but largely by virtue of their harmonics, supplemented by the tendency for most drivers to frequency double when driven hard without adequate baffling. What should be a rich 16ft Bourdon emerges as a much lighter something-else, which could best be described as a rather bubbly 8ft sound. And a 16ft "reed" comes out as all reed and no pipe!

While it is easy enough to conclude that a separate external enclosure is necessary to house the bass speaker at least, giving it practical expression is another matter. It involves decisions about actual rather than ideal bass end response, cost, size, appearance, and where the darned thing is going to stand in an already crowded room! The problem usually boils down to getting the largest possible sound out of the smallest possible box!

About 12 months ago, we happened to be chatting over these problems with Dr Richard Small of Sydney University who, there and then, decided to sponsor some kind of a practical exercise at the first opportunity. What came out of it was a design study by two engineering students: Michael Hintze and David Hughes. Since we had been involved in the initial discussions, Dr Small kindly made available the results of this study to be passed on to E.A. readers.

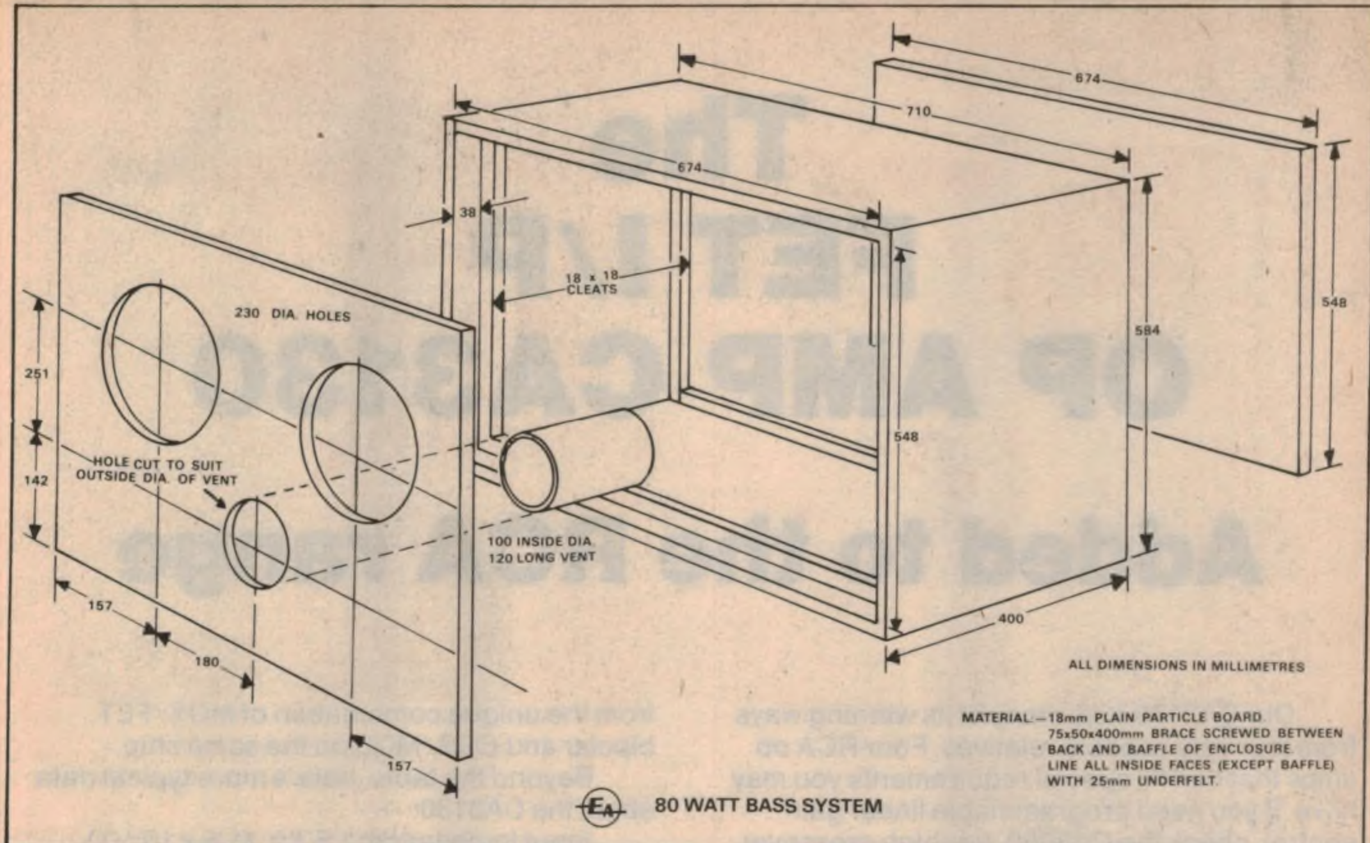
We think that many will be interested.

Instead of starting with an exotic and highly priced imported driver, attention was focussed on the recently developed Magnavox 10-40, a "big brother" of the same company's very well known 8-30 woofer. As the type number implies, the 10-40 has a nominal overall diameter of 10 inches and a nominal RMS power rating of 40 watts. It is designed primarily as a woofer but, with a response extending usefully to about 5kHz, it can cope with the mid-range if necessary.

From the purchaser's point of view, an attractive feature is that the 10-40 can be purchased for less than $30, tax included, which should not be too daunting a figure to a non-professional musician.

Initial consideration was given to a single 10-40 in a suitably designed vented enclosure but a conviction emerged that the end result erred on the side of being too modest. While capable of a very wide, flat response, it was really more suited to being half of a stereo pair rather than a single "gutsy" musician's loudspeaker.

Out of this came the concept of using two 15-ohm 10-40 drivers in parallel in



Essential details of the prototype enclosure. The one item not drawn is a strut which needs to be provided between the centre of the back panel and the centre of the baffle. The proportions can be modified somewhat, provided the internal volume remains at 120 litres. While a bass box can theoretically be used in any position, it is best to keep the cones in the vertical plane to minimise risk of the suspension sagging over a long period.

a single box, to produce an 8-ohm 80 watt system. Even with tgo drivers, cost would still be well under the "exotic" level, and 80 watts would be much more in line with what enthusiasts would be looking for.

Accordingly, sample drivers were obtained, their parameters carefully measured as part of the academic exercise, and their behaviour predicted with the aid of a computer program. This was compared with the measured performance when mounted in a nominal 120 litre enclosure—twice the volume normally recommended for a single driver in a hifi system. A slight modification was made to the length of the port tube and the final design emerged as per the accompanying dimensional diagram.

Considering the specifications and the end result, it appeals as a particularly good compromise. It can produce all the bass ever likely to be required in a home or chapel situation, without being so large as to pose an impossible accommodation problem. And again, while no one would choose to carry it around the block, it is transportable!

Not surprisingly, the final response curve below 200Hz turned out to be very similar to curves already published for a single 10-40 in a 60-litre enclosure. Taking the response from 200 to 100Hz as level and on reference, the output rises through a broad 2.5dB peak at 65Hz, falling back through reference at 46Hz. It is about 7dB down at the fundamental frequency of the bottom C 16ft pedal.

It is possible that the curve could be smoothed somewhat by applying some damping to the drivers but with the risk that constructors might over-damp. As it is, the fullness around 65Hz could even tend to be a plus for guitars and double bass. Our main concern was whether the curve would be appropriate for use with organs where lumpiness from one pedal note to the next can be an embarrassment.

We were fortunate in being able to gain the cooperation of well known Sydney organist David Parsons, who happens to live handily close to the author and who has his own 3-manual theatre model Conn. It was only a few minutes' work to slip the back off the organ, remove one lead from its in-built 15-inch woofer and divert the output to the twin 10-40 system.

It took even less time to be convinced of the difference. There was a very noticeable increase in the fundamental content of the pedal notes and the whole "weight" of the bass was increased to the point where it encouraged some reduction in bass registration.

No less interesting was the fact that output from the pedals seemed quite smooth, despite any reservations which the measured response curve may have engendered. This probably would be due in part to the fact that proper organ tones, even the "round" ones, are not pure sine waves. The loudness is therefore not a function of the response at one frequency, but is the aggregate of all the harmonics present. In this case, any lack at 32Hz would tend to be masked by the extra couple of dB at 64Hz, the second harmonic.

While this implies some gradation, still, in the harmonic structure of the pedal notes, the fact remains that it was far less than from the original, inadequately baffled 15in woofer. When we subsequently tried the system on a much smaller organ with an ordinary 12in speaker in the console, the improvement in the quantity and quality of the pedal bass was even more startling.

One further point came out of our observations. From the console, David Parsons immediately appreciated the improved bass quality but also contended that the middle and upper register sounded sharper and more clearly defined. There was no way that the substitute loudspeaker system could have accounted for this, because it was obviously receiving from the organ only frequencies up to a few hundred hertz. The explanation seemed simply to be that removal of the bass output from the front of the console was allowing the player to hear the remainder of the sound to better advantage—a simple case

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MORE PIPE-LIKE BASS

of aural masking!

Certainly from the audience viewpoint, the extra spaciousness was a bonus.

Coming now to the actual enclosure, the system pictured was the prototype used for the design and proving procedures and is only in the rough, as far as appearance is concerned. Logically, it would be surfaced with real or imitation veneer for domestic use, lacquered or coated with vinyl cloth for an in-between situation, or made completely "with it" by covering it completely with black, short-pile carpeting. The fret area could be decorated as necessary with anything from acoustically transparent cloth to a metal, plastic or wood grille.

The basic structure of the prototype enclosure was of 3/4in particle board throughout, and nothing less than this should be considered. Thicker material can be used, but increase the outer dimensions, leaving the internal volume unchanged.

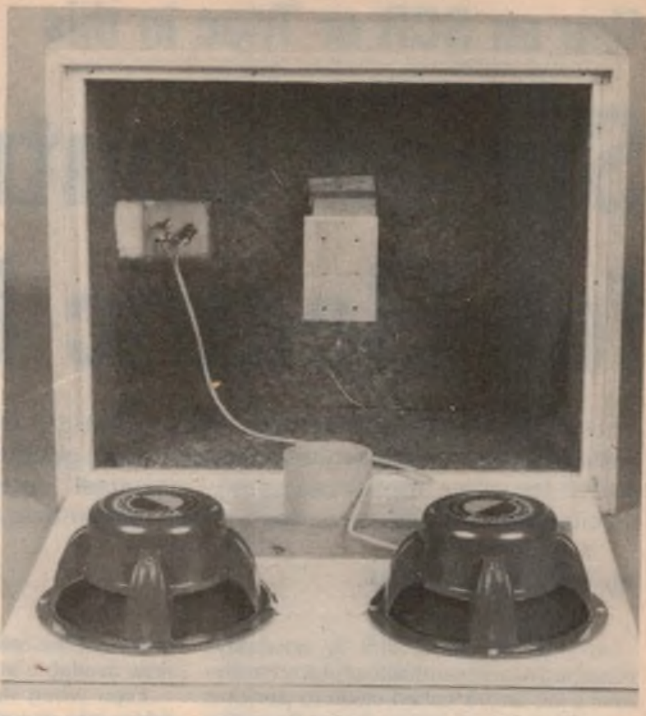
In fact, the proportions of the box can be varied to suit material size, or furnishing needs, or to take best advantage of the trunk space in a vehicle. The vital considerations are to maintain the same internal volume and to avoid certain unacceptable shapes: cubical with major internal dimensions coincident; obviously "tubular" or column-like; or so flattened as to crowd the rear of the port tube.

NEXT MONTH:

In our next issue, Editor Jim Rowe plans to discuss the question of adding extra pitches to an organ using either of two approaches: extra contacts and busbars under each playing key, or using fewer contacts and the new MOS solid-state keyers. The article will be of interest, not only to prospective constructors, but to those who may want to expand the specification of existing instruments.

Any approved constructional method can be employed, according to the skills and facilities available—butt, mitre, or cleats. Whatever the method, however, the structure must be completely rigid and it must be completely airtight. Study our article in the March issue "How Tight Is Airtight" and remember that your whole aim here is to cope with powers of up to 80W RMS, down to a frequency of 32Hz.

Our advice would be to make the box as airtight as possible mechanically, then allow a line of PVC glue to set against and along all internal joints. Seal the back panel firmly in position and make sure that the outgoing leads or terminals are rendered airtight by internal caulking. The drivers, by the way, are simply wired in parallel, plus to plus, minus to minus.



An internal view of the 80W bass speaker system, showing the twin Magnavox 10-40 drivers. The picture reveals a cleat on the rear of the baffle but this can be regarded as optional if the strut is fitted. Note the underfelt padding and the stout output lead, which is desirable to obviate unnecessary resistance in the drive source.

Note also that they should be 15 ohm types if the required total impedance is to be 8 ohms. Two 8-ohm drivers in parallel would come down to 4 ohms.

The design allows for the drivers to be mounted behind the baffle against their own cork buffers but make sure that any breaks in the buffers are filled with caulking compound. If, for any reason, you want to mount the drivers from the front, mount them against a ring of caulking compound or of adhesive backed foam tape (Engels No 5C draught excluder). Use the same technique to provide a bed against which the front baffle can screw, being particularly fussy about the corners.

In the prototype, an additional precaution against vibration was a strut between the rear panel and the front baffle. Its position and dimensions need to be arranged carefully so that it can be picked up neatly by screws through the front of the baffle.

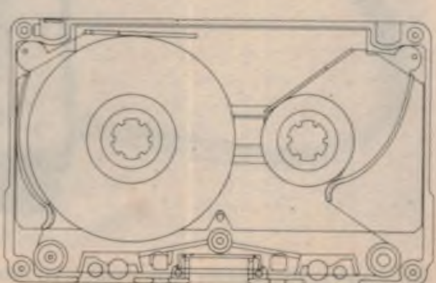
And that's about all there is to it—$50 odd worth of drivers, the requisite amount of particle board and detail materials, the requisite amount of patience and energy, and you can have some real, fundamental bass.

Perhaps we should add this footnote: If the instrument or amplifier circuitry is such as to use the new system in a purely bass role (up to a few hundred Hertz) its substitution will serve mainly to affect and improve the bass performance, as described.

If, on the other hand, it is going to be called upon to cope with mid and upper frequencies as well, it may need to be supplemented with an external upper range driver, or else the existing console speakers should be left in circuit. However, this would open up a whole new subject. Our prime purpose here has been to describe a practical system which will accomplish one prime purpose: to put some true fundamental pitch into those pedal notes!

C-180 cassette: The longest play!

In a recent survey of the blank cassette market in the USA, TDK noted that over 50% of cassettes sold were of the longer play variety: C-90 or C-120. Only 5% bought C-40s.



Reacting to this trend, TDK have now released a C-180 cassette, giving a full 3 hours of playing time. Because the tape has to be very thin—6.5 microns—TDK advise against using it in anything but well maintained high quality decks—certainly not the often dubious and often dirty players found in cars.

At the same time, TDK have devised an entirely new internal mechanism to guide the tape and inhibit kinking or slackening and, for those with appropriate decks, the C-180 offers a very simple means of assembling 3 hours of background music in one small package. (Inquiries: Convoy International Pty Ltd, 4 Dowling St, Woolloomooloo 2011).

Use an SCR or Triac in this

Speed Control for Electric Drills

These two simple SCR circuits allow electric drills to be used over a wide range of speeds while still maintaining good torque. They are also suited for other appliances using "universal" brush-type motors such as circular saws, jig-saws, food-mixers and movie projectors.

by LEO SIMPSON

An electric hand drill is nowadays regarded as an essential tool in any handyman's kit, and is called upon to perform a multiplicity of tasks. Apart from the mundane jobs of drilling holes and powering various attachments such as circular saws and orbital sanders, it is also used to drive pumps, stir paint, and polish furniture or the family car.

As versatile as the electric drill may be, however, the chuck speed is often too high, even on the two-speed models. This is a problem when larger drills and bits are used, particularly in the case of masonry drills.

Both of the speed controls featured here enable a large range of useful speeds to be obtained, as much as ten-to-one in some cases. This means that larger drill bits can be used for drilling in metal with ease. And with the control adjusted to give the lowest usable speed, your electric drill makes a very efficient screwdriver which can be a real boon when there are a large number of screws to be driven (for example, when assembling a loudspeaker cabinet).

An important point to remember when using this type of speed control is that it should only be used for intermittent operation. This is not because of any limitation on power dissipation within the controller, but due to temperature rise within the drill motor. When the motor runs at low speed its inbuilt fan is ineffective, so that there is little airflow to cool the armature. So make it a practice to only use the controller for a few minutes at a time.

Another point to consider is that if the drill is used very frequently with the controller there is a possibility of shorter brush life and also reduced commutator life. This is because of the higher peak currents which result from low speed operation with the SCR control.

If you anticipate that your drill will be required to perform a large amount of low-speed work then it may be better to consider a separate low speed drill such as one of the rechargeable cordless units now available at an attractive price.

Even when the above limitations are taken into account, the SCR speed control can greatly extend the usefulness of your single-speed or two-speed electric drill. And the total cost of the circuit components is only about five dollars.

Now let us describe the operation of both circuits. The first, designated "Drill Speed Control Mk I" was originally published in "Electronics Australia" in May 1971 was featured more recently in our handbook "Projects & Circuits". We have modified it slightly, but the basic circuit remains the same.

Heart of the circuit is the SCR or silicon controlled rectifier(also known as thyristor), which behaves like a special sort of rectifier diode which only conducts in the forward direction when it is triggered by a small positive voltage applied between gate and cathode. Once triggered into conduction, the SCR will continue to conduct until the current falls to zero or the anode-to-cathode voltage reverses.

Thus an SCR can be used to control the amount of AC power fed to a load by varying the instant during each positive half-cycle at which it is triggered into conduction. If the SCR is triggered early in each positive half-cycle more power will be delivered to the load than if it is triggered late in each positive half-cycle. This method of control is referred to as "phase control" since the SCR trigger point is varied with respect to the phase of the AC supply voltage.

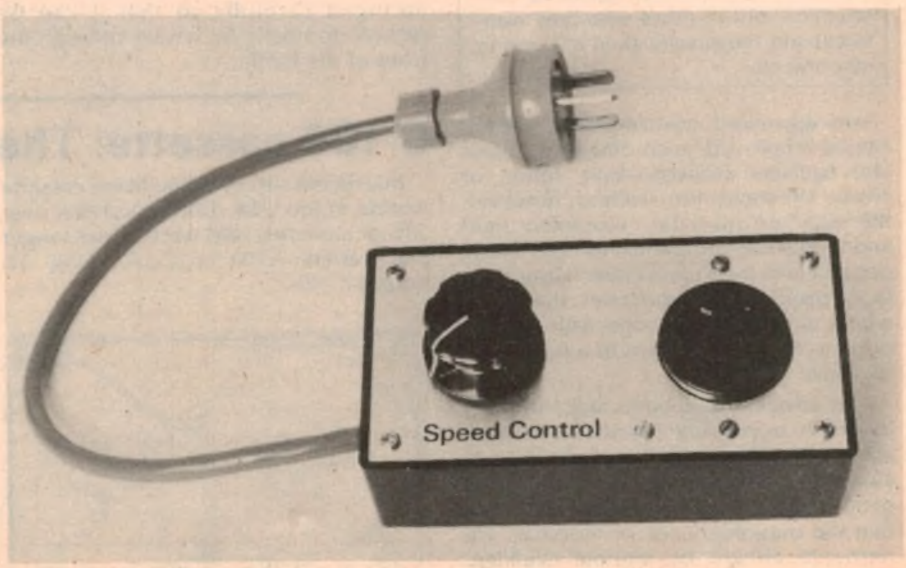
In this circuit the SCR trigger point is controlled to a large extent by the "back EMF" generated by the motor. The "back EMF" can be defined as a voltage developed by a motor which opposes the supply voltage. The back EMF of any motor is directly proportional to its speed.

Refer now to the circuit of the Mk I version. The SCR is connected in series with the output socket so that then it is non-conducting, no power is applied to the motor. A divider chain consisting of an 11k resistor (actually 3 x 33k/1W resistors in parallel) a 1.8k resistor and a 2k potentiometer provide a positive-going reference voltage for the SCR gate, via diode D2. Diode D1 reduces the power dissipation of the series resistor chain by half and protects the SCR gate if the load is open circuit, as for example, when the motor is switched off.

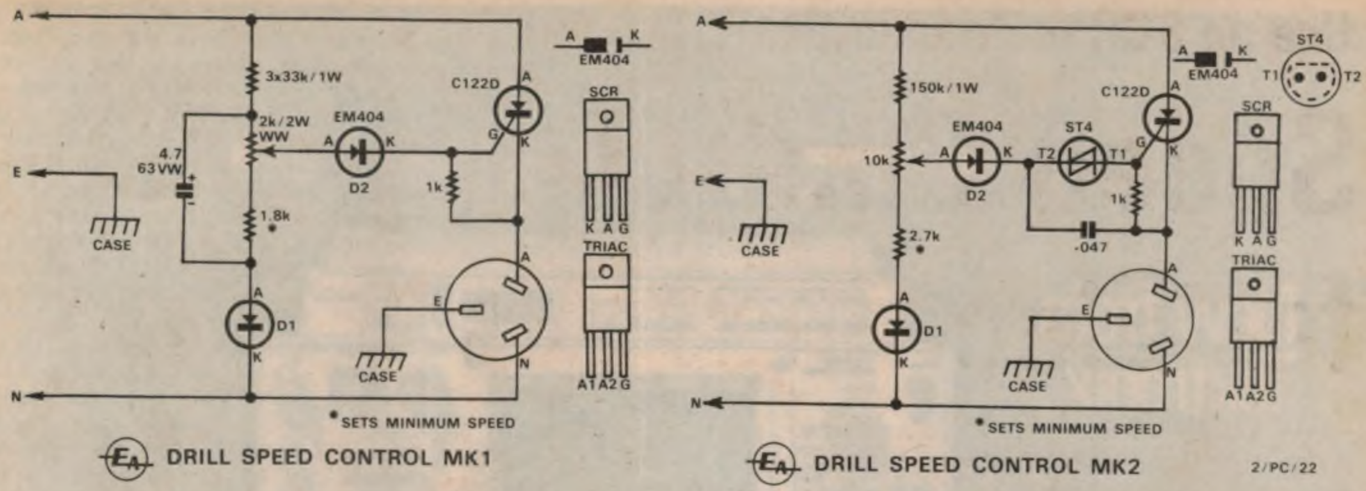
Diode D2 protects the gate of the SCR when it is in the conducting state.

The triggering voltage for the SCR is controlled by the setting of the 2k potentiometer. During each positive half cycle of the AC supply when diode D1 conducts, the pot provides a sinusoidal triggering voltage with amplitude variable from 20V to 50V RMS approximately. Ignore the capacitor connected across the potentiometer for the moment.

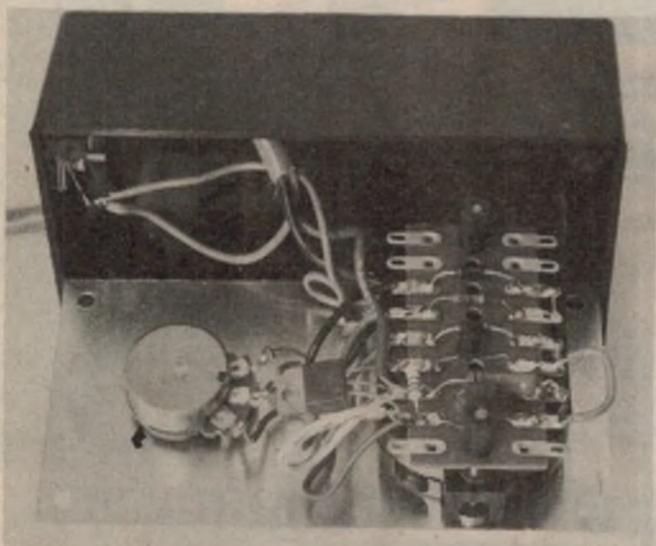
The voltage applied by the potentiometer wiper is not the effective SCR triggering voltage because the motor is

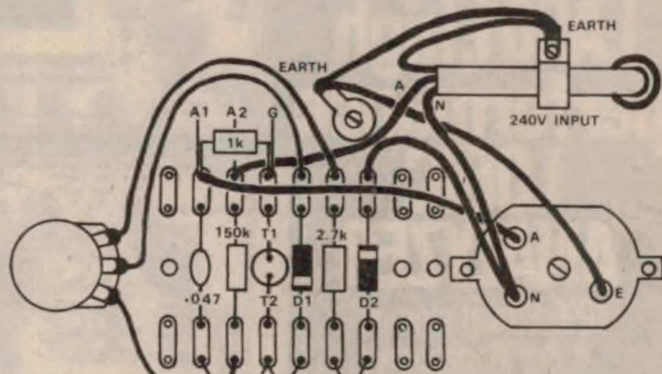


An economical plastic box makes an attractive case for the Drill Speed Control.



Both of these circuits give good speed control characteristics with electric drills. They are for intermittent use only.





Use the wiring diagram and the photograph opposite to assemble your Speed Control. All exposed metalwork of the case must be earthed, as in the diagram.

connected in series with the SCR cathode. This means that the effective SCR trigger voltage is that applied by the pot wiper minus the motor back-EMF. Thus we have negative feedback from the motor, which will act to maintain motor speed despite load variations.

Note that there are actually TWO different back-EMFs from the motor: one present during the conduction periods of the SCR and the other present during the negative half-cycles and the early part of the positive half-cycles before the SCR is triggered into conduction. It is this latter back-EMF which controls the firing point of the SCR as described above.

As the motor back-EMF rises with increasing speed, the effective SCR triggering voltage is reduced so that it is triggered later in each half-cycle and supplies less power to the motor. The motor speed ceases to rise when the SCR trigger voltage is reduced to a level where the SCR is only just supplying sufficient power to maintain the selected speed.

If the load on the motor increases, it will tend to slow down and the back-EMF will be reduced in proportion. This increases the effective SCR trigger voltage so that it conducts earlier in each positive half-cycle. Thus more power is delivered to the motor to maintain the selected speed.

The circuit as described so far is quite satisfactory if the SCR trigger angle is 90 degrees or less. This corresponds to relatively fast motor speeds. However, if lower motor speeds are required, corresponding to an SCR trigger point later in each half-cycle than 90 degrees, the above feedback system will not work.

If the SCR is already firing at 90 degrees and the motor speed rises slightly due to a reduction in load, the gate trigger voltage necessary for the SCR to be triggered later will not be available, since at 90 degrees the gate voltage is at maximum. As a result, the SCR may not conduct for the next one or two positive half-cycles until the motor speed drops below the selected speed. Thus the motor will tend to "hunt" or "cog" as it attempts to adjust to a stable operating mode.

A major improvement in this respect is obtained by connecting the 4.7uF capacitor across the potentiometer and 1.8k resistor. This converts the sinusoidal gate voltage waveform from the potentiometer to a "ramp" waveform which reaches a peak near the end of each positive half-cycle. The result is reliable triggering over a greater part of the half-cycle and considerably smoother running at low motor speeds. Note that there will still tend to be some "cogging" at low speeds. The 4.7uF capacitor is not a complete cure.

The 1.8k resistor in series with the potentiometer sets the minimum speed of the motor and ideally it should be selected to suit the motor the control will normally be used with. If the resistor is too large, the minimum motor speed will be too high and if the resistor is too low there will be a "dead spot" at low settings of the potentiometer.

The 1k resistor between gate and cathode of SCR is often omitted from similar speed control circuits but it is recommended by the SCR manufacturers. It reduces the possibility of false triggering due to leakage and dv/dt effects and consequently lessens the chance of catastrophic failure in the device. So while this circuit has three extra components compared to the most rudimen-

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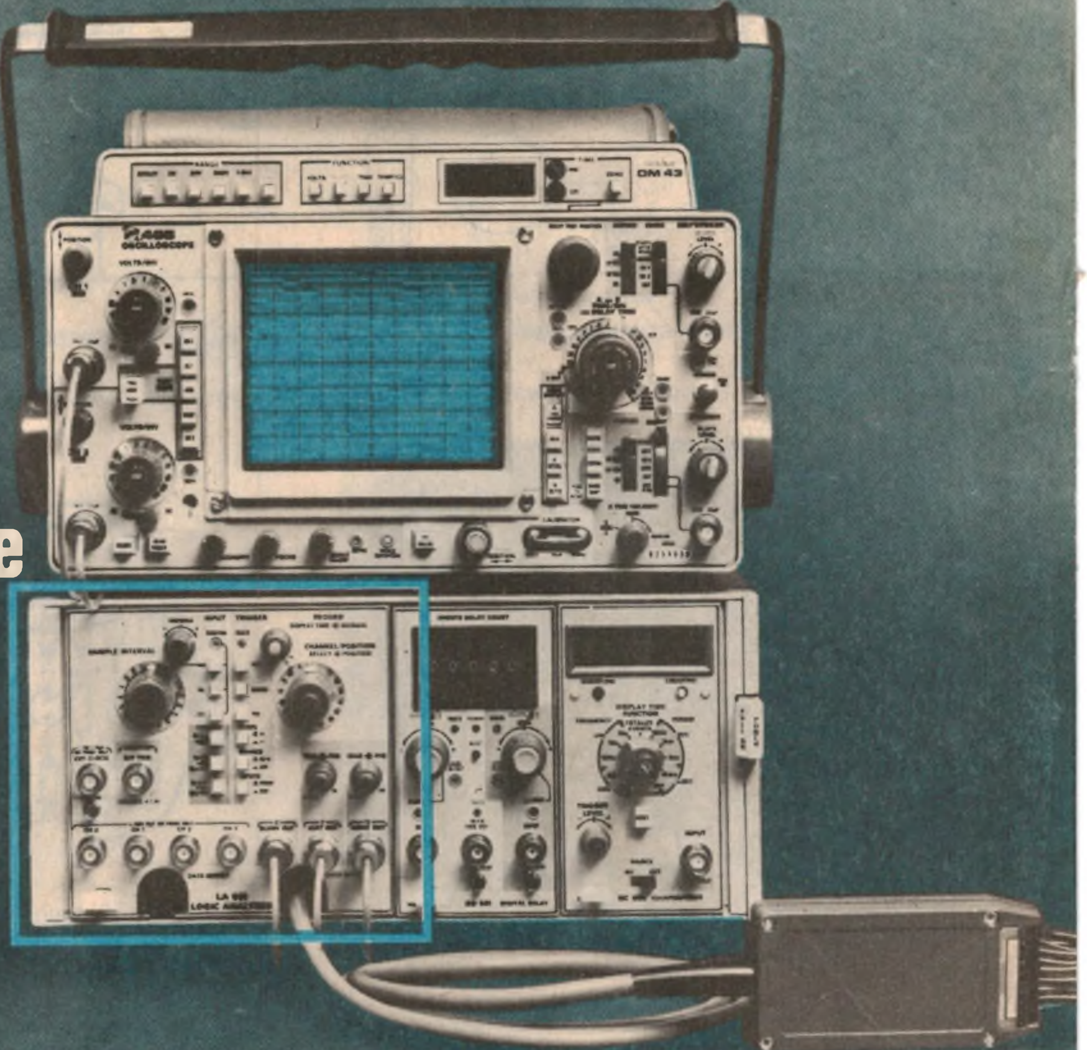

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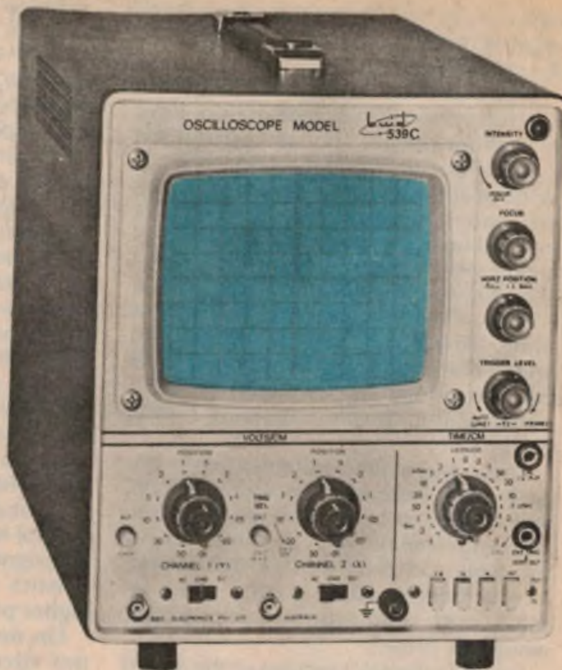

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tary circuits we have seen, the overall improvement in operation is well worth the small extra cost.

While the Mk I version of the speed control is entirely adequate, it does have several drawbacks. The first is that it has a power dissipation in the series resistor string of about 3 watts. The second is that the current through the resistor string may not be adequate to give reliable triggering with the more insensitive SCRs. The only cure for this in the Mk I circuit is to increase the current in the resistor string, which will further increase the power dissipation. The third drawback is that the potentiometer needs to be a wirewound unit with a rating of 2 watts or more.

These wirewound potentiometers are now quite expensive, at around $2.50, and may be at times difficult to obtain. (We understand that at the time of writing, Radio Despatch Service, 869 George Street, Sydney, have a large stock of these pots selling below the current wholesale price.)

So while the Mk I version of the speed control has the inherent advantage of simplicity we have developed the Mk II version to overcome the above drawbacks. As can be seen from the circuit, it is very similar in configuration, the main change being the addition of an ST4 trigger device and a .047uF capacitor between the SCR cathode and the junction of the diode D2 and the ST4.

The ST4 is a breakover device similar to a diac except that while a diac has breakover voltage of about 30 volts in either direction, the ST4 is asymmetrical. In one direction it has a breakover voltage of about 16 volts from which it breaks down with a relatively high impedance with a conduction voltage of about 8 volts; in the other direction it has a breakover voltage of about 8 volts and a low conduction voltage of about 1½ volts. We use it in this circuit in the latter mode only so that it is equivalent to a Silicon Unilateral Switch (SUS).

Instead of using the voltage from the pot wiper to trigger the SCR directly as in the MK 1 circuit, the pot wiper voltage is used to charge the .047uF capacitor via diode D2. When the capacitor is charged to the ST14 breakover voltage a high energy pulse is delivered to the gate of the SCR, triggering it into conduction.

In this circuit, the motor back-EMF acts to reduce the charging voltage to the .047uF capacitor rather than reducing the effective SCR gate voltage as before. The net effect is still the same and the feedback is just as effective. However, the circuit is much more efficient since there is less power dissipation—only about 200 milliwatts, in fact. Note that we have specified a 150k resistor with a rating of 1W to ensure it has adequate voltage rating.

The 2.7k resistor in series with the 10k potentiometer again sets the minimum motor speed. The 10k pot is a standard ½ watt carbon element type with a linear resistance characteristic.

Comparisons with a variety of electric drills indicate that perhaps the Mk I circuit is a trifle smoother in low speed operation, while the Mk II circuit has marginally better torque characteristics (at low speed).

Both the circuits described here are featured with the General Electric plastic-pack SCR, C122D. This has a DC rating of 8 amps and a blocking voltage rating of 400 volts. Using this SCR, both circuits are suitable for electric drills or appliances with "universal" brush-type motors having nameplate ratings up to 3 amps. With motors of this rating or less, the SCR specified will be able to withstand the "locked rotor" current if the motor is stalled.

We do not recommend the substitution of higher rated SCRs to enable bigger motors to be used. If a higher power control is required the circuit should be redesigned to suit the different characteristics which can be expected from higher power motors.

On no account should a speed control circuit such as this be used with induction motors.

Construction details of either circuit are quite simple. We mounted the prototype in a plastic box measuring 130 x 68 x 42mm (available from Dick Smith Electronics). The thin aluminium panel supplied with the box is not strong enough to prevent buckling once the cut-out for the flush-mounted mains socket is made. It should be suitably braced or discarded in favour of a plate made of 22 gauge or thicker steel.

Long mounting screws are used to secure the AC socket and these also mount the nine-way tagboard. Use nuts or washers to space the tagboard a suitable distance above the AC socket.

The C122D SCR may be soldered directly into circuit and does not require a heatsink. If this SCR is hard to come by, a 400V Triac such as an SC141D may be substituted. It is soldered in the same way. (A2 is equivalent to the anode of an SCR while A1 is equivalent to the cathode.) The ST4 asymmetrical trigger device should be soldered in as shown in the wiring diagram. Incorrect polarisation will not result in damage but will cause ineffective speed control.

The earthing details must be followed exactly. All exposed metalwork is to be earthed. This includes the mounting screw for the mains cord cable clamp. A grommet should be fitted to the entry hole in plastic case to prevent chafing of the mains cord.

Failure to follow these wiring details could result in a lethal appliance. Observe them carefully.

SPEED CONTROL PARTS LIST

(Mk. II version)

1 plastic box, 130 x 68 x 42mm with steel front panel.
1 Clipsal flush-mount AC socket
1 nine-way miniature tagboard
1 knob
1 C122D silicon controlled rectifier
1 ST4 asymmetrical trigger device
2 1-EM404 400V silicon diodes
1 0.047uF/100VW polyester (greencap) capacitor
1 10k(lin) potentiometer
1 x 150k/1W, 1 x 2.7k/¼W resistor
2 solder lugs
1 cable clamp
1 grommet
Mains cord, plug, connecting wire, screw, nuts, lockwashers, solder.

Note: Components with higher ratings may be used if physically compatible. Do not use components with lower ratings.

Amended 50Hz crystal drive for LSI digital clocks

Many constructors who built the crystal-controlled 50Hz drive source for LSI digital clocks described in September 1975, have had problems with the circuit. Two solutions are presented, one for the mains-powered version and the other for the battery circuit.

by LEO SIMPSON

When we presented the crystal-controlled 50Hz drive source based on the Solid State Scientific SCL5411T device it seemed like a very neat circuit. The SCL5411T is certainly an impressive IC in itself. It comprises an oscillator inverter, a chain of 16 flip-flops, and a low impedance buffer stage with sufficient drive to interface with bipolar transistors or miniature synchronous motors.

In fact, we understand that the SCL5411T is used to drive the clock in at least one imported Japanese car with large sales in Australia. That should establish the reliability of the device so that the doubt surrounds our circuit.

At the time of publication of our original circuit there was a dearth of information on the SCL5411, especially regarding typical circuits. As a result, our circuit was based in part on a circuit for a similar device, the SCL5440. This device also has an oscillator inverter.

Feedback from our readers indicates the circuit has misbehaved in a number of ways. First, the oscillator appears to malfunction and/or the divider chain has a random output at around 25Hz; second, the integrated circuit becomes hot and the output frequency jumps from 50 to 100 or even 200Hz, indicating a malfunction in the divider chain.

We requested further information plus critical comment on our circuit from Solid State Scientific via their Australian distributors, Cema (Distributors) Pty Ltd. It was only recently that we obtained a brief reply to the extent that the SCL5411CT and SCL5411AT devices include a 12.5V (nominal) zener diode between Vdd and Vss for voltage limiting. These devices and not the SCL5411T are the only types available in Australia.

In our experience there is no external evidence of this limiting, either on the 50Hz buffered output from pin 1 or the oscillator output from pin 8. We assume that the voltage limiting applies to the whole or part of the flip-flop divider chain. This may explain the misbehaviour of the circuit whereby the output jumped from 50Hz to 100 or 200Hz. So the device should be operated at 12 volts DC or below.

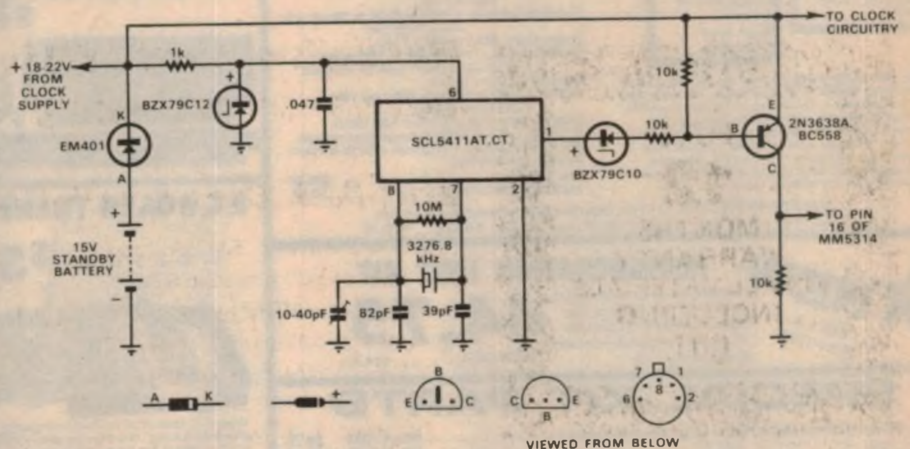
Further experimentation we have carried out indicates that the 33k resistor between pin 8 and the crystal may be omitted and a direct connection made instead. In this mode the device oscillates reliably with supply voltages down to below 4V DC and the current drain is considerably less. Application literature for similar devices, notably the National Semiconductor MM5369, suggests that this is closer to the optimum circuit configuration.

So there are two changes to the battery powered version of the circuit: omit the 33k resistor and change the zener to a 12V unit.

The solution with the mains powered version is not quite as simple however, particularly if full brilliance is desired from the digital readout. For the clock chip to work correctly the 50Hz input must be of the same amplitude (peak-to-peak square wave) as the clock supply rail. This necessitates a buffer stage to increase the 12V peak-to-peak 50Hz output from the SCL5411AT, CT to that required by the higher supply voltage.

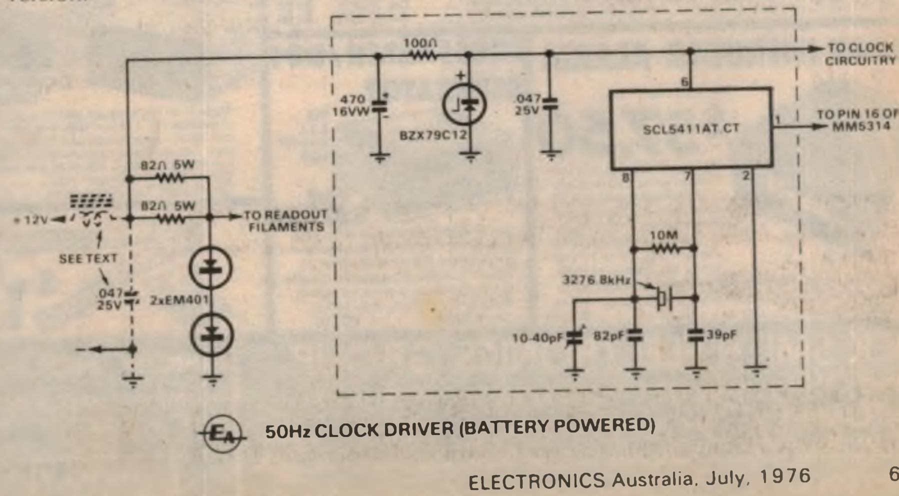
The buffer stage consists of three resistors, a 10 volt zener diode and a PNP transistor. Notice that in the amended circuit, the 12 volt supply for the 50Hz driver is now derived from the clock supply via a 1k resistor.

A small piece of Veroboard will accommodate the extra components for the buffer stage. Alternatively, the complete 50Hz driver plus buffer may be assembled on Veroboard.



50Hz CLOCK DRIVER (MAINS POWERED)

The mains-powered version is a little more complicated than the September 1975 version.



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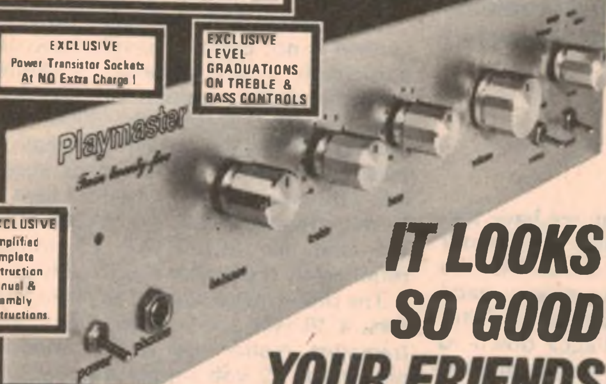

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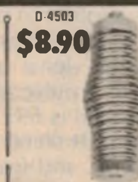

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LSI digital clock has BIG readout, calendar

by GREG SWAIN

This is probably the most unusual digital clock that we have published. It features a large display readout made up of discrete LEDs, can operate in either 12 or 24 mode, and can function as a calendar as well as a clock. If you've always wanted a digital clock/calendar to hang on your kitchen wall, read on.

The Digitronic Model 7010 Calendar Wall Clock is not only the most unusual digital clock that we have published—it is also the biggest, at least in terms of the display readout. Actual height of the readout numerals is 33mm, while the display measures some 265mm in length. The unit is housed in a plastic case of simple form, having overall dimensions of 300 x 100 x 40mm (W x H x D).

As supplied in kit form, the clock is intended to be constructed such that it operates in the 12 hour mode, with calendar, and with flashing colons between the second and third and the fourth and fifth digits. However, by means of several simple modifications, the clock may be built in any one of a number of operating modes.

Before proceeding with the circuit description, however, let me state that as a kit of parts this unit leaves a few things to be desired. To my mind, any project sold as a kit should be absolutely complete, with mounting holes ready drilled, etc. This kit does not measure up to this definition.

Those items whch are missing, or which should have been incorporated, are: a 3-pin mains plug, a 3-way insulated terminal block, a mains cord clamp and grommet, and several nuts and bolts. Furthermore, there are no mounting holes provided for the master board, and there is a danger of the transformer laminations shorting the copper tracks on the display board when the latter is dropped into position (unless the necessary precautions are taken).

In addition to this, some rather dubious constructional methods are specified in the (rather sparse) constructional notes. Our most serious criticism of the unit has to do with the recommended method of mounting the power transformer. The instructions suggest mounting the transformer on its side with the core resting on the ends of two bolts protruding through the back of the case. In this manner, the transformer would be fixed in position when the display board was dropped into position. Need we say that this method is definitely not recommended!

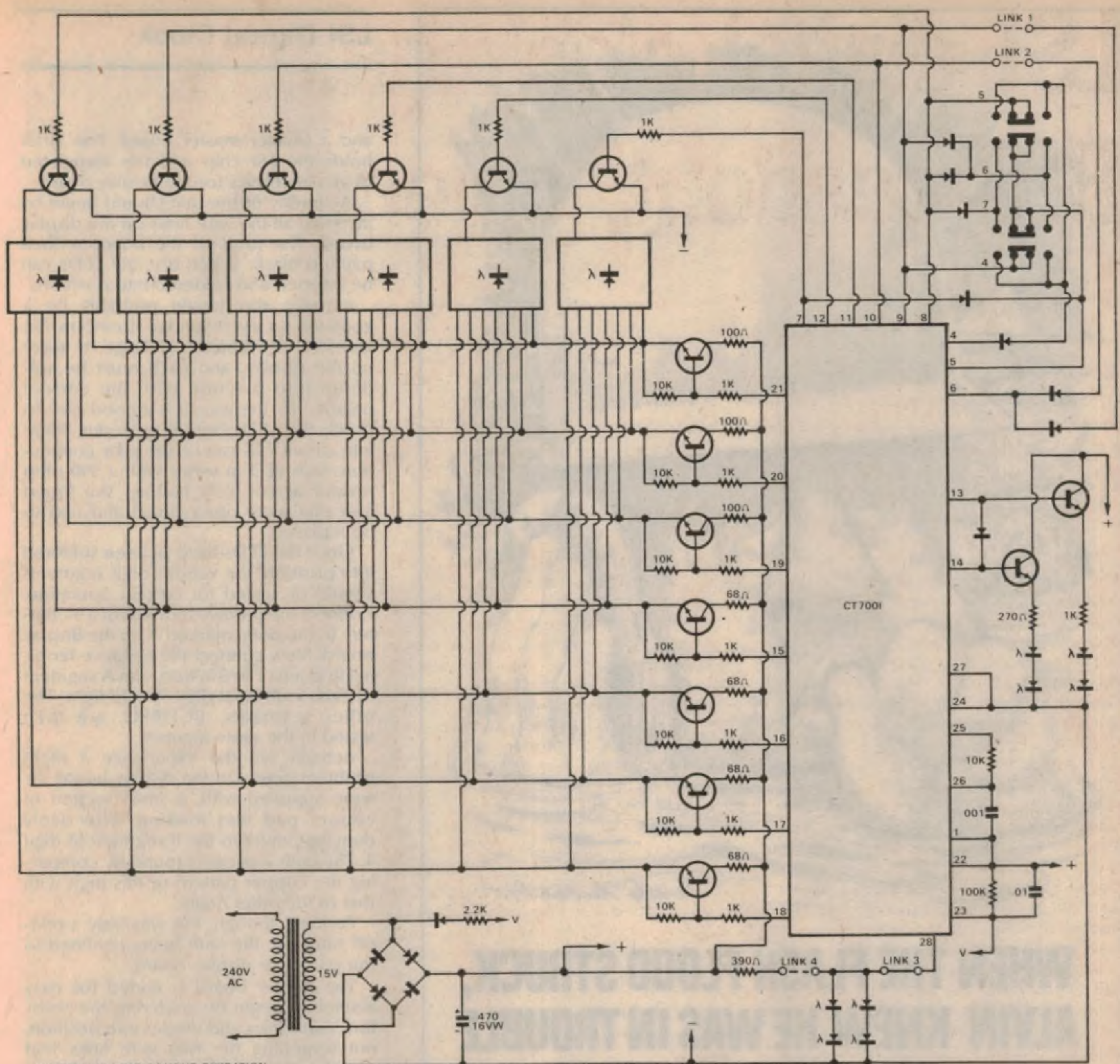
The foregoing is not meant to imply that the project is without merit. On the contrary; with a few easily incorporated modifications, a worthwhile project can be constructed. We will detail these modifications later in the article. First, let's have a look at the circuit.

The clock described here is designed around a single LSI digital clock chip, type number CT7001. Contained on the LSI chip is all the electronics necessary to convert the 50Hz pulse input to pin 23 into a multiplex readout for 6 digits, together with AM/PM indication. Also contained on the chip is the electronics necessary for the calendar function.

Basic clock operation is as follows. First, half rectified 50Hz is applied to pin 23 of the clock chip. An internal signal shaping network squares the signal up, and then divides it down to 1 pulse per second (1pps). The 1pps signal is fed to a counter which cycles from 01:00:00 to 12:59:59 in the 12 hour mode, and from 00:00:00 to23:59:59 in the 24 hour mode.

The output from the clock counter is decoded and multiplexed to drive the display.

Each digit is made up of 7 segments, each segment comprising two or more LEDs connected in series. The anodes of all equivalent segments of the various digits are bussed to seven common lines, each driven by an NPN "segment driver" transistor (which are driven from pins 15 to 21 of the IC). The segment cathodes of each digit are bussed together to form six common lines (one from each digit). These are connected to the collectors of six NPN transistors, controlled by pins 7 to 12 of the IC.



INSERT LINK 1 FOR 24 HOUR OPERATION
INSERT LINK 2 TO DISABLE CALENDAR
TO POWER COLONS CONTINOUSLY BREAK
LINK 3 AND INSERT LINK 4
CIRCUIT DRAWN FOR 12 HOUR OPERATION
WITH CALENDAR AND FLASHING COLONS

LSI DIGITAL CALENDAR CLOCK

7/CL

To display the various digits correctly, the segment cathodes of each digit are brought to ground sequentially by their respective control transistors. At the same time the corresponding common segment lines for each digit are driven high by the segment driver transistors. The signals change appropriately as the segment cathodes of each digit are brought to ground.

The AM/PM sign is driven by two NPN driver transistors controlled by pins 13 and 14 of the IC. An interesting point here is the diode connected between pins 13 and 14. This is because, in the display used, the AM sign is simply an extension of the PM sign. Thus, when pin 13 goes high pin 14 will remain high, ensuring that the LEDs used for the PM sign remain on.

Multiplex operation is also used to allow the time and calendar readouts to share a common display. To explain further, in operation the time function is first displayed for a period of 8 seconds. On the eighth second the display is switched to the calendar mode, remaining on for two seconds before reverting back to the time mode on the tenth second. The cycle is thus 8 seconds time mode, 2 seconds calendar mode, 8 seconds time mode and so on.

Two 3-position slider switches are provided for time and calendar setting. These allow the time to be set to the nearest minute, and for the day and month to be set. Pushing the time setting switch, for example, to its uppermost position cycles the hours forward at a 1Hz rate. Similarly, moving the switch to its bottom position cycles the minutes forward at a 1Hz rate.

Note that only the month and day are displayed when the clock is in the calendar mode. Digits 5 and 6 are blanked, as is the AM/PM sign. The day counter will count the correct number of days for each month, the normal count for February being 28 days. February 29 must be manually set, the counter automatically counting straight from this date to March 1.

Physically the unit is constructed on two PC boards—a large display board and a smaller master board. The latter holds the LSI chip and the associated drive electronics for the display board.

Assembly of the unit should begin by inserting all the wire links on the display board. The front of the board is then painted black. When dry, the LEDs can be inserted and soldered into position.

Actually, this would probably be a good job for a wet Sunday afternoon. No less than 123 separate LEDs go to make up the display, and each must be soldered into position with the correct polarity! By the way, it is a good idea to check the LEDs before soldering them into circuit.This can be done by connection each LED in series with a 390 ohm resistor across a 9V battery. We found four that were open circuit and had to be replaced.

Once the LEDs have all been soldered into position, the various digit segments should be tested for correct operation. Connect the positive terminal of a 9V battery to the point marked A on the display board. Now connect the negative terminal to points 1 to 6 in turn. The A segment of each individual digit should light. The other segments, BCDEFG, are then tested in the same manner.

Actually we did experience a slight problem here. On the display board we were supplied with, a small section of copper pad was missing, effectively denying power to the B segment of digit 4. The fault was easily found by comparing the copper pattern of this digit with that of the other digits.

Perhaps, though, this was only a one-off situation, the fault being confined to our particular display board.

The master board is coded for easy assembly. Begin by soldering the resistors, capacitors and diodes into position, not forgetting the two wire links that must be inserted. Next solder the 15 transistors into position, paying particular attention to lead configuration. Make sure that all diodes, and the 470uF electrolytic capacitor, are soldered into circuit with correct polarity.

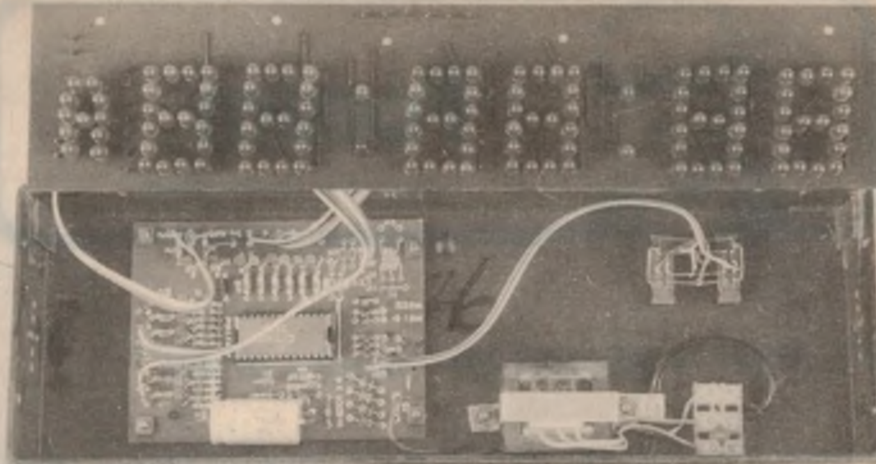
Due care should be exercised when handling the CT7001 clock chip. This is a MOS device and, as such, is susceptible to damage by static charges. Do not touch the pins of the device. Instead, hold the two ends of the device between your fingers, and push it firmly and evenly into the IC socket.

Be sure to orient the IC so that the notched end is as indicated on the PC board. Because the IC can be so easily damaged, we recommend that it be left in its protective foam package until required. It should be installed in the circuit as the final job of assembly.

We recommend the use of PC stakes to facilitate external connections from both the master board and the display board. This will involve enlarging the appropriate holes with a PC drill so that they will accept the stakes. In this manner, terminations may be made to the back of the display board without the danger of the copper pattern lifting off.

A further advantage is that PC stakes will allow for easy above-board modifications to the master board. These modifications give a number of different operating modes for the clock, and are described later.

Our main criticisms of this unit, made earlier in the article, concerned the recommended method of mounting the power transformer and the lack of proper anchorage for the power cord. The approach we used in overcoming these problems can be seen in the photographs.



Interior view of the unit with all wiring completed. Note transformer mounting.

First we fashioned a simple U-shaped clamp for the power transformer from a piece of scrap 20-gauge aluminium. The transformer was then mounted in position using an existing hole to secure one side of the clamp, and an additional hole drilled through the case to secure the other side.

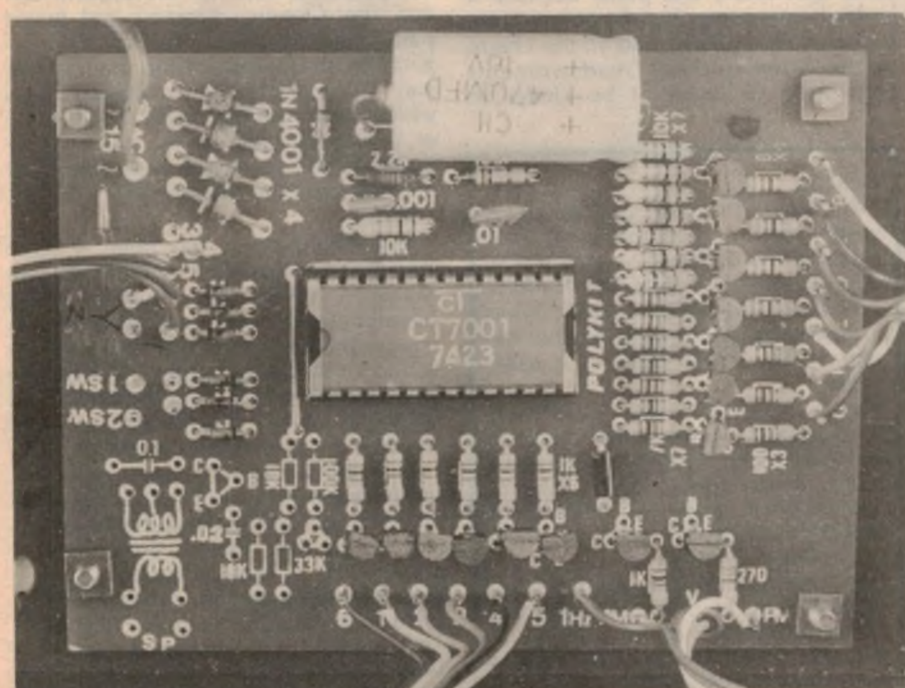
The mains cord is passed through a grommetted hole relocated in the bottom of the case and securely anchored with a cord clamp. Terminate the mains active and neutral to the terminal block as shown. The third position on the terminal block is used to terminate the unused 110V centre-tap.

Three additional holes drilled through the case, together with an existing hole, are used for mounting the master board. External connections from the master board to the display board and the time and calendar set switches can now be made. We spurned the use of the twisted pair hook-up wire supplied, preferring to use instead multi-strand flat ribbon cable.

Pay particular attention when wiring to the segment terminations on the display board. Unlike the master board, these terminations are not laid out in alphabetical order.

Once all wiring has been completed, the unit can be assembled into the case. The display board is simply dropped into position, and is supported at both ends by the case and on one side by the transformer. It is then held in position when the front panel is attached. Make sure that the copper tracks on the display board are insulated from the transformer laminations when the board is dropped into position.

Now what about those various optional operating modes that were mentioned earlier?



Above is a view of the completed master board. The area left vacant at the bottom left of the board is for the optional alarm circuit.

Depending upon the constructor's whim, several simple modifications allow the following operating modes: colons off, colons on continuously, and 12 or 24 hour display. In addition, the calendar function may be disabled, so that the time is displayed continuously. These modifications may be carried out together or separately.

The various circuit options are shown on the circuit diagram, which we have redrawn. For example, to operate the clock in the 24 hour mode, a silicon diode is connected between pins 6 and 9 of the clock chip as shown. A second silicon diode connected between pins 6 and 10 will disable the calendar function. Suitable diodes are the 1N914, 1N4148 and EM401.

Note that the AM/PM sign is blanked when the clock is operated in the 24 hour mode.

The colon modifications are equally as simple. To operate the colons continuously link the 1Hz terminal on the display board to the positive supply rail via a 390 ohm resistor; for flashing colons link direct to the 1Hz terminal on the master board; and for colons off make no connection to the 1Hz terminal on the display board.

We elected not to wire up the optional alarm circuit. The necessary components are not supplied as part of the kit and, in any case, an alarm circuit is out of keeping with the concept of this unit as a wall clock. If you want a digital alarm clock we recommend the unit described in the November 1975 issue (File No. 7/CL/19).

The Digitronic Time Model 701C calendar wall clock retails around the $50 mark. It is available from the following components suppliers: Paradio Electronics, Radio Despatch Service, Pre-Pak Electronics, MS Components, Willis Trading Company, J. H. Magrath & Company, Ham Radio Suppliers, Gerard and Goodman Pty Ltd, George Brown & Company, and Hunts Electronics.

Forum

Conducted by Neville Williams

PC boards should be "works of art"

A reader from Artarmon, NSW, is deeply perturbed because certain of our printed board patterns are not a delight to his eye, nor a thing of joy forever. What's more, if they don't look good, how can he be sure that they are going to work good? His letter raises quite a few interesting points.

It may seem like a modern problem, peculiar to the age of printed circuit boards, but it really isn't. In essence, it's as least as ancient as my own early recollections of "wireless" construction.

The first sets that I can remember personally were built on a wooden baseboard, behind a glossy black bakelite panel. You could see what was inside by simply lifting the lid and the routine of so doing was part of the buying and selling operation.

Largely as a result, wireless sets of the era were a geometric joy. Components were carefully aligned and the wiring executed with square-section busbar proceeding from point A to point B by a series of meticulously executed right angles. They didn't contribute to performance, but they certainly looked good.

The convention tended to carry over quite strongly into the subsequent generation of receivers built on inverted metal dish chassis. Customers rarely saw the underside by this stage but, as often as not, the wiring could still have stood up to visual display. Sometimes it had to when (hopefully) typical chassis were put on show perched above a 45-degree mirror.

I remember my first job in a small factory where four or five of us were engaged in building up early superhets of this general pattern. There was an official way of doing things but we gradually imposed our own inclinations. In fact, a certain amount of competition became evident as to who could turn out the "prettiest" wiring. Maybe it inspired some pride in workmanship but it also managed to use up quite a bit of extra wire, spaghetti tubing, lacing, clips—and time.

It even used up a bit of stability when "hot" RF leads were unobtrusively routed according to visual rather than technical standards.

Of course, there was the other extreme where reactionary designers let their heads go beneath the inverted chassis, like dogs let off the leash! How we geometric purists despised those early "Eclipse" and other such sets, where rubber-covered wires ran unashamedly from point A to point B, irrespective of the angle they made with the vertical and horizontal!

They were cheap and nasty sets, we reckoned. They had to be, with the wiring thrown in like that.

One of the strongest contrasts I can remember—and a good deal nearer home—involved the Stromberg Playmaster electronic organ which we described for home construction about 15 years ago. Our own kit version of the main amplifier was wired neatly, partly by personal inclination, and partly because it had to be photographed. By contrast, the factory built amplifier had all the charm of the often quoted "mad woman's breakfast"; or would it be kinder to invoke the equally quotable "pakapoo ticket"? Visually, some of those factory-built amplifiers had the roughest wiring I have ever seen. I even went to the extreme of rewiring one that I acquired, simply to feel better about it.

You think K.N.S. is a fanatic!

But, electrically, there was nothing to it. The respective amplifiers were equally as good and as bad as their counterparts. As good, when they worked properly; as bad, when the capacitors began to leak and the composition resistors climbed to five times their marked value! In the face of those problems, the wiring didn't amount to a stamp.

I see comparable emotional elements behind current attitudes to printed circuit boards. Some expect visual qualities well beyond mechanical and electrical essentials. To others, the prime need is to support and interconnect components, with appearance largely incidental.

K.N.S. is clearly in the former group and, without seeking to put down the particular viewpoint, I must take him to task about the sentence: "Please let's have artworks that look as their name implies—a work of art". In my book, that is a real red herring!

It is true that, in the printing industry, material that goes under the camera is commonly referred to as "artwork". It may even have been produced by an artist but, these days, large proportions of "artwork" can be the output of another camera or a computer controlled printer, or the work of a "cold type" compositor, or a draftsman or a tracer—or even an engineer!

In short, the term "artwork" is a carryover from the days of engravings and woodcuts and is a thoroughly inappropriate term for the present day and age. Circuits, diagrams and board patterns are not works of art and it is begging the question to define them in this way. They are primarily functional things which must meet the prime requirement of communicating to the reader (for diagrams and circuits) or supporting and interconnecting components (for PC board).

But, having made this point, I agree with the correspondent to the extent that there is some satisfaction in going beyond purely functional requirements and producing an end result that is orderly and visually acceptable. The question is what we mean by "acceptable" and what proportion of the total effort should be dedicated towards "cosmetic" ends.

In a normal manufacturing situation, the background to a PC board might be something like this: The designer figures out appropriate circuitry, then mocks it up "rat's nest" fashion or using a more formal testing set-up. When it looks promising enough, he may rough out a PC board himself, or turn it over to a board draftsman to do the job. This becomes the basis for the next step in proving the design. It's a step that will be repeated as many times as may seem

Dear Sir,

Why do you have to spoil an otherwise excellent magazine with such poor PC board patterns as featured on page 45 of EA May 1976. Surely I have seen better executed PC track layouts elsewhere in your magazines but the one by Mr. David Edwards is really awful.

Being occupied with PC artwork layouts all day I would like to point out to Mr. Edwards that his style is not quite the way how to do it. I am sure many readers would, as I, think twice before following the invitation to trace this congested mess.

Furthermore, if so little care has been taken with the PC board, one wonders how good the rest of the project is.

Please let's have artworks that look as their name implies—a work of art.

K.N.S. (Artarmon, NSW).

desirable or tolerable and, each time, the professional board draftsman will have the opportunity to contribute to its cosmetic, as well as to its electrical and mechanical qualities.

He will also express in the pattern his company's own policy in regard to the soldering techniques envisaged, and whether copper is to be retained to minimise the load on the etching bath, or dissolved to optimise any copper recovery program.

I guess that this is the kind of background from which K.N.S. is reacting, "being occupied with PC artwork layouts all day".

Our own scene is very different from this. We also do the initial figuring on the circuit and the initial mock-up testing. But we don't have, and cannot afford, the kind of lead times that apply in institutions and commercial operations. What they do in months, we have to do in weeks. If it were otherwise, readers would be getting fewer and more dated designs—and paying more for the privilege.

Of necessity, members of our technical staff prepare their own board patterns and, while we try to maintain a reasonably uniform approach, the patterns will inevitably bear the stamp of the individual. Nowadays, they are all done actual size, using adhesive tapes and shapes stuck directly on to a transparent base. While much faster and more economical than the old idea of drawing them oversize by drafting techniques, the preparation of a complex pattern is still a long and tedious job.

If fortune smiles very generously on a particular project, the first pattern may even be the final one, thereby saving a tremendous amount of time and effort. More typically, the PC board prototype shows up some unforeseen fault or the need for a modified approach and new board has to be made. If time were no object, a whole new pattern could be made at this stage, to include cosmetic as well as circuit changes. But time is an object and the natural urge is to adapt the existing "artwork", leaving most of the pattern unchanged.

In the case of the pattern under consideration, David Edwards had to cope with a larger than usual array of problems—normal development, wrong information about allegedly suitable ICs, and elusive coupling effects between supposedly isolated functions. The pattern, as published including some lines with discernible wobbles, was the end result of considerable plastic surgery—not of a single operation in which "little care has been taken".

But, even so, is it fair to brand it a "congested mess"? In my reading a "congested mess" implies more than a criticism of detail—lines that aren't quite straight, little areas that could have been made into lands, &c. These things could easily be modified to individual taste by anyone who did elect to trace the pattern, as envisaged.

Surely "congested mess" implies a criticism of the basic layout, and things that could not be corrected during the mere operation of tracing. Perhaps the layout of the wiring components is thought to be bad or untidy; or that the pattern is far more complex than it need be. Maybe it should be completely rearranged to use shorter leads, fewer leads, fewer links, and more obvious allocation of the logic elements?

Frankly, I doubt that anyone would see the component layout as visually untidy, so it must be a matter of the copper pattern. This was, indeed, somewhat less devious at the outset but it had to be quite deliberately "fiddled" to obviate some unforeseen coupling between certain logic elements. Far from being an indication of "so little care" changes were made to the pattern on the board to improve the pattern on the screen!

But, could the pattern be improved visually by being laid out afresh?

Almost certainly, and David Edwards himself could do the job, given the opportunity. As a professional PC board man, K.N.S. may well be able to go one better again.

Would the reworked pattern give a better electrical result?

Almost certainly not. However, a complete unit would have to be built up using it to make sure that the revision didn't inadvertently make the performance worse.

Would I, as Editor-in-chief, like to see all our printed circuit patterns uniform and to the highest industry standards?

Most decidedly.

Would I be prepared to sanction a substantial increase in man-hours and costs for purely cosmetic reasons?

No way. They're already embarrassingly high.

In case this last remark should sound trite, K.N.S. or anyone interested in so doing might care to work out how long it would take him to start with the published pattern as a prototype, and produce a new "work of art" equivalent. Then send out and have the board made, get it back, obtain the "bits," assemble and re-test it thoroughly for publication. Now multiply that many hours by what it costs any company to retain the services of a skilled technician or engineer; remember that the cost is at least 20% above gross salary, while actual productive working hours are far less than the formal figure, due to holidays, sick leave, and a variety of personal distractions.

My guess is that it would add up to between $200 and $300 and, in the particular case, would have delayed the project one complete month. To paraphrase the great: "It would be an option, up with which I would not put!"

Well then, has K.N.S. wasted the paper and the cost of a stamp?

Indeed not. When you get a broadside like that, it may not sink the ship, but it doesn't pass unnoticed!

Further thoughts on amateur microwaves

Between May and August 1972 we presented a series of four articles by this author entitled "Microwaves for the Radio Amateur". The present series is intended to bring the microwave enthusiast up to date on recent experiments, in the hope that the author's practical experience will assist others to avoid the more serious problems in this fascinating and expanding field.

by DES CLIFT VK2AHC

This article is an attempt to pass on some results of a long series of battles to master solid state and antenna techniques in the UHF and microwave regions. The pile of half-finished units and highly modified prototypes at the writer's QTH bear witness to the struggle! However, the result has been to acquire the basic knowledge to start on future projects with some ideas on how to achieve success with a minimum of time and money.

Before we go any further, let it be firmly understood that there are Problems—with a capital "P"—in this fascinating game. By coincidence, a few of the major aspects also begin with P. These may be summarised as follows:—

1. PLANNING. Do not understimate the importance of really careful thought being given to all aspects of the project. In your time scale be prepared to do everything two, and probably three times, before you get anywhere near the end product. Be conservative; do not attempt to be too clever and make it too compact unless it is just an updated version of a prototype or earlier design.

2. PORTABILITY. Unless you are among the .01% of amateurs with a really good UHF location the majority of equipment for 1296MHz to 10GHz will operate from portable locations. This immediately defines the size of the modules, the power supply arrangements and the antenna system. Therefore, plan for portability or you will regret it before you have even had a contact with it.

3. POLARITY. It is a pity that most Australian vehicles operate on the negative chassis system. As pointed out in (2), most equipment will operate from portable locations and so one automatically tries to make it compatible with other portable and home station rigs. The majority of suitable transistors are NPN and, since it is decidedly advantageous to ground the collector tuned circuits, a conflict arises. Possible solutions are:—

(a) Install DC/DC converters and use both collector and emitter grounded circuits, and at a variety of voltages.

(b) Simply disconnect the car battery every time operation is required, use −12v, and do not mix equipment of both polarities. (Dangerous practice anyway.)

ABOUT THE AUTHOR

Des Clift was licensed as G3BAK in 1947 and since 1965 has operated as VK5CO and VK2AHC. He is probably one of the few amateurs who can claim to have had contacts in every amateur band from 1.8MHz to 10GHz. He holds Australian records for 2.3GHz, 5.65GHz, and 10GHz.

Although his main interest for some years has been in developing and building solid state UHF and microwave gear, his call is still to be heard on 7MHz CW—a band on which, as G3BAK, he made numerous contacts with VK and ZL stations in the 1950s.

(c) Stick to emitter grounded circuits.

For the beginner (b) is highly recommended, followed by (a) as interest grows: otherwise the position which prevails at VK2AHC will soon be reached, where so much use has been made of (c) that it is now a major problem to implement the desirable alternatives. Be bold—make the right choice at the start!

4. PRODUCTIVE CAPACITY. Before embarking on a major project, weigh the pros and cons of doing it on your own or teaming up with a colleague or club. You must have access to:

(a) Reasonable workshop facilities. A minimum requirement is a decent electric drill, with stand and vice, medium size vice and simple tools.

(b) Some form of test equipment. A power meter, capable of measuring from a few milliwatts up to the maximum expected output, is absolutely essential. Some means of determining the frequency of individual stages, in the high order multiplying chains which usually occur, is also essential. These need not be elaborate providing they are calibrated. Anything else, such as access to a spectrum analyser or a sweep generator with VSWR capability makes the job so much easier.

(c) A reasonable stock of suitable new components and odds and ends of mechanical gear, salvaged from surplus UHF gear, are invaluable. (It is usually far easier and more satisfying to make something from scratch than try to modify existing equipment.)

5. PATIENCE. If you do not possess more than average patience don't bother to get involved.

6. PROCRASTINATION. The hardest part of the job often is to get started. It is easier to find excuses for putting the job off than it is to start it. Once moving however, it is a lot easier to keep things going.

Not all amateurs, particularly the younger ones, possess all the essentials in (4), hence the earlier comment. More important, in order to operate the finished article, particularly in the microwave bands, two lots of gear, with an operator for each, are required. So you either make up two lots and loan one out (as usually done by the writer in the past) or make two lots as a team effort and share resources with the second operator. In the latter case he then knows as much about the gear as you do—a decided advantage when one strikes trouble in the field.

The techniques to be described are more or less in accordance with international practice and fall into two groups.

Group 1 covers 432MHz, 1296MHz, and 2.3GHz crystal controlled, narrow band FM systems with separate transmitters and receivers using separate or switched antenna systems.

Group 2 covers 3.4GHz, 5.8GHz, and 10GHz duplex medium wide band FM transmitter/receiver systems using one oscillator spaced the IF away from the oscillator frequency of the distant station.

Usually only one antenna is used at each station. (Ref. Electronics Australia May 1972 pp53-57.)

There is no reason why either system may not be used in any band. It just happens to be more convenient to operate the various bands as described. The main difference between the two groups is in stability requirements for the oscillators. Group 1 uses high order multiplication chains and narrow band receivers, while group 2 usually, but not always, uses self excited oscillators and wide band receivers. The availability of relatively cheap solid state devices now makes possible simple and effective gear for group 2; an added attraction towards greater use of these three bands.

Solid state techniques for group 1 are still expensive but reduced size and power requirements and, to some degree, the simplification of the electronics, make it worth while and very instructive. $30 or $40 spent on some relatively exotic device can more than offset the use of cheaper alternatives requiring more complicated power supplies and longer development time.

So much for the preliminaries—now down to the details. Just about the most important thing in the whole set up is the antenna. It is also, unfortunately, the sphere in which most amateurs just have to turn to various amateur periodicals and hand books for a design—which usually has its qualities quoted in glowing terms. The writer's advice is: beware! No matter how accurately you duplicate them they very seldom perform in a manner even approaching what is claimed. And, because of the lack of test equipment, the constructor never knows how good (or bad) they really are.

By far the worst frequency in this respect is 1296MHz. Dishes with simple feeds are not often practical as the minimum effective size is around four to five feet in diameter. At the same time the dimensions of parasitic or driven element types, usually used as a compromise, are of necessity small and highly critical.

I have carefully constructed an 8 over 8 skeleton slot array (Radio Commn. March 1966, p183), a 34 element long yagi (Radio Commn. Aug. 1971 and March 1974), a four square helix (ARRL Antenna Book p261), a 34in diameter conical reflector with dipole feed (Radio Commn. Sept. 1973) and a circular waveguide feed (QST March 1973); all claimed by the authors to be highly successful. It is very interesting to compare the vastly different dimensions of both the radiator and parasitic elements in these designs and others, such as Ham Radio May 1972. It leaves one somewhat confused, to say the least.

The writer is fortunate in having access to a Telonic SM2000 VSWR sweep generator and, when these aerials were checked with this, the results were very dismal.

It was found impossible to make the 8 over 8 show any signs of response around 1296MHz and three or four subsequent attempts, spread over a three or four year period, failed to make it work. (This particular design on 432MHz is exceptionally good.)

The long yagi was finally made to resonate by substituting a three wire folded dipole with a four-to-one step up balun for the skeleton slot and one-to-one balun detailed. Good matching, rather than maximum gain, was then achieved by adjusting the spacing of the reflector (also modified from the original design), and the first two directors.

Gain measurements against a medium size dish, the modified helix array, and a corner reflector, indicate that the antenna gain is somewhere near the figures claimed for the original (equivalent to a 3ft dish).

The lesson learnt was that it is extremely difficult to modify the design, even when high quality test equipment is available, since all the element lengths are highly dependent on adjacent elements and in any case are all cut, spaced and soldered. The same criteria apply to a lesser extent on 432MHz where the chances of making a design "to the book" are more likely to be successful.

As an alternative the writer considered:

(a) A colinear array with mesh reflector

(b) an array of corner reflectors (since one alone has not enough gain)

(c) an array of helex antennas.

Option (a) was rejected, unless all else failed, since it was considered a major project in itself. (c) was constructed to ARRL Antenna Book (p261) dimensions and (b) was completed in part ie, one corner reflector, based on RSGB VHF/UHF Manual 9.24.

Despite the fact that the helix array was meticulously duplicated the initial VSWR was around 10:1! A review of the design pointed to the culprit being the matching section—four (one to each helix) single wire feeds (transformers) close to the ground plane—which attempts to match a 50 ohm feed.

Despite moving the transformer and spacing the helix turns the VSWR could not be improved to better than 2:1. In the case of the helix mechanical changes can be made reasonably easily and it was decided to match each helix to 50 ohms by a quarter wave coaxial section and then join all four by a four way 50 ohm in, 50 ohm out splitter. (Radio Comn. Dec. 1974 & Dec. 1975). The literature showed the helix impedance was in the region of 130 ohms and thus the quarter wave sections were made about 80 ohms.

They were made from 1in O.D. copper pipe, with ¼in diameter brass rod as the centre conductor. Length is 5.5cm. One end is terminated in a type "N" connector, soldered directly to the copper pipe and the centre conductor.

The VSWR of one helix was about 1.75:1 and altering the turn spacing, particularly of the first turn to the reflector, had far less effect than anticipated. However, the array was completed and fed by the splitter. (The splitter showed a VSWR of 1.1 with all four arms terminated by 50 ohms.) The result varied with the proximity of surrounding objects but was certainly far lower than the 2:1

Fig. 1. The helix array, seen from the rear. Two of the four helices can be seen through the mesh and one of the 80 ohm matching transformers is clearly visible on the left hand helix. The four way splitter is also plainly visible.

achieved by modifing the original design.

Each helix was again examined using the VSWR sweep generator. Due to the inherent wide band characteristics of this aerial the VSWR display appeared as ripples about 50MHz wide, superimposed on a wide band pattern, which peaked over the region 1.1GHz to 1.4GHz.

It was decided to investigate the only other parameter not previously varied ie, the actual wire length. By clipping off bits of wire it was apparent that the minima of the closest ripple below 1296MHz could be made to move to 1296MHz.

Hey Presto! The VSWR dropped to below 1.25:1 when a quarter of a turn had been removed. All four were treated the same way, and when fed with the splitter the overall VSWR was better than 1.5:1.

a gain considerably lower than the complete helix array, but obviously of the right order.

An array of four such reflectors would be very simple to make, mount, and feed with the same simple splitter used with the helix array. Work is proceeding on a simple dipole feed which does not have the bulk of the TS129U/P.

The conical reflector with dipole and reflector feed was somewhat more successful than the previous types tried. Its performance was about the same as the modified helix array but the rigidity was far less, even though the reflector was made from solid galvanised sheet. As a result, it also had much highher wind loading. The extension to this referred to in the RSGB article, which uses two different sections joined together, seems to

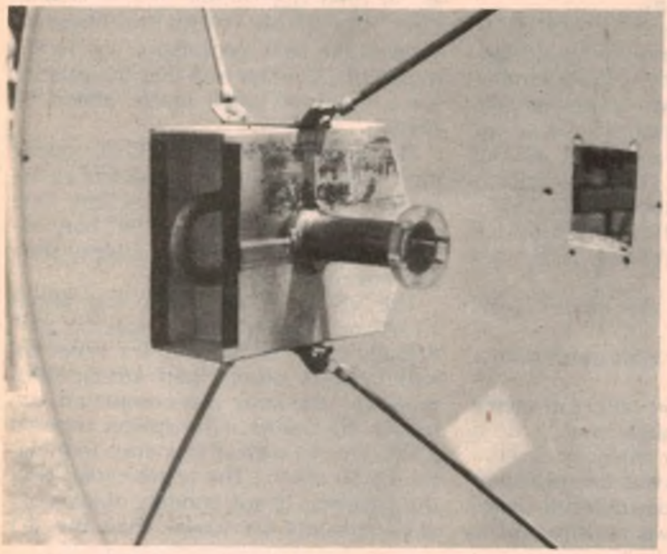
reflected power or, somewhat less refined, peaking a weak signal on the receiver.

This story may seem rather long winded but it describes the ordeals the really interested amateur has to go through. If it saves others some frustration, it will have been worth while.

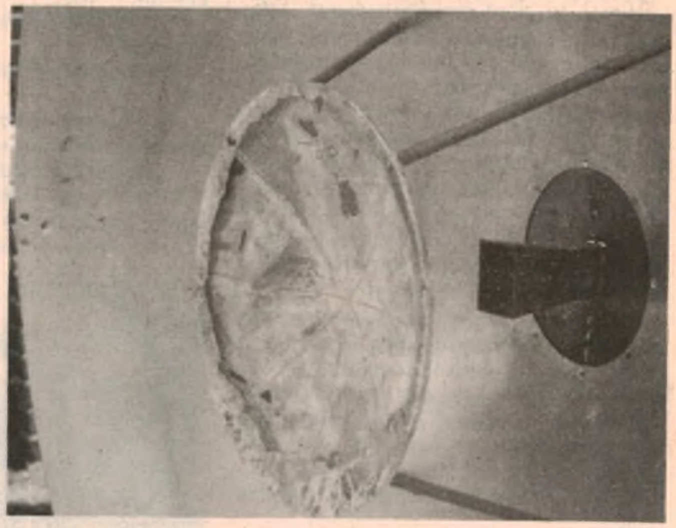
Antennas for 5.8GHz and 10GHz have been more successful. Apart from home made horn antennas (Electronics Australia Aug. 1972) two other types have been used. The first, in continual use for well over 20 years, is the dipole/reflector feed used in the wartime APS3 radar and also described in the Aug. 1972 issue.

When used with 6in, 15in, and 17in parabolas with short focal lengths (ie. 5.65in for the 17in dish) they work superbly and, because of the rear feed method, they connect very simply with the transmitter/receiver. However, when one was tried with a 30in dish with a 12in focal length the results were disappointing. This was put down to the dish not being illuminated efficiently and the tests were suspended.

Two methods of front feed have been further investigated. The first (Fig. 2b of Electronics Australia May 1972 p57) showed great potential because it did



Left: Fig. 2. The rectangular waveguide made from downpipe and fitted with a waveguide to coaxial transformer type feed.



Right: Fig. 3. The Cassgrain type feed using horn and subreflector. The subreflector is cast in fibreglass and covered with thin aluminium foil.

The gain was found to be between the corner reflector and the modified long yagi. (Bear in mind the 3dB loss in the helix antenna when used with linear polarisation.) However, this was considered a major step forward in that a practical 1296MHz antenna suitable for both permanent and portable operation had been produced, which could be tuned to resonance, and which would handle horizontal and vertical polarisation equally well (Fig. 1).

The corner reflector was constructed by making a hinged 2ft square aluminum frame work with mesh fitted to each half. The dipole was a surplus TS129U/P 50 ohm feed antenna, which is a simple dipole with sleeved balun. On its own it exhibited a remarkably good VSWR from about 1GHz to 1.4GHz. However, when inserted into the corner reflector with the angle optimised according to the RSGB charts the VSWR was far worse than expected.

At the expense of gain, it was necessary to open the angle to 90° or 100° to improve the VSWR. It was concluded that the charts were probably for use at much lower frequencies and that the rather bulky balun section at the apex of the reflector was upsetting the match. However, the results were encouraging;

be its only advantage, giving a structure approaching the size and efficiency of a larger parabola.

The dish system was then tried. The dish was not parabolic, but a 24in radius spherical section. The first feed was the circular waveguide feed from QST which, apart from the fact that it did not appear to agree with theory and would not tune well, was discarded because of its size and mounting problems. It was decided to use rectangular waveguide, in the form of 6½ x 3¼in downpipe and make a simple waveguide to coaxial transformer type feed. This was very easy to make and worked well from the first. It has since been adopted as the standard feed for 1296MHz, 2304MHz and 3400MHz parabolas (Fig.2).

It is the only type of feed investigated which can be tuned in situ using either a reflectometer indicating minimum

away with a 3dB coupler or a circular duplexing system. It was reluctantly dropped because it was impossible to secure the same angle of transmission and reception when using the 30in diameter dish, with its very narrow bandwidth.

The second, more recent, is a modified Cassegrain type feed for use with short focal length parabolas (the surplus types usually available) and described in the excellent article of Radio Comm., March 1975.

Two pairs of 5.8GHz and 10GHz horns of this type were made for 28in and 30in diameter dishes (Fig.3).

Four major problems were encountered during this excercise, which took about three months of available amateur time to complete.

1. The sub reflector. Having designed the sub reflector profile, the problem of

its manufacture arose. Two methods were tried and both were reasonably successful in that each produced a usable device. Briefly, both consisted of making a fibreglass mould, from which a fibreglass reflector was made, this then being covered with aluminium cooking foil (Fig. 3).

But the amount of work involved, and the problems encountered, convinced the author it would be a far better proposition to take the design to a wood turner or pattern maker, and have a wooden mould made. Among other things, this should be robust enough to permit its continual re-use. The fibreglass moulds were destroyed the first time they were used.

2. Construction of the horns was the most difficult part of the job since the design had both faces tapered. The first attempt was to cut out two half sections, bend and join them. This proved impractical as, when bent up it was over 1/16 in out. A solution, not tried, may have been to bend it first and then cut it to size.

The second attempt was to cut out four separate pieces and solder them, using the technique previously successful with the much larger horns. This proved virtually impossible. Due to the small size the heat flowed over the work too easily and it was impossible to tack one end and then attack the other end properly without it all dropping to bits!

The final, successful, method was to make an accurate 90° aluminium jig. Using this jig two pieces were first soldered together, the second pair likewise, then the two halves were pinned together and soldered whilst heat sinking the previously soldered edges in the jig. It was relatively easy to join the completed horn to the waveguide, cut and file out the pin and clean up the joining edges, because of the small size of the horn. A crude electroform will be tried if another set is required.

3. Having produced the antennas and feed, measurements showed a high VSWR caused by reflection from the closely spaced subreflector. This necessitated inserting a matching network (4 screw tuner) immediately behind the horn. This proved highly successful but, because of the need to find the correct position of the horn by experiment in the field, it meant that every time the horn was moved, the matching process had to be repeated.

This did not appear to be practical and an attempt to use the 3dB coupler reverse output of one system as a reflectometer also was not, even after tuning out the leakage component, since confusion arose in interpreting a meter serving three purposes; oscillator output, mixer current and reflectometer.

Some in-the-field method is required and tests on the prototype suggest that a separate dual directional coupler would be the solution, serving the dual role of forward power (oscillator output) and the reflected power monitor. A similar problem is worse at 5.8GHz because less test equipment for that band is available. Things are much easier if a circulator is available but, as these are hard to come by, they have not been suggested.

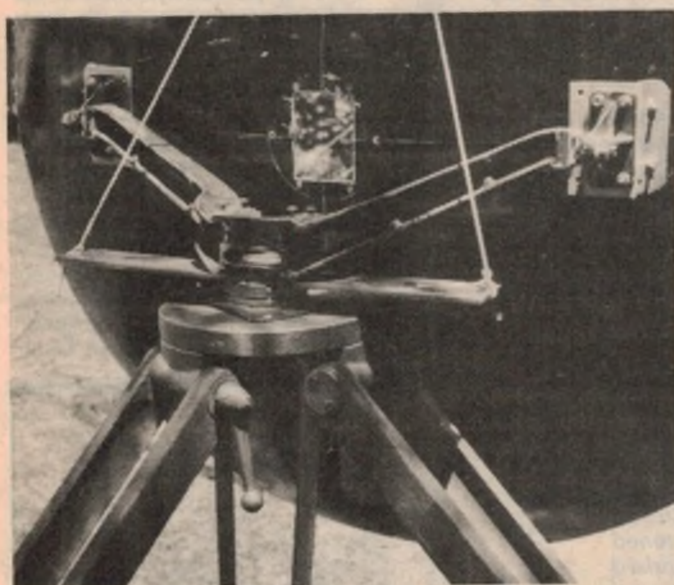


Fig. 4. The best support for a dish is a stout tripod. Photo shows the method of mounting using a pair of screwed rings, one fastened to the tripod, the other to the equipment.

4. Mounting the dish and ensuring that the 5.8GHz and 10GHz feeds, oscillators, and associated waveguidery could be easily changed in the field. It can only be stressed that in this game the only way to learn is by experience. The problems of a previous design can usually be corrected in the new one and so on.

As a result of many projects, spread over many years, the writer would advise:

(i) do not try to use a fixed framework for mounting the antenna dish—obtain as good and strong a tripod as possible for dishes up to 30in diameter. For larger dishes fix the dish very rigidly to a mast or short galvanised pipe and arrange for this to be movable over about 10°.

(ii) Do not underestimate the effect of the wind; it is surprising how severe this can be on the spots usually chosen for /P microwave sites!

(iii) Try to make everything demountable, very rigid, and compatible with the transport available—bearing in mind that transport of wife and family may be required at the same time!

After many failures VK2AHC/P has arrived at the position where self and one passenger and /P equipment for 144MHz, 432MHz, 1296MHz, 5.8GHz and 10GHz can all be transported in a Ford Falcon (with roof rack mounted 4ft dish and 30 ft telescopic aerial). Something larger is desirable but not essential.

Try to estimate the centre of gravity of the assembly at this point, even though it might make the dish harder to mount. Two well tried hints are (a) use a pair of screwed rings for UK style WG16 flanges. Solder one half to the top of the tripod or to a thick piece of brass, which can be fixed to the top of the tripod. Use the other half for mounting the equipment (Fig. 4). This has been a complete 10GHz Tx/Rx box to which the antenna was fitted, or an angled bracket fixed to the back of 17in and 30in dishes.

(b) Use surplus anti-vibration equipment trays on which a frame is mounted, which holds the rest of the microwave equipment to be mounted, as well as the dish. Both these methods allow azimuth control without moving the tripod. The latter also allows a small amount of elevation control.

What's new in Solid State

Esoteric uses for the LM3909—Part 2

Here is the second part of the article on interesting applications of the LM3909 "LED flasher" IC, written by Peter Lefferts of National Semiconductor:

The ideas of negative and positive feedback can also be presented. The circuits presented below are intended as illustrations or demonstrations of circuitry concepts such as would be used in an experimenter's kit. They are not meant to be used as parts of finished commercial products with specific performance specifications. In other words, working circuits have been breadboarded, but no measurements of performance such as frequency range and distortion have been attempted.

Figs. 5 and 6 show an RF oscillator and a simple AM radio. Both tuned circuits use standard AM radio ferrite antenna coils (loopsticks) with a tap 40% of the turns up from one end. The oscillator works up to 800kHz or so, and the radio tunes the regular AM broadcast band. Both also use standard (360pF) AM radio tuning capacitors.

The oscillator has the normal capacitive positive feedback used with LM3909 circuits, but with frequency determined by the tuned circuit loading the output circuit. Detailed operating descriptions of these experimenter's circuits will not be attempted in order to keep down the length of this note.

In the radio circuit of Fig. 6 the LM3909 acts as a detector amplifier. It does not oscillate because there is no positive feedback path from pin 2 to pin 8. The tuning ability is only as good as a simple "crystal set", but a local radio station can provide listenable volume with an efficient 6 inch loudspeaker. Extremely low power drain allows a month of continuous radio operation from a single "D" flashlight cell.

Antennae for the radio circuit can be short (10 to 20 feet) and connected directly to the end of the antenna coil as illustrated. Longer antennae (30 to 100 feet) work better if attached to the previously mentioned tap on the coil . . . also illustrated.

By leaving out the positive feedback capacitor, the LM3909 can become a low power amplifier (Fig. 7). This little audio amplifier can be used as a one-way intercom or for "listening in" on various situations. Operating current is only 12 to 15 mA. It can hear fairly faint sounds, and someone speaking directly into the microphone generates a full 1.4V peak-to-peak at the loudspeaker.

Finally, here are some practical application hints. With 1.5V supplies, certain problems can occur to stop oscillation or flashing. Due to the way gain is achieved and the type of feedback, too heavy a load may stop an LM3909 from oscillating. 20 ohms of pure resistive load will sometimes do it. Strangely enough, lamp filaments, probably because of some induction, don't seem to follow this rule. Also in flasher circuits, an LED with leakage or conductivity between 0.9 and 1.2 V will stop the LM3909. Maybe 1% of LEDs will have this defect because they are not often tested for it.

Great frequency stability was not one of the design aims of the LM3909. In LED flasher circuits it is better than might be expected because the negative temperature coefficient of the LED partially compensates the IC. We planned it this way. Simple oscillators, without the LED, are uncompensated for temperature. This is due to using ⅔ of a silicon junction drop as the on-off trip point and the use of the integrated timing resistors with their positive temperature coefficient. Further, most capacitors of 1uF or over, shown in the circuits, will usually be electrolytics for size reasons. These, however, are not particularly stable with temperature and their initial tolerances vary greatly with type of capacitor.

In most of the oscillator circuits, frequency is also proportional to battery voltage. This must be considered when starting with a completely unused cell at 1.54 V or so and deciding what the "end-of-life" voltage is to be. This can be in

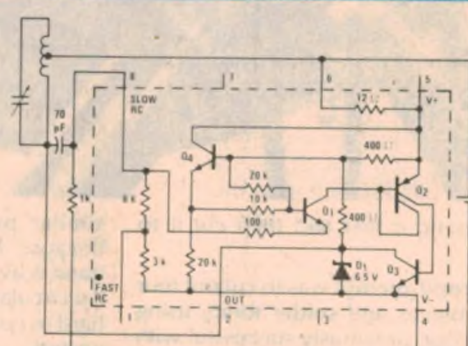


Fig. 5: A simple RF oscillator circuit using the LM3909. The tuned circuit can be a standard AM radio ferrite rod with coil, tuned by a suitable capacitor.

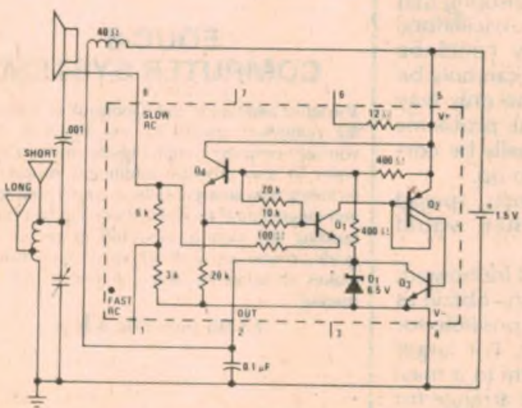


Fig. 6: A simple AM radio using the LM3909.

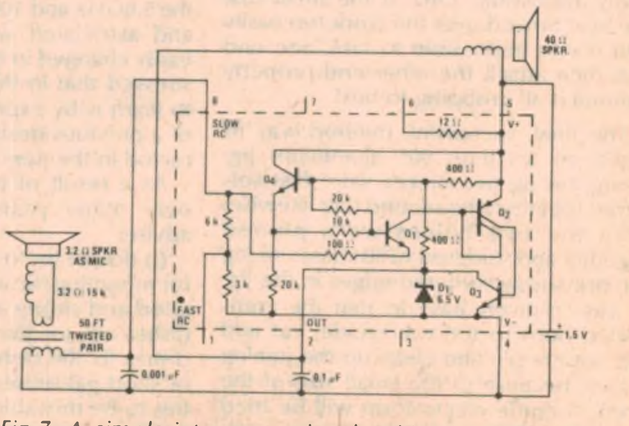


Fig. 7: A simple intercom, using the chip as an AF amplifier.

COMPETITION

How good are you at lateral thinking?

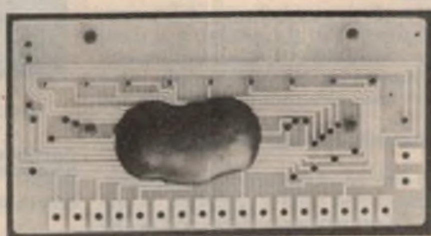
As you can see from this article and the one we published last month, quite a few interesting applications have already been found for the LM3909 device—many quite different from its nominal intended function as a LED flasher!

Intrigued by the potential of the LM3909, one of our advertisers has decided to sponsor a competition to see how many more new applications for the device can be dreamed up by our readers. The advertiser is Tekniparts, of 95 Latrobe Terrace, Paddington, a suburb of Brisbane, and this firm is offering a $100 credit voucher to the reader who can dream up the most interesting and imaginative LM3909 application.

The credit voucher may be used to purchase from Tekniparts any desired electronic components or equipment, including calculators, to the value of $100. We also plan to publish details of the winning entry in EA, together with other interesting entries, and publication fees will be paid for all entries published. So there should be plenty of incentive to put on your "lateral thinking" cap!

Tekniparts has asked EA to judge the competition, and agreed that our decision will be final. Entries should reach us posted no later than September 30th, 1976, so that we can announce the winner in the December issue.

Send your entries to Electronics Australia, Tekniparts Flasher Competition, PO Box 163, Beaconsfield, NSW 2140.



CHIPS DIRECTLY MOUNTED ON PC BOARD: This new calculator module from National Semiconductor has both the calculator chip and the monolithic display chips mounted directly on the gold-plated PCB pattern, for lower cost and higher reliability. A blob of epoxy protects the main chip on the rear of the board (picture at right).

the range of 1.1 to 0.9 V, a drastic change. It helps to remember how bright flashlights are with a fresh set of batteries, and how dim they are when the batteries are finally changed.

Flashers and tone generators for alarms are not, however, demanding for stability. Flash rate changes of 50% or tone shifts of 1/2 an octave are not particularly annoying or even too noticeable.

One interesting point is that the low operating power of most of the circuits presented allows them to be powered by *solar cells* as well as regular batteries. In bright sunlight, 3 to 4 cells in series will be needed. In dimmer light, 4 to 6 cells will do the job. Current from cells way under an inch in area generally will be sufficient, but circuits drawing a high pulse current will need a surge storage capacitor across the solar cell array.

The LM3909 was designed to be inherently self-starting as an oscillator, and LED flasher circuits *are*, at any voltage, because the load is nonlinear. A load with sufficient self inductance will always self-start, although possibly at a higher than expected frequency. There is an exception for largely resistive loads on an oscillator operating with a supply larger than 2 or 2.5 V. A stable state exists with Q_3 turned completely "on" and the timing resistors from pin 8 to the supply minus still drawing current. A reliable solution is to bias pin 8 (for instance with a resistor to V+) so that its DC voltage is half a volt less than half the supply voltage.

The duty cycle of the basic LED flasher is inherently low since the timing capacitor is also driving the very low LED "on" impedance. For other oscillators the "on" duty cycle can be stretched by adding resistance in series with the timing capacitor. Additionally, nonlinear resistance can be used as timing resistance, as in circuit of Fig.3.

The LM3909 demonstrates the practicality of very low voltage electronic circuits. They can work at high efficiencies if ingenuity is used to design around transistor junction drops. In such circuits stresses on parts are so low that extremely long life can be predicted. Often transistors, capacitors, etc., that would be rejects at higher voltages can be used. Voltage dividers, protective diodes, etc., often needed at higher voltages can be left out of designs. Power drains are so low that circuits can be made that will last months to years on a single cell.

For further data on devices mentioned above, write on company letterhead to the firms or agent quoted. But devices should be obtained or ordered through your usual parts stockist.

Circuit & Design Ideas

Conducted by Ian Pogson

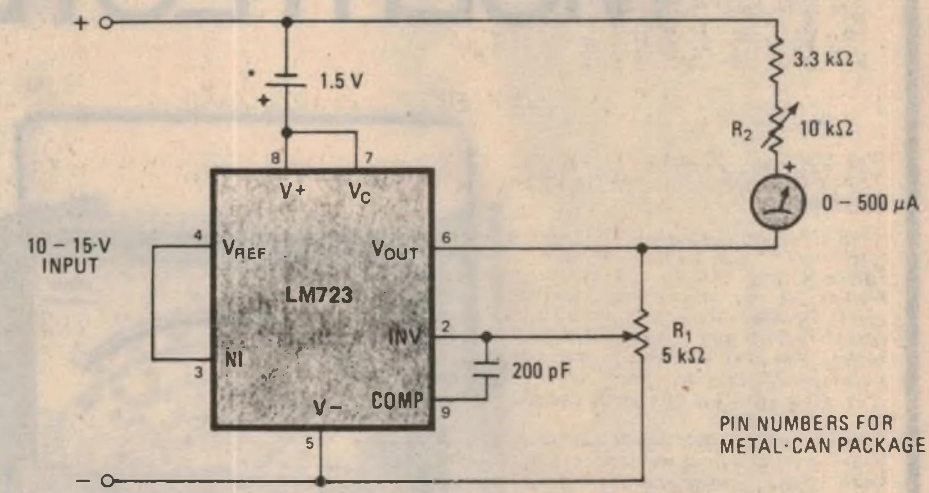
Interesting circuit ideas and design notes selected from technical literature, reader contributions and staff jottings. As they have not necessarily been tested in our laboratory, responsibility cannot be accepted. Your contributions are welcome, and will be paid for if used.

Voltage—regulator IC biases expanded scale meter

To monitor the state of charge of a standby storage battery system, only voltages between 12 and 15 volts need to be read. A conventional test meter reading 0 to 15V full scale will suffice, but readings can more easily be observed when the voltmeter has an expanded scale that reads from a minimum of 10V to a maximum of 15V.

In one such expanded scale circuit a battery provides a 10V bias to the meter so that when a voltage source of 10 to 15V is applied to the combination, the meter shows the difference of 0 to 5V. This arrangement is unsatisfactory, both because it must have a battery for operation and because its accuracy depends on the battery having a potential of exactly 10V.

There is a better way. Since the voltage to be monitored will be above 12V, a National Semiconductor LM723 voltage regulator can be used as shown in the figure to provide a stable 10V bias. A 5000uA meter and a series resistor R2 constitute the 0 to 5V voltmeter. If the battery voltage should drop below about 11.7V, regulation falls off, but this inaccuracy can be corrected by using a 1.5V dry cell if readings below 12V are necessary. The dry cell does not affect the accuracy of the meter calibration—it simply extends the reading range down to about 10.2V.



The unit draws about 3mA and can be used continuously across the storage battery system. The entire circuit can be constructed on a small circuit board and mounted on the terminal posts of the meter.

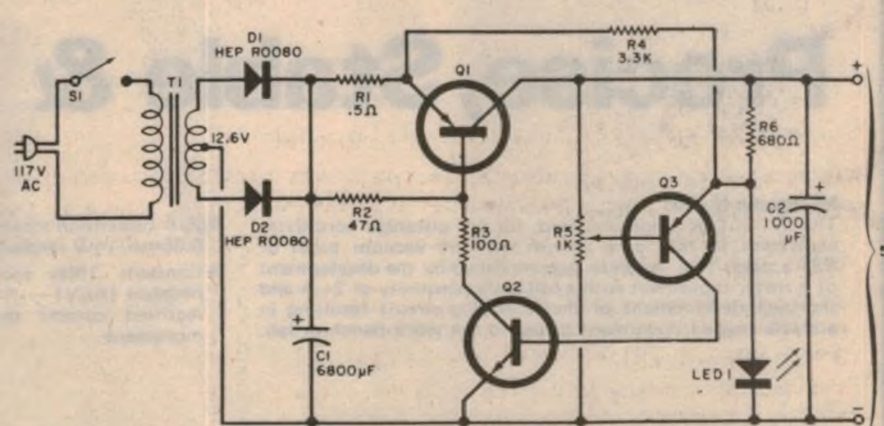
The circuit is calibrated by applying 15V to the input and adjusting R1 for 10V at the output of the 723. Then R2 is set for a full-scale reading on the meter. For the 500uA meter, 200uA corresponds to 12V, 300uA to 13V, etc. Normal battery voltage reads near centre scale, and small deviations can be seen at a glance.

(By Alan D. Wilcox, in "Electronics".)

Junk-box 5V power supply

The circuit described here can be built from junk-box parts, offers 0.15V stability, 5mV noise and ripple, automatic current limiting and an overload indicating light!

No transistor type numbers are given, as almost any will do. The PNP series pass transistor Q1 is a power type with a BVceo of 15V and a minimum current gain of about 30 at 1A. If the power device you have has a gain a bit lower than 30, R3 can be reduced to compensate. Enough heat sink should be provided to dissipate 7 or 8 watts under worst overload conditions. As shown, the collector is the positive output rail. A piece of aluminium bolted to the + terminal will do nicely. If you want to use an NPN power transistor, invert the entire circuit into its complementary form. Thus the transistor's case is conveniently grounded and the chassis can be used for heat sinking. It is also possible to use a germanium transistor if R2 is lowered to about 22 ohms.



The other two transistors are general-purpose, small-signal silicon devices. Resistors are not critical. A 2W wire wound component should be used for R1. A length of resistive wire wrapped on the body of a higher value resistor can form R1. R3 should be ½W carbon.

The LED is used as a reference voltage with an output of about 2V. The forward voltage drop of most GaAsP yellow, green, or orange LEDs will vary from 2.0 to 2.2 volts. Select one with a Vo close to 2V.

Feedback action sets the base of Q3 to about one Vbe below the reference voltage on its emitter. Since the Vbe of

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±DCV 0-60mV
0-0.3-1.2-3-12-30V
(500kΩ/V)
0-120-300-1.2k
(50kΩ/V) ±2%
0-30k (w/HV probe)

ACV 0-3-12-30-120-300-1.2k
(1MΩ)+2.5%
Freq. 20Hz to 50kHz
(±1dB)

±DCA 0-2μA 0-0.03-0.3-1.2-3-12-30mA
0-0.12-0.3-1.2-12
(300mV) ±2%

ACA 0-1.2-12A
Ω x1 x10 x100 x1k x10k x100k (max. 200M)
Batt. 1.5VX1 & 9VX1
dB −20 to +63
252x191x107mm 1.95kg

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Q3 and the turn-on voltage of the LED usually have similar temperature coefficients, this combination works very well.

R3, together with R1 and R2, limit the maximum (overload) current of Q1. As more output is demanded, Q3, and in turn, Q2 turn increasingly on, grounding the bottom of R3. This action sets up a voltage divider, R2 and R3, limiting base drive to Q1.

A variable resistor in series with R3 can be added to set lower current limits. This is especially desirable when the supply is feeding easily damaged devices. Maximum current output of the series pass transistor is set by R1 and R2, and R3 limits the base current into it. This gives the current limiting action.

Because Q3 and the reference LED are fed from the stable side of the supply, the circuit gives excellent rejection of ripple and input variations. If R4 is excluded, complete current shut-off will occur when the supply is short circuited. Although this is very desirable in protecting the load, it also will not self-start. At the specified value, R4 bleeds enough current into the error amplifier (Q3) to allow start-up against a 5 ohm load. If desired, a normally open push-button switch can be placed in series with R4 to get the best of both configuration.

The LED also acts as a pilot light. It will extinguish when the power supply is shut down by overload trip-out. The only adjustment that must be made is the setting of R5. Adjust it so that the output is 5 volts. Once the setting has been determined, fixed resistors can be substituted for both sides of the potentiometer for stability.

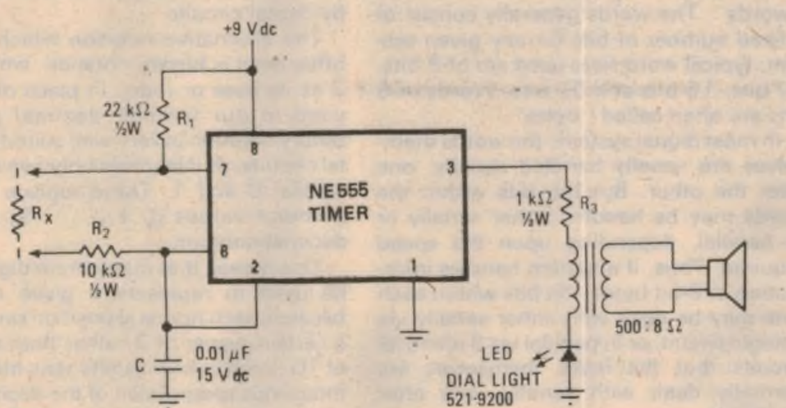
(By R. C. Foss, in "Popular Electronics".)

Audio continuity tester indicates resistance values

A continuity tester built around a 555 timer audibly and visually indicates a wide range of resistance values. The unit, which can be assembled for a few dollars, is especially handy for testing devices without having to glance from test probe to meter and back again. However, by merely changing the value of one resistor, the tester can function as a multivibrator.

The meter can indicate by tones over a loudspeaker or a headset forward and reverse continuity conditions from 0 to more than 30 megohms for such devices as resistors, diodes, transistors, capacitors and light-emitting diodes. In addition to the audio output, a LED serves as a pilot light and flashes when the output frequency falls below 10 to 12 pulses per second. The output is a square wave, and an audio pulse sounds each time the LED is turned on or off.

The tester can also determine the charges stored in mercury and nickel-cadmium cells. A full charge of 1.2 to 1.4 volts will either not sound at all or sound in only one direction, depending on the probe's polarity. However, a partially discharged cell with a polarity of 0.9V or less will create a sound in either direction because the audio frequency depends on the resistance of the cell in either direction. For the value of resistors used an on-to-off duty cycle of about 60% is obtained. The circuit draws about 7mA from a 9V battery.



The circuit shows where unknown resistor Rx is connected into the multivibrator circuit. The unknown can have any resistance value from zero ohms to more than 30 megohms. At 0 ohm, which is a short circuit across the test probes, the audio output frequency is about 7000 pulses per second. This frequency sounds like a sine wave to the ear. At 30 megohms, the frequency is about 1 pulse per second.

Very low current flows through the tests probes. When Rx is 0 ohm, the current is about 270 microamps, and when Rx is 1 megohm the current is about 9 microamps.

The 555 timer is operated in the astable-oscillator mode. The free-running frequency and duty cycle are both accurately controlled with three external resistors and one capacitor. The external capacitor C charges through R1, R2 and Rx, but it discharges only through R2 and Rx. R2 limits the upper frequency of oscillation when Rx is 0 ohm. The lower frequency limit of approximately 1 pulse per second is set by the value of Rx when it is above 20 megohms.

Resistor R3 limits the current drawn through the output circuit. A value of 1k provides adequate audio volume.

(By Calvin R. Graf, in "Electronics".)

Numbers, data & codes

To properly understand the operation of more complex digital elements and circuits, you need to have a good grasp of numerical notation and the codes used to handle both numeric and alphanumeric data in digital systems. In this chapter we discuss most of the codes you are likely to come across: binary, octal, hexadecimal, binary-coded-decimal, and the alphanumeric codes ASCII and Baudot.

by JAMIESON ROWE

As we saw back in chapter 1, digital circuits are capable of handling not just logic signals, but virtually any sort of information. All that is necessary to do this is to encode the information, so that it may be represented by suitable combinations of the two voltage or current levels provided in most digital circuits.

A single digital circuit can only adopt one of the two possible voltage or current states at any one time. In other words, it is only capable of conveying one tiny snippet of information at a time—such as a distinction between "hot" and "cold", "yes" or "no", "up" or "down", and so on.

This is, in fact, the smallest amount of information which can be defined. It forms the fundamental unit of information, and is given a name which you have perhaps already seen used: the "bit".

A single digital circuit element can only convey a single bit of information at any one time. But, needless to say, there are a great many practical situations where we wish to convey much more information than this. Typically quite a large number of bits may be required to convey the desired information, so that digital circuits must somehow be arranged to deal with multiple bits. In general, there are two broad ways in which this is done.

One is by sending the various bits of the information one after the other in time, through the same single digital circuit. This is known as the "serial" method. The other way is to duplicate the circuit a number of times, and use the resulting multiple circuits to convey each of the bits of information simultaneously. This is known as the "parallel" method.

Each of the two methods has its advantages. The serial method tends to save money, as it uses single circuit elements. But it also tends to be relatively slow, because of the need to shuffle the information through bit by bit. In contrast the parallel method tends to be somewhat faster, as the bits are handled at the same time, but it also tends to be more costly because of the circuit duplication.

The serial approach thus tends to be used in applications where low cost is essential, and speed is not important, while the parallel approach is favoured in applications where speed is important enough to justify the higher cost.

The two approaches are not mutually exclusive, however, and in practice a mixture of the two is generally used. This is mainly because a fully parallel approach is impractical where large amounts of information must be handled.

It is convenient to handle large amounts of information in groups of bits known as "words". The words generally consist of a fixed number of bits for any given system; typical word sizes used are of 8 bits, 12 bits, 16 bits and 32 bits. Words of 8 bits are often called "bytes".

In most digital systems the words themselves are usually handled serially, one after the other. But the bits within the words may be handled either serially or in parallel, depending upon the speed required. Thus, if a system handles information in 8-bit bytes, the bits within each byte may be dealt with either serially via a single circuit, or in parallel via 8 identical circuits: but the bytes themselves are normally dealt with serially, one after the other.

Irrespective of the way in which the digital bits and words are to be handled, some consistent method must be used to encode the actual information in digital form. This is to allow for the eventual decoding of the information, at the output end of the system, and also for ease of trouble-shooting if this is required.

In many cases, information is encoded by using each of the various possible truth-value combinations of a group of bits to represent one of the symbols normally used to convey the information. This is the encoding technique generally used for information expressed in normal language, using alphabetic and numeric (or "alphanumeric") symbols. We will look at this sort of encoding later on.

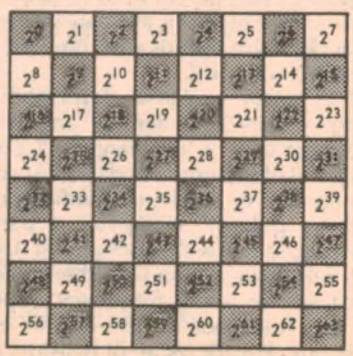
Where the information to be handled is solely numerical data, a different technique is generally used. Here the data itself is converted from its normal form, in decimal notation, into an alternative notation more suitable for manipulation by digital circuits.

The alternative notation which is very often used is **binary** notation, which uses 2 as its base or radix, in place of the 10 used in our familiar decimal system. Binary notation is very well suited for digital circuits, as it involves only two numeral values: 0 and 1. These replace the ten numeral values (0, 1, 2, . . . 9) used in decimal notation.

This means that many more digits must be used to represent a given number, because each numeral position represents a certain power of 2 rather than a power of 10. In place of the units-tens-hundreds-thousands progression of the decimal system, the numeral positions to the left of the "binary point" represent units, twos,

SISSA'S REWARD: binary notation can be deceptive

In antiquity, according to legend, the Grand Vizier Sissa invented the game of chess for the Indian King, Shirham. When invited by the King to name his reward, he asked only for the quantity of wheat required to cover a chess board by placing one grain on the first square, two on the second, four on the third, eight on the fourth, and so on. The King marvelled at his self-denial, until Sissa explained that the number of grains required would be only one less than the 64th power of 2: more than 18 million, million, million...



fours, eights and so on. Here are a few decimal numbers and their binary equivalents:

decimal 5 =	101
decimal 16 =	1000
decimal 50 =	11010
decimal 99 =	110011

As you can see, the binary system is clumsier in the sense that rather more digits are required to represent the same numbers. But each numeral position only has two possible values, so that it may easily be represented by a digital bit. In fact this is where the word "bit" comes from, being contraction of the words "binary digit".

Most digital computers and other digital systems handle numbers in binary form. However we human beings tend to find large binary numbers difficult to interpret, and as a result it is convenient to interpret the binary numbers in terms of one of two related notation systems.

One of these is the **octal** system, based on a radix of 8. This uses eight numerals: 0,1,2,3,4,5,6, and 7, with each digit position corresponding to a power of 8. Thus reading to the left from the "octal point", they correspond to units, eights, sixty-fours, five-hundred-and-twelves, and so on.

In itself, the octal system has no particular relevance to digital circuitry. But the fact that 8 itself corresponds to the third power of 2 means that each octal digit is equivalent to three consecutive binary digits. Or if you like, an octal digit may be used to replace each group of three, according to the following table:

octal	binary
0	000
1	001
2	010
3	011
4	100
5	101
6	110
7	111

A large binary number may thus be represented by its equivalent octal number, simply by starting from the right and replacing each group of three bits by its equivalent octal digit:

binary 100 011 101 010 = octal 4352
binary 111 000 110 001 = octal 7061

(in these examples the binary bits have been grouped in threes merely to make the equivalence more evident).

As you can see, the octal representation of a 12-bit binary number involves only 4 digits, making it rather easier to handle and remember as far as we humans are concerned. And the important thing is that one can convert quite easily from one notation into the other as required, after very little practice. Hence it you are presented with a number in octal notation, it is really quite easy to convert it into binary:

octal 5742 = binary 101111100010

Actually even octal arithmetic is quite easy to get used to after a little practice, being not all that different from decimal arithmetic. The main things to remember are that the numerals "8" and "9" have no significance, and that the "carry" takes place after 7:

7 + 1 = 10
77 + 1 = 100

Many computer programmers become very adept at thinking in terms of octal notation, and are able to interpret virtually all of a computer's binary operation in octal terms.

The other binary-related notation often used to represent binary numbers for the convenience of we humans is **hexadecimal**, often shortened to "hex". This is notation based on a radix of 16, and as you might expect from this, it requires 16 numeral symbols—six more than we normally have available.

Any suitable symbols could be used for the additional six numerals, but for various practical reasons it is common to use the first six letters of the alphabet: A,B,C,D,E and F. This makes hexadecimal numbers look quite strange until you get used to them, as at first sight they seem like a strange mixture of numbers and letters, or even just letters alone. For example 5C72, 631F, C008 and FFFA are all perfectly sensible hexadecimal numbers.

Like the octal system, hexadecimal notation has no particular relevance to digital circuitry. But again, 16 corresponds to the fourth power of 2, so that each hexadecimal digit is equivalent to four consecutive binary digits. This makes hexadecimal notation very convenient for handling large binary numbers. Each group of four bits is replaced by its equivalent hexadecimal digit, thus:

hexadecimal		binary
0	=	0000
1	=	0001
2	=	0010
3	=	0011
4	=	0100
5	=	0101
6	=	0110
7	=	0111
8	=	1000
9	=	1001
A	=	1010
B	=	1011
C	=	1100
D	=	1101
E	=	1110
F	=	1111

A large binary number may thus be represented by its equivalent hexadecimal number, simply by starting from the right and replacing each group of four bits by the appropriate hexadecimal digit:

e.g. binary 1111 0110 1010 1101 = hex F6AD
binary 1110 0000 0011 1011 = hex E03B

After a while, it becomes quite easy to convert from hexadecimal to binary and vice-versa, whenever this is necessary.

The binary notation we have looked at so far in this chapter is what is often called "pure binary", where all the consecutive digit positions correspond to increasing powers of 2. This is the binary notation used to encode numerical data in a great many digital systems, but there are some applications where it is more convenient to use other binary codes. These still use only two digit values (0 and 1), but in general they weight the digit positions differently from pure binary.

One important group of these binary codes are the **binary-coded-decimal or "BCD" codes**, which tend to find use where it is either necessary or convenient to handle numerical data in binary words which directly represent the various decimal digits. Typical applications of this sort include digital instruments such as frequency counters and DVMs (digital voltmeters).

Broadly speaking, a code of this sort must use four bits to represent each decimal digit. This is because this many bits are required to provide the necessary 10 different value combinations: three bits only provide 8 different combinations. But four bits actually provide a potential of 16 different combinations, as we have seen from the table of hexadecimal equivalents.

A BCD code only uses 10 of these combinations, "wasting" the others available in each 4-bit group. This makes BCD codes less efficient than pure binary, but gives them a measure of "redundancy"—a characteristic which allows a degree of error detection. This will be discussed in a later chapter.

Perhaps the most obvious way of getting a BCD code is to use the first 10 value combinations of normal "pure" binary notation. This gives the so-called "8421 BCD" code, where the digits in the name reflect the significance or "weighting" of the four bits:

decimal	8421 BCD
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001

(the remaining 6 combinations are unused, or "illegal").

This is probaly the most often used BCD code, but it is by no means the only one possible. In fact, if you care to work out the total number of ways in which any 10 combinations out of the 16 possible could be selected to represent the 10 decimal digits, you will find that there are close to 76 million possible BCD codes!

Happily there are only a few others used apart from 8421 BCD, and even these are not encountered very often. They are mainly used in specialised situations where some special characteristic is needed, such as the need to use the least number of "1's".

Just before we leave BCD codes, it may be a good idea to give an example to show the difference between pure binary notation and 8421 BCD. It is important to realise that the two are quite different where large numbers are concerned, even though they are identical for numbers less than 10. Here is a number expressed in eight bits, with the first and second groups of four separated for convenience:

1001 0111

If this is interpreted as being in pure binary, it corresponds to the decimal number 151 or (1 + 2 + 4 + 16 + 128). But if instead we interpret it as two digits of 8421 BCD code, it corresponds to the decimal number 97.

In other words, it makes a great difference whether a number is encoded in pure binary or 8421 BCD. With pure binary, all bits have an increasing significance or weighting as a power of 2, whereas with 8421 BCD this is only true within each 4-bit group representing a decimal digit. With all BCD codes, each group of 4 bits is regarded as being quite separate from the others—even when a number of 4-bit groups are handled together as larger words, for convenience.

All of the specific binary notations and codes we have looked at so far have used fixed weighting, in which each bit carries a consistent weighting as a power of two. But this is again not essential. In fact there are situations where a binary code having variable weighting can offer decided advantages.

An example is where continuously varying analog quantities such as voltages, pressures, temperatures, shaft positions and so on must be encoded digitally, or "digitised". When this is done using a fixed-weighting code such as pure binary, there are many parts of the code where a very small change in value requires a simultaneous change in the value of many of the encoding bits. If we are using 5 bits, for example, and the value changes from decimals 15 to 16, all five bits must change in value:

15 = 01111
16 = 10000

To accurately encode such a change, the measuring sensor or circuit must be arranged so that all of the bits do in fact change values exactly in synchronism. Otherwise, the output of the encoding circuit may pass momentarily through other combinations of the bits concerned, causing errors. This can be very difficult to prevent.

The problem can be made much easier by using a variable-weighting code such as the "reflected binary" or **Gray code**, named after its originator Elisha Gray. This code is cyclic, and so arranged that every transition from one value to the next involves a change in the value of only one bit. Here are the first 16 numbers in the Gray code, with the pure binary equivalents included for comparison:

Decimal	Binary	Gray code
0	0000	0000
1	0001	0001
2	0010	0011
3	0011	0010
4	0100	0110
5	0101	0111
6	0110	0101
7	0111	0100
8	1000	1100
9	1001	1101
10	1010	1111
11	1011	1110
12	1100	1010
13	1101	1011
14	1110	1001
15	1111	1000

The reason for calling this a "reflected" code should be clear if you look at the three least significant bits, and compare the patterns of the first eight numbers with those of the last eight. As you can see, the patterns "reflect" in the second eight, being simply repeated in reverse order. The only difference is in the fourth bit position.

Normally the Gray code is used as a "pure" code, using as many bits as required to gain the necessary accuracy. Part of the code could be used as a BCD code, but it would not retain its feature of a single bit change when changing from decimal 9 back to 0. This can be overcome by using a modified Gray code, of which there are quite a number.

There are a variety of other codes used

TABLE 1: ASCII CHARACTER CODE

B6	B5	B4	B3	B2	B1	B0	COLUMN → / ROW ↓	0	1	2	3	4	5	6	7
→								0	0	0	0	1	1	1	1
	→							0	0	1	1	0	0	1	1
		→						0	1	0	1	0	1	0	1
			0	0	0	0	0	NUL	DLE	SPACE	0	@	P	\	p
			0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
			0	0	1	0	2	STX	DC2	"	2	B	R	b	r
			0	0	1	1	3	ETX	DC3	# (£)	3	C	S	c	s
			0	1	0	0	4	EOT	DC4	$	4	D	T	d	t
			0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
			0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
			0	1	1	1	7	BELL	ETB	'	7	G	W	g	w
			1	0	0	0	8	BACK SPACE	CAN	(	8	H	X	h	x
			1	0	0	1	9	HOR. TAB	EM	)	9	I	Y	i	y
			1	0	1	0	10	LINE FEED	SUB	*	:	J	Z	j	z
			1	0	1	1	11	VERT. TAB	ESCAPE	+	;	K	[	k	{
			1	1	0	0	12	FORM FEED	FS	,	<	L	\	l	∫
			1	1	0	1	13	CARRIAGE RETURN	GS	—	=	M	]	m	} (ALT MODE)
			1	1	1	0	14	SHIFT OUT	RS	.	>	N	∧ (↑)	n	~
			1	1	1	1	15	SHIFT IN	US	/	?	O	—	o	DEL (RUB OUT)

for numerical data, but they are rather too specialised for us to discuss here. Many are designed to detect errors in transmission, using techniques which may involve the addition of extra bits of information to each word group.

To round off this brief look at the ways in which information is encoded in digital form, let us consider codes used to handle information expressed in alphanumeric form—i.e., in normal language. As mentioned earlier, this sort of information is encoded by using each of the various truth-value combinations of a group of bits to represent one of the symbols normally used to express the information. The encoding scheme is thus rather like that for BCD coded numeric data, but using more than 4 bits in each group because of the larger number of characters involved.

From a look at the keyboard of a typewriter, you would perhaps guess that about 40 characters would be required to convey most alphanumeric information—the 26 alphabetic characters, the 10 decimal numerals, and a few punctuation marks. In fact quite a few more than these are needed, because of the need to convey non-printing or "control" characters such as carriage return, line feed, space and so on. These are needed in order to convey information in neat and easily intelligible form.

It turns out that even for sending information in fairly crude form, something like 64 different characters are required. And if you want refinements like upper and lower case letters, brackets and a few special symbols, the list grows to around 128. This means that a code using at least six bits is required for handling basic alphanumeric information, or seven bits if full flexibility is required. (A group of 6 bits is capable of 64 different truth-value combinations, while 7 bits provide 128 different combinations.)

As with BCD codes, there are a very large number of possible codes which could be used for alphanumeric encoding. And quite a few have been used, in various applications. However we have space here to deal with only two.

The first of these is the code in most common use nowadays, known as "**ASCII**". Pronounced "asskey", this is an acronym standing for "American Standard Code for Information Interchange". Although originated in the USA, it is now very widely used for alphanumeric encoding.

The full ASCII code uses 7 bits, to provide encoding combinations for 128 different characters. These are shown in Table 1, which is arranged in columns according to the values of the three most significant bits (B6, B5 and B4). Within each column are the 16 truth value combinations provided by the four least significant bits. Within the 128 cells formed by the 8 columns and 16 rows are the corresponding characters.

As you can see, columns 4 and 5 provide the upper case alphabetic characters, together with a few special characters. Columns 6 and 7 provide the lower case characters, while column 3 provides the numerals and some punctuation marks. Further punctuation marks are provided by column 2, together with "space" and some special symbols. Columns 0 and 1 provide non-printing or control characters, including format control characters.

TABLE 2 : BAUDOT CODE

CHARACTER		CODE				
LETTERS	FIGURES	B1	B2	B3	B4	B5
A	–	1	1	0	0	0
B	?	1	0	0	1	1
C	:	0	1	1	1	0
D	$	1	0	0	1	0
E	3	1	0	0	0	0
F	!	1	0	1	1	0
G	& (OR @)	0	1	0	1	1
H	STOP (OR £)	0	0	1	0	1
I	8	0	1	1	0	0
J	, (OR BELL)	1	1	0	1	0
K	(	1	1	1	1	0
L	)	0	1	0	0	1
M	.	0	0	1	1	1
N	,	0	0	1	1	0
O	9	0	0	0	1	1
P	0	0	1	1	0	1
Q	1	1	1	1	0	1
R	4	0	1	0	1	0
S	BELL (OR !)	1	0	1	0	0
T	5	0	0	0	0	1
U	7	1	1	1	0	0
V	; (OR =)	0	1	1	1	1
W	2	1	1	0	0	1
X	/	1	0	1	1	1
Y	6	1	0	1	0	1
Z	" (OR +)	1	0	0	0	1
SPACE		0	0	1	0	0
CARRIAGE RETURN		0	0	0	1	0
LINE FEED		0	1	0	0	0
"LETTERS"		1	1	1	1	1
"FIGURES"		1	1	0	1	1

Sometimes an abbreviated form of ASCII code is used for purposes which do not require lower case letters, etc. This uses only the bit combinations of columns 2, 3, 4 and 5, and involves only six encoding bits (bit 6 is omitted). It is often called "6-bit ASCII".

There is nothing like a little practical example to help you visualise something. Here is a very short message encoded in 7-bit ASCII, which you might like to try decoding:

1000111
1001111
1001111
1000100
0100000
1001101
1001111
1010010
1001110
1001001
1001110
1000111
0100001

Actually this particular message could have been encoded in 6-bit ASCII, as it uses only characters from columns 2, 4 and 5. And if this had been done, we could then have expressed the resultant string of 6-bit binary words as eqivalent 2-digit octal words, for convenience:

07
17
17
04
40
15
17
22
16
11
16
07
41

Have you decoded the message yet? It is simply the familiar greeting "GOOD MORNING!", complete with a space between the two words, and the final exclamation mark.

The other alphanumeric code we should look at briefly is the **Baudot code**, also called the "Murray code" and the "International Telegraphic Code No. 2". This code originates from about 1906, when teleprinter machines were developed for sending automatically encoded messages over telegraph lines. It is still in wide use throughout the world for transmission of news services, ship-shore messages, etc.

The basic encoding used in Baudot code is shown in Table 2. There are two main points to note, one being that the code follows no logical progression of the sort evident in ASCII. This makes conversion between Baudot and a progressive code like ASCII rather more complicated than it might have been.

The second point to note is that although a total of 57 characters may be transmitted, only five encoding bits are used! At first sight, this may seem to be achieving the impossible, as from theory 5 bits have only 32 truth-value combinations. But the Baudot code gets around this by using two special control characters, which work in conjunction with a "memory" function in the equipment used to receive and decode the information. Depending upon which of the two control characters has been sent last, the receiving equipment interprets each encoded character in two alternative ways.

If the "letters" control character has been sent last, the encoded characters which follow are assumed to be alphabetic characters. If on the other hand the "figures" control character has been sent last, the characters which follow are assumed to be either numerals, punctuation marks, or non-printing characters.

In other words, the Baudot code is not really a 5-bit code, but is equivalent to a 6-bit code. The information which would otherwise be carried by a sixth bit is sent only when required, in the form of the two control characters "figures" and "letters". This is an economical approach, and fairly satisfactory for many purposes, although it can be rather unwieldly where the information to be handled contains a lot of mixed alphabetic and numeric characters.

The Serviceman

Some kind of record?

One set I encountered this month has the dubious honour of presenting the most degraded picture I have ever seen, as well as alerting me to a fault which I had not encountered before. There is also some discussion in this article on the problems of trying to overhaul very old sets—at a reasonable price.

This is the story of a colour set which displayed a most puzzling symptom. It was a Pye 26in model with a vertical stripe tube—almost certainly one of the first such models by this company and probably the first of its kind in this country. In short, a very recent design and, in fact, only just out of the manufacturer's warranty.

It was also the first of this model that I had come face to face with, at least on a professional basis. The owner complained of poor picture quality which, as it turned out, must be the understatement of the year.

To be more accurate, the picture was almost non-existent. All that could be seen was a vague suggestion of the larger details. In the case of a head and shoulders picture of an announcer, for example, there was only a vague "blob" for the face, without any details such as eyes, nose or mouth. Similarly, a colour bar pattern which one station happened to be radiating was simply an indeterminate gradation of colour across the screen, with no indication whatever of the individual bars.

I have no hesitation in describing it as the most degraded picture I have ever seen.

Several possible causes occurred to me. The first one was a catastrophic failure somewhere in the system, whereby the video response had been reduced to about 1000Hz, or something equally ridiculous. Another possibility was that the luminance signal had been lost altogether, leaving only the low definition chrominance signals to form a picture.

The only snag with the latter theory was that, while chrominance signals are low definition relative to the luminance signal, they are not that low. From previous experience they would produce a much more recognisable picture than the one I had. In any case, this was easily checked. I simply turned down the colour control. All that happened was that the colour disappeared, leaving the vague shapes in monochrome.

So what about the loss of video response? I noted that the sound was normal, which seemed to rule out anything ahead of the sound take-off point, such as tuner, IF system, etc. This left the video amplifier system as the logical suspect.

But before delving too deeply into the innards of the set, it was fairly simple to check the video waveform directly at the picture tube pins. To my surprise, it seemed to be quite normal, and certainly in no way indicative of the dreadful image on the screen.

Which more or less exhausted my current theories. But, if a normal video signal was being delivered to the picture tube, then the fault would seem to be something to do with the picture tube, either in itself or its operating conditions.

I took another look at the murky image and realised that I could not see any line structure; a fact which further confirmed that it was a display fault rather than a video information fault. But why? Was it a faulty tube (perish the thought!) or was it a faulty operating voltage?

On an impulse I started looking for the focus pot, thinking to give it a twiddle and note the effect, if any. I found the pot readily enough on the circuit, but it took me several minutes to find it in the set. I eventually found it nestling beside the EHT tripler box, but even then it wasn't easy to see properly at first.

My first impression was of a shaft in a set of bearings, from which a second shaft went off at an angle, with the actual coupling between them obscured. I had visions of a universal joint being used to get the control movement into some awkward spot.

A moment later I realised that what I had taken to be simply a shaft and set of bearings was, in fact, part of the actual pot. And the second shaft, set at an angle, was the other part, the pot having broken in two! I also realised that the pot was like no pot I had ever seen before. On reflection, this wasn't surprising, since it turned out to be a 100M unit, which was connected across about 8kV; hardly the kind of environment for a conventional tab pot.

The works of this unit were about two and a half inches long and consisted of a shaft of insulating material on which appeared to be deposited a path of resistive material in a spiral groove. A sliding contact was mounted above it and engaged the groove in such a way as to make contact with the resistive element and also to move backwards or forwards as the shaft was rotated.

As it was, with the element broken in two, there was no focus voltage on the tube. And that believe it or not, was all that was responsible for the dreadful picture presentation. A new pot fitted in its place—and VERY carefully adjusted—was all that was needed to produce a top quality picture.

I must confess that the experience rather staggered me. I had no idea that loss of focus voltage could have anything like this effect on a colour tube. Monochrome picture tubes have always been notably non-critical in this regard. Even the most critical ones did little more than produce fuzzy scan lines if the focus voltage was lost, while some recent ones were so tolerant that the set manufacturers offered only a choice of fixed voltages selected by a flying lead; usually two actual voltages plus a dead pin.

Nor do I appear to be the only one surprised at this discovery. I have mentioned it to several colleagues and they have all expressed similar sentiments to my own; it would be the last thing they would suspect, based on monochrome experience. What is more, I have been unable to find any reference to it in any of the colour TV textbooks I have perused to date. So perhaps this story may help someone else caught with similar symptoms.

And here are a few thoughts on a different theme. While most of the stories which find their way into these notes do so because they have an element of novelty or mystery, it is important to realise that faults of this nature are—fortunately—in the minority. I say "fortunately" because, while they may be intriguing technically and provide a boost to the ego when one licks them, they are seldom profitable.

As I may have hinted on previous occasions, it is the routine fault which one can diagnose from experience and repair with a minimum effort that puts the fruit on the sideboard.

But there is another type of routine job, and one that I am encountering more and more of late; the routine overhaul of old TV sets. Some of these sets have been around since the beginning of TV in Australia, some 19 years ago now, and the practicability of repairing some of them is open to question. But it is not simply a matter of age. Some 19 year old sets are still capable of giving good results and still worth repairing. Other, younger, sets may not be worth the effort.

Some sets, for example, made prolific use of very high value resistors—22M, for example—and these are notorious for their unreliability. Even where only one may have failed at time of service, it is odds-on that the others are on the way. Yet tracking down and replacing all of them can be time consuming business, and one which the customer has to pay for.

Similarly with the old paper capacitors. Some brands have stood up well, others are notorious and, again, replacing all of them can be costly.

There can also be problems with replacements for the more specialised components, such as EHT transformers, vertical output transformers, and deflection windings in general. Part of the trouble is that the original parts have, in many cases, not been manufactured for some years, the manufacturer recommending the substitution of a more recent component which is just as satisfactory.

The big problem is to keep track of all these substitutions, and even substitutions for substitutions in some cases. Usually, one has to check with the manufacturer, and this takes time; time which must be added to the bill.

And, sometimes, not even the manufacturer's advice is completely reliable. I recently had occasion to diagnose a faulty EHT transformer in an old set, and this immediately raised the question of a suitable replacement. It was for a 90° deflection system and I knew that the original type had not been made for years. What I didn't know was the type number of the replacement.

But I did have a transformer on hand from the same manufacturer, and I had an idea that it might be the replacement. So, I quickly lashed it into circuit. The result was so horrible that I had no doubt that I had guessed wrong.

So I did what I should have done first off: phoned the manufacturer, contacted the store, and asked for the replacement type number for such and such an EHT transformer. The sweet young thing on the other end left the phone for a few minutes, then returned with a type number which I hastily scribbled down and thanked her for her trouble.

It was only when I returned to the bench that I realised that the number she had given me was the same number as that of the transformer I had already fitted. Which suggested very strongly that I had more than one fault in the set; either that or I had connected the transformer incorrectly.

I spent some time going over the set, investigating both possibilities. Both proved negative and I eventually became suspicious of the suitability of the transformer, the manufacturer's advice notwithstanding. So I rang them again, and insisted on speaking to the service department this time. Sure enough, the head of that department was able to assure me that the transformer I had was for a 70° deflection system—and he gave the correct type number for the 90° system.

The result was a good deal of wasted time, and it could have been worse had I not become suspicious when I did. And, although an extreme example, it is not an isolated one. They happen fairly regularly and, overall, one has to take the time they waste into account in costing the jobs.

Another problem concerns picture tubes. For some reason which remains a mystery to me, the older 17in and 21in picture tubes, mostly reconditioned types, are quite reasonably priced whereas the modern 25in types are quite expensive. So we have the silly situation that it is sometimes much cheaper to repair an old set than a reasonably modern one.

More importantly, one has to be sufficiently on the ball to recognise those sets which are a proposition to overhaul, and those which are not. And for those which are not, a fair amount of tact is sometimes needed to convince the customer that you are not simply trying to steer him into buying a new set.

Finally, following my comments in the March issue on the lack of standardisation between batteries from some Asian manufacturers and the rest of the world, I received the following comment from a reader.

"The March story on non-standard batteries reminded me of a problem I had with a transistor voltmeter. This was fitted originally with Eveready "C" cells but, on trying to fit some imported batteries they jammed so tight that there was a danger of damaging the holder. On examination I found that the shapes differed on the base as shown."

(Two sketches show that the Eveready cell has a recessed base while the imported one does not.)

One interesting aspect of this comment is that, in one of the cases mentioned in the March issue, it was the imported cell which fitted a piece of test equipment, and the Eveready cell which seemed to be too large. Apparently, not even their lack of standardisation has been standardised!

As a matter of interest, I checked up the SAA standards on this particular point. These leave the shape of the base, ie, recessed or not, up to the manufacturer, provided that the essential dimensions are maintained. More precisely, their dimension drawings carry this note: "Where the bottom form of cells involves the use of a recess, the contact-to-contact dimensions must also fall within the range of these dimensions".

It would seem that it is the failure to observe this latter point, rather than the actual shape of the base, which caused this reader's problem.

When your fi is high and your ears are low

. . . there's always amateur radio

There are lots of titles one could give to this story. Perhaps we should have called it "The Trials and Tribulations of a Slightly Deaf Amateur." Eh, what's that you say? Anyway, we thought it might make for some light reading; a welcome change from the seriousness that has prevailed since those "dastardly" April fool jokes.

by ALAN SHAWSMITH, VK4SS

The local GP and I are cobbers in an abrasive sort of way. He's a bit kinky about electronics and spends more time than he should in my shack, twiddling the transceiver, listening to the new hi-fi set and getting more critical about everything, as each month passes.

First, it was the rig and the way I listened. "If you need that much audio in the phones then your ears are on the blink," he said, pointing to the audio gain setting. "Half that is still too loud for me. I've noticed, too, that you always clamp the same headset on your right lug with the left one free. How long have you done that and why not use both ears?"

"It's a habit of 40 years. I like to keep in touch with both worlds, together."

"You mean you've been pouring S9 QRM into that one same ear all that time, looking for S4 DX. I'll bet the ear drum's got the tone of a clapped-out petrol pump car diaphragm, by now. No wonder you're always screaming for analgesics after every one of those kooky contests you go in for. Auditory nerve battle fatigue—that's what it is!"

"Aw, give over," I said. "I can hear as well as you."

"At your age—impossible!" was the scornful retort. The Doc is a much younger man and always trying to infer I'm ready for the Senior Citizens' Club.

Then he got to commenting about a band pass audio filter I was constructing. The parts of it were scattered over the table. "That," I said in answer to his query, "is a little unit to chop off all audio frequencies except the few hundred you want to hear—say around 1kHz, for CW. It's a bit like running tomatoes down a grader: all sorts go in but only the selected size reach the end—the rest are culled."

"H'm," he said doubtfully.

Next, we got to arguing about the hi-fi; so far, I'd had little enjoyment from it. Somehow the thing irritated me: it had cost more than my transceiver. I felt I'd been 'sold a pup', and this raped my Scottish instincts of value for money. The Doc had perused its specifications and now cocked a critical ear to the sound it gave forth. "H'm, flat to 20kHz, eh. So it should be, at the price. Pity though, isn't it?"

"What is?" I demanded testily.

"Your hearing—low frequency loss and no highs over 10 or 11kHz; and maybe one or two dead spots in between. The hi-fi's great—but for you, there's not much point in going past that." He indicated the old battered mantel radio of 1940 vintage. "The last time I was here, you only had one speaker running on the hi-fi and didn't know the difference."

It was too much. "Look," I said, "don't be so bloody superior and assumptive. You stick to your placebos and pink pills and bulk billing and leave my ears and electronics to me. I'm happy with what I hear: no one has to shout, or raise their voice. If you're so certain I'm going half deaf, why don't you test me properly. Surely you must have some gadget, like an audiometer, in that command module you call a consulting room."

A far away look came into the Doc's eyes. "No-o," he said pensively. "I've only a tuning fork and one or two other methods a GP uses, but I have a friend who'll be able to test you."

It should be said here that in the years B.M. (before Medibank), we stuck together because of mutual need. I did the electronic repairs at his surgery and he serviced me medically. A lopsided arrangement, because his service to me usually took no more than ten minutes writing out a prescription of sorts, whereas my labours often occupied hours.

Anyway, a few days later I was bashing the spine on the shack divan and getting nice and relaxed with a few chilled 807s (also known as cold tubes, or the amber nectar). The hi-fi was set to play an hour of 'soothe me out of this world' music, when in walked the Doc, closely followed by a tech type in a white dustcoat and with an armful of gear. Every Ham welcomes visitors but nothing stirs a man to irritation quicker than the unannounced invasion of his privacy, especially, when he's mentally set for an hour's peace from the rat race.

"Who's this?" I queried, a trifle rudely.

The Doc smiled benignly. "This," he said, "is Eddie. He's with a firm which specializes in aural equipment. You know, everything from an invisible hearing aid to a 6ft exponential floor ear horn. I don't think you'll need the latter, though." Slight sarcasm crept into his tone.

I should have felt grateful for the offer of free testing in this time of outrageous service costs, but the spirit wasn't in me. Besides, I smelt a 'rat'. After having been 'ripped off' over the hi-fi, no-one was going to sell me anything, least of all a hearing aid.

"I told you," I said, refusing to rise or be social, "I'm happy the way I am. Do I have to repeat it? **I can hear. OK!**"

"OK, but let's give the hi-fi a frequency test run. I listen to it too—remember."

He had me there: 90% of the hi-quality LPs in the shack belonged to the Doc.

"Aw right," I grumbled without grace, "but I can test the thing myself, if I want to." The truth was, I didn't want to: I was afraid of what might come out.

The tech type went to work in a professional manner and soon had it all together, down on paper. "Yeah, it's close enough to the book," he said. "Even the speaker resonances have been taken care of."

"Great," enthused the Doc, thinking of his own LP classics. Next, a small unit was set up on the table and plugged in to AC. "Al," he said, indicating I should confront

Author Alan Shawsmith, VK4SS, is a long-time amateur who collects Morse keys of "any type, age or condition". The collection shown here dates back 100 years. If you have a similar interest, or have a key to sell or swap, you can write to Alan at 35 Whynot St, West End, Brisbane, Qld. 4101.

it. Reluctantly I struggled vertical and pulled up a chair.

"This," said the tech type, "is an audiometer and I am about to give you what is known as the 'threshold test'. All you have to do . . ."

"Yes, yes," I said testily, "I know the set-up. Starting at a low frequency you take me through to about 15 or 20kHz in a series of steps, sufficient to plot a graph. You reduce the level of each frequency given, until I can just hear it and no more. OK?"

"Spot on," said Eddie. He picked up the set's phones and was about to hang them on my ears when he stopped and looked at the Doc. "Is he clean?" he asked.

Now, I ask you: have you ever had a guest or stranger imply you needed Uncle Sam! I was ready to retort in kind, when the Doc interposed hurriedly. "He just wants to know if I've de-waxed your ears." He nodded an OK to Eddie.

The "threshold" test didn't impress me: it was so easily rigged and this tech type surfaced all my latent paranoia. I felt he could sell the Sydney Opera House back to Joern Utzon, as a futuristic houseboat.

"These phones", I queried, "are they balanced and flat? You'd have to say 'Yes', of course."

"Yes, of course", said Eddie, without a flicker of an eye, "and they're specially tested regularly."

"OK, but I'll switch ears and get a double run on each, just to be sure," I said, determined to be bloody-minded.

"My pleasure," said the tech type evenly.

We got down to work and very soon Eddie came up with two graphs. "Your left ear's below par for your age and the right one's clapped out on both lows and highs: but there's a peak around 2kHz." He looked at the hi-fi and then the old mantel radio. "They'd be about the same to your ears, I'd say." I felt the Doc smirk behind my back.

He put his own phones carefully away and picked up mine. "Hm-m army disposals, eh!" There was contempt in the voice.

"Yes," I said defiantly: "thirty years old." He plugged them into the audiometer and swung tone across the spectrum, listening first with one ear, then the other. A superior smile spread over the thin face. This one you've painted red, is like your right ear—clapped out. No high, low on lows and peaks about 1½-2kHz. The other piece is passable only.

"You must have a hearing range like a canine," I said sarcastically.

"Yes", he replied without emotion, "they test perfect."

"He always uses the red phone on his right ear," observed the Doc, from the divan where he was enjoying my last remaining 807.

Eddie's glance settled on the half-built bandpass. "You know pal, you don't need this. You've already got it in-built into the right ear and the red earpiece—the two together should give you a pretty good notch." The job done, the tech picked up his gear and the Doc reached for his bag, smiling broadly. "Now we know, Al, don't we. See ya."

Left alone, I began to ponder the graphs Eddie had left. They clearly showed one ear below par and the other one on the blink. I had tried using the other ear and piece for DX but no go: it felt like wearing shoes on the wrong feet. A habit of a lifetime can't be broken. Anyway, I mused, the dud ear helped by the phones did let a bit of audio through, around 2kHz—good enough for CW.

I turned to the hi-fi and felt cheated. The thing seemed to sneer at me. They were right—I could hardly pick the difference between its response and the battered old mantel radio—something had to be done. Good music is high on my list of pleasures and quality sound costs money. Now, it seemed, I had a decision to make. Finally I rang the GP "Say Doc, that know-all b...... you had here today. What's his phone number?"

"Al," said the Doc, "you've got Eddie all wrong. He'd give you the shoes off his feet."

"Yeah, and take my wallet as a swap!"

"OK, OK, have it your way but he wasn't out to rip you off—just help you."

I've had my hearing aid ten days. The tech type chose to fit me out for the bad ear—'better balance', was his advice. The thing seems to have an awful lot of hiss and background noise but I'll adapt to it—so he assured me. Many hours have been spent listening to the hi-fi: just relaxing and soaking up the new realism of its sound. Well, I think I hear the lows and highs better. I'm not sure; I wonder sometimes if I'm kidding myself.

While in this undecided state, it just so happened that my eyes spotted an article in our City newspaper by the National Health and Medical Research Council. It was headed **"Hearing Aids Won't Help Ears Damaged by Prolonged Noise Stress."** The report went on to say that, in some cases, hearing aids only make matters worse—efforts to increase the basic level, only tend to distort the sound even more.

I listened to the hi-fi: then I removed the hearing aid and listened again—and had a moment of truth. Of course, of course, my real need was for a new ear drum—not an audio booster—and Eddie would know it. I went to the phone and dialled.

"Doc, you made me an offer for this hi-fi before we had it tested, remember?"

"Yes."

"I'll take it."

"OK, but I thought Eddie had you all set up . . ."

"Yep—and conned and fleeced!"

"not Ed . . ."

"And when you see him, there's something here for him—and by the way, I've a newspaper clipping for you . . ."

I'm now back at the rig, poorer in pocket but richer in experience, and DXing with the same old headphone clamped to the same old ear. Hi-fi may be sweet music to any right responsive ear—but to my right ear, CQ DX in A1 mode is beautiful.

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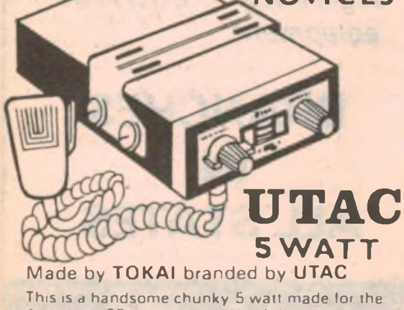

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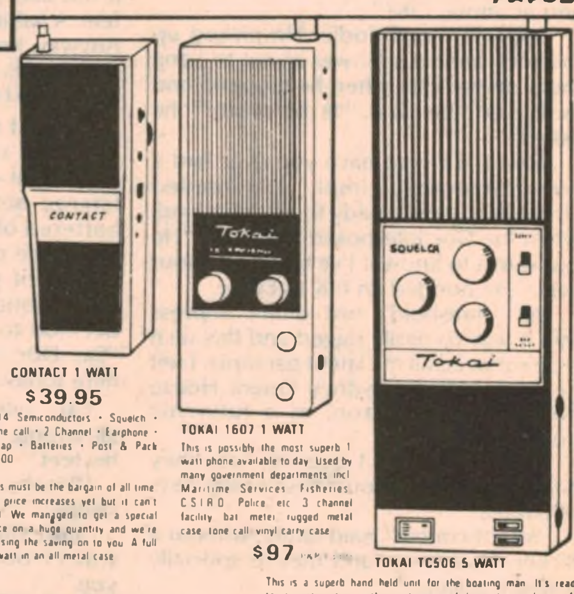

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RESISTOR MARKING CODES

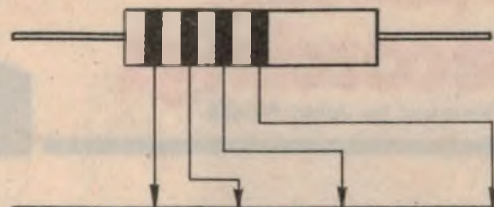
Resistance colour code

The majority of low power resistors in use today have an insulated body with coloured bands to designate the value and tolerance. The colour code was originally devised to overcome the expensive problem of printing the value on the small bodies, although many close-tolerance, high stability resistors have the value, tolerance and power rating printed on them nowadays. However, for general purpose resistors, colour coding is still a cheaper and more effective method. The value is easily read and the colours are not likely to be erased by careless handling.

The appropriate colours are applied as three or four parallel bands around the resistor and toward one end. The overall colour of the body has no significance. The first two bands designate the two significant figures of the resistor value. The third band defines the multiplier in powers of ten, e.g., orange indicates a multiplier of ten raised to the power 3 which equals 1000.

For values of resistance below 10 ohms the third band will be either gold or silver to indicate a multiplier of one-tenth or one-hundredth, respectively.

The fourth band designates the tolerance.

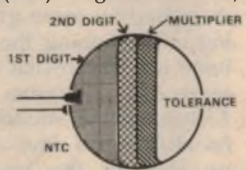


COLOUR	TENS	UNITS	MULTIPLIER	TOLERANCE
BLACK	0	0	1	20% (M)
BROWN	1	1	10	1% (F)
RED	2	2	100	2% (G)
ORANGE	3	3	1000	—
YELLOW	4	4	10000	—
GREEN	5	5	100000	—
BLUE	6	6	1000000	—
VIOLET	7	7	—	—
GREY	8	8	—	—
WHITE	9	9	—	—
GOLD	—	—	0.1	5% (J)
SILVER	—	—	0.01	10% (K)

The international colour code is used to indicate the value and other characteristics of resistors, capacitors, and other components. Various arrangements, differing slightly from that shown, are used by individual manufacturers. (The letters in the tolerance column are sometimes used in place of colours.) Resistance values are in ohms. In the case of some close tolerance resistors it may be necessary to indicate three significant figures, in which case five bands may be used; three significant figures, multiplier, and tolerance.

NTC resistors

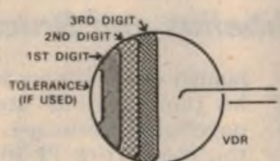
Negative temperature coefficient resistors may or may not be colour coded, depending on their physical size, the temperature at which they are likely to work, etc. When used, the colour code may indicate simply the resistance at 25°C (R25) using three colours, or value plus tolerance



using four colours. Colour coding is usually restricted to the disc types and the code should be read from where the two leads are fastened to the disc. Other characteristics need to be obtained from the manufacturer's data sheets.

Voltage dependent resistors

Data concerning voltage dependent resistors are quite complex and not capable of being conveyed by a simple colour code. The best that a colour code can do is identify a particular type; detailed information should be obtained from the manufacturer's data sheets. In some cases



only a single colour is used, in others three or four colours. Where four colours are used one will indicate tolerance (eg, silver, 10%) and the other three a portion, usually the last three digits, of the type number. Multi-colour codes are read TOWARDS the leads with the tolerance (if any) being first.

Resistor types

Composition resistors consist of a rod of resistive material, mainly carbon and possibly carborundum, held together with a suitable binder. They have the advantage of low cost and low inductance, but tend to drift in value throughout their life, particularly in the first few years. Their in' :nal noise also tends to be high, particularly in the higher values, ie, 1M and up.

Film type resistors consist of a rod of insulating material on which is depositied a thin film of resistive material. A variety of materials are used, such as carbon, carbon with the addition of boron, metal oxides, and precious metal alloys. The carbon types tend to drift with age or as a result of heating and cooling and have a relatively high natural noise level. The carbon-boron types are significantly more stable but still have high noise level. The metallic oxide and metal alloy types have excellent noise characteristics and are popular where a high order of performance and reliability are required in critical circuits.

Wire wound resistors are most suitable for high wattage applications and exhibit a high order of long term stability. They tend to be more bulky than other types, particularly in the higher values, and also more expensive. They have a relatively high inductance unless specially wound, and even then may not be as suitable for high frequencies as the film type.

Wattage ratings

Resistor wattage ratings are normally based on a specific temperature rise, according to the type of resistor, when mounted in free air at a specified ambient temperature. Since the free air situation seldom applies in practice, and there is normally some rise in temperature of the surrounding air due to heat from other components in the equipment, some order of derating is almost inevitable. A handy rule of thumb for any resistor enclosed by a box or cabinet is to at least halve the manufacturer's wattage rating. If, in addition, the equipment runs at a temperature significantly above ambient, it may be necessary to halve it again. Beyond this, an empirical approach may be necessary.

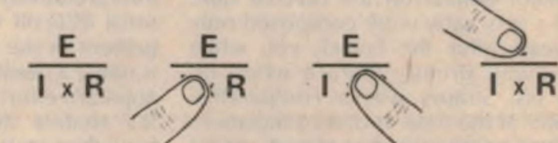
The wattage which a resistor will dissipate can be calculated from simple equations using voltage, current, or resistor values.

$$W = E \times I$$
$$W = I^2 \times R$$
$$W = \frac{E^2}{R}$$

Where W is the dissipation in watts
I is the current in amps
E is the pressure in volts

Ohm's law

The equations associated with Ohm's law are among the most useful and most frequently referred to in technical literature. Nevertheless, many students have difficulty remembering the three different versions. The combination of symbols shown in the diagram is quite easy



to remember and will quickly indicate the appropriate equation for any unknown factor. Simply cover the symbol for the unknown and the combination remaining becomes the right hand side of the equation.

Classical Recordings

Reviewed by Julian Russell

Jacha Heifetz in concert—excellence

JACHA HEIFETZ IN CONCERT. With Brooks Smith (piano). CBS Stereo S2BR 220341.

This recital was recorded live in the Dorothy Chandler Pavilion, Los Angeles but, although the audience behaves in an exemplary manner during the music, loud and irritatingly prolonged applause precedes and follows it. Here is another veteran in his 70s with all his musical faculties unimpaired. According to the program notes, he was fully developed technically at the incredible age of 13. He of course matured interpretively later. Indeed there is an amusing story told—not in the sleeve notes—about his New York debut in the early 1920s. Violinist Mischa Elman was there seated next to Pianist Leopold Godovsky. When it came to interval time Elman said to the latter that he was going home. "Why?" asked Godovsky. "It's too hot in here," replied Elman. "Not for pianists it isn't too hot," replied Godovsky.

Heifetz has never been an effusive player, even in the most romantic pieces. Indeed he has often been accused of being a bit too cool for some tastes, though his technique has always been a cause for wonder. He starts his recital with Franck's A Major Sonata and his current reading of this now faded bit of romanticism is always essentially aristocratic in its effortless authority and temperamental control. But he can still play as sweetly as ever yet without cloying. His accompanist throughout the recital is Brooks Smith who is consistently admirable. His excellence is immediately apparent in the immensely difficult piano part of the second movement of the sonata. Here is as fine a performance as you would hear from any combination today.

This Sonata occupies the whole of Side 1 and what might well be a novelty to many listeners is the Richard Strauss E Flat Major Sonata on the reverse side. This is a very early work composed only two years after the Franck yet, while Franck was already mature when he wrote his, Strauss was a comparative beginner at the time. It owes allegiances to former composers but already, in its soaring lyrical melodies, foreshadows the later Strauss. It even hints, but only hints, at the modulations to remote keys that became characteristic of the composer later in his career. The piano part reminds me more of Schumann's writing for that instrument than anyone else. Both performers are kept busy and the writing is already idiomatic. Strauss was 24 when he composed it and it has a highly burnished finish despite its youthful freshness and zest. It is by no means a great work nor original but it is always pleasant to listen to, especially as it is presented here. Now and again Heifetz can be heard retuning his instrument very quietly between the movements. But you'd hear that on the concert platform too, for that matter.

Heifetz then goes on—on Side 3—to J. S. Bach's unaccompanied first, second and last movements of the E Major Partita. Here, in the slow movement, Heifetz' multiple stopping is so exactly pitched that it reminded me of the late Bronislow Hubermann. Hubermann used a flatter bridge than usual to make it easier to get his bow across the strings, but whether or not Heifetz does so I do not know. I doubt it.

Follows a Bloch piece, called by the composer an improvisation from his Baal Shem. This is in Bloch's "Jewish" style as exemplified in the Violin and Cello Concertos. Its general atmosphere is reminiscent of Jewish synagogue cantillation and Heifetz manages to get a "sob" into his tone, a characteristic of this ancient form. The third side finishes with a transcription by Leon Roques of Debussy's slow waltz, La Plus Que Lente. Heifetz plays this a little more expressively that I think the composer might have approved of, an unusual treatment coming, as it does, from Heifetz. It is the only item on the two discs which disappointed me slightly.

Side 4 is mostly made up of encore type pieces. The first is a Heifetz transcription of a Rachmaninov fast piano study in E Flat. In this the violinist is as busy as all get out. The slow Falla piece that follows, a berceuse from his Seven Popular Songs, is played with an exquisite sense of desolation by the violinist.

Kreisler's The Hunt offers a fast hunting-type theme in which Heifetz brings off some spectacularly fast double stopping with astounding accuracy. Ravel's now famous rhapsodic monologue, Tzigane, comes next rewarded by some quite horrible shouting and clapping that might well have been cut. The recital ends with a sugary piece, Sea Murmurs, by Castelnuovo-Tedesco which sounds like it dates from his Hollywood days. At any rate it gives no idea of the beautiful setting of Shakespeare songs that he wrote in the 1920's and a recording of which I have awaited for many long years. But despite my very minor grumbles mentioned above this two-disc recital is very worth while owning, especially if you are, as I am, a Heifetz fan.

Zino Francescatti plays Sibelius and Bruck

SIBELIUS—Violin Concerto in D Minor. Zino Francescatti (violin) with the New York Philharmonic Orchestra conducted by Leonard Bernstein.

BRUCH—Violin Concerto in G Minor. Zino Francescatti (violin) and the New York Philharmonic Orchestra conducted by Thomas Schippers. Odyssey Stereo ODA 5061.

This reissue of a memorable performance originally recorded in 1965 is very welcome indeed. The sound is still very respectable and the production a desirable property. Francescatti's performance is astonishing, technically and interpretatively. The Sibelius is one of the most difficult of all violin concertos to present in the way he does here. There is never a hesitation, never a stumble. Of apparent effort there is none. Here, as in the Heifetz discs noticed above, you have the same exemplary mutable stopping, every note dead on pitch no matter what the interval between them. The concerto shows the composer in a less stern mood than usual. It is a warmly human work without any suggestion of his more familiar atmosphere of an unpeopled landscape. The soloist and the New York Philharmonic under Leonard Bernstein join in what I can only describe as a passionate collaboration.

The first movement throbs with vitality without the distortion of a single bar, however difficult. This passion is more contained in the slow movement but it is still there, its elegiacal quality making a striking contrast to the vigour of the first. Bernstein opens the Finale with quietly persistent rhythm which might have been made to sound just a tiny bit more exciting if the supporting timpani could have been better heard. But this is the only criticism I can make of a performance which must remain for a long time the definitive one. Sometimes the violin is recorded a wee bit too forwardly but never to the extent of obscuring the orchestral part.

I didn't enjoy the Bruch quite so much. Francescatti's playing is still technically dazzling but, for my taste, his ultraromantic approach is slightly overblown by fashionable contemporary standards. Also his tone is marred much of the time by a wide vibrato. I am aware that two or three generations ago this was the accepted way of presenting it but nowadays it sounds just a little too juicy. Also Bruch's heavily upholstered orchestration sounds very thick at times. But this, too, was fashionable in former days and the whole might well still appeal to those with nostalgic memories of Elman, Kreisler and company. There is a tendency to "tear a passion to tatters." In spite of this, however, there are some exquisitely lyrical moments. And the conductor reflects his soloist's mood whether he approves of it or not. In any case the disc is well worth its modest price for the Sibelius alone.

* * *

MAHLER—Symphony No. 4 in G. Chicago Symphony Orchestra conducted by James Levine with Judith Blegen (soprano). RCA Red Seal Stereo ARL1—0895.

James Levine is a new name to me on records but I have already conceived a great respect for him after listening to this performance. His reading is full of contrasts, in tempos and dynamics. some of the most extreme delicacy, others quite violent. He also makes eloquent use of the many silences. But follow it with a score and you will see that he is playing it exactly as the composer intended. Mahler was lavish with directions in his scores and Levine observes them all scrupulously. If, beside Szell's beautifully chaste interpretation Levine's sounds just a little bit schmaltz—well, wasn't that Mahler's idea? This is the place to mention also the splendour of the engineering. It seems to have a little more stereo spread than usual and a very wide dynamic range. Its clarity and depth make audible a truly impressive number of the composer's many-stranded textures.

The Chicago Symphony improved vastly, some years ago under the regime of Reiner, sustained this response under Solti and is now one of the finest orchestras in America under Levine who, I was surprised to learn, has been with them for four years. The string tone is lustrous, the woodwind capable of playing with the greatest imaginable delicacy and accuracy of attack and release, and the brass solid with a fine cutting edge. I believe Levine is going to record all the Mahler Symphonies and, on the evidence of his performance of this one, they should be well worth while waiting for. This is certainly a performance and a recording of which you won't easily tire. For me it has only one minor disappointment. The soprano, Judith Blegen, though preserving the innocence of the child's song in the last movement, tends to sing it all a little too loudly. It is more effective when sung quietly as indicated by the composer. As it is here it loses just a little of its childish wonder. But to mention this seems almost churlish after the magnificence of everything else in the production. Very highly recommended indeed.

* * *

LAURIS ELMS (contralto) in Songs and Ballads of various nationalities. A Ranger Stereo recording released in Australia by the World Record Club. R/01874 (S/5758).

This is a supremely enjoyable recital by contralto Lauris Elms, one of Australia's most distinguished singers. The 17 items are mostly very brief traditional songs of many nations, including even some Negro spirituals. Ms Elms uses her glorious voice with flawless technique and unfailing good taste. Some of the songs might be described as mere ditties, others are of sterner material. But whatever their mood or origin Ms Elms delivers them with impeccable sense of style. I have only one minor criticism to make. Her diction in some of the faster numbers is often difficult to catch, and this applies, too, to some of the slower ones.

Not the least appealing feature of this enchanting disc is in the accompaniments arranged for nine assorted instruments used in various combinations and imaginatively arranged by George Pikler. These are all played with the scrupulous attention to detail always a characteristic of conductor Robert Pikler's handling of small combinations. A wide variety of moods is presented by soloists and instrumentalists, all the way from the light-hearted to the deeply devout. It has always surprised me that the quality of Ms Elm's discs have not yet attracted the attention of overseas distributors.

* * *

TCHAIKOVSKY—Piano Concerto No. 1 in B Flat Minor.
PROKOFIEFF—Concerto No. 2 in G Minor. Tedd Joselson (piano) with the Philadelphia Orchestra conducted by Eugene Ormandy. RCA Red Seal Stereo ARL1—0751.

This is the debut recording of a brilliant Belgian-born, American educated 23-year-old pianist. Nowadays it has become trite to mention the vast technical resources of the younger generation of pianists. They seem, in some remarkable way, to have brought technique with them. Here Tedd Joselson always uses his at the service of the music and not as a mere means of self-advertisement. But despite his undeniable brilliance his reading of the Tchaikovsky is essentially refined. But that doesn't mean that it lacks fire. There is plenty of that and plenty of rhythmic vitality, too, especially in the splendidly accented Finale. There is no swooning over the juicier bits. Instead Joselson's outlook is always elegant. Very rarely some of his lighter figurations disappear behind the orchestra but these occasions are too few to destroy enjoyment of the whole. Just a bar here and there. The orchestral part, by the Philadelphia is in the secure hands of Eugene Ormandy so that there are no surprises in the superb orchestral tone and the conductor's reflection of the soloist's moods. You'll have to look far to find a better performance than this.

In the Prokofieff, after a smooth, lyrical start, Joselson adjusts his style admirably to the more percussive writing of this composer. He gets plenty of volume out of the piano but always without harshness. He and the orchestra build up some truly massive climaxes. And the soloist can change instantly to a lovely pearly tone, as effective as it is beautiful. He takes the second movement well up to a very fleet tempo most fluently articulated. Despite the speed, no single note trips over the heels of its follower. Nor does he lack authority of the most mature kind in the heavy-laden strict tempo next movement. He copes with great resource with many changing moods of the work, as, of course, does Ormandy too. Here is a young musician to be watched and it will be interesting to learn the extent of his repertoire.

One word of warning—devotees of the Tchaikovsky First, with its endless flow of great melodies, might not respond so enthusiastically to Prokofieff's more ascetic style.

Lighter Side

Reviews of other recordings

Devotional Records

THE STORY TELLIN' MAN. Ken Medema. Stereo, Word WST-8651-LP. (From Sacred Productions Australia, 181 Clarence St, Sydney, and other capitals.)

Here is yet another Christian musical, but of the simpler kind, intended for a younger cast. The central theme is the parables of Jesus — hence the title: the Story Tellin' Man. The presentation opens with the tracks "Listen To The Happy Sound" and Story Tellin' Man", which is followed by the narration of "The Lost Coin" and "My Sheep Is Lost". The happy ending of both parables is picked up by the musical theme "Let's Have A Party".

Leading into side 2, other musical themes and narration cover the stories of "The Prodigal Son" and "The Good Samaritan".

I gather that a complete vocal score is available from Sacred Productions Australia and, listening to the record, I had no difficulty in visualising a chorus of Sunday School children framing a central stage area on which the scenes are enacted using simple costumes and simple choreography.

If your church youth group has access to a rhythm backing group, someone to conduct and someone to arrange choreography at a children's level, this one would be well worth considering. (W.N.W.)

* * *

JUBILATION. Songs of Praise and Worship. 2-record set, Myrrh, MST-6555, price $8.50. (From Sacred Productions Australia, 181 Clarence St, Sydney and other capitals.)

As the jacket notes point out, "Jesus revolution" music had a tough time for many years: it had too much rock for traditional christians, and too much christianity for rock fans! And, even when it began to appear in the charts, it did so in part because established artists took up the religious theme as the thing to do.

More recently, a whole new generation of musicians have been composing and expressing themselves in the rock medium as a matter of conviction and as their way of communicating the Gospel to their contemporaries. They still face a large generation gap and a sizeable proportion of those reading these notes still have no use for their sound.

Having said that, it is also necessary to concede that many others will, and they will find this 2-record set a compelling collection of terms from the American mod. Gospel scene. It is, in fact, an elaborate sampler of discs from the Word organisation, but it comes across really as a mod. Gospel program, highly listenable to those who like the idiom.

It is all the more so because of the technical quality of the pressings. It is indeed hifi demonstration material of a different kind.

With 20 artists and 20 songs on the two sides, I will not attempt to list them but, if the idea appeals and you can spare the $8.50, you won't begrudge the outlay. (W.N.W.)

* * *

MACDONALD CAREY Narrates "The Magnificent Christ Called Jesus" Astor Gold Star series GGS 1496.

Macdonald Carey is a veteran of more than fifty motion pictures, a stage and radio actor and a two-time Emmy Award winner for his role in the NBC TV network program "Days Of Our Lives". More personally, he has been a member of the Catholic Big Brothers Organisation and of the Los Angeles Country Juvenile and Delinquency Crime Commission.

On this record he gives testimony to the vital part Christian faith has played in his life. There is some background music and supporting solos by Mitch Davis but the whole point of the record rests in the spoken word. There are four main themes on the two sides: Look Up A Friend Called Jesus — Just A Closer Walk With Thee — Help Us This Day — The Old Rugged Cross. The narration climaxes in the phrase which forms the title of the album: "The Magnificent Christ Called Jesus".

The sound is clean and the diction is good so that, if you have a personal interest in Macdonald Carey and the message he brings, you can buy with confidence. (W.N.W.)

Instrumental, Vocal and Humour

TOMITA: PICTURES AT AN EXHIBITION (Moussorgsky). Isao Tomita and the Moog Synthesiser. Stereo cassette, RCA ARK1-0838.

Isao Tomita is a young Japanese musician who has established himself as one of the world's leading exponents of electronically generated music.

His Debussy recording "Snowflakes Are Dancing" prompted my enthusiastic review — a reaction not shared by everyone on the E.A. staff.

If Tomita's Debussy one started arguments, his "Pictures At An Exhibition" should start bigger and better ones, as the well-known pictures are recreated in turn in virtually pure electronic sound: The Two Jews — Limoges — Catacombs — Cum Mortuis In Lingua Mortua — Baba Yaga — Great Gate Of Kiev — Promenade — The Gnome — Promenade — The Old Castle — Promenade — Tuileries — Bydlo — Promenade — Ballet Of The Chickens In Their Shells.

Devotees of electronic music will find plenty to analyse in the recording but others will divide two ways: "a fun recording", and "who wants cartoons at an exhibition"? But one would have to be pretty dour not to be amused by the electronic fowlyard creatures in the last segment — especially when they are scattered by 4-channel! (W.N.W.)

* * *

COPLAND CONDUCTS COPLAND. The New Philharmonia Orchestra, London Symphony Orchestra. CBS SBR 235773 Stereo.

Rural America is easily conjured up listening to this collection of smallish works from Aaron Copland, probably the best-known of contemporary American composers. There are five main track headings on this record, leading with "The Red Pony" the theme music for a film based on a novel by John Steinbeck, about the dreams of a young farm lad and his pony.

The well-known story of John Henry, the "Steel Drivin' Man" is set to music on track two, followed by a collection of Copland's movie music from "The City", "Of Mice And Men" and "Our Town". Then comes "Letter From Home", commissioned by Paul Whiteman for a broadcast performance in 1944. The last track is "Down A Country Lane". Originally scored as a piano solo in 1962 and rescored for small orchestra 3 years later.

Apart from a few minor surface prickles on the review copy the quality was above reproach, in a word a good sampler of the composer's work. (N.J.M.)

Reviews in this section are by Neville Williams (W.N.W.), Leo Simpson (L.D.S.), Norman Marks (N.J.M.) and David Edwards (D.W.E.).

LIGHTER SIDE—continued

RENAISSANCE, SCHEHERAZADE And Other Stories RCA Victor VPLI-4024.

It would be very difficult to categorise this record in any way; it is such a mixture of styles, from shades of "Tubular Bells" to something like a full symphonic sound, with superb sound overall.

The name group, Renaissance, consists of John Tout, Keyboard; Annie Haslam, lead vocals; Jon Camp, Bass; Terence Sullivan, Drums, percussion; Michael Dunford, Acoustic Guitars; all take part in the vocals. The sleeve notes are not very specific but credit is given to members of The London Symphony Orchestra.

Side One carries three songs: Trip To The Fair, Vultures Fly High and Ocean Gypsy, with side two giving the main title work, a musical version of the story of Scheherazade, broken into nine songs. At first hearing you might not like it but it's the sort of record that grows in appeal after a while. I for one would be happy to hear any more offerings from such a talented group. (N.J.M.)

★ ★ ★

THE PAUL MAURIAT ORCHESTRA Philips 6325 240.

Paul Mauriat should need no introduction, being an orchestra leader in the same mould as Henry Mancini and Mantovani, with a big lush sound, plenty of strings and strong rhythm backing.

There are a dozen titles: El Bimbo — Mandy — Angie — Baby — Pacific Holiday — I Got A Name — Rock Your Baby — Have You Ever Been Mellow — Feel Like Making Love — Until The End Of My Song — The Entertainer — The Way We Were — I Won't Last A Day Without You.

Charles Aznavour fans would recognise the style as nearly 150 of that singer's hits have been orchestrated by Paul Mauriat over recent years. The sound quality is excellent, making the disc an ideal background or party platter. (N.J.M.)

★ ★ ★

DANCE AGAIN WITH RUDI BOHN Sonic (Somerset) 9085 Astor release.

Imagine, if you can, "Rock Around The Clock" in strict tempo and you have one of the twelve tracks on this enjoyable record from a German orchestra, playing very much in the Silvester tradition. The other tracks are: Snowbird — La Journee — Roses of Picardy — Velvet Dreams — El Choclo — La Cumparsita — La Estrella — Killing Me Softly With His Songs — El Bimbo — Tranen Lugen Nicht — Schneewalzer.

It is a record which the average ball room dancing fan will really flip over, with excellent quality and nine different tempos to choose from. If you still believe in real dancing, rush out and buy it for your next party. (N.J.M.)

SWORD OF HONOUR. The Band Of The Royal Corps Of Transport Astor GGS 1462.

You can forget the old-fashioned 'Band in the Park' image with this bright and enjoyable record of fourteen band numbers, some composed especially for this band.

The titles are: Wait For The Wagon — Trumpet Fiesta — La Bella Roma — Slavonic Dances — Latin Lullaby — Roses Of Seville — Old Glory — Marching With Teike — Mellow Dee — The Countryman Suite — The Thrush — Galloping Home — Ferbelliner Reitermarsch — Evening Hymn & Calvalry Last Post. Some of the tracks sound like a big dance orchestra, particularly 'Latin Lullaby'.

Quality is generally good, although lacking a little in top on some tracks. Overall it is an excellent example of skilled musicians giving of their best. (N.J.M.)

★ ★ ★

THE GREATEST GIFT IS LOVE. Mantovani and his Orchestra. EMI Decca SKLA 5216 Stereo.

A very pleasant collage of soft, dreamy music in the Mantovani style is the fare on this record, with twelve, mainly recent, hits given the full treatment: The Greatest Gift — The Old Fashioned Way — Si — Solitude — Sing — Cool Summer Evening — What Are You Doing The Rest Of Your Life — The Day Of The Locust — The Entertainer — Send In The Clowns — Love Song (from 'The Freak') — She.

The sound leaves no room for complaint, making for an ideal record for background to that quiet little dinner for two, or how many you like. One thing you can't complain about: over twenty composers and joint composers are listed in the credits, so there is no shortage of talent represented. (N.J.M.)

★ ★ ★

KGB. KGB (Carmine Appice, Rick Grech, Barry Goldberg, Mike Bloomfield, Ray Kennedy). MCA Records MCA-2166.

Get together a group of almost-greats, and what do you have? Sometimes you have a super-group, but mostly you just have a collection of near greats. KGB is formed from fragments of Electric Flag, Vanilla Fudge, Blind Faith and Traffic, but I believe it has already broken up (don't quote me on that!).

As you would expect, this record shows all the signs of musical professionalism. The sound is powerful, with very clean highs. Tracks featured are: Let Me Love You — Midnight Traveller — I've Got A Feeling — High Roller — Sail On Sailor — Workin' For The Children — You Got The Notion — Baby Should I Stay Or Go — It's Gonna Be A Hard Night — Magic In Your Touch.

Summing up, quite an enjoyable record, but not in the class of the really great groups. (D.W.E.)

AMERICAN GRAFFITI VOL III. Varied Artists. MCA Records MAPS 8152. (Double Record Set.)

The motto of MCA must be "If you're on a good thing, stick to it". This is the third double album featuring 1960's style rock. On this one, all the old stars are featured, including people like the Beach Boys, Little Richard, Everly Brothers, Johnny Tillotson, Richie Valens and Buddy Holly. None of the tracks presented here appeared in the movie, so I suppose the three records could be considered a set.

The thirty-one tracks are too numerous to list here, so I'll only mention the few that appealed to me: Lucille (Little Richard) – Wake Up Little Susie (Everly Brothers) – Surfin' (Beach Boys) – Bye Bye Love (Everly Brothers) – Rave On (Buddy Holly) – Good Golly Miss Molly (Little Richard) – Mountain Of Love (Harold Dorman).

As before, quality is excellent, and none of the tracks have been electronically reprocessed for stereo. (D.W.E.)

* * *

SCHOOLBOYS IN DISGRACE. The Kinks. RCA Victor LPL 1-5102.

Ray and the other Kinks have produced a sort of rock opera style concept album. All the songs are connected, and together they tell the story of a naughty schoolboy, who finally gets expelled.

Several songs are real gems. Perhaps the best is "Jack The Idiot Dunce", which has a very catchy tune. Others to impress were "Schooldays", "Education" and "The Last Assembly". Although as a concept album, it does not compare with the likes of those by the Who, it is still a creditable effort, and

RELEASES ON CASSETTE

MOVIE THEMES.101 Strings. Astor stereo Musicassette BCT-5313.

As the Godfather theme opens this program, one's first reaction is to wonder where all the strings have gone—such is the profusion of other instrumental sound. But, as title follows title, the identity of the orchestra is beyond doubt: Airport '75 – Lenny –Lara's Theme – Love Beat Of The City – San Francisco At Night – Murder On The Orient Express – Earthquake – Chinatown – We May Never Love Like This Again (Towering Inferno) – The Grande Ball – Tender Miss.

I found the string tone a trifle harsh but, by way of compensation, the response is wide and the sound notably free of background noise. A good collection of dramatic themes.

* * *

HAPPY SOUND 2. The Sid Sidney Orchestra with Gene Harrison and Jacques Romain. Stereo, Dolby cassette, Contata A-103.

A real mixed brew this, or should I say smorgasboard? Straight orchestral, soft rock, male and female vocals and—while it was playing – speculation around the room as to whose style was being copied. The fourteen tracks:

Bye Bye Darling – Time For Pop – Hey, Tonight – Love Story – The Lonesome Road – Hirten Bossa Nova – And We Are At This Again – Rosegarden – Patrica In Love – Karina – Dreamy Moments – Limelight – Casa Blanca – En Ti.

It's not one that I'd choose personally for domestic listening but, in the different ambience of a car, it would be more appropriate. Technically, the quality is okay. (W.N.W.)

* * *

THE IMMORTAL AL JOLSON. With orchestra and chorus. MCA Musicassette BCT-5246.

Strictly for nostalgia is this recording of "the immortal" Jolson, presumably made at a concert appearance, with audience applause overlapping the end of each number:

Easter Parade – Alexander's Ragtime Band – A Tree In The Meadow – Don't Let It Get You Down – Just One Of Those Things – Nearest Thing To Heaven – Ma & Dinah – Chicago – Rock-A-Bye Your Baby – Yaaka Hula Hickey Dula – She's A Latin From Manhattan – For Me And My Girl – The Best Things In Life Are Free.

If you're a Jolson fan, you'll enjoy it along with the audience. If you're not, I doubt that this recording will change your mind.

LIGHTER SIDE—continued

would be well worth a listen. Old Kinks fans will certainly appreciate the lyrics, which are helpfully provided on the inner sleeve.

As is usual with this label, the quality of my pressing is excellent. (D.W.E.)

* * *

ROLLED GOLD. The Very Best Of The Rolling Stones. Stereo and mono. Decca double album ROST 1/2.

No, this isn't a new Rolling Stones record, it's just a re-grouping of earlier records, that you may have anyway. Essentially, it is a collection of important singles and album cuts from their very early days in 1963 up to 1969, when their Decca recording contract expired.

Starting off with their first ever single, "Come On", and finishing with "Gimme Shelter", all their really great tracks are included, songs such as: (I Can't Get No) Satisfaction — Get Off Of My Cloud — As Tears Go By — Lady Jane — Out Of Time — Paint It Black — Let's Spend The Night Together — She's A Rainbow — Jumpin' Jack Flash — Honky Tonk Women — Sympathy For The Devil — Street Fighting Man.

All of the tracks are studio recordings, and all have been released either as singles or on albums. Included on the cover is a comprehensive set of notes, giving the history of each featured track. This set would make good party music, as all of the tracks are well known, and most of them are good for dancing.

On the technical side, the copy submitted for review was not a good sample. Side 1 had a neat scratch across two tracks, producing a very audible click. The second record was labelled "side 4" on both sides, which made finding a particular track a little difficult! Apart from these imperfections, recording quality was quite good. (D.W.E.)

* * *

GOLDEN HOUR OF MR & MRS MUSIC. Jackie Trent & Tony Hatch. Astor GH 5001.

If you overlook the variable sound quality and some surface noise in parts on this record, you certainly get your money's worth of the talents of Jackie Trent and Tony Hatch, with twenty tracks to choose from. A sampling of the titles would be: The Two Of Us — The Fool On The Hill — A Man And A Woman — Make It Easy On Yourself — Who Can I Turn To — Little Green Apples — Norwegian Wood — Downtown — Thank You For Loving Me — Call Me — Up Up And Away.

Half the tracks are Trent-Hatch compositions, a good indication of their combined skills. I feel the process of fitting a full thirty minutes on each side of a record must cost something in terms of dynamic range and this tends to be noticeable on this album. (N.J.M.)

* * *

IT'S ONLY LOVE. Rita Coolidge. A & M records L35732. Festival Release.

Rita Coolidge has been singing from the age of two. Her credentials include work with Delaney & Bonnie & Friends, the Mad Dogs & Englishmen tour, and session work on albums with Graham Nash, Eric Clapton and Stephen Stills. Capping it all off, she is married to Kris Kristofferson.

This is her fifth album with A & M, and contains much familiar material, such as songs like "I Wanted It All", by Jackie De Shannon and John Bettis, "Star" by Donna Weiss, and Kris' "Late Again". These songs are presented with all the appeal and warmth her fine voice can muster, and all I can say about them is that I liked them very much.

The last two tracks on the album are different, however. At a concert in January 1975, Rita was joined on stage by jazz pianist Barbara Carroll, who backed her sultry vocals on a few emotional old standards. This was repeated in the studio for the album, with only an upright bass and drums added, and the result has to be heard to be believed.

When the record finishes, one is left waiting for more, and hoping that the experiment will be repeated on the next album. Technically, the album cannot be faulted, which only adds to the pleasure. (D.W.E.)

THE COLLECTOR'S HANK WILLIAMS. Vol. 1. Hank Williams. Mono. MGM 2315 230. Phonogram Release.

This, the first of an intended series of albums, is designed to allow the listener to hear some of the lesser known songs in the extensive Hank Williams' catalogue. Most of the tracks featured here are unfamiliar, but they all bear the stamp of Hank's greatness.

The sixteen tracks cover a wide range of styles, from humour (Nobody's Lonesome For Me), through heartbreak and loneliness (Crazy Heart – Blue Love), religion (Last Night I Dreamed Of Heaven) to politics (No No Joe). This last mentioned track, a Fred Rose original, is full of dire threats to Stalin – real 1950's style.

On two of the tracks, Hank is accompanied by his first wife, Audrey, while in another two he features as "Luke The Drifter". I have been a fan of Hank for many years now. In fact the first record I ever owned was one of his, and I was very impressed with this one. Listening to it, I almost feel as though history is being made once again.

On the technical side, the record is not up to modern standards. This is not surprising, however, as some tracks were recorded privately by Hank in his own home. And even though the record is labelled as mono, some tracks have had an accompaniment added, in stereo. Still, this does not detract from the basic appeal of the material.

Definitely, then this record is a must for all country and western fans. Personally, I am anxiously waiting for the release of the next record in the series. (D.W.E.)

* * *

GET RIGHT INTAE HIM. Billy Connolly. Stereo. Polydor 2383 368. Phonogram Release.

Billy Connolly is a Scottish comedian, and this is a live recording of one of his shows at the Apollo Theatre in Glasgow. Its authenticity has been compromised somewhat by the substitution of a few beeps, although some readers might feel that the whole record should have been beeped!

The material presented ranges over a wide range of subjects, and provokes many laughs from the audience. Billy's latest hit song, D.I.V.O.R.C.E. is a feature of side one. The high point of side two is track 8, entitled "Back To School". Make sure that you listen to this one in stereo; it's a beauty.

Technically, the record is okay, although to my mind there is a little too much audience noise. (D.W.E.)

* * *

NARVEL FELTS GREATEST HITS VOL. I. Narvel Felts. Dot Records L35763. Festival Release.

If you know who Narvel Felts is, you're one up on me, because I've never heard of him. The dust jacket is singularly devoid of information, so there's not much I have to go on. Judging from the picture on the front, Narvel is a male ballad singer and, fortunately, his voice sounds a lot better than his name reads.

His style seems to be somewhere between that of Gene Pitney and Englebert Humperdink, and it is quite pleasant to listen to. Songs featured are: Drift Away – Before You Have To Go – I Want To Stay – Fraulein – Raindrops – When Your Good Love Was Mine – Foggy Misty Morning – Look Homeward Angel – She Loves Me Like A Rock – (I Can) Wrap My Arms Around You The World – All In The Name Of Love.

Record quality is excellent. I suggest though, that you sample a fair number of tracks before you purchase. You may be in for a few surprises, as some tracks are not exactly as you would imagine them to be. (D.W.E.)

* * *

RICHARD TAUBER

A PORTRAIT OF RICHARD TAUBER. Mono. EMI OXLIP-7615.

A true portrait of Richard Tauber would need to contain a much greater breadth of material than here, but it could have been an awkward mix. This is a protrait of the romantic Tauber singing no less than fifteen evergreen songs: When Day Is Done – Solitude – The World Is Waiting For The Sunrise – A Little Love, A Little Kiss – Macushla – Song Of Songs – Vienna, City Of My Dreams – Love's Last Word Is Spoken – Silver Hair And Heart Of Gold – Mexican Serenade – Starlight Serenade – J'Attendrai – Love's Old Sweet Song – Little Grey Home In The West – None But The Lonely Heart.

Sometimes a venture into the past proves a disappointing experience, but not with Tauber. With no gimmicks, few orchestral interludes, no covering up, his performance is one of impeccable phrasing and pitch, a real lesson in a style and presentation.

Technically, the sound is surprisingly clean and consistent and, while it has been filtered back to the point where the sibilants have almost disappeared along with the noise, an adequate sense of presence has been retained. If you like the romantic Tauber, you'll like this "portrait". (W.N.W.)

THE BEST OF FRANKIE CARLE. RCA Gold Seal stereo ANL1-1079.

If you fancy an album of old favourites with a noted pianist tinkling the ivories, then latch on to "The Very Best Of Frankie Carle". It makes pleasant listening indeed although there was a slight amount of surface crackle and tape hiss on my sample.

Track titles are: Whispering – Intermezzo – Sunrise Serenade – A Lover's Lullaby – Falling Leaves – Symphony – Blue Moon – My Silent Love – Twilight Time – Beg Your Pardon – Oh! What It Seemed To Be – Moonlight Cocktail. (L.D.S.)

Letters to the editor

AOCP exams

I find recent criticism of the A.O.C.P. examination hard to understand. Certainly it is a reasonable standard but should not take years of study for the average person, and it may be of encouragement to some readers to hear of the method used to help my son get his ticket.

At the age of 14 he showed interest in getting his own licence but after a few months of part time study from a set of A.O.C.P. Course Notes it was realised these studies did not mix with school work and should wait until the Christmas Holidays. By this time he had a fair knowledge of simple AC, DC theory which proved very important in understanding the remainder of the course later on, although at this stage only one of the nine questions from an A.O.C.P. paper could be attempted, about a quarter of the course had been covered.

A few weeks holiday at a beach house over Christmas became an intensive full time study course for the A.O.C.P. and it was evident that to be able to draw circuits of receivers and transmitters, basic ideas would have to be remembered. Many circuits were common to both, for example the circuit of an RF Stage, Mixer, or IF Amplifier could be the same as a buffer of doubler stage in a transmitter as far as a circuit is concerned. One type of oscillator such as a Hartley Oscillator could be used for most oscillator circuits such as H.F. Oscillator and BFO in a receiver, the VFO of a transmitter and as a GDO for test equipment.

Most text-book circuits have too many frills and it was necessary to get down to basic circuit ideas by redrawing them to make them more suitable as examination answers by removing such things as band switching, meter switching and substituting simple common basic arrangements for each stage where possible.

All told about eight weeks of school holidays proved sufficient time to be successful in all subjects in the February A.O.C.P. examination. Only a few weeks after turning 15 years of age, he is now the holder of the full call VK4AXJ. It did spoil this particular for the rest of the family but it was worthwhile and proves that an average high school lad can get a full ticket within a couple of months if he has sufficient interest and guided tuition.

L. J. Brennan, VK4XJ
Kenmore, Brisbane, Qld.

Super-bass speaker

Following publication of my article on a transmission-line super-bass speaker in EA, Vol. 37, No. 2, May 1975, pp 40-43, I have had several enquiries from readers wishing to incorporate the idea into a full-range speaker, preferably of more conventional proportions. So far I have been unaware of the publication of such a design, and have been unable to help.

However, I am now aware of an article "Transline", by R. E. Lord, which appeared in "HI FI SOUND", Vol. 5, No. 1, November 1971, pp 94-98. The published design uses two drivers, but is readily adaptable to three. I have no other information on the design, but merely put it forward as being of possible interest to experimenters.

B. J. Simpson
Turrumurra, NSW

Calculator query

In your review of the Texas Instruments SR52 calculator, on page 100 of April 1976, there is an interesting statement which seems calculated to impress the reader:

"For example, try (5+(8/(9−(2/(3+1))))) on your own calculator."

I did so on a Hornet SR30, and found it required only 15 keystrokes compared with 21 required on the calculator under review.

I therefore ask if the persuasive example was aptly chosen in the context used? Despite this I enjoyed the necessarily curtailed review, and look forward to purchasing such an instrument, should finances and an eventual price drop occur.

Thank you for a most informative and enjoyable magazine.

J. E. Millane
Creswick, Victoria.

COMMENT: From the detailed listing you give of the actual keystrokes, the advantage seems to stem from the fact that your machine provides an "X-Y interchange" key, a feature not often found.

Logic symbols

I was interested to read your article on logic conventions and laws in the April issue but cannot agree with your treatment of it.

It is completely inadmissible, from a

practical point of view, to change your logical convention between the input and output of a device thereby arguing that a NAND can be turned into an AND. This will only lead to utter confusion on the part of anyone trying to interpret the diagram. Apart from being used as an inverting amplifier a NAND device can only be used as such or as a NOR device in the complementary form. In your figure 4, (a) is correct as NAND, (b) as NOR in complementary logic and (c) cannot be obtained from the same device but could be the complement of an AND.

I strongly suggest that you obtain a copy of Australian Standard 1102 Part 9 which defines the use of symbols and the "bubble" or complementary function. It is worth noting that different branches of the same bus can be active in either the high or low state and that the "O" is used to define the low active branches only.

If everyone using logic symbols followed the above standard drawings would be a lot more meaningful and you will be doing a service to all concerned if you could draw the attention of your readers to their proper use.

E. A. Walker
Ascot, Queensland

COMMENT: Whether or not mixed logic convention is "admissible" is a matter of opinion. From theory, it is quite valid; it also works, so that presumably no one has told gates that they aren't allowed to work in this way. We are familiar with the standard to which you refer, and it certainly provides one way out of the drawing problem. However, in the discussion concerned we were attempting to give readers a broad view of the problem so that they could make up their own minds regarding solutions.

Organ Keyboards

I was one of your readers who noticed and took steps to get in touch with a firm in the UK (EA November 1975).

This is, as was mentioned, a very good firm. What brought this up was the electronic organ described in a recent issue. I agree that new keyboards are rare but not necessarily expensive. A new keyboard with single pole contacts costs approximately $50 (not including p&p). If sent by airmail, the keyboard should only take about 2 weeks, but a considerable amount of money would be involved. If you are not in any hurry, it could be sent by boat which would make the cost approximately $60.

D. M. Zemedes
Elizabeth North, SA.

COMMENT: Thanks for the advice. The keyboards seem likely to be those made by Kimber-Allen, which as mentioned in the May article are also available locally ex stock, from firms such as Maxwellectronics and Jaycar Pty Ltd. We have also been advised by Dick Smith Electronics that this firm now has them also.

New Products

Interstate 20MHz sweep function gen.

Here is an ideal instrument for the development laboratory. The Interstate 20MHz Sweep Function Generator can produce sine, triangle, square and pulse waveforms, either symmetrical or with variable duty cycle, over a frequency range of 0.001Hz to 20MHz, and with the output frequency swept over a 10 to 1 range if required.

The instrument is housed in an attractive and sturdy metal case, fitted with a carrying handle, tilt mechanism and rubber feet. These can be removed if required, to facilitate mounting in a standard rack structure. External measurements are 282mm wide x 133mm high x 356mm deep. The shipping weight is approximately 10kg.

As you can see from the photograph, the front panel is dominated by the large vernier frequency dial. There are six function and range switches, all of which have at least two functions, two smaller rotary controls, two toggle switches and five BNC connectors. The main power switch is an illuminated rocker type. All controls are clearly and adequately labelled.

The output connector is on the extreme right. This is short circuit proof, and has an output impedance of 50 ohms. The output level is switchable in four steps from 15V (p-p into 50 ohms) to 15mV. Concentric with this switch is a 20dB vernier adjustment, so that output signals between 1.5mV and 15V can be generated.

The waveform control, immediately above the output control has six positions. These select sine, triangle, square, DC pulse and sweep ramp waveforms. Using the offset control, the DC level of all these waveforms can be adjusted. (The DC waveform is in fact an adjustable DC level.)

Concentric with the waveform switch is a combined pulse width and variable symmetry control. This has a range from 5% to 95%. The mode switch selects one of seven possible modes of waveform generation. In the continuous mode, a conventional continuous wavetrain is produced, with the frequency controlled by the frequency dial and frequency multiplier controls.

In the triggered mode, a single cycle of the selected main generator waveform occurs in response to a voltage trigger signal applied to the trig-sync in connector, or in response to a momentary actuation of the manual trigger toggle switch. In the gated mode, an integral number of cycles are produced in response to the trigger signal. The actual number of cycles produced depends on the gate pulse duration and the dial frequency.

In the continuous sweep mode the output sweeps linearly in frequency between limits established by the frequency dial and the associated sweep limit control. The swept frequency pattern occurs at a rate determined by the sweep time control.

The maximum sweep range is 1000:1, although calibrated sweeps are limited to a little over a 10:1 range. The sweep ramp waveform is available for driving pen recorders and the like. Note that the retrace is not blanked, the frequency returning to the starting point in an inverse sweep, at a rate which is significantly faster than the main sweep time.

In the trigger sweep mode, a single frequency sweep occurs in response to a trigger signal, supplied either via the trig-sync in connector or via the manual trigger switch. In the sweep and hold mode, a single sweep occurs as before, but the output remains at the final frequency. This mode is reset by the sweep reset switch.

In all swept modes, the sweep can be reversed, and commenced at the higher frequency by operating the sweep down control. All sweeps are linear with respect to frequency. The output frequency can also be swept or modulated by a signal applied to the vcf in terminal. A signal changing by 5V will sweep the generator over the full dial range. This signal is summed with the dial and sweep commands generated internally, so by applying a suitable signal to this input, it is possible to generate a "wobbled" sweep.

The burst mode is similar to the gated mode, except that the gate time is internally derived from the repetitive sweep rate. Burst duration is controlled by the trigger level control. Burst repetition rate is nominally the inverse of sweep time.

The basic frequency range is from 0.00002Hz to 20MHz, although the dial is only calibrated for frequencies above 0.001Hz. Note that 0.00002Hz corresponds to a period of about 14 hours(!), so we were not able to check this feature. The dial accuracy was quoted as 1% from 20Hz to 200kHz, with slightly higher limits for ranges above and below this. We were able to check this over some ranges, and found the sample submitted for review to be within these limits.

The output frequency response is within 0.1dB for frequencies up to 100kHz, within 0.25dB for frequencies up to 2MHz, and within 2dB for frequencies up to 20MHz. These figures apply to sine, triangle, square and pulse waveforms. Once again, the sample was within these limits.

The distortion on sine waves is less than 0.5% for frequencies up to 100kHz and less than 1% for frequencies up to 1MHz. Between 1MHz and 20MHz, all

Multi-band AM-FM portable

Those people, including migrants, who enjoy listening to overseas programs but who hesitate to invest in an expensive communication receiver, will be interested in a series of Russian made multi-band receivers recently released on the Australian market.

One of these, the "Selena" B206, was recently submitted to us by the Australian agent, Electroimpex Australia Pty Ltd. The B206 is an 8-band model covering the low frequency band, the broadcast band, five segments of the HF (short-wave) band, and the FM band.

More specifically, the coverage is as follows: 150-408kHz (LF), 525-1605kHz (BC band), 5.9-7.3MHz (41-50m band), 9.5-9.77MHz (31m band), 11.7-12.1MHz (25m), 15.1-15.45MHz (19m), 17.7-17.9 (16m), and 88-108MHz (FM band).

Other features are alternative mains or battery operation, earphone jack for private listening, and signal outlet for tape recording.

Band selection is by means of a turret, similar in general principle to TV tuner turrets. For the FM position the turret not only selects the appropriate coils but, by means of an additional cam and lever mechanism, operates a multi-pole switch to select the alternative circuitry to handle the FM signals.

The set operates from either internal batteries—six "D" size cells—or from the mains. Regarding the latter, the sets for sale in Australia have been modified by fitting a three pin inlet socket and three core cable to meet Australian electricity authority safety standards.

Signal pickup is via a ferrite rod, but this can be implemented by extending a telescopic aerial about 1m long. This is pivoted at the base and may be varied from vertical to horizontal as required. Further improvement in signal pickup can be provided by using an external aerial and earth, and suitable terminals are fitted.

The set is fitted with separate bass and treble controls, specified as having a range of at least 9dB each. Power output is given as 500mW and the speaker measures 10 x 15cm.

The selectivity response is quoted as −34dB at plus or minus 10kHz. While this is a commendable figure as far as it goes, it is unfortunate that additional figures are not quoted, which would enable the shape factor to be determined.

One limitation in the FM section is that the bandwidth will only accommodate ± 50kHz deviation, whereas the Australian FM system (and most others) use ±75kHz. This would result in some distortion on maximum deviation (loud) signals, and would seem to rule it out for serious FM listening. On the other hand, it appears to be adequate for casual listening. We understand that the Australian agents can, on request, increase this bandwidth but at some sacrifice in sensitivity.

The short-wave coverage provided is necessarily a compromise, though a logical one. The segments chosen are the main international short-wave bands, where most of the short-wave stations are concentrated.

As it is, most stations will be available in the bands chosen, while the limited range in each band makes for ease of tuning which will be especially appreciated by the unskilled short-wave listener.

The earphone jack is so wired that inserting the earphone plug disconnects the speaker. The outlet for tape recording is a standard DIN socket connected across the outer terminals of the volume control. Thus the set's own audio system can be used as a monitor, at any convenient level, without upsetting the recording level.

Tested in a typical suburban location the set gave a very satisfactory performance. The stronger overseas stations were available on the telescopic aerial and, in some cases, this may be all that is required. On the other hand, a modest outdoor aerial brought in a lot more stations and lifted several doubtful ones into the "good listening" category.

Fitted with a turret tuner giving 8 bands, the Selena B206 seems well suited for general DX listening.

The need to provide an adequate aerial should not be ignored, for this or any set. Sales literature notwithstanding, the user will get the most value for his money when he can connect the set to a reasonable outdoor aerial.

The set was commendably free from self generated whistles and other spurious responses, but neither this set nor any other can separate stations which are on virtually the same frequency, or do much about the audible heterodynes which this situation produces.

Our overall impression was one of a very well behaved receiver, easy to use, and one which should appeal to the non-technical listener particularly. Used with even a moderate external aerial it should receive most usable overseas signals.

The Australian agents assure us that they are providing adequate spare parts, service, and other back up facilities; an important point where any imported device is concerned.

Further details may be obtained from the agents, Electroimpex Australia Pty Ltd, 343 William St, Melbourne, 3003, or their Sydney branch, 91 Goulburn St, Sydney, 2000. (P.G.W.)

Function generator...

harmonics are greater than 26dB down with respect to the fundamental. We were only able to check these figures over the medium ranges, where the sample was within limits.

The triangle linearity is quoted as better than 99% up to 100kHz, and better than 95% up to 2MHz. We were unable to check these figures. The stability of amplitude, frequency and offset voltage is within 0.05% for 10 minutes, and 0.25% for 24 hours, after a 30 minute warmup.

In the squarewave and pulse modes, the rise and fall times are less than 15 nanoseconds, while the pulse width can be varied from 30 nanoseconds to milliseconds, independent of the repetition rate.

Overall the F-74 20MHz Sweep Function Generator appears to be a remarkably versatile and useful instrument. In the short time available for review, we could only just start to appreciate the many uses to which it could be put. A companion unit, the F-77, is also available, featuring both logarithmic and linear sweep modes.

The F-74 unit sells for $898.00, plus 15% tax if applicable, while the F-77 unit sells for $1040 plus 15% tax if applicable. They are available from Parameters Pty Ltd, 68 Alexander Street, Crows Nest, 2065. (D.W.E.)

Surplus teleprinters

Ex-Government teleprinter equipment which should be of considerable interest to radio amateurs and computer enthusiasts is now available in Sydney. The equipment is all designed for 5-level Baudot code, at a speed of 50 bauds. Available are Creed model 7B page teleprinters; Teletype model 15 page teleprinters, and model 19 page teleprinters with tape punch; Teletype model 14 typing reperforators; Teletype tape punches and readers; also a few items of miscellaneous gear.

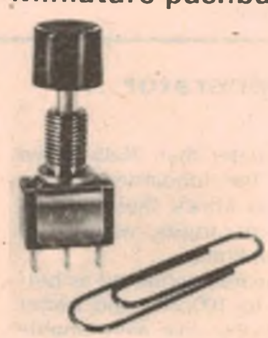
The Creed machines have 240V motors, while the Teletype equipment is fitted with 110V motors.

Basic prices for the machines are as follows: Creed 7B, $120; Teletype model 15, $100; Teletype tape readers, $50; Teletype punches, $80; Teletype model 19, $150. All of the above are supplied working and tested. Model 14 typing reperforators are available untested at two for $20, plus $10 extra for keyboard.

Sample machines which we tested were in sound condition, and well adjusted.

Individual machines are available from Studio 20 Sales, 367 Bourke St, Darlinghurst, NSW 2010. Wholesale quantities from General Building and Engineering Co, 492 Jones St, Ultimo, NSW 2007.

Miniature pushbutton switch

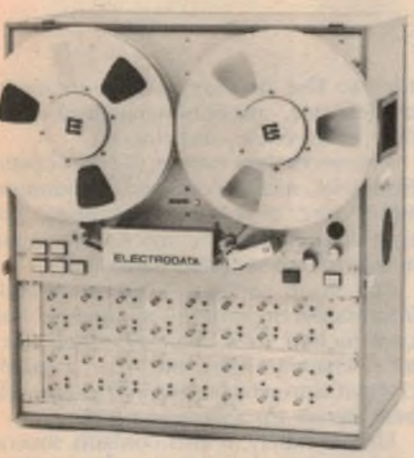


C & K Components Inc have released a new series of alternate action push-button switches. The series, designated 8161/8168, has a contact rating of 6A at 120VAC or 28VDC, and 3A at 240VAC.

A unique snap-action loading spring gives the new switches a behind-panel depth of only 11mm—significantly less than competitive models. The switch body measures 12.7 x 6.86 x 11mm.

For further information contact C & K Electronics (Aust) Pty Ltd, Office 2, 6 McFarlane St, Merrylands, NSW 2160.

Digital tape recorder



Electrodata Associates Pty Ltd, 18 Coward Street, Mascot, NSW, recently delivered a special purpose digital tape recorder to the Department of Defence (Army).

The recorder, which was designed and manufactured to an Army specification, is a rugged, portable instrument for writing data at 1600 bpi on 8 tape tracks simultaneously. Unique features of the recorder include its capability to write or read data at 5 tape speeds, with all equalization being automatically controlled by a single speed select switch. Furthermore, the electronic modules may be un-plugged and replaced with FM or DR electronics for analog recording purposes.

Electrodata Associates Pty Ltd, is a Sydney based company specializing in the design and manufacture of instrumentation, digital, voice logging and audio tape recorders.

Instructional module system

Released just over two years ago, the EAI-TIMS (Telecommunications Instructional Module System) has established itself as a valuable telecommunications teaching aid. Recently, to enable all aspects of transmission and receiving techniques to be demonstrated, pulse code encoder and decoder facilities were added to this versatile unit.

Among the many systems that can be readily demonstrated are—amplitude modulation (AM), double side band (DSB), single side band (SSB), independent single side band (ISSB), time division multiplexing, and pulse code modulation.

For further information contact EAI-Electronic Associates Pty Ltd, PO Box 170, Crows Nest, NSW 2065.

Stick-on lettering for front panels

Two useful aids for the home constructer are currently being offered by Dick Smith Electronics Pty Ltd. A major problem with home made equipment is to provide suitable control markings which have a professional appearance. One convenient way to do this is by means of rub-on lettering, and Dick Smith is offering three rub-on letter packs which should suit most amateur and professional requirements.

Each pack contains several sheets and over one thousand communication terms, plus the alphabet and numbers. They are supplied by Amidon Associates, of California, USA. Two sizes of letters are available, 3.1mm high (size 1) and 2.3mm high (size 2). In latter size, both black and white lettering is available.

Price is $4.75 per pack.

Also from Amidon associates is a set of transfers sheets designed to facilitate one-off printed board construction. The sheets contain lines, circles, ellipses, pads, etc., in a variety of sizes, allowing almost any pattern to be produced.

The pattern required is built up directly on the copper surface, the transfer acting as an etch resist. Any desired type of etchant may be used. The idea would be most useful for "one off" experimental patterns, although there appears to be no reason why the same transfers could not be used on a transparent base to a master for subsequent copying.

Price per pack is $3.50.

Further enquiries to Dick Smith Electronics Pty Ltd, 160-162 Pacific Highway, Gore Hill, NSW 2065.

Service centre for mobile radio gear

Plessey Australia has established a new fully self-contained mobile radio service and installation centre at Meadowbank in Sydney.

Located on a 1,400 sq. metre site in Angas Street, Meadowbank, the centre is within easy reach of Victoria Road and Ring Road Three. It comprises three drive-in installation bays and an enlarged service facility equipped to handle all types of mobile two-way radios.

The centre is staffed by fully qualified and trained Plessey technicians, and fitted with modern testing equipment. Fully equipped radio controlled service vans are also available for travelling to a customer's premises.

Books & Literature

At the bench

HOW TO BUILD ELECTRONIC KITS, by Vivian Capel. Published by Argus Books Ltd (Fountain Press Imprint), Herts, England, 1975. Soft covers, 138 x 216 mm, 87pp, many diagrams. Recommended retail price $5.25.

In his preface to this little book, the author writes that it was produced to give practical assistance and guidance to the potential and established hobbyist. After a fairly careful look through it, I would suggest that he has been too modest. Although only brief, it is one of the most useful and down-to-earth introductions to the practicalities of electronics construction that I have seen to date.

I believe it should therefore be of value to anyone just starting to build or assemble electronic equipment, not just to hobbyists.

There are chapters on components, on soldering, on wiring techniques, on PC board etching and assembly, on case and chassis construction, and on trouble-shooting fundamentals, to name a few. And all are treated clearly and in an easily followed manner.

At the suggested price it seems very good value for money.

The review copy came from the local representatives, Thomas C. Lothian Pty Ltd, who advise that it should be available from all large bookstores. (J.R.)

All about batteries

DRY CELLS, BATTERIES & ACCUMULATORS. Published by Motel and Allied Publications Ltd, U.K. Soft covers, 210 × 150mm, 56pp, many drawings and graphs. Recommended Australian price, $1.50.

This in the nature of a reference book, with most of the drawings, graphs and other data being fairly obviously reprinted from manufacturers' data sheets. Most have also been published in various journals and technical magazines from time to time.

This latter point is not intended as criticism; the mere fact that all the data has been gathered between one pair of covers enhances its value considerably, since there is a good chance of its being available when needed. There is, in addition, a fair amount of original text.

The book is divided into three broad sections, dealing with primary batteries, secondary batteries, and special batteries. The primary section covers carbon-zinc, alkaline-manganese, mercury, silver-oxide, and zinc-air.

The secondary battery section covers lead-acid, nickel-iron, nickel-cadmium, silver-zinc, and silver-cadmium. The special batteries section covers water activated and standard batteries.

The book contains a lot of valuable information on batteries in general; their construction, their chemistry, their electrical characteristics, etc, plus valuable comparisons which assist in choosing the best battery for a particular job.

Unfortunately, it also contains several annoying errors and mistakes. While most of them are obvious, some may confuse the beginner. One such is the description on page 12 of the chemical reaction in a carbon-zinc cell, being based on the old, but erroneous, concept of the carbon rod as an active electrode. Fortunately, this is corrected in a more detailed explanation on page 23.

Page 37 suggests that most lead-acid accumulators are supplied with their plates in an unformed state and need to be put through a forming procedure before being put into service. The accuracy of the word "most" would seem to be debatable and some kind of qualification would avoid confusion.

Among the "annoying" errors is an incorrect (or incomplete) graph on page 26, the use of the word "discharged" when, presumably, "charged" was intended (p36), and a figure of "40V" which, presumably, should have been "40uV" (p53).

But anyone interested in batteries—and that means most of us—should not be put off by these points. It is still a very useful little volume and represents good value at a very modest price.

Our copy from Thomas C. Lothian Pty Ltd, 4-12 Tattersall's Lane, Melbourne, Victoria, 3000 (P.G.W.).

Computer reference

COMPONENTS OF COMPUTERS, by F.F. Mazda, published by Electrochemical Publications Ltd, Ayr, Scotland. Hard cover, 215 × 305mm, 100pp, many illustrations. Price $28.50.

A fairly specialised book, written for the technician or engineer wishing to become familiar with the components and circuit configurations used in both digital and analog computers. It has been adapted from a series of articles originally published in Electronic Components.

The text of the book does not attempt to give more than a basic introduction to the subject. Instead the author has given a very comprehensive bibliography—covering some 34 years, and with more than 3000 entries—so that those who wish to dig deeper in any one area can find the appropriate source material.

In short, it seems primarily a reference work, suitable mainly for engineering libraries.

The review copy came directly from the publisher, who gave no details regarding local availability (J.R.).

Recording, mikes

MICROPHONE RECORDING TECHNIQUE, by G. Praetzel and T. M. Jaskolski. Published 1976 by Sennheiser Electronic. Heavy paper covers, 70 pages 290mm x 210mm. Available from R. H. Cunningham Pty Ltd or their dealers and technical booksellers. Australian recommended price $3.50 plus 50c post and pack.

Although a simply produced book — by offset reproduction from typed sheets — this is one which is packed with useful information for the recordist, who has not had the benefit of formal training in microphone techniques.

While having been translated from the original German, and containing a few minor literals, it is still very easy to read. The first major section, "Fundamentals", discusses the nature of sound itself, moving coil and capacitor microphones, the important performance parameters of such microphones, and connection conventions and problems.

The second major section, "Microphone Practice" covers mono recording techniques, discussing such vital aspects as choice of microphone, consideration of individual instruments or groups, "Presence" and reverberation. Recording for stereo is similarly considered, leading into a general discussion of recording varying types of instrumental sound and from loudspeakers.

It would be quite easy to expand this evaluation of the book by quoting a number of interesting facets covered by the authors—microphone self-noise, signal/noise ratio of electret transducers, the importance of sensitivity, why high impedance microphones are 50k, etc. — but best you buy and read for yourself!

Our review copy came from R. H. Cunningham, 493-499 Victoria St, West Melbourne 3003.

FOUR STOPWATCHES IN ONE

Man has measured time for thousands of years. Ever since he noted the movement of the sun from horizon to horizon. Ever since he discovered the necessity of gauging his own movement from place to place. Crude timing mechanisms gave way to more sophisticated devices. From the sun dial to wristwatch. From Stonehenge to the Atomic Clock. And naturally, the units of measurement became more precise. Days were divided into hours. Hours into Minutes. Minutes into Seconds.

Man's progress has always been reflected in measurements of time. And just such a reflection is CRONUS, quite simple, accurate, stylish, rugged and complete competition stopwatch in the world.

Accurate because it's electronic, is crystal controlled that records to world championship specifications. To the hundredth of a second. Rugged because there are no moving parts. Stylish because, well, just look at it. A modern, compact design that fits comfortably into a shirt pocket.

Up to 8-digit display that is so bright and easy to read under any lighting condition, due to extra bright LED's and use of an Anti-reflective Filter. Complete because of its functions. Up to four distinct ways. Standard Start/Stop. Taylor/Sequential.

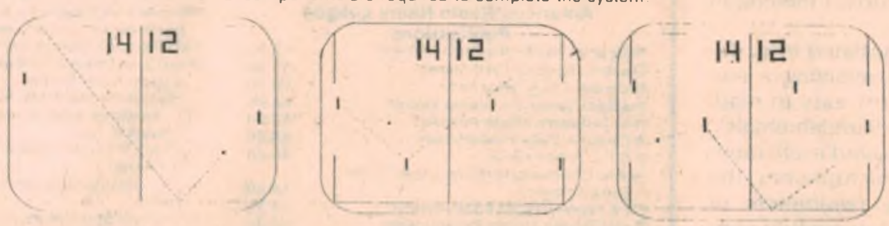
Split. And Event/Time-out. With a measuring range of up to 23 hours, 59 minutes and 59.99 seconds. Which means that virtually any event or activity can be timed. And when CRONUS (1) is not clocking a swim or track meet, a sports car rally or sailing regatta, it slips into a handsome designed desk base to become a most accurate, stylish and complete executive desk clock in the world. The CRONUS (1) has remote control capabilities in any of the four operational modes.

MODEL	DESCRIPTION	Sales Tax Paid	EXEMPT
CRONUS 1	8-digit, 24 hour digital stopwatch, 4 timing functions, rechargeable batteries, remote control and desk clock capability, complete with carrying case and recharger (240V)	$136.44	$111.00
CRONUS 2	59:59:99 minute digital stopwatch, 4 timing functions, 3 replaceable size AA Batteries	103.25	84.00
CRONUS 3-S	59:59:99 minute digital stopwatch, 2 timing functions (single event and split/comulative), 3 replaceable AA Batteries	48.45	38.00
CRONUS 3-T	59:59:99 minute digital stopwatch, 2 timing functions (single event and Taylor/Sequential), 3 replaceable AA Batteries	48.45	38.00
Carrying Case	Fully turned glove leather protective case for CRONUS 2	13.00	10.20
Carrying Case	Fully padded leather-look like vinyl carrying case for CRONUS 3-S and CRONUS 3-T	7.52	5.90
CRONUS 2-K	Same as CRONUS 2 above in kit-form, with assembly manual	74.97	58.80
CLOCK BASE	Clock Base Stand for CRONUS 1 converts it into a 24 hour desk clock/chronometer	38.25	30.00
REMOTE CABLE	Pushbutton controlled cable for CRONUS 1. Coil extends from 4' to 9'	15.30	12.00

This low price is only current until August 15th, 1976. After that, the suggested Retail Price will increase by 20%. In the meantime, we will be appointing Distributors in all capital cities in Australia, Papua New Guinea, New Zealand, etc. Enquiries from prospective Distributors, giving details of outlets, are invited now.

6 TV GAMES ON ONE IC

This 24-pin device has been designed to provide 6 different games using a standard television receiver. This MOS Integrated Circuit is intended to be battery powered and a minimum number of external components are required to complete the system.



FEATURES: 6 Selectable Games—Tennis, Football, Squash, Pelota or Rifle Shooting—two games; Automatic Scoring; Score display on TV Screen, 0-15. Selectable Bat Size; Selectable Angles; Selectable Ball Speed; Automatic or Manual Ball Service; Realism Sounds; Shooting Forwards in Football Game. Visually defined area for all Ball Games. Price each—$28.00. Prepaid orders received before August 15th $25.50 each. Discount: 1-4 nett, 5-9 less 5%, 10-24 less 10%, 25 onwards less 15%. Post, Pack & Insurance $2.00 per Order. For more details, see the June edition of 'Electronics Australia' or 'Electronics Today', or send stamped, self-addressed envelope marked TV GAMES.

SIEMENS INTEGRATED CIRCUITS:

UAA 170 LED Driver for electronic scales drives up to 16 LED's or 30 LED's with two UAA 170 or 106 LED's with seven UAA 170, ideal for analogue Displays. LED Arrays listed below. ea	$2.59	($2.25)
UAA 180 LED Driver, similar to UAA 170 but drives displays a band instead of single diodes ea	$2.59	(2.25)
LD 462 Red LED Array of 10 diodes 0.1'' spacing	$2.08	(1.80)
LD 472 Green LED Array of 10 diodes 0.1'' spacing	$2.76	(2.40)
LD 482 Yellow LED Array of 10 diodes 0.1'' spacing	$2.76	(2.40)
The above LED Arrays make ideal large 7-segment displays (2½'' high) connect all 10 LED's in series and use 7446 as Decoder/Driver		
LD 41A Red LED (red diffused)	$0.21	(0.18)
LD 55A Yellow LED (yellow diffused)	$0.28	(0.24)
LD 57A Green LED (green diffused)	$0.28	(0.24)
LD 41/II high brightness Red LED (diffused)	$0.24	(0.21)
LD 55/II high brightness Yellow LED (diffused)	$0.31	(0.27)
LD 57/II high brightness Green LED (diffused)	$0.31	(0.27)
Mounting Sleeve and Ring for above LED's	$0.07	(0.06)
LD 261 Infra-red LED Array, up to 10 diodes—please specify, per diode	$1.27	(1.10)
BPX 81 Silicon photo transistor Array, up to 10 ideal for card readers 0.1'' spac. per Tra	$0.86	(0.75)
ELECTRONIC ORGAN IC's (one each needed SAJ 410 & SAJ 205)		
SAJ 410 7-stage frequency divider	$1.65	(1.29)
SAJ 205 Staircase Generator	$8.88	(6.90)
S554 & 556 Infra-red Transmitter & Receiver IC set with 26 instructions per set	$30.98	(24.30)
BPW 34 Infra-red Receiver with 6 LD 241T Infra-red LED's for Infra-red Headphone Receivers with circuit diagram for Transmitter & Receiver	$10.83	(8.50)
SAJ 341 4-decade presettable Counter with decoder for 4 digit display, selectable time base input, can be programmed to be used as clock digital time relay, quantity counter etc.	$13.36	(11.62)
TCA 955 Motor Speed Regulator IC	$2.79	(2.40)
SAS 560S 4-channel touch-key-control	$4.85	(3.80)
SAS 570S 4-channel touch-key-control	$4.85	(3.80)
S 183 4-decade up-down counter IC, can be programmed and cascaded with decoder to drive displays	$24.73	(21.50)
BUX 28 400V, 10A, NPN Darlington Transistor gain min. 300	$4.85	(3.80)
LGR 7621 1 mW He-Ne Laser Tube	$299.00	(260.00)
Application Notes with circuit diagrams for above items	$1.00 per device	

1'' INTERPLEX single tube colour vidicon with printed deflection coil assy, low priced Liquid Crystal Displays up to 200 mm symbol heights, low priced LED Displays, Tuning Diodes, Hall Effect Devices, Character Generators, Memories etc. We also distribute the complete SIGNETIC range of Integrated Circuits from Microprocessor, Memories to Op Amps at low prices. Digital Voltmeter Kits, Computer Kits, Printers, Keyboards large range of Software incl. Games etc. all listed in our last technical catalog No. 7. Please forward $2.50 (with the catalogue you receive vouchers in the value of $2.00) Education & Government Departments are eligible for a free catalogue.

W.H.K. ELECTRONIC & SCIENTIFIC INSTRUMENTATION

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POSTAL ADDRESS: P.O. BOX 147, ST. ALBANS, VICTORIA, AUSTRALIA, 3021.

How it works— THE TELEPHONE

Elementary Electronics

Everyone knows how a telephone works—or do they? It forms so much a part of our way of life that we tend to take it for granted. Even if you have a broad idea about it, this article could fill in a lot of details you may not have appreciated.

In telecommunications, the basic goal is the transmission of intelligence with a minimum of distortion, from the point of origin to the intended destination. This intelligence may be in the form of speech, a scene, a picture, a series of electrical signals, or a modulated electric wave.

A telephone system establishes a voice communication path between any two telephones in that system. To do this successfully, the system must convert sound waves to electrical signals and back again in such a manner that the distant receiver hears the original voice with a minimum of distortion.

The difference in nature between sound signals and electromagnetic signals necessitates using converters designed to permit passage from one medium to the other. While in theory, and to a certain extent in practice, it is possible to produce one device that converts sound to electromagnetic impulses and back, power limitations have forced the design of two separate converters.

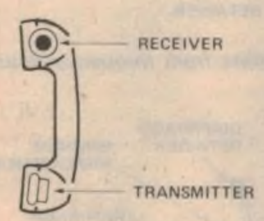

Fig. 1. The transmitter and receiver in the telephone handset covert audible sound signals to electric signals, and back to audible sound.

The converter that changes sound variations to corresponding electrical variations is called—by telephone engineers—a transmitter. (Radio engineers would call it a microphone).

The converter that changes electrical variations back to corresponding sound variation is called a receiver—or earphone. (Fig. 1)

A telephone transmitter converts mechanical vibrations in the air to electrical "sound" vibrations in an electrical circuit. This is accomplished by varying the resistance in a portion of the transmitter in step with the incoming sound. The varying resistance causes a direct current to increase or decrease.

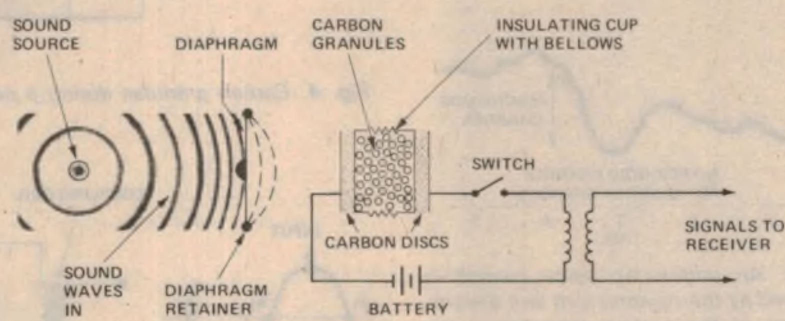

Fig. 2. A simplified telephone transmitter.

The simplified telephone transmitter shown in Fig. 2 consists essentially of two components—a diaphragm and a capsule filled with carbon granules. The diaphragm is usually made of a stiff metallic material, and is held in place by a retaining ring. A rod connects the diaphragm to the carbon-filled capsule. The capsule is made of two metal-backed carbon discs held together by an insulating cup with paper bellows. The space between the discs is filled with carbon granules. Because of the action of the bellows, one disc moves freely with the diaphragm. The other disc is rigidly held. The whole capsule is part of a circuit through which direct current can flow.

Sound waves meeting the diaphragm cause it to move back and forth. These movements are transmitted to the movable carbon disc. The carbon granules between the two discs are then alternately compressed or decompressed in step with the incoming sound. The compressions and decompressions (rarefactions) vary the resistance of the granules causing the direct current (DC) in the circuit to increase or decrease.

The mechanics of the resistance changes are shown in Figs. 3 and 4. (While carbon granules are irregular in shape, they are shown here as round for simplicity). Fig. 3 represents a steady-state condition with no sound meeting the diaphragm, and a steady current in the circuit. There is a possibility of several paths for the current. It can, for example, travel from the carbon disc to granule 1, 4, 2, 5, 3, etc.

Fig. 4 shows an instant in time when the granules are compressed by a wave. Granules 1, 2, and 3 have now come in contact, thus providing an additional path

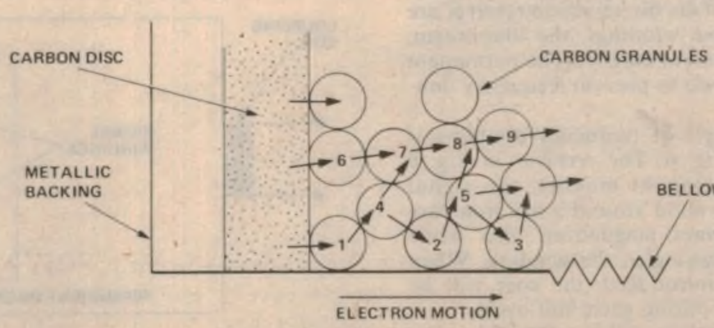

Fig. 3. Carbon granules in a normal or decompressed condition within a telephone transmitter capsule.

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for the current. Also, granules 6, 7, 8 and 9 have been compressed so that instead of there merely existing point contacts, there are circular-area contacts between them. This increase in contact area decreases the overall resistance and thus increases the current.

A high resistance is produced by a decompression wave which causes the carbon disk to move to the left, allowing the granules to separate. In some cases contacts are broken and in other cases only point contacts are established. The undulating voice current (Fig. 5) produced by the compression and decompression of the carbon granules is carried by the line to the distant end where it is coupled to a receiver circuit and changed back into sound.

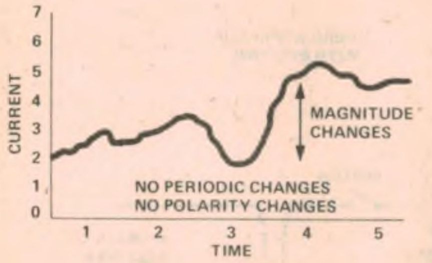

Fig. 5. An undulating voice current is produced by the compression and decompression of the carbon granules in the telephone transmitter.

A telephone receiver changes electric voice signals to sound by magnetically vibrating a diaphragm in step with the signals. Voice signals enter the receiver circuit over a coupling coil then pass through coil windings and generate a fluctuating magnetic field. The magnetic field causes a rigid diaphragm to vibrate, thus producing sound.

There are two types of receivers commonly used—the biased or direct-action receiver and the polar or indirect-action receiver. In the first type, a magnetic diaphragm is directly vibrated by the fluctuating field. In the second type, the field vibrates a magnetic armature which transmits the vibrations through a linkage to a non-magnetic diaphragm.

The direct action or biased receiver has been a standard unit for many years. Its diaphragm is the link between the electric circuit and the air. The voice signals are changed into magnetic field fluctuations by two coils. These fluctuations then vibrate the magnetic diaphragm. The principal parts of the direct-action receiver are two inductive windings, the diaphragm, and a permanent magnet. The permanent magnet is used to prevent frequency doubling.

An example of frequency doubling is shown in Fig. 6. The receiver in Fig. 6 has no permanent magnet, the signal winding is wound around a soft iron core which becomes magnetized only while current is flowing in the winding. When a signal is introduced, the core will be magnetized during each half-cycle.

The diaphragm will be attracted as the signal increases from a_1 to b; then, as the signal decreases from b to a_2, the diaphragm will be released. Thus, while the input signal goes through a half-cycle (from zero at a_1, to maximum positive at b, and back to zero at a_2), the output goes through a complete cycle (from zero at a_1, to maximum negative or decompression at d, to zero at b, to maximum positive or compression at e, and back to zero at a_2). These events are repeated on the negative half-cycle of the input. Each input cycle, therefore produces two cycles in the output.

The practical receiver shown in Fig. 7 is designed to prevent frequency doubling. The permanent magnet biases the diaphragm to a position midway between its minimum and maximum displacement. The signal windings are wound on the permanent magnet poles in such a way

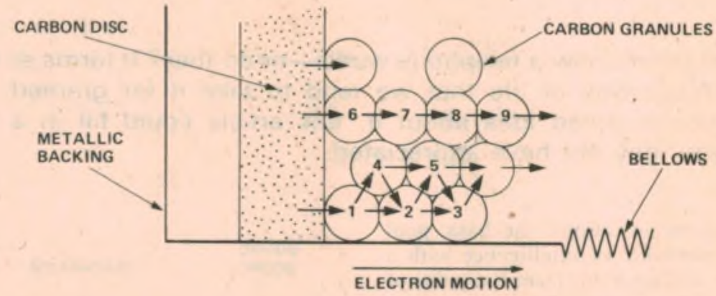

Fig. 4. Carbon granules during a period of compression.

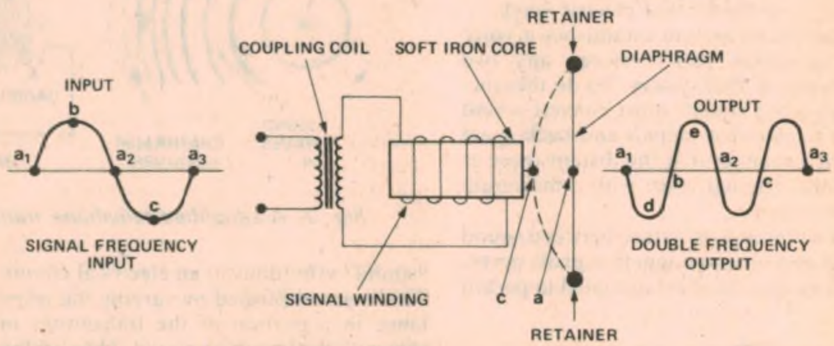

Fig. 6. A receiver with no permanent magnet suffers from frequency doubling.

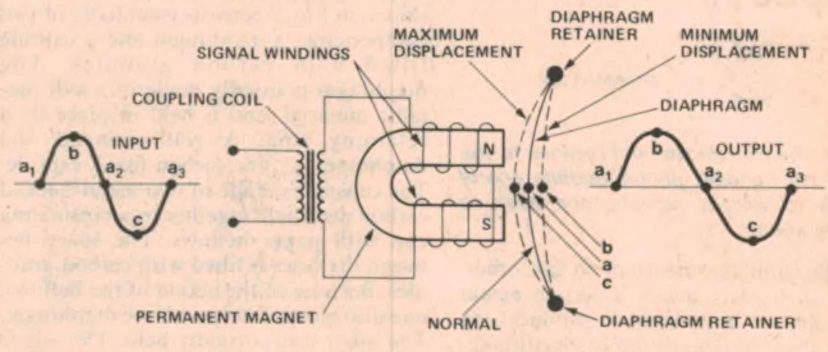

Fig. 7. Addition of a permanent magnet prevents frequency doubling.

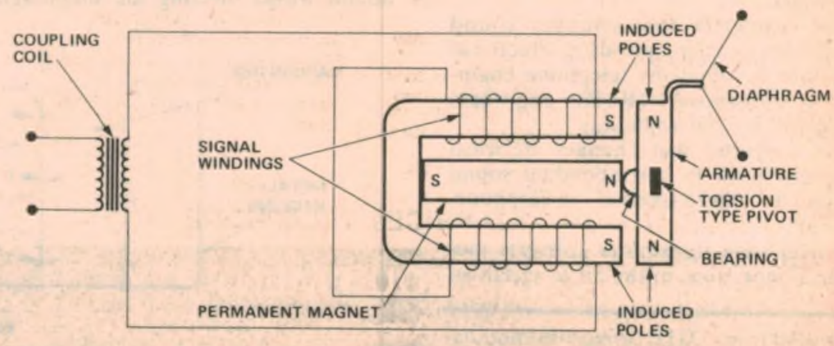

Fig. 8. Polar or indirect action receiver.

that a positive going pulse will weaken the poles, and a negative going pulse will strengthen the poles. When the input rises from a, to a maximum positive at b, and back to a_2, the diaphragm is released and returned, producing a compression. On the negative swing of the input signal (from a_2 to maximum negative at c, and back to a_3), the diaphragm is attracted and returned to normal, producing a decompression.

direct-action receiver.

The permanent magnet in Fig. 8 polarizes the movable armature and the signal winding cores as indicated. The armature is held in normal position by a torsion bar and the equal attraction of the winding cores. The windings are wound so that current in one direction produces a magnetic field that aids the induced pole in one core and opposes the induced pole of the other.

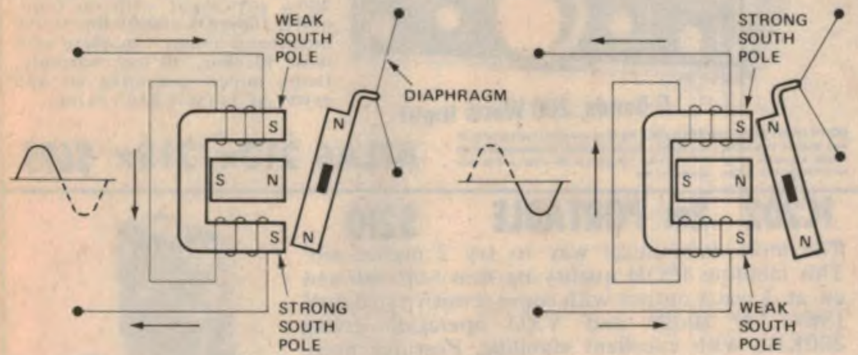

Fig. 9. Operation of the indirect action receiver.

However, there is a certain amount of amplitude distortion. On the negative half-cycles of the input, the diaphragm offers greater elastic resistance than on the positive half-cycles. This causes the decompressions to be weaker in amplitude than the compressions.

The indirect-action or polar receiver (shown in Fig. 8) is a more recent development than the direct-action receiver; it is more sensitive and introduces considerably less distortion than the

These unequal forces cause the armature to see-saw about its pivot as shown in Fig. 9.

One advantage of the indirect-action receiver is that the diaphragm is designed specifically for producing sound and does not have to serve the dual purpose of being a good magnetic conductor as well as a good acoustical generator. Also, less electrical energy is required because the magnetic circuit is more compact and efficient.

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The IC502 ssb/cw portable runs 3 watts output 53-54 MHz and features VFO control, RIT receiver tuning, noise blanker, high sensitivity (0.5uV [S+N] /N 10dB), provision for external power and antenna and light weight (2.1 kg). Comes complete with mic, carry strap, dry cells and of course, the VICOM 12 month warranty.

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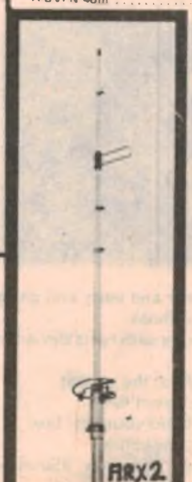

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The Amateur Bands

by Pierce Healy, VK2APQ

WARC—An appeal to all amateurs

The International Telecommunication Union World Administrative Radio Conference, to be held in Geneva in 1979, was the subject discussed at an International Amateur Radio Union conference held in Miami, USA.

Early in May, 1976, a recorded message from Noel Eaton, VE3CJ, president of the International Amateur Radio Union (IARU) was broadcast through the WIA Sunday morning news sessions. Points made refer to the future status of amateur radio and should be considered by all amateurs.

Referring to the IARU Region II conference held in Miami in April, 1976, when representatives from Australia, Japan, Great Britain and Region I executive were present, the IARU president's comments were:—

"This was a most important conference. The first of its kind when all three IARU regions and headquarters had been able to get together and exchange ideas in preparation for the World Administrative Radio Conference (WARC) in Geneva, 1979.

"If there is ever a time when unanimity of purpose and preparations for a conference was necessary it is now. For undoubtedly amateurs face probably the greatest challenge that has ever been experienced.

"No matter what is done by the national amateur radio societies in preparation for this conference, the benefits which will result will effect all amateurs.

"It is not possible for any country to get exactly what it wants and therefore must compromise to some extent with the wishes and desires of other countries. For this reason there will be, in the years prior to the WARC, a great deal of travel, planning, and preparation, not ony with your own government but with the rest of the world, and the expense will be very heavy.

"In this work it is essential for the average amateur to support his society by belonging to it."

This message could be referred to as an open invitation to non-members of national amateur organisations to do their bit in strengthening the amateur ranks.

In Australia this represents about 50% of the total licensees. Therefore it is commended as a wise move to become a member of the WIA, irrespective of the reasons for not doing so in the past.

OSCAR VIII—PLANNING NEEDED

"Thinking ahead"—AMSAT newsletter March, 1976, deals with possible problems when the phase III AMSAT spacecraft is in orbit. Careful planning between amateurs worldwide will be necessary if chaos is to be prevented on the spacecraft channels.

"Almost every day a new call sign is heard through the down link of AMSAT's OSCAR VI and VII. When the phase III space craft is in orbit the situation will change drastically.

"For the first years of operation any stations in substantial areas of the northern hemisphere will be able to communicate with each other for up to 15 hours a day, as well as with areas of the southern hemisphere for part of the time. This will be irrespective of the sunspot cycle, solar flares and most other phenomena that upset conventional HF band communication.

"Consider what that will mean in terms of QRM?"

"On a typical HF band such as forty metres, a number of QSO's can take place on one frequency at any time because, depending on the time of day, two stations located in, say, Europe can work each other without hearing two stations in North America on the same Frequency. It would be possible for more QSO's to take place on that frequency, with minimal QRM, as long as they were well separated or within the dead zone (skip effect). In fact, this is normal on forty metres.

"Now consider two metres. 144. 12MHz is a typical SSB frequency. At any given time QSO's could take place on that frequency, without any QRM, because of geographical spacing between stations and the line of sight properties of two metre propagation.

"What would happen if the characteristics of forty metres were suddenly superimposed onto the two metre bans? Instant QRM! Local QSO's could take place, simply by covering up more distant stations on the same frequency. DX working would be possible only if no locals appeared at either end.

"This is what may happen to part of two metres (and 70cm) when the phase III supercraft is in its final orbit. It is up to us to plan ahead to control the QRM so that QSO's can take place.

"A two metre FM repeater puts a station in contact with any other one within, say, 100kM or so for up to 24 hours a day.

"The transponders on AMSAR's Oscar VI and VII increase that range up to 8000kM, but only for 20 minutes or so, three or four times a day. The phase III spacecraft will put a vast area in range for up to 15 hours a day. Round table QSO's between stations in Europe, the USA and Japan could become commonplace. This would introduce a whole new era in phone patches, traffic handling, emergency communications and educational uses.

"It is these latter uses that will justify getting a place aboard the launch vehicle for the spacecraft.

"It's going to take a lot of planning to ensure that we use the phase III spacecraft in the best way. For a start some sort of a band plan may be required, splitting the pass band into modes, similar to the voluntary band plans in IARU Region I on all amateur bands.

"In that plan, starting at one end of the transponder band, there is a CW section, then an SSB section, with an overlap area for mixed modes contacts. The top end of the SSB section and the bottom end of the CW section could be used for special traffic and messages, where allowed by the licensing authorities. There follows a segment reserved for SSTV and RTTY. Another segme s reserved for educational use and the use of the SAT Command Stations as an intercom frequency. It may also be used for announcements, similar to those presently being made on AMSAT's OSCAR VI and VII. The locations and pass bands allocated to each assignment must be made by us as users, because it is voluntary and can only be enforced if the users agree to do so.

"The development of a band plan should be started now, because it is going to take two years to get everyone to agree.

"Your comments are needed. Comments on the type of band plan (if any), the amount of spectrum allocated to each mode, and on any other points."

Radio clubs and other organisations, as well as individual amateur operators, are cordially invited to submit news and notes of their activities for inclusion in these columns. Photographs will be published when of sufficient general interest, and where space permits. All material should be sent direct to Pierce Healy at 69 Taylor Street, Bankstown 2200.

RSGB EXHIBITION

The Radio Society of Great Britain has supplied the following information for those who may be in London at the end of July, 1976, and extends an invitation to attend the Radio Communication Exhibition, Alexandra Palace, July 30/31 & 1st August, 1976.

The opening ceremony will be performed by Lord Wallace of Coslany, next year's RSGB president, at 1200 hours on Friday 30th July.

The exhibition opens at 1000 hours each day until 2000 hours on the first two days and 1600 hours on the final day.

Talk-in facilities will be provided on two, 80 and 160 metres.

There will be many facilities provided free which members of the family not interested in the exhibition may use.

An international night will be held on Friday evening 30th July, with a reception at 6.00pm for overseas visitors.

Buffets and bars will be provided and open during all exhibition hours.

COASTGUARD OPERATORS WANTED

The Australian Volunteer Coast Guard is a voluntary organisation designed to promote boating safety by education and example. It provides a number of voluntary manned radio bases around Australia that keep listening watches on the major marine frequencies used by small boat owners. These are 2524kHz, 27.88MHz, coastguard domestic channels and, when allocated, one of the new VHF channels.

The base station which covers Broken Bay and adjacent waterways is located at Cottage Point in the Kur-ring-gai Chase, north of Sydney. It is open seven days a week, 24 hours a day, and has been responsible for saving many lives since its inauguration.

Over the past three months there has been an increasing demand during the weekend periods, amounting to an average of 70-80 calls per day. With this comes the need for more operators.

The association is looking for amateur operators or radio enthusiasts willing to undergo training and licensing. Such volunteers would then join the present team of operators and be called upon for duty on weekends of their choice, within reason.

Those interested should contact the Radio Section, C/- Chris Walker, 26 Gilroy Road, Turramurra, Sydney, NSW 2074, or telephone 44 3602.

WIA NEWS

Not much information had been released on the discussions and the decisions made at the 1976 Federal Convention of the WIA when these notes were being compiled.

However, it was reported that the federal council recommended that all divisions adopt a uniform policy and that novice licensees be accepted as full members of the WIA, with some qualifications.

The proposals in preparation for the ITU—WARC were extensively reviewed.

The report on the suggested restructuring of the WIA along the lines commented upon in last month's notes was received by the convention and was, basically, left to lay on the table, to be reviewed from time to time.

The need for eight repeater channels was agreed to. Also that the channels would be renumbered as follows:

New No.	MHz in	MHz out	Orig. No.
1	146.05	146.65	
2	146.10	146.70	1
3	146.15	146.75	5
4	146.20	146.80	2
5	146.25	146.85	6
6	146.30	146.90	3
7	146.35	146.95	7
8	146.40	147.00	4

RADIO CLUB NEWS

SOUTH WEST ZONE CONTEST: This contest is to celebrate the official opening of the Wagga Repeater VK2RWG, on Mt Flakeney, operating on channel 5 (146.15MHz in—146.75MHz out).

The contest will run for ten weeks; commencing at 0000hours EST 1st July, 1976 and finishing at 2359 hours EST 12th September, 1976.

There will be four separate sections; DX station contacts, DX receiving, local station contacts, and local receiving.

Prize winners will be announced at the official dinner at Tumut, NSW, on Saturday, 2nd October, 1976.

A copy of the rules can be obtained by sending a stamped-self-addressed envelope to—Harry Cuthbert, VK2AEC, PO Box 10, Grong Grong, NSW 2593.

UNIVERSITY OF NEW SOUTH WALES AMATEUR RADIO SOCIETY: Officers elected by members for 1976-77 are: President — Chris Simmeonoff, VK2ZAX; Vice-president — John Lowe, VK2BSJ; Secretary — Steve Blair, VK2BZB; Treasurer — Frank Sobora, VK2BHQ; YRS liaison officer — Sam Voron, VK2BVS.

The society's public relations activities have become known as "get out into the community campaign" and has done a great deal to publicise amateur radio among staff and students. On alternate Tuesdays from 1.00pm to 3.00pm HF and VHF stations (call sign VK2BUV) and an information desk is set up on the library steps at the University. Regular 11 metre and 160 metre hidden transmitter hunts are held at lunch times on the University campus. Students and staff are invited to participate.

The annual summer vacation courses the Society has organised over the past three years, has produced two active groups within the NSW Division of the WIA. These are the DX Group and the Novice Amateur Radio Group.

General meetings are held on the first Thursday of each month from 1-2pm in meeting room 2 of the stage 3 students' union building.

A special long term project is to promote interest in moonbounce and meteor scatter. Discussion groups designed to encourage novice licensees to join on-air learning projects are held on 27.125MHz.

For information write to—UNSWARS, The Union Box 57, PO Box 1, Kensington 2033.

DX GROUP: This has grown into one of the most active groups around Sydney. It meets on the first Friday of each month at the WI Centre, 14 Atchison Street, Crows Nest, at 7.30pm. In addition, field camp radio holidays are organised during high school and university vacations. A 30 page magazine "Bandspread" is produced monthly for members. Visitors and intending members are welcome to attend meetings.

During April a three day trip was organised to Mount Bowen in the Blue Mountains, NSW, 30 members participating. Four transmitting sites and one listening site were set up and frequencies from 160 metres to two metres were used.

Some novel experiments were conducted using a quarter-wave 160 metre antenna supported by two helium balloons. Contacts were made into Sydney and interstate on 160 metres, and America on 40 metres. Contacts into Europe were made on 20 metres using a full-wave three element wire beam.

On 15 metres, using an inverted "V", American novice licensees were heard. On 10 metres, using a five-eighth ground plane, several contacts were made with Hawaii, America and Japan. For intercamp communication, 11 metres was used. For OSCAR satellite experiments, two metres was used with several stations in Australia and New Zealand being heard on the 10 metre down link.

If interested, contact the president Roger Brown, VK2BEQ on telephone 969 2487.

NOVICE AMATEUR RADIO GROUP: This group conducts a free novice radio course every second Saturday at the WI centre, 14 Atchison Street, Crows Nest. About 40 persons aged from 12 to 60 years, are currently attending.

Anyone is welcome, no previous radio knowledge is necessary, and there is no age limit.

For details telephone the president Brian Belcher on 43 5632.

GEELONG AMATEUR RADIO & TV CLUB: The new committee elected for 1976-77 were:— President — Haydn Chittock, VK3BFL; Vice-president — Mike Trickett, VK3ASQ; Secretary — David Mann, VK3ZMZ; Treasurer — Harold Selman, VK3CM; Public relations officer — Alan Bradley, VK3LW; Technical officer — Peter James, VK3ZOS; Property officer — Albert Gnaccarini, VK3ZZX; Newsletter editor — Carlo Gnaccarini, VK3ZSG.

All correspondence should be addressed to the Secretary, PO Box 520, Geelong, Vic. 3220.

GOLD COAST RADIO CLUB: A visitor at the April meeting was the president of the WIA Queensland Division, Dave Laurie, VK4DT. A number of qoestions were asked and answered and an exchange of ideas, which will be of mutual benefit, took place.

A working bee installed new aerials at the repeater site, which are expected to give better performance in wet weather. Visitors to the Gold Coast are sure of a cordial welcome through the channel 1 repeater VK4RGC.

It has been suggested that the GCRC Sunday night net on 3650kHz be changed to enable novice licensees to participate.

Suggested novice net frequencies are 3535kHz, 3545kHz, 3550kHz, 3565kHz.

Postal address of the GCRC is PO Box 588, Southport, Qld. 4215.

GEELONG RADIO AND ELECTRONICS SOCIETY: M. G. Hepner, VK3BAX, Secretary of GRES, advises that the correct station and postal addresses for the society are: VK3ANR—Geelong Radio and Electronics Society.

Station—Recreation Reserve, Breakwater Road, Belmont, Victoria 3216.

Postal—PO Box 962, Geelong, Vic. 3220.

CENTRAL COAST AMATEUR RADIO CLUB: Twenty-four members were present at the annual general meeting on 6th May, 1976 in the club rooms at Kariong, ten others sent their apologies. Annual reports were prèsented by the outgoing president, Bill Smith, VK2TS. Ross Mudie, VK2ZRQ reported on the very successful field day and the Gosford repeater, VK2RAG, channel 5.

Some delay is being experienced in getting approval for re-siting the repeater at Somersby.

Officers elected for the coming year were: President—Ray Wells, VK2ZSX; Secretary—Suzanne Wells; Treasurer—Leon Brett, VK2ZEC; Vice-president—Bill Smith, VK2TS; Publicity officer—Jeff Campbell; Repeater committee chairman—Ross Mudie, VK2ZRQ; Public relations—Dick Maitland, VK2BBK; Store sales—Ken Lidden.

Club meetings are held on the first and third Fridays of each month and the postal address is PO Box 238, Gosford, NSW 2250.

ST. GEORGE AMATEUR RADIO SOCIETY: The annual general meeting was held at the Bexley headquarters on 5th May, 1976. A large attendance heard Bill Shakespeare, VK2AGF, deliver the president's report. Due to personal commitments, Bill did not stand for another term as president. A vote of thanks was moved by Chris Jones, VK2ZDD, on behalf of all members for the sterling work Bill had done during his tenure as president.

The new officers elected are:

President — Noel Spratt, VK2BSN; Vice-president — Erik Piip, VK2BQP; Secretary — Jim Lupton; Treasurer — Allan Burt, VK2ZIS; Committeeman — Allan Walker, VK2ZEW; Dragnet editor — Jim Lupton; Publicity officer — Mike McKenzie, VK2MM.

A handsome trophy for the 1975 "Remembrance Day Contest" was presented by the retiring treasurer, George Hodgson, VK2OH, to Bill Shakespeare, VK2AGF who scored the highest number of points by a SGARS member in that contest.

Meetings are held at the Civil Defence Headquarters, Highgate Street, Bexley at 7.30pm on the first Wednesday of each month. All are welcome.
Postal enquiries should be addressed to the Secretary SGARS, PO Box 77, Penshurst, NSW 2222.

ILLAWARRA AMATEUR RADIO SOCIETY: The United States, Canadian and Japanese segment of the April, 1976, moonbounce tests were carried out by Charlie Proctor, VK2ZEN and Charles Hedley, VK2MT from VK2AMW at Dapto.

Results were quite good, with contacts made for the first time with W4NUS and VE4JX. Contacts were also made with VE7BBG and JA1VDV.

During the previous tests in March, 1976, JA1VDV and F9FT were worked and VE7BBG, I5MSH and VE4JX were also heard. Weak but unreadable signals were heard during the SM5LE and ZE5JJ test period. At the same time VK2AMW echoes were between 6dB and 10dB above noise.

SOUTH EAST RADIO GROUP: Participation in the "Back to Mount Gambier" celebrations was a highlight of SERG during February, 1976. A special call sign, VK5BMG, was allocated for the group during that period. More than 200 contacts were made, most on the 80 metre band.

The group's display of radios and equipment ranged from antique models to present day equipment.

All who operated the special event station agreed that it was a successful public relations exercise and did a great deal to improve the status of amateur radio.

Postal address of SERG is PO Box 1103, Mt Gambier, SA 5290.

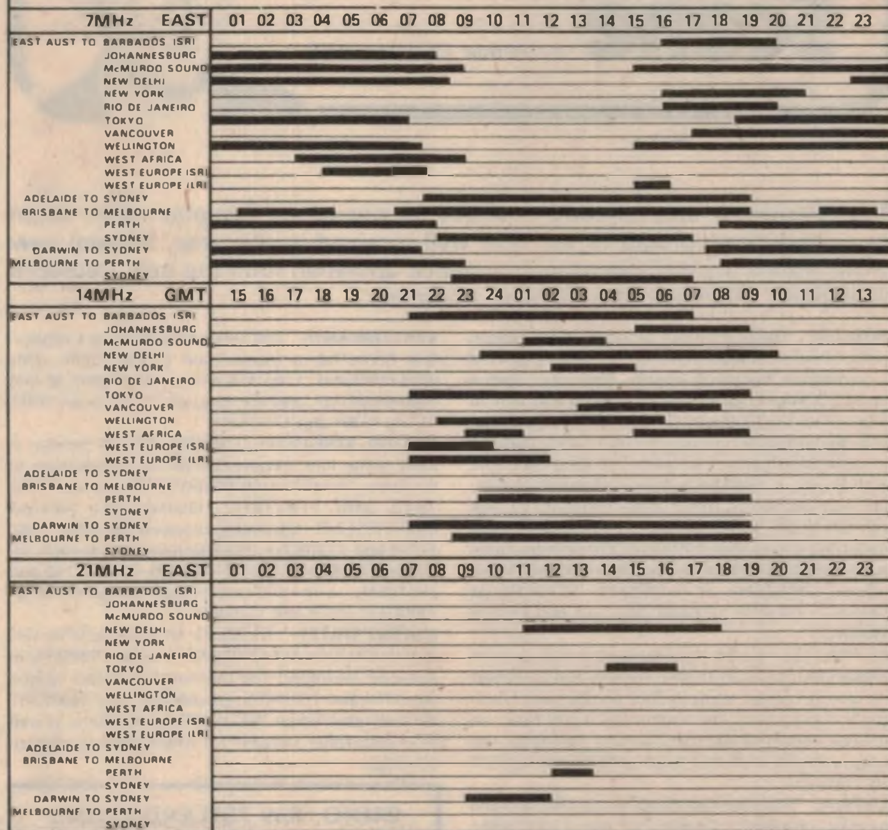
MOORABBIN AND DISTRICT RADIO CLUB: It is expected that the club will move into its new rooms in the Moorabbin City Council and combined clubs new Turner Road Reserve clubrooms in August, 1976.

The MDRC committee have studied many aspects of setting up the club in the new premises. It has been suggested that $1445 be allocated to fitting out the room in the way of floor coverings, window furnishings, chairs, benches, etc. This is in addition to the $500 already allocated to the combined clubs management committee for the main hall furnishings. Four individual clubs will have their own rooms and share the main meeting hall.

Postal address of MDRC is PO Box 88, East Bentleigh, Vic 3165.

IONOSPHERIC PREDICTIONS FOR JULY

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. 4/76



Shortwave Scene

by Arthur Cushen, MBE

Major frequency and schedule changes for our winter reception have taken place, and many programs are now well received in this area. Several new transmissions are also about to commence operation from the new Deutsche Welle Relay Station on the Island of Antigua.

ANTIGUA: The new Deutsche Welle Relay Station on the Island of Antigua in the Caribbean is expected to commence operation shortly. This relay station consists of four transmitters of 250kW and two of these are for use by the BBC. According to Deutsche Welle the proposed frequencies have been assigned for some broadcasts. A frequency to be used to the South Pacific is 9605kHz, which is planned for German transmissions from 0600-0950GMT. From 2130-0015GMT transmissions in Portuguese and Spanish are scheduled on 9590kHz. Other frequencies have been assigned for short transmissions and these include 11765kHz at 0300GMT, 9735kHz at 1100GMT, 9545kHz at 0400GMT, and 6065kHz at 0530GMT.

AUSTRALIA: Radio Australia now has a new program format for its English service, and no longer has special English transmissions for Europe, North America and Africa. The station has world news on the hour and Australian news on the half-hour. On Sundays the DX Session is heard at 0840GMT on 9570 and 5995kHz.

AUSTRIA: The transmission to South Asia and the Pacific is now broadcast on 15280kHz 0600-0900GMT. This broadcast includes English 0830-0900GMT, and is also available on 6155, 15410 and 17840kHz.

CANADA: Radio Canada has retimed its service to the South Pacific, and this is now heard 1000-1100GMT. The two frequencies used are 5970 and 9625kHz.

GREECE: Athens is broadcasting to North America 0000-0350GMT on 9760kHz. A broadcast in English has been noted at 0215GMT.

JAPAN: Radio Japan in Tokyo has broadcast to Australia and New Zealand for many years on the same two frequencies—11875 and 15235kHz. The transmission time 0930-1030GMT continues to remain the same, but the frequency of 15235 has been replaced by 9670kHz.

KOREA: Radio Korea in Seoul has retimed its English broadcasts. Best reception is provided by the transmission at 1000GMT, which is carried on 7150, 9600, 9640 and 11860kHz. The broadcast is of 30 minutes' duration, and these same four frequencies are used in transmissions at 0200, 0400, 1000, 1130, 1530, 1800 and 2000GMT.

PAKISTAN: Radio Pakistan broadcasts in English 2345-0045GMT 9460, 11730 and 15325kHz. The frequency of 11730kHz has been in operation since March and causes interference to the BBC. Radio Pakistan is using another new channel and this is 9780kHz for the Service to the United Kingdom 1915-2145GMT. The same World Service program is available on 11672kHz.

SWEDEN: Radio Sweden continues to relay the home service in Swedish 0630-0800GMT on 11705kHz. During the period from March to May this provided excellent reception, but in recent weeks Radio France has been using the same frequency.

Notes from readers should be sent to Arthur Cushen, 212 Earn Street, Invercargill, NZ. All times are GMT. Add 8 hours for West, 10 hours for East and 12 hours for NZT

SWITZERLAND: The Swiss Broadcasting Corporation Berne has a transmission to the Pacific daily 0700-0930GMT. English is broadcast 0700-0730 and 0900-0930GMT, and the frequencies in use are 9590, 11775, 15305 and 17840kHz.

UNITED KINGDOM: The BBC World Service is using some new frequencies for its transmission to this area. Broadcasts 0600-0915GMT are on 7150, 9640, and 11955kHz. During the period 0900-1115GMT signals are received on 6195, 9740, 11750 and 15310kHz. The morning transmission for our area is 2000-2245GMT on 7120, 9410, 11750 and 15070kHz with two additional frequencies at 2200GMT (9570 and 15260kHz).

UNITED STATES: The Voice of America in its service to Oceania 2200-2400GMT is using 15205kHz in place of 21610kHz. The transmission is also carried on 11760 and 17820kHz. Broadcasts from 1100GMT are well received on 5955, 6110 and 9730kHz, as well as several other frequencies which offer secondary coverage.

RADIO NEW ZEALAND CLOSES

The sudden closure of the External Service of Radio New Zealand on May 1 came as a complete surprise to listeners. The shortwave service had been in operation since September 26 1948 and though it still used the two 7500W transmitters it provided a service to the South Pacific and Australia and beyond.

The station was closed due to a budget cut in the funds of the Ministry of Foreign Affairs, which, since Radio and Television in New Zealand had been broken into three corporations, provided the funds for the External Service. Radio New Zealand, which is the name of the radio corporation, could not finance the station and so it was closed.

FOOTNOTE: Information to hand just before this issue went to press indicated that the External Service would resume operation on June 5, relaying the national program from 1800-1030GMT. The decision to re-open followed a flood of protest letters to the NZ Government from listeners in Australia and the Pacific region.

NEW ENGLISH SERVICE

The Spanish National Radio at Madrid has two new transmissions for listeners in Europe. The program is now received at 2030GMT and repeated at 2130GMT, excepting Sundays. Program duration is one hour.

The first transmission at 2030GMT is carried on 5955kHz and gives good reception, although there is some interference with Moscow. The second transmission at 2130GMT is also on 5955kHz with the additional frequency of 9505kHz which gives fair reception. The station is asking for reception reports from listeners, and these should be sent to the European section of Radio National Espania.

FEBA SEYCHELLES

Test transmissions beamed to East Africa have been heard on two frequencies at 0405GMT from the Far East Broadcasting Association at Seychelles. The reception on 11810kHz is the best of the channels in use, though 15270kHz also provides fair reception. Bill Vogel of Adelaide first reported this test in DX Post and since then reception has been noted by listeners in both Australia and New Zealand. Reports on reception are requested, and they should be sent to FEBA, PO Box 234, Seychelles. FEBA is a gospel station, but the test transmissions have been heard with mainly light music and announcements every five minutes. The transmission opens at 0405GMT with an interval signal and music is heard at 0410GMT.

NEW HEBRIDES VERIFIES

Our report of reception of the new station Radio Tanafo on January 20 has now been verified. In a long letter the following information was given. Radio Tanafo is operated by the Na-Griamel Federation and is located in the village of Tanafo in the hills on the island of Espiritu Santo in the New Hebrides.

Broadcasts are every day of the week, 2330-0200GMT and 0700-1000GMT. The programs are directed to the domestic audience in Pidgin, and later they hope to include both French and English programs for overseas listeners. They have, for the moment, dropped 7120kHz and only use 3975kHz. The station has an aerial power of 60 watts, with a dipole aerial. Proper QSL cards are being printed. The letter is signed by President Jimmy Moli Stevens.

MEDIUM WAVE NEWS

INDONESIA: Radio Rajawali Surabaya has verified a report of reception from Ray Crawford of Invercargill, NZ, who heard their broadcasts on 1165kHz. According to a letter from the director of the station the power used is 500W into a 36 metre vertical aerial.

AUSTRALIA: This month a new Community Radio Federation station, with the call-sign 3CRT, is expected to be in regular operation after a series of tests. According to I. Rutenfelds, Heidelberg, Vic, the transmitter has a power of 440W and commenced testing in early May between 0800-1000GMT. This non-commercial organization has its studios at 1112 (rear) High Street, Armadale, Vic 3143 and the transmitter is located at the same site. The station is expected to operate 8 hours a day when fully operational.

The ABC repeater 2WA Wilcannia NSW is operating on 1570kHz and has been heard by Chris Martin of Sydney at 2100GMT, which is one of the few times it breaks from the South Australia ABC regional network. At this time it carries local news relayed by landline from 2NB's studio in Broken Hill. Station 3MT Omeo, another repeater which will carry the Victorian regional network program of the ABC, is to operate on 720kHz, and it is expected to be in operation this month.

ABU DAHBI: A powerful signal from Abu Dahbi on 728kHz has been heard around 1900GMT. Chris Martin in DX Post reports reception is later blocked by 5CL, while in New Zealand 4YZ on 720kHz causes the main interference. Reception of this broadcast has already been confirmed in a letter to Ray Crawford of Invercargill, NZ.

LISTENING BRIEFS

AFRICA

NIGERIA: Kaduna Nigeria has been heard by Jack Buckley of Sydney on 9570kHz at 2130GMT. Reception is possible after Madrid leaves this frequency.

ETHIOPIA: Radio ETLF at Addis Ababa has been heard on 9510kHz around 0330GMT. Our reception has been after this time, as the BBC is using this frequency for the World Service up to 0328GMT. ETLF has a program in French to 0330GMT, and then in Malagacy up to 0355GMT. An English identification is given at 0330GMT and the programs are of a gospel nature.

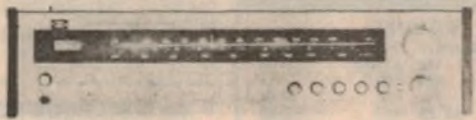
AMERICAS

BOLIVIA: Radio Fides, La Paz, has been heard opening at 1030GMT on 4845kHz. The station opens at 1030GMT and uses the same interval signal as the Vatican Radio. This station is assigned the call CP72, and after opening transmits a long series of announcements between short musical items. Signals fade out around 1100GMT. Transmitter power is 5kW.

CHILE: La Voz de Chile has been noted on 9566kHz at 2145GMT by Jack Buckley of Sydney. The signal is noted at this time after Radio Free Europe leaves the air with its interval signal.

136 VICTORIA RD MARRICKVILLE, NSW 2204 PHONE 51-3845

A.C.E. RADIO



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Two great models for low cost top quality hi fi home entertainment. Model DX 2400 12 + 12 watts RMS $156.00. Model DX-2200 6 + 6 watts RMS $129.00. Freq Resp 30 Hz — 2500 Hz. Distortion better than 0.8% for mag ceramic. Aux tape. Bass. Treble. loudness controls. FM88 — 108mHz sensitivity 2.5UV. P&P N.S.W. $3.50.

GARRARD MODEL 82

$49.00

A superb 3 speed transcription changer/player. Auto/manual operation. 4 pole magnetically shielded syn motor. Resiliently mounted. Counterbalanced. Elegant tone arm with slide-in cartridge carrier calibrated. Antiskate 265mm (10½"). Aluminium platter. Cue and pause control. Cartridge tilting lever. Magnetic cartridge diamond stylus. Size 375 x 335 x 170mm (14¼" x 13¼" x 6¼") 4.5kg (10 lbs) P & P $2.50. Interstate $3.50.

Also available is the deluxe changer/player **SL95B**. Has all the above features plus the world famous synch-RP LAB motor, a tone arm of advanced design. A new record release mechanism, also a heavyweight non magnetic platter. With magnetic cartridge, diamond stylus. Each model is supplied with comprehensive instruction manual. Super price $65.00 P & P $2.50. Interstate $3.50. Mounting base and perspex dust cover for either model **$28.50**. Send S.A.E. for more details.

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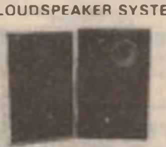
Complete kit of parts	$59.50
Constructed ready to operate	$69.50
P&P	$2.50
Interstate	$3.50

PLAYMASTER 3-45L
LOUDSPEAKER SYSTEM



Features the mighty 8-30 woofer. 6J midrange and the incomparable Philips AD016/T8 tweeter. This top quality low cost 3 way hifi system is available from stock in either walnut or teak veneer and complies with the specs as per April '75.

$84.00 EACH

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10-40 10" base 8 ohms **$20.95**. 625 6" mid range 8 ohms **$14.95**. XJ3 dome tweeter **$7.80**. Famous 8-30 8 ohms **$13.50**. Magnavox 3 way cross-over for 10-40, 625 and 2 XJ3 **$19.50**. P & P N.S.W. $1.40. Interstate $2.20.

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Latest design speed auto or manual operation. 11in heavy weight diecast turntable driven by fully shielded 4 pole dynamically balanced 240V motor. Noise suppressor. Silicone damped cueing device. Square section brushed aluminium pick up arm. Adjustable counterbalance. Calibrated stylus pressure control. Antiskate bias compensator fitted with magnetic cartridge diamond stylus. $55.00. Postage NSW $1.85. V. Q. SA. T $3.50. WA $5.50.

MAGNAVOX WIDE RANGE TWIN-CONE SPEAKERS

8-16 OHMS	30-16,000Hz
6WR MK5 12W RMS	$9.90
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10WR MK5 16W RMS	$11.50
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FOLDED LINE
Reverberation Device
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For 8-30 and MV 50 system. veneered pyneboard, teak or walnut. Our kits are extra simple to finish, as the top, bottom, both sides and back are factory assembled, baffle pre-cut. Innerbond included. Only **$48.00** pair. Add $1.50 for packing. Freight on delivery.

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ARN 6 receiver 200 KC — 1750 KC ideal for D.F. Similar to MN 26 compass receiver **$10.00**. APN-1 Radio Altimeter, complete with Wobulator as used for sweep generator **$12.50**. AT5 aerial tuning unit 2.20 MHz with RF Ammeter var condensors Variometer **$7.50**. Transmitter PA can be modified for 6 or 2 metres complete with 805 output value **$7.50**.

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Complete kit of top quality parts $89.00. Separate items are available. Send S.A.E. for quote. Fully constructed $118.00. P.P. N.S.W. $3.00. Interstate $4.50.

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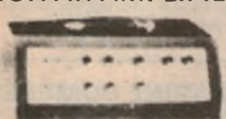
Height Indicator 1D-331/FPS-6 has absolute height readout and relative HT (in thousands) readout—3 selsyn motors **$15.00**

DIGITAL CLOCK RADIO

AM-FM. Automatic cut off after 1 hr. Seconds indicator. Alarm 240V 50 Hz. $28.50. P.P. N.S.W. $2.00. Interstate $3.00.

GUITAR AMPLIFIER



50 watts RMS solid state guitar amplifier PM125. 4 inputs, 2 channel with separate volume, bass and treble controls, speed and intensity controls for vibrato. Remote foot switch with plug and lead. Black vynex carry cabinet. Fully constructed and ready for operation off 240VAC **$135**

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Attractive. Lightweight. Rugged. 8 ohms.
6" dia 10 watt $15.00. 8" dia 10 watt $17.00.
8" x 5" 15 watt $18.50.
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P.P. N.S.W. $1.50. Interstate $2.50.

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Receiver model 1417 30-300 MHz **$95.00**
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Great boat or mobile rig. Auto noise limiter, squelch, A.G.C. over-mod. limiter. Low pass filter for bandwidth. SPECS. T-mitter. Crystal locked. 5 watts input to RF stage. Freq. coverage. Any 11 channels in 27 MHz band. Receiver, crystal locked, double superhet 6.5 MC and 455 Kc 1½ 3" speaker, dynamic mic. 50 ohm antenna. 20 t-sistors, 8 diodes. 12VDC operation. Sensitivity 0.5UV 10dB S/N. Size 6½" x 2½" x 7¾". Wt. 4½ lbs.

$133.50 P.P. $2.00

EMI 3" OSCILLOSCOPE

1 MHz bandwidth. Centre Zero meter + — 5V. A handy unit for the workshop. **$37.50**

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Floor model. 2 section telescopic. heavyweight base. **$22.95**

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Uni-Directional Electret Condenser 86 D. Freq. 40-18000 Hz. 1MP. High 40k ohms Lo 1k ohms. Output level (1kHz) H1 46 Dd. Lo — 54 Dd. on. off switch. 5M cable and plug. Mic holder for stand mounting $29.00. P.P. $1.50. Uni-directional Tie-Tack Mic imp. 1000 ohms $14.75. P.P. 75c.

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$35.00 (2 TELEPHONE SETS)

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Quadraphonic. High frequency. Professional quality, low noise.
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Provides a visual indication of signal output. Tests electrode open circuits, short circuits, current gain. $14.95 ea.
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100KHz 30MHz **$95**

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50 volt DC, suit slot car Lap counters, etc.
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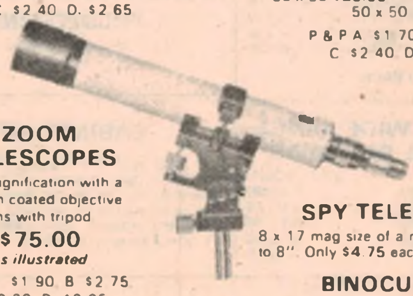

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$75.00
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3in x 2in containing 2 valves, qty of resistors, etc.
ONLY 75c P & P 60c

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Austronic type DFC 4 240V 50 cycle 0 100KHz **$150**

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New gunmetal body, Stainless Steel Shaft, Neoprene Impeller. Up to 15ft Lift, suitable for almost any type of liquid. Self prining. Ideal boat bilge pump, sullage drains, etc. Approx size 8" x 5"

⅜"	$23.30
½"	$31.95
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2-16 M/cs $65
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Palec Model SG1 150 Kc/s to 30 M/cs 240 VAC $37.50
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INFORMATION CENTRE

PLAYMASTER 125 DRIVER TRANSFORMER: Could you please give me information as to the availability and price of the 3:1 + 1 driver transformer used in the Playmaster 125 Guitar Amplifier, described in the July 1969 edition (File No. 1/GA/17 & 18)? (A.F.B., Christchurch, N.Z.)

• As noted earlier in these columns (February 1976), this transformer is out of stock, and appears to be unobtainable through normal channels. We suggest that you contact the reader mentioned in the February issue with regard to other possible sources.

DEAD LETTER: We are holding a package addressed to Mr Palmieri, P.O. Box 412, Mareeba, 4880. This has been returned by the postal authorities marked, "Addressee unknown by box holder". If Mr Palmieri will contact us with his correct address, we will forward the material to him.

ELECTRONIC METRONOME: Could I suggest that now might be an appropriate time to update the Electronic Metronome featured in Electronics Australia in May 1967. I built one at the time, and am about to build another; but the transistors are not now available locally. This project could interest more people than in 1967, as I believe there is an increasing number of people learning instruments, particularly the piano. (S.B., Zillmere, Qld.)

• Thank you for your suggestion about the Electronic Metronome (File No. 3/MS/13) S.B. As you will have seen by now, we have developed an entirely new circuit and have published it in this very issue. This appears to be exactly what you had in mind.

1971 AUTOMATIC BATTERY CHARGER: I am endeavouring to build the Automatic Battery Charger (October 1971, File No. 2/BC/9). I have come up against problem after problem, my last one being that in no way can I get the "set current" trimpot to have any effect.

Assuming the circuitry to be correct, are there any component changes you can recommend to achieve current control? I have come to believe that this particular circuit is a little unstable if not unreliable. Is there available a circuit of similar nature that is most dependable, reliable, and yet still the trickle charge and reducing charge rate features? Any assistance you can give me will be greatly appreciated. (C.L., Waterloo, NSW.)

• There have been no Notes and Errata for the Automatic Battery Charger, C.L. This circuit has proven to be quite reliable, and has been successfully constructed by many readers. We suggest that you check the polarity of D2, and that VR4 is not open circuit. Check also that the 0.1 ohm current sensing resistor has the correct value.

LSI DIGITAL CLOCK: Having desired to own a digital clock for some time, the one in the November 1975 issue looked ideal in all respects. In particular, I required the snooze facility. Without further ado I purchased the kit and assembled it.

On switch on, the clock functioned normally except for a malfunction in the snooze facility. After a thorough check of the wiring components, I finally deduced that the chip was faulty and ordered a replacement. When the replacement was installed the snooze facility came good, and the clock functioned perfectly.

I have also found that this new chip

If you are unable to complete an "Electronics Australia" project because you missed out on your regular issue, we can usually provide emergency assistance on the following basis:

PHOTOSTAT COPIES: $2 per project, or $2 per part where a project spreads over multiple issues. Requests can be handled more speedily if projects are positively identified, and if not accompanied by technical queries.

METALWORK DYELINES: Available for most projects at $2 each, showing dimensions, holes, cutouts, etc., but no wiring details.

PRINTED BOARD PATTERNS: Dyeline transparencies, actual size but of limited contrast: $2. Specify positive or negative. We do not sell PC boards.

REPLIES BY POST: Limited to advice concerning projects published within the past 2 years. Charge $2. We cannot provide lengthy answers, undertake special research or discuss design changes.

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OTHER QUERIES: Technical queries outside the scope of "Replies by Post" may be submitted without fee, for reply in the magazine, at the discretion of the Editor.

COMMERCIAL, SURPLUS EQUIPMENT: No information can be supplied.

COMPONENTS: We do not deal in electronic components. Prices, specifications, etc., should be sought from advertisers or agents.

REMITTANCES: Must be negotiable in Australia and made payable to "Electronics Australia". Where the exact charge may be in doubt, we recommend submitting an open cheque endorsed with a suitable limitation.

ADDRESS: All requests to the Assistant Editor, "Electronics Australia", Box 163, Beaconsfield, 2014.

carries out the AM/PM change at 12 o'clock, suggesting an updated chip design in which other readers might be interested. The new chip is designated TMS3834NC and has the number BA7549 below this designation.

To say that the display is bright is an understatement, as at night with all other lights out I can read my "EA" by it. I considered several ways around this but opted for the simplest method which readers may care to copy.

There is enough room to fit a miniature pot inside the case. Remove the blue +28V transformer lead from the PC board and connect it to one end of the pot. Connect a lead from the centre tap of the pot to the point at which the +28V lead was removed, and connect the other end of the pot to the OV rail. The display can now be varied to suit one's preference. A value of 33k or thereabouts proved most suitable for the pot, and this results in a current drain of less than 1mA extra from the supply. (M.I. Ipswich, Q.)

● Thank you for your information M.I. We have published your letter, in somewhat abbreviated form, for the benefit of other readers who may care to experiment with the brightness control you described. Yes, the clock chip has been modified by the manufacturer to change the AM/PM indication at the correct time.

DOG REPELLERS: In the news lately it has been stated that postmen and meter readers have been bitten and harassed by dogs, and are now being issued with ultrasonic dog repellers. Many people have trouble with dogs which invade gardens and kill plants with their urine.

Q.1: How about a do-it-yourself dog putter-offer?

Q.2: Do you know of any commercial units?

Q.3: Has any frequency unpleasant to dogs been worked out?

Although I have asked three questions, I am sure they could be treated as one, as you will appreciate. (R.L., Merimbula, NSW 2548.)

● While we agree that it may be possible to repel dogs using ultrasonic tones, we have no definite information on this subject. Without such information, it is unlikely that we would be able to describe any device of this type.

NOTES & ERRATA

CALCULATOR STOPWATCH (May, 1976; File No. 7/CL/22). On page 71 it is stated:

"Note that it is necessary to modify the calculator board by cutting the copper track on both sides of pin 1 of the MM5736 chip. The tracks on both sides of pin 1 should be rejoined ... leaving pin 1 isolated."

This step is both unnecessary and incorrect. Pin 1 should remain connected in circuit, and no cuts in the copper tracks of the calculator board are necessary. Note also that one side of switch S2 (labelled stop/start) in Fig. 2 is connected to V+.

VIDEO BALL GAME (May, 1976; File No. 3/EG/8). In the parts list on page 46 there are two misprints. In the first column, the fourth entry from the bottom should read "2 0.0047uF polystyrene". The fifth entry in the RF modulator section should read "1 0.001uF ceramic capacitor". In the circuit diagram on page 39, gates 5a, 5b, 5c and 5d have been shown incorrectly as nand gates instead of nor gates. The list of ICs at the bottom of the diagram is correct.

It has been brought to our attention that some retailers have been supplied with single-sided rather than double-sided PC boards for the modulator. These boards may still be used, provided that an earthed metal plane is provided underneath the board. This can be done by completely enclosing the modulator in a metal box, which should be connected to the earthy part of the pattern.

PLAYMASTER TWIN 25 (May, 1976; 1/SA/56). There is an error in the text on page 59 concerning orientation of the driver transistors: the metal flat on each BD140 faces to the rear of the chassis while on the BD139's it faces to the front. The photograph on page 67 shows the orientation.

QUINTRIX TUBE . . . continued from p.29

Under such conditions, a bright picture is essential to compete with the natural light and help maintain an acceptable contrast. The main difficulty is to produce a convincing black on the TV screen, since the "black" can never be any darker than the colour of the unenergised phosphor.

The brighter picture helps by tricking the eye into seeing the unenergised areas as darker than they really are, when compared with the bright areas. But this trick can only be carried so far. Increasing the brightness beyond a certain level, assuming it is possible, creates other problems, such as increased flicker perception.

This is where the black matrix comes into its own. The reasoning is that the small areas between the dots contribute nothing to the picture but, by reflecting ambient light, help to degrade the blacks. If, on the other hand, these areas are made black, less light is reflected from the screen and, at normal viewing distances, the screen looks significantly darker, thus enhancing the black quality.

This, then, is the basis on which the Matsushita company claims an improved quality picture and one which, more importantly, can be maintained over a wide range of ambient light conditions.

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D30/500 m/V	57.95
D40/600 m/V	79.30
D12/1500 m/V	67.10
MH 20 Mast Head	64.63

LAB GEAR AMPLIFIERS.

VHF UHF

	Price
Mast Head 22 dB	$72.43
CM 6014/DA 20 dB	60.25
CM 6034/DA 4 outlets 8 dB each	54.90
CM 6036/DA VHF 30 dB UHF 28 dB	84.63
Televerta (VHF to UHF frequency convertor)	67.48
Channel Master Telstar 0023A	58.91

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Wall brackets, chimney mts., J Brackets, Turnbuckles, Guy Rings and Guy Wire. All types of masts, etc.

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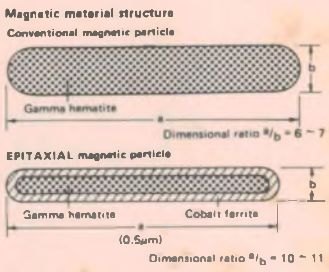
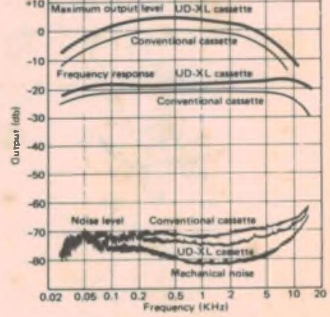
Advertising Index

Introducing the revolutionary UD-XL EPITAXIAL cassette

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.

maxell®

For further information please write to Maxell Advisory Service, P.O. Box 49, Kensington, N.S.W. 2033.

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