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Editorial

By Milton S. Snitzer, Editor

A LOOK INTO THE FUTURE

Some months ago, 400 top managers from the electronics industry got together in Chicago to look into the near future and forecast the shape and size of their industry a dozen years from now. In 1985, the world electronics market will be nearly $200 billion, of which the U.S. share will be about $81 billion. Of this latter figure, the industrial market is expected to account for $45.5 billion, government sales $22.5 billion, and consumer sales $12.9 billion.

From the same meeting, sponsored by the EIA (Electronic Industries Assn.) here are some predictions for products in the consumer area. George Simkowski of Bell & Howell predicted that we'll have octaphonic (8-channel) "moving sound" by 1985. He also thinks that the leading audio-visual product will be a low-cost video disc, the sales of which could reach 5 million yearly.

William Boss, Jr. of GTE Sylvania said that color-TV sets will be the predominant consumer electronic product in the home, possibly being found in 95 percent of U.S. households. He said that "an attachment to the color television receiver that would provide the capability of screening taped material either home-originated, rented, or sold will become the consumer electronics industry's dominant product by 1980." The product will sell for around $400 to $500 and will be marketed much like audio components are today. Also forecast were large, flat-screen TV displays that will resemble a movie screen.

Robert Adler of Zenith Radio also called the large flat screen a definite possibility by 1985. In addition, he forecasts very small flat-screen TV sets that will fit into a briefcase. A "frame grabber", which can hold and display a single frame of a TV picture and allow the user to play it back for as long as he wishes, will also be in wide use. He said that three-dimensional full-color laser displays will still be in the future by the 80's.

J. Herbert Hollomon of MIT stated "In the next decade, for every 10 jobs created in the U.S., nine of them will be classified in the service industry and one in manufacturing and agriculture. That's a new kind of world."

Where will we, as hobbyists, fit into this glowing future? We will want to keep up with the exciting new world of electronics with its variety of new products. We will want to learn how all these new devices operate and get some practical knowledge by building and working with equipment and projects that take advantage of the new technology. We will continue our need to know all there is to know about our own field of special interest.

Letters

NOT ENTIRELY ACCURATE

I wish to commend Mr. Ello for part one of his article "Nuclear Radiation & Detection" (Oct. 1972). However, there are some inaccuracies in the text. The drawing showing the paths of alpha, beta, and gamma rays in a magnetic field seems to indicate that alpha particles are attracted to the north pole of a magnet, while beta particles are attracted to the south pole. Actually, the force deflecting a charged particle moving through a magnetic field is perpendicular to the field and perpendicular to the velocity of the particle.

Mr. Ello further states that ". . . the gamma is a ray—not a particle . . . Since gamma rays are not particles, they are unaffected by a magnetic field." Einstein and Compton demonstrated that gamma rays are indeed particles, called photons. Nor are alpha or beta particles necessarily "particles." Whether something behaves like a wave or a particle depends entirely upon how one detects and interprets its interaction with its surroundings. The reason gamma rays are undeflected (notice that I did not say unaffected) by a magnetic field is that the photons are not electrically charged.

JOHN M. CROWELL
Baltimore, Md.

We agree that some confusion might exist in Mr. Ello's "deflection diagram." The illustration was not intended to imply that specific types of radiation are drawn toward or deflected by a given magnetic pole. It merely showed that alpha and beta particles are indeed deflected by magnetic fields. The word "unaffected" was an unfortunate choice here. As regards the particle/ray question, "The International Dictionary Of Physics and Electronics," Second Edition (Van Nostrand) lists alpha and beta radiation as consisting of particulants, while the gamma radiation entry is listed only as "gamma rays."

CHECK THE LEGALITY

I read with interest "Scanners For Monitoring VHF and UHF" (November 1972). One thing you did not mention is that mere possession of one of these types of receivers fitted with crystals to receive the police frequencies by anyone other than a law official is a crime in the state of Kentucky. A copy of Kentucky Revised Statute 432.570 is attached.

I am quite certain that many people in this state own receivers that are capable of receiving police calls but are unaware that they are breaking a state law. There have been recent convictions in my community of persons having this type of equipment.

I believe that in all fairness to the public, any articles or advertisements concerning this type of equipment should contain a statement that lists the states where it is considered illegal.

DWAIN ABELL
Mayfield, Ky.

The laws of Kentucky, as received, appear to leave no doubt that possession of a police monitor by other than a duly authorized official in his official capacity is illegal. Since state laws on this subject are many and varied, we must assume that the reader (and the buyer of such equipment) is aware of the technicalities.

TAKES AN OPPOSING VIEW

I object to Mr. Holt's statement that ". . . it is a Federal offense to record a phone conversation without informing both parties that a recording is being made" ("Stereo Scene," December 1972). While this statement may be true if the recordist is a third party, it is not true if the recordist is the called party—in most states, anyway.

Historically, the conversation is the "property" of the *called* party, and he never need inform the calling party that he is recording if he is doing this for his own personal use. The recording cannot, of course, be revealed to anyone not party to the conversation (see Communications Act of 1934, as amended).

ERIC G. LEMMON
Vandenberg AFB, Calif.

Mr. Holt's statement is correct—in all states of the U.S. (Federal law, remember). Furthermore, even if the recordist advises the other party that he is about to record a telephone conversation, the FCC Rules state that prior arrangement to do any recording of telephone conversations must be made with the telephone company! To support this latter statement, we refer you to "Legal Booby Traps In Tape Recording," June 1972.

CORRECTION—*In the November 1972 "Letters" column, under "Wants Solid-State Circuits Book," we incorrectly stated the title of the recommended John Markus book; the correct title is "Electronic Circuits Manual" (McGraw-Hill Book Co. No. 07-04044-5). Our apologies for any inconvenience.*

In "Build an Alpha Brain-Wave Feedback Monitor," (January 1973) on page 42, the voltage rating of C10 and C11 should have been 15 or 25 volts, not 2 volts.

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Stereo Scene

By J. Gordon Holt

The Optimum Amplifier

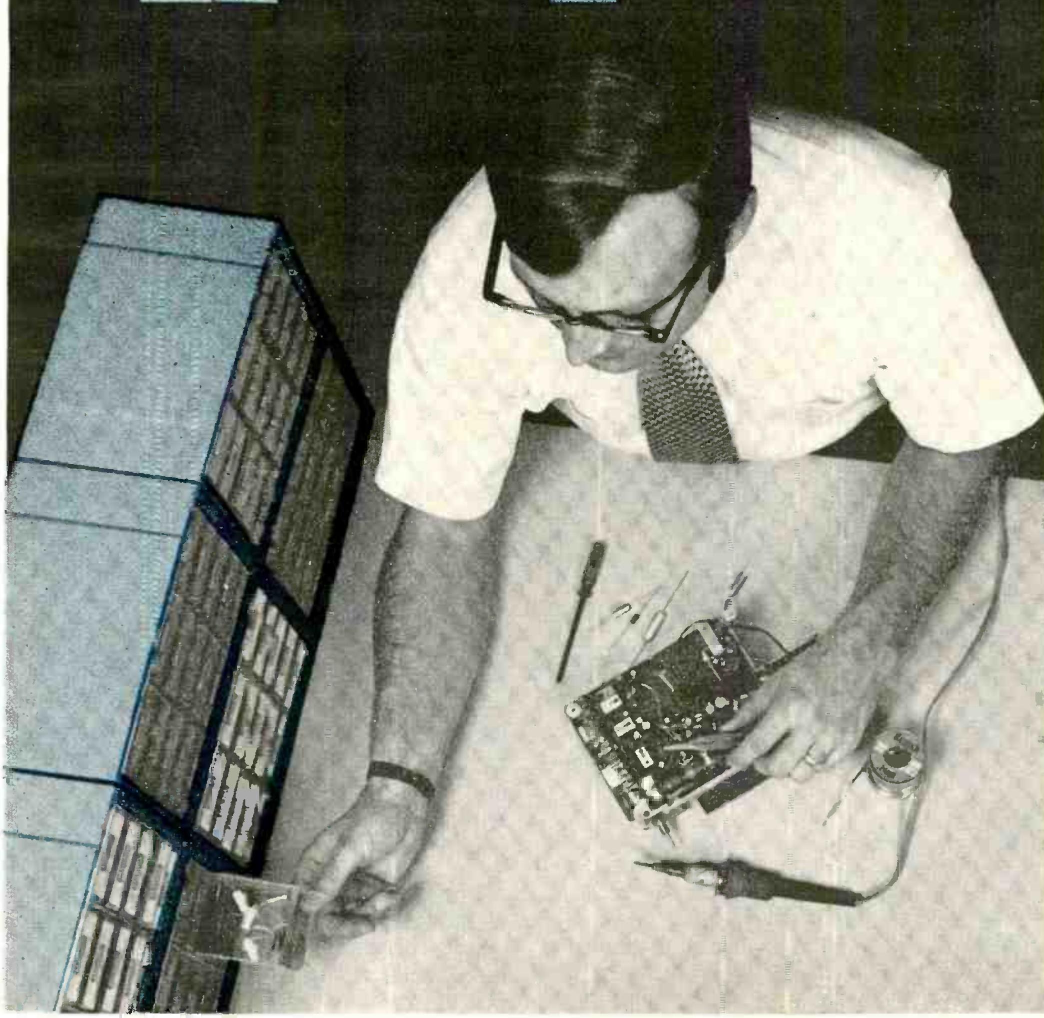
Go into a typical hi-fi emporium, buttonhole a salesman, and ask him what power amplifier you should use with your favorite loudspeakers, and he is likely to counter with the question: "Well, how loudly do you like to listen to music?" He will then proceed to inform you that all power amplifiers are pretty much the same, and that the only differences are in power output, price, and features like super-fast-acting protection circuits and front-panel meters that tell you what your ears could tell you if you'd only listen.

Well, it's not true. Some power amplifiers are, quite simply, better than others of similar price by any standard of comparison—objectively, via measurements, or subjectively, via listening—and some are better suited to some loudspeakers than others. Some are rock-solid stable under any or all conditions of use; some will oscillate (destroying themselves, the speakers, or both) under certain conditions or will operate on the verge of oscillation, doing nothing worse than fouling up the sound. Some are remarkably tolerant of impedance/frequency variations in loudspeakers. Others will balk at such idiosyncratic loads and either deliver but a mere fraction of their rated output power, or teeter on the edge of oscillation. A few will even emit bursts of full-power pulses under these conditions, causing loudspeaker damage or, again, destroying themselves, and normally foolproof protection circuits often give no protection from this kind of thing. Yes, there *is* a difference between power amps, and you'd better believe it.

Available Output Power. Of course, available power *is* one of the primary considerations in choosing an amplifier; because, if the sound starts to shatter from overload before it's only about half as loud as you want it to be, you're not going to listen to it very often—even if the amplifier is the best thing that ever came down the pike in other respects. So, let's get the power thing out of the way first.

To begin with, if you are an absolute nut of a perfectionist, you will probably have observed that, all other performance parameters being equal (and we'll question that subsequently, too), the more power that is available, the better the sound, even at low listening levels. There is not, to my knowledge, any convincing explanation for this. It just seems to be so, which is why a surprising number of perfectionists risk wiping out their speakers (as well as their bank accounts) by purchasing 300-watt-per-channel behemoths with which to listen to chamber music at volume levels that don't even discourage normal conversation.

It's easy to rationalize such a risky situation by saying, "I'll just be careful not to turn it up too high;" but you never know when someone is going to try plugging phono cables into the preamp when the volume is turned up. Fuses are a help here, but fuses have dc resistance. Such resistance in speaker lines reduces the amount of damping the amplifier can bring to bear on the speakers, and some speakers need



all the amplifier damping they can get. The net result of fusing is usually an impairment of some of that lovely bass detail that justified the cost of a high-powered amplifier in the first place.

Let's say, though, that you don't feel compelled to invest half a grand in a portable power station, but just want enough power to prevent overload when you're listening at the highest levels you're likely to want. Then you figure the necessary power on the basis of things like speaker efficiency, room size and acoustics, and your listening habits (loud, very loud, insanely loud, etc.), according to criteria that have been described often enough elsewhere so that I'm not going to go into them here. Right now, we're concerned with some of the other things that make one amplifier ideal for your needs and another less so.

What About Distortion? If you peruse manufacturers' literature—and you should if you're planning a purchase—you may have noticed that amplifier manufacturers almost never mention distortion except at maximum output power levels. This is not because they are hiding anything from us, actually, but because many of them prefer that prospective buyers not discover one of the ways in which competing products really do differ.

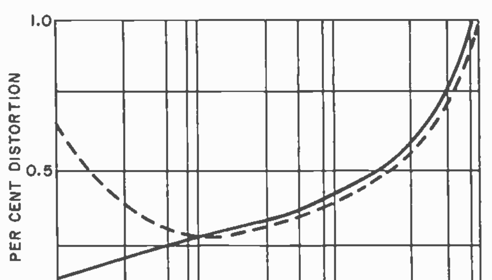


Fig. 1. Distortion curves for some amplifiers (solid line) may not show true condition at low power outputs.

If an amplifier has a certain amount of distortion at full rated output, it is natural for us to assume that its distortion is lower at lower output powers. This is, of course, nearly always the case. But when we get down to an amplifier's *half*-power point or thereabouts, strange things may start happening. Some amplifiers continue to lose distortion with further power reductions, but the majority of them start to level out, so that as output falls steadily, distortion may start to level off. Thus, below a certain output, further reductions cause no concomitant reduction in distortion. In fact, some units start to show a *rise* in distortion as power output falls below a few watts; and by the time they are putting out less than half a watt, their distortion may be back up almost to the point where it was at full rated output (Fig. 1).

Okay, so who cares what the distortion is at half a watt out when we're blasting away with peaks hitting 50 watts? You care, that's who; because those peaks are only the top of the sonic iceberg. They're an aggregate of the musical fundamentals at any given instant, and virtually all of the overtones that give musical sounds their identifiable character are of substantially lesser intensity. In fact, in a period of one second, it is likely that more than 95 percent of the frequencies you are hearing in music are overtones, and many of these represent less than 1/10 of a watt of amplifier output, even when it is on the verge of overloading on peaks.

What makes matters worse is the fact that the distortion that some amplifiers produce at low power levels is of a particularly virulent kind, as far as our ears are concerned. It consists of what the ear perceives as a series of tiny, sharp-edged clicks. We can't hear the clicks individually, because they occur so rapidly. They tend to merge into what sounds like a hard, brittle edginess that makes cymbals and high percussion instruments sharp but also puts razor edges on sounds that aren't *supposed* to be sharp. So, try to choose an amplifier whose distortion at *low* power levels is as low as possible. If a manufacturer won't supply the information necessary to glean this, check equipment reports in this and other magazines, many of which show curves relating distortion to power output.

Impedance of the Load. Most solid-state amplifiers made in the US are designed to deliver maximum power at minimum distortion into a load of 6 to 8 ohms. Loads of higher impedance cut down on the amount of power the amplifier can put out,

while lower loads increase the available power—usually at the expense of higher distortion. Nearly all solid-state amplifiers are equally impedance-sensitive in this way, so the way to get maximum power transfer from amplifier to speaker is by choosing a speaker whose impedance varies as little as possible from its nominal value, from the highest to the lowest frequencies.

Generally speaking, electrostatic speakers have the worst impedance characteristics of any. Some full-range designs vary from 30 ohms at middle-low frequencies to an ohm or so, at extremely high frequencies, and most of them drop to a fraction of an ohm at ultrasonic frequencies (Fig. 2). Some solid-state amps have been designed specifically for use with electrostatics (the Quad 33, for example) and work very well

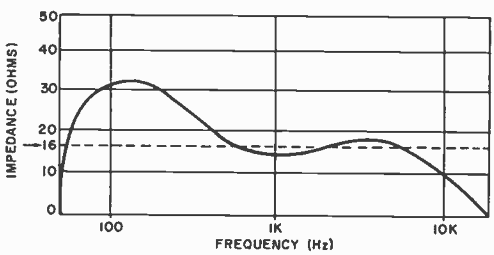


Fig. 2. This is a typical impedance curve for full-frequency-range type of speaker; nominal impedance, 16 ohms.

with them; but by and large, transistor amplifiers are just not very "happy" with electrostatic loads—particularly full-range electrostatics.

Tube-type amplifiers, on the other hand, are ideal for driving electrostatics, because they are far more tolerant of the electrostatic's impedance variations, complementing the sound.

One of the things that make electrostatic tweeters such accurate reproducers of the detail and "snap" of natural sounds is their outstanding transient response. This can become a liability when the program material itself is a little sharper than it might be. And while much solid-state equipment is extremely good, some of it has a tendency to add its own sharpness or hardness to the sound. Tube equipment, on the other hand, may go in the other direction —the better the component, the less it tends to soften or sweeten the sound. With virtually the whole audio industry, from

recording studio to home hi-fi manufacturer, using solid-state equipment, the accumulation of hardness is such that electrostatic speakers may end up sounding more musically natural—while their associated electronics soften the sound a bit (which is to say, when they are used with tube-type components).

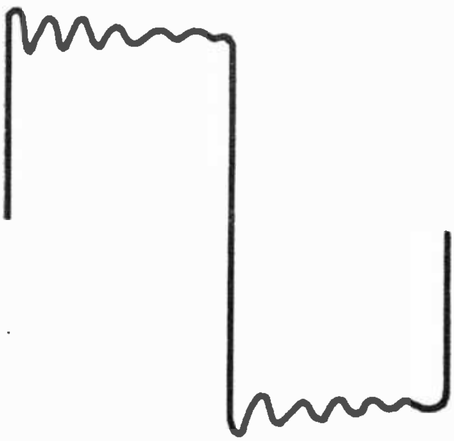


Fig. 3. A 1000-Hz square wave from power amplifier with marginal high-frequency instability (or ringing).

Of course, not *any* tube-type amplifier will do better with electrostatics than any solid-state amplifier. As a matter of fact, the wildly reactive load that electrostatics impose on the amplifier puts really extreme demands on the stability of the amplifier's feedback circuits. Many tube-type amplifiers either oscillate or produce damped oscillation (ringing) into an electrostatic load. So the amplifier you choose for your electrostatics should either be one that was specifically designed for electrostatics or one whose literature touts its rock-solid stability to the point where you have to believe that *some* effort went into stabilizing it.

Again, those test reports in magazines often show square waves that can be a good index of an amplifier's stability.

Solid-state amplifiers, too, can suffer from instability problems; and, while dynamic speakers aren't as likely to give them hysterics as do electrostatics, marginal instability (ringing), as evidenced by wiggles all the way across the tops and bottoms of square waves, can make them sound more fiery or "shimmering" than they could or should sound (Fig. 3). Different speakers tend to bother marginally unstable amplifiers more than others, and speakers with irregular or widely varying impedance curves are usually the worst. Rather than hope the speaker won't trigger things, though, it's safest to select a highly stable amplifier.

Bass Performance. A loudspeaker's bass performance too is often affected by the amplifier, in ways that have nothing to do with the intrinsic quality of the amplifier. All cone-type woofers have an inherent resonance at some frequency, and designers usually utilize this resonance to extend the low-frequency response of the system. The resonance must be properly damped, though, or the speaker's bass response will either fall off (overdamping) or become uncontrollably boomy (underdamping). Designers usually assume that most of the necessary damping will come from the amplifier, since most solid-state amplifiers have high damping factors. The rest of the damping is then applied acoustically in the speaker enclosure. The result is a nicely controlled, properly balanced low end—at least in theory. In practice, there is a wide range of damping factors available in current amplifiers, and since it is possible to design a speaker for only one damping factor, others may underdamp it while still others overdamp.

There appears also to be a direct relationship between an amplifier's power and its ability to damp a woofer. As mentioned previously, high-powered amplifiers seem better able to control spurious cone motions (underdamped vibrations), even at low listening levels and in comparison with lower-powered ones having the same damping factor.

This is one situation, however, where there is no substitute for listening tests, since loudspeaker manufacturers do not specify whether their products need high or low power or damping factors; and many in fact deny that these things have any effect on their speakers at all. Nonetheless, it is often possible to straighten out a case of thin or flabby bass by switching to another amplifier that provides less or more damping on the cone. Tube amplifiers, by and large, tend to underdamp most modern loudspeakers, and although the richly liquid quality of their bass is very pleasing, the net result with some dynamic speakers may prove to be a somewhat floppy low end. ◈

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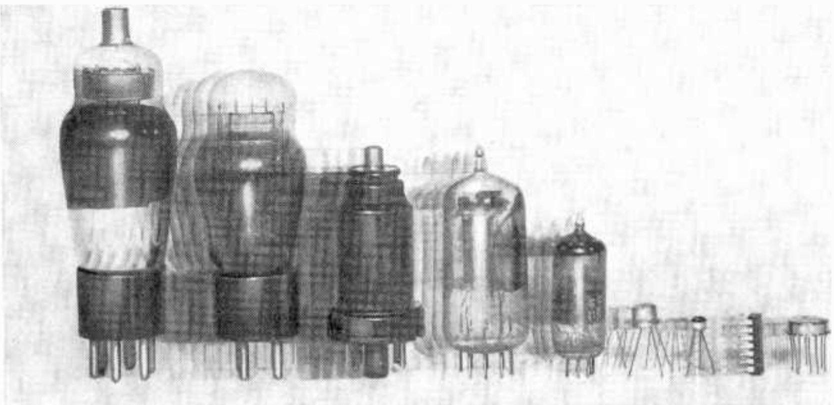

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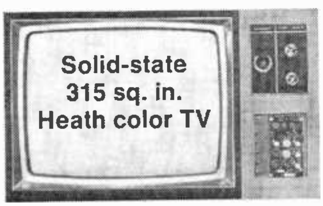

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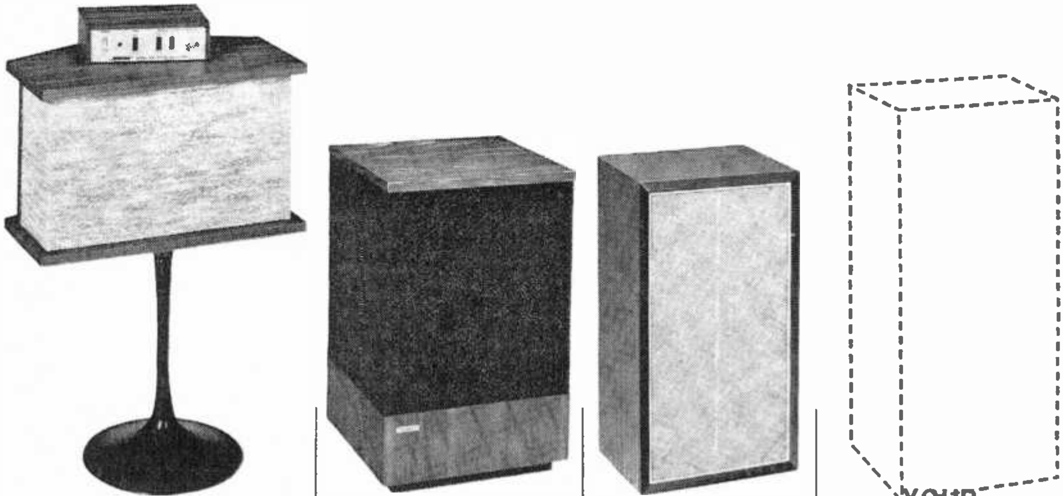

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3 The use of an optimum combination of direct and reflected sound — to provide the spatial fullness characteristic of live music.

4 The use of flat power response instead of the conventional flat frequency response — to produce the full balance of high frequencies without the shrillness usually associated with Hi-Fi.

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† Copies of the Audio Engineering Society paper, 'ON THE DESIGN, MEASUREMENT AND EVALUATION OF LOUDSPEAKERS', by Dr. A. G. Bose, are available from Bose Corp. for fifty cents.

CIRCLE NO. 4 ON READER SERVICE CARD

News Highlights

Signs of Better Times

American consumers will buy over two million solid-state color-TV receivers this year, more than double the number purchased in 1972, according to William H. Anderson, Div. Vice President, Marketing, for RCA Consumer Electronics . . . Electronic component shipments continued their upward trend in the beginning of the year . . . Solid-state sales show significant increases during the first five months of 1972, according to the Electronic Industries Association . . . FM radio moved closer to a break-even point last year with a sharp rise in time sales and revenues that brought about a substantial improvement in its overall operating deficit, according to the National Association of Broadcasters . . . A survey among exhibitors in New/Com '72 (trade show for electronics parts distributors) indicates that the show was about a $20-million marketplace.

Licensing Rules for Ham Repeater Stations

Beginning July 1, 1973, a separate station license will be required for every amateur repeater station. These stations will be identified by a call sign having the prefix "WR." In order to qualify for a repeater station license, an applicant must be at least a Technician Class licensee and must submit certain data regarding the proposed station. The remote control may be any qualified amateur designated by the licensee. The new rules permit a licensee to use his own repeater station while he is operating mobile or portable. About one-half of each vhf ham band and 9 MHz of the 240-MHz band was authorized for repeater usage, and Technician Class licensees will be permitted to operate in the entire 145-to-148 MHz segment.

Job Market Recovery for Engineers

The 1972 graduating class of engineers and technologists benefitted from a late increase in campus hiring by industrial employers. As a result June graduates were largely successful in finding jobs. Older graduates too found the job market noticeably improved, according to placement directors in most of the nation's engineering schools. Prospects for 1973 already look even brighter, while real shortages of engineering graduates are envisioned three or four years from now when the small freshman and sophomore classes currently enrolled complete their basic curriculum. This information comes from a survey conducted by the Engineers Joint Council.

Searing Grills for Microwave Ovens

One drawback of the new microwave ovens that are finding their way into home kitchens is that the ovens will not sear steaks and roasts, put crusts on cakes and breads, or fry eggs. All that has been changed now with the introduction by Litton (Minutemaster) and Amana (Radarange) of special searing grills and dishware. The ceramic grills and dishes have imbedded within them some sort of material (probably ferrite) which absorbs the microwave energy and in doing so gets very hot (around 500 degrees). As a result, anything that is placed atop the grill or dish and cooked within the oven takes on a nice seared or browned appearance. This enhances the looks and taste of the food. In some cases the grills are available with deluxe versions of the oven or separately at around $20.

Dynaquad Patent Issued to Dynaco

A U.S. patent has just been issued for the invention by David Hafler of a two-channel, four-component stereo sound system known as Dynaquad 4-Dimensional sound reproduction. This matrix technique is far simpler and less costly for the consumer than other approaches to 4-channel sound. It uses an inexpensive passive decoder at the output of a conventional 2-channel stereo amplifier to separate the signal for four speakers typically located near the corners of a room. It is the only such system which does not require an additional stereo amplifier. It relies on the fact that much ambience information is contained within the ordinary 2-channel disc or tape in the form of a difference (L - R) signal that can be fed to the two rear speakers.

Satellite Earth Stations Being Bought by Russia and China

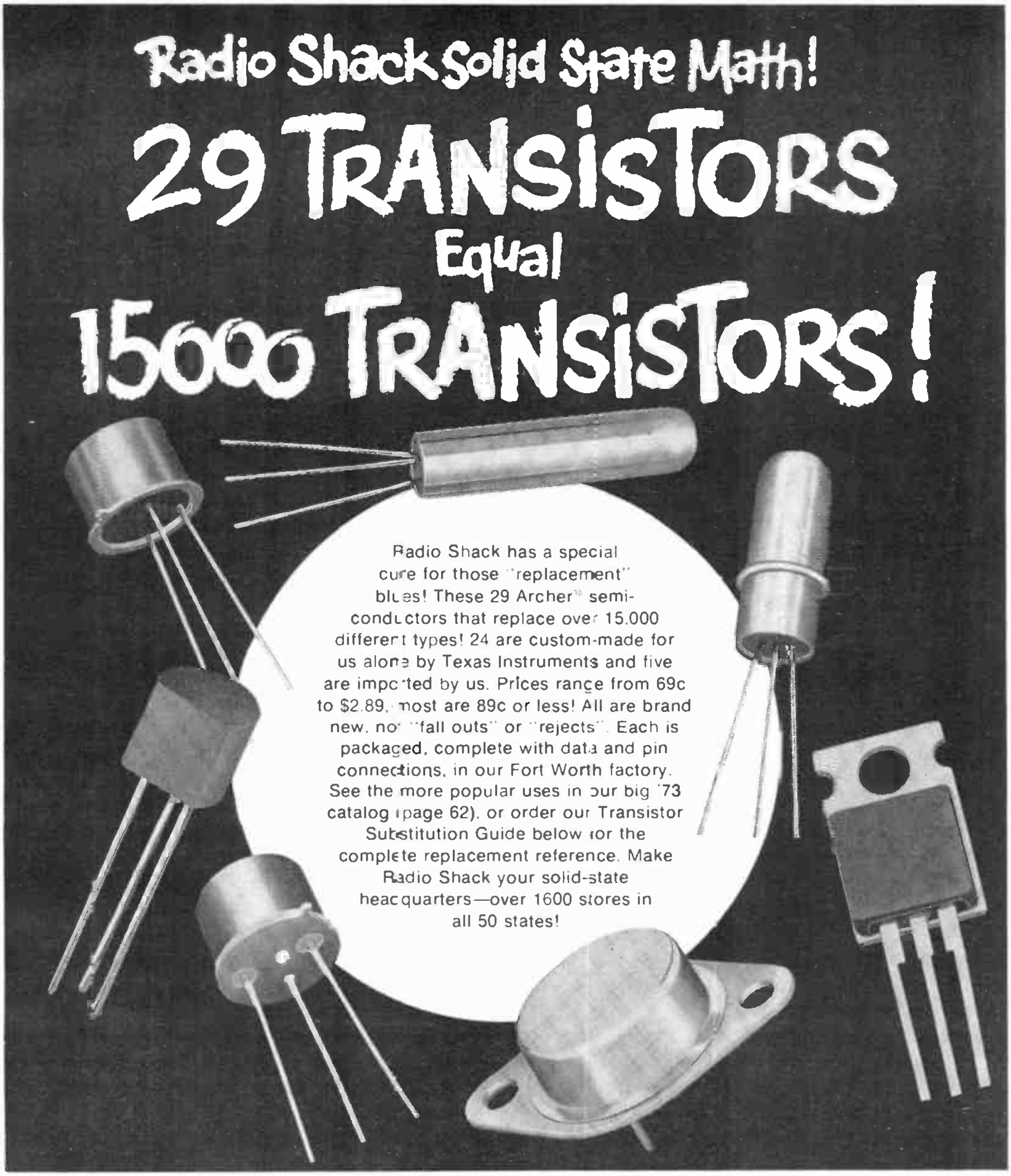
A contract for about $1 million has been awarded by the Soviet Union to ITT Space Communications. This is for earth-station equipment to provide a new Hotline communications link via satellite between the Kremlin and the White House. The equipment includes high-power amplifiers, low-noise receivers, other radio and control equipment, as well as a specialized digital communication system. Orientation and training of Soviet personnel by ITT will also be provided. The Soviets will build their own antenna structure. Also, Western Union International has announced the sale of a satellite earth station to the People's Republic of China. WUI will furnish a 98-foot antenna satellite earth station terminal to be installed in the vicinity of Peking.

N.Y. Enforcing New Noise Law

Using sound-level meters, the new noise-pollution inspectors for New York City recently began checking up on too-loud noise sources around town. Some of the early violators that were found include music stores that make it a habit to attract attention by using an outdoor sidewalk loudspeaker to play some of their wares. Fines range from $50 for an unnecessarily loud radio to $1000 for excessive construction noise after normal working hours. The new regulations are part of the city's Administrative Code; hence, violators may be tagged by the city's policemen. Although there are no overall sound levels which may not be exceeded, each noise source (such as an air compressor, jack hammer, etc.) has a specific sound level in dB that it may not exceed at certain distances. Sidewalk-located loudspeakers are specifically prohibited.

First Domestic Communications Satellite

The world's first domestic synchronous communications satellite has been launched into a 22,300-mile-high orbit. It will link Canada's vast land mass which stretches across six time zones and north from the populous 200-mile-wide strip along the U.S. border to the isolated Arctic ocean. The new 1200-lb satellite, developed and built by Hughes Aircraft and two Canadian subcontractors, is the first of three such satellites ordered under a $31-million contract by Telesat Canada. The satellite is called "Anik," an Eskimo word meaning "brother." It has the capacity to provide more than 5000 two-way telephone circuits or 12 color-TV channels. The satellite's antenna will "see" all of Canada, the second largest country in the world, next to the Soviet Union.



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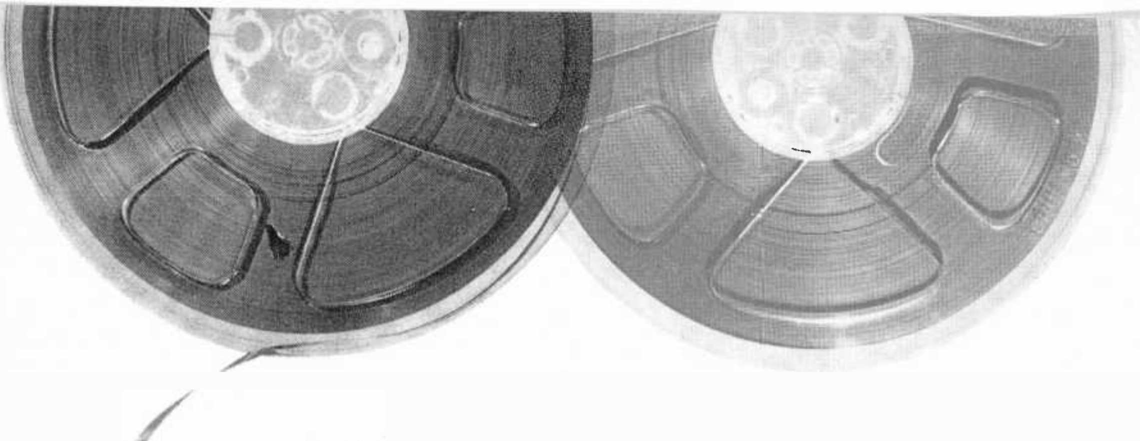


WHICH REEL-TO-REEL

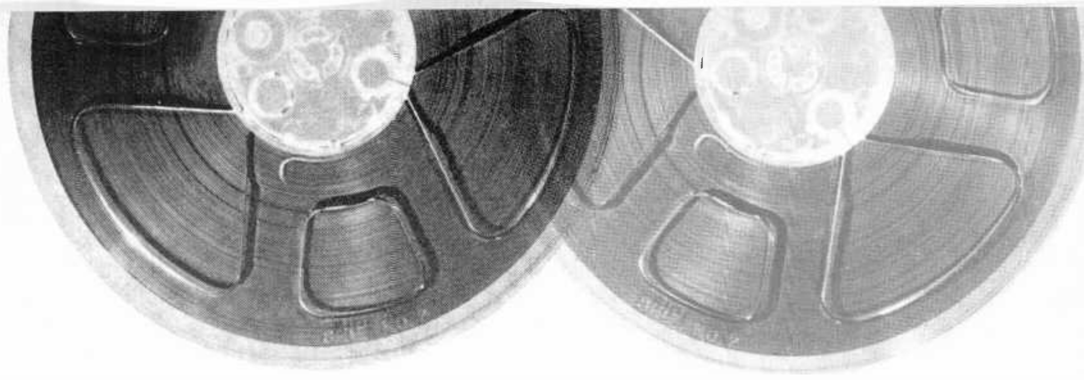
THE PROBLEM confronting serious open-reel tape recordists today is that the very progress that has produced increasingly better tapes has also generated a greater variety of tapes from which to choose. In magnetic recording tapes, there are three basic variables—length, backing material, and oxide formulation. A variety of possibilities also exists within each variable. Moreover, each possible combination is available under many brand names. While it is too much to hope that one particular tape will be in all respects and for all purposes the "best," in making a selection it is helpful to know how each compares with its competitors and what can be done to maximize performance.

There are hundreds of tapes we could have tested. But a line had to be drawn somewhere. For practical purposes, we settled on the brands listed in the tables in this article. Some readers may be distressed to note that we did not test "white-box" or obviously fictitiously branded tapes. For one thing, even if such tapes *were* as good as local salesmen claim, they most likely are not nationally available. We *have* tested many obscure or unknown brands in the past but never found any worthy of consideration for serious recording. Their common faults have been: excessive oxide shedding, improper edge slitting (leading to dropouts and losses of high frequencies), bias and equalization requirements markedly different from normal audio tapes, poor signal-to-noise ratio (particularly characteristic of re-slit videotape "seconds"), and high-frequency response that varied so much along the tape's length that it could not be reliably measured.

We did not test the same oxide coating on various backing materials (cellulose acetate, polyester, and polyvinyl chloride) since the results would have been identical. Some professionals prefer acetate because they feel that it is easier to edit and tends to break cleanly without stretching. On the other hand, the other backing materials have better long-term storage qualities and are inherently stronger. If "tensilized," they also break cleanly without stretching in the event of a mishap.

One development that we feel may be significant is a recent technique for treating the outside surface of the backing material to obtain a rough, matte-like finish. While it is desirable to have the oxide side of the backing material as smooth as possible, the slight roughening of the opposite side permits more even tape winding at high speed and provides a firmer "grip" as the tape passes between the capstan and puck roller during normal play. The latter benefit lessens the danger of "squeals" and erratic tape drive. (Specially backed tapes are noted in the accompanying tables with an asterisk.)

Ultra-thin "double-play" and "triple-play" tapes with 2400′ and 3600′ of tape on a 7″ reel are not generally recommended for critical recording because both the backing material *and* oxide coating thicknesses have been reduced. A thinner-than-normal oxide layer means less undistorted output at lower frequencies where the greatest musical power is encountered and, hence, a poorer potential signal-to-noise ratio. By the same token, we did not test old-style "high-output" tapes that used abnormally thick oxide coatings which



TAPE TO USE?

Lab tests show performance of various tapes with bias and equalization adjusted.

BY SCOTT WAVERLY

yielded a high output at the low end, all right, but tended to accentuate the very high frequencies.

Our tests were limited to 1200′ and 1800′ tapes (for a 7″ reel) from major tape manufacturers whose products are available nationally. (Our apologies to any we may have overlooked.) We were thus left with tapes in three basic categories: "standard," "low-noise," and "low-noise/high-output." All three employ needle-shaped gamma-ferric-oxide particles as the magnetic medium since "cobalt-doped" and "chromium-dioxide" (CRO_2) coatings are still largely restricted to tapes in the cassette field.

Recording Process. To understand the differences between tape types and to properly interpret our test results, it is necessary to consider some of the basic factors involved in the process of magnetic recording. We begin with "bias," which is a supersonic alternating current (usually 50 kHz to 150 kHz) fed to the record head along with the audio signal to be recorded. In the proper amount, bias current achieves the two objectives of drastically reducing distortion and permitting (up to a point) a higher signal level to be recorded on the tape. The higher the undistorted recording level can be made, naturally, the larger will be the ratio between the desired "signal" and unwanted tape hiss, otherwise known as "noise."

Unfortunately, the bias current level that yields maximum recorded output at middle and low frequencies (commonly 400 to 1000 Hz) tends to attenuate the extreme high frequencies, essentially by partially erasing them as fast as they are recorded. The treble signals do not penetrate as deeply into the oxide layer as do the low-frequency tones and are more susceptible to erasure. Paradoxically, in much larger strength, the bias current, without which undistorted recording is impossible, is the same as that fed to the erase head for the purpose of eliminating previous signals recorded on the tape.

There are several things that can be done to offset the high-frequency losses encountered during recording. No tape head is perfect; all exhibit a 6-dB/octave rise in output with increasing frequency. So, if a tape on which all audio frequencies were recorded at a *constant* flux level were to be played back on a tape recorder, the output signal would double in level every time the frequency doubled. This is because the playback head responds to the *rate of change* from one magnetic pole to the other on the tape. There are twice as many changes in the octave from 100 Hz to 200 Hz as there are in the octave between 50 Hz and 100 Hz. Consequently, playback heads tend to introduce some low-frequency variations, particularly at the very low speeds, and contribute a few dB of treble loss. Over most of the audio range, however, they do follow the 6-dB/octave rise described. And, since this cannot be permitted, standardized "playback equalization curves" are introduced to provide a complementary bass-boost/treble-cut of 6 dB/octave to even out the overall record/playback response. NAB curves for playback equalization at 7½ ips and 3¾ ips speeds are shown in Fig. 1.

If there were no treble losses to be con-

	Bias Noise (Weighted)	Bias Noise (Unweighted)	400-Hz Output for 0 VU Input	400-Hz Output for 3% THD	(S + N)/N (Weighted)	(S + N)/N (Unweighted)	(Results are referred to 1 k) 3k	5k	7k	10k	12k	15k
	Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8	Col. 9	Col. 10	Col. 11	Col. 12
	(All figures are in dB)											
STANDARD TAPES												
AMPEX 341	−59.5	−53.0	−0.2	+6.2	65.5	59.0	−0.1	−0.1	+0.8	+1.6	+1.9	+2.7
AUDIOTAPE Formula 10	−58.2	−52.0	+0.8	+7.6	66.6	60.4	+0.1	+0.6	+1.5	+2.5	+3.1	+4.0
BASF SP-52	−59.8	−53.5	−0.1	+9.2	68.9	62.6	−0.3	−0.2	+0.3	+1.2	+2.0	+3.0
IRISH 231	−59.0	−53.2	−0.1	+5.0	63.9	58.1	−0.1	+0.2	+0.7	+1.1	+1.4	+1.8
MAXELL E-35-7	−59.8	−53.7	+0.2	+6.3	66.3	60.2	−0.3	−0.1	+0.4	+0.9	+1.3	+1.5
SCOTCH 111 (Reference)	−59.6	−53.8	±0	+6.0	65.6	59.8	−1.1	−1.4	−1.6	−1.7	−1.4	−1.7
RCA 10M 18	−58.6	−52.9	+0.8	+7.8	67.2	61.5	−0.4	−0.2	+0.2	+1.0	+1.6	+2.3
SONY PR-150	−59.5	−53.2	−0.7	+7.2	66.0	59.7	−0.6	−0.4	−0.1	+0.5	+1.0	+1.4
SOUNDCRAFT S-12	−59.8	−53.8	±0	+7.2	67.0	61.0	+0.1	+0.3	+0.8	+1.4	+2.3	+2.7
TDK 150H	−60.3	−53.5	+0.3	+9.1	69.7	62.9	−0.2	+0.2	+0.9	+1.9	+2.6	+3.4
LOW-NOISE TAPES												
AMPEX 344	−63.1	−55.3	−1.5	+8.7	70.3	62.5	+0.4	+1.3	+2.4	+3.9	+5.0	+6.3
AUDIOTAPE Formula 15	−61.1	−54.4	−1.2	+7.1	67.0	60.3	+1.0	+2.2	+3.2	+5.1	+6.1	+7.7
BASF LP35/LH	−63.1	−57.8	−0.8	+9.8	72.0	66.8	+0.6	+1.5	+2.7	+4.4	+5.3	+7.1
IRISH 274	−62.7	−55.7	−1.4	+8.5	69.8	62.8	+0.3	+1.4	+2.5	+4.3	+5.4	+6.9
MAXELL LNE-35-7	−63.0	−56.1	−1.0	+8.9	70.9	64.0	+0.8	+1.9	+3.0	+4.9	+5.9	+7.5
MEMOREX 1800	−61.2	−54.7	±0	+9.1	70.3	63.8	+0.9	+2.4	+3.8	+5.4	+6.6	+7.9
SCOTCH 202	−64.0	−57.1	−2.0	+7.1	69.1	62.2	+0.4	+1.2	+2.0	+3.2	+4.0	+5.4
SOUNDCRAFT GTA-12	−58.6	−52.6	−1.7	+8.1	65.0	59.0	+1.3	+2.6	+3.8	+5.4	+6.4	+7.8
WABASH (Primus)	−60.7	−53.1	−1.1	+7.1	66.7	59.1	+1.0	+2.2	+3.3	+4.9	+6.0	+7.5
LOW-NOISE/HIGH-OUTPUT												
MAXELL UD-35-7	−62.2	−54.4	−0.9	+9.6	70.9	63.1	+0.9	+2.4	+3.8	+5.9	+7.0	+8.9
SCOTCH 206*	−62.7	−56.0	−0.2	+10.0	72.5	65.8	+0.2	+1.0	+2.0	+3.5	+4.5	+5.9
SONY SLH-180	−61.2	−53.9	±0	+9.5	70.7	63.4	+0.9	+2.3	+3.5	+5.6	+6.8	+8.0
TDK SD-150H	−60.7	−53.4	+0.7	+11.4	72.8	65.5	+0.9	+2.3	+3.7	+5.8	+6.9	+8.3

Table 1. Measurements on various tapes with bias and equalization adjusted for "Standard" Scotch III.

	Bias Noise (Weighted)	Bias Noise (Unweighted)	400-Hz Output for 0 VU Input	400-Hz Output for 3% THD	(S + N)/N (Weighted)	(S + N)/N (Unweighted)	3k	5k	7k	10k	12k	15k
							(Results are referred to 1 k)					
	Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8	Col. 9	Col. 10	Col. 11	Col. 12
	(All figures are in dB)											
STANDARD TAPES												
AMPEX 341	–58.7	–52.7	–1.1	+9.9	67.5	61.5	+0.1	+0.3	+0.4	+0.1	–0.4	–2.0
AUDIOTAPE Formula 10	–57.8	–51.7	+1.7	+7.8	67.3	61.2	–0.1	0	0	–0.3	–0.8	–1.5
BASF SP-52	–60.0	–53.9	+3.5	+6.8	70.3	64.2	–1.9	–2.5	–2.7	–3.1	–3.3	–4.2
IRISH 231	–58.8	–53.1	–1.0	+9.2	67.0	61.3	0	0	–0.2	–1.0	–1.7	–3.6
MAXELL E-35-7	–60.1	–54.2	±0	+8.5	68.6	62.7	–0.4	–0.6	–0.8	–1.3	–1.9	–3.6
SCOTCH 111	–59.9	–54.3	–0.2	+8.2	67.9	62.3	–1.6	–2.2	–2.9	–4.1	–5.4	–7.0
RCA 10M 18	–58.6	–52.7	+1.7	+7.3	67.6	61.7	–1.3	–1.6	–2.0	–2.7	–3.5	–4.7
SONY PR-150	–59.3	–53.3	+1.1	+5.8	66.2	60.2	–1.3	–1.8	–2.4	–3.5	–4.5	–6.7
SOUNDCRAFT S-12	–59.2	–53.5	–1.7	See caption			+0.6	+1.2	+1.6	+1.7	+1.7	+1.4
TDK 150H	–60.1	–53.9	+3.0	+6.4	69.5	63.3	–1.0	–1.5	–1.7	–2.0	–2.5	–3.8
LOW-NOISE TAPES												
AMPEX 344	–62.6	–55.4	+1.9	+6.6	71.1	63.9	–0.7	–0.6	–0.3	+0.1	+0.2	0
AUDIOTAPE Formula 15	–61.0	–54.4	+0.8	+5.8	67.6	61.0	+0.5	+1.3	+2.0	+2.7	+3.0	+3.3
BASF LP35/LH	–63.2	–56.1	+1.3	+8.0	72.5	65.4	+0.2	+0.7	+1.3	+1.9	+2.5	+2.7
IRISH 274	–62.3	–55.2	+2.0	+6.7	71.0	63.9	–0.4	–0.2	+0.2	+0.7	+0.9	+0.5
MAXELL LNE-35-7	–63.0	–56.2	+1.6	+6.4	71.0	64.2	+0.2	+0.7	+1.3	+2.1	+2.4	+2.6
MEMOREX 1800	–60.3	–53.2	+1.3	+8.5	70.1	63.0	+0.9	+1.9	+2.8	+3.5	+3.7	+3.1
SCOTCH 202 (Reference)	–63.7	–56.5	±0	+6.0	69.7	62.5	–0.1	+0.1	+0.3	+0.4	+0.3	–0.2
SOUNDCRAFT GTA-12	–57.0	–51.7	–3.5	See caption								
WABASH (Primus)	–61.1	–54.6	–1.1	+8.0	68.0	61.5	+0.8	+1.8	+2.5	+3.3	+3.7	+3.5
LOW-NOISE/HIGH-OUTPUT												
MAXELL UD-35-7	–62.1	–55	+3.0	+7.7	72.8	65.7	+0.2	+0.6	+1.7	+2.8	+3.2	+3.5
SCOTCH 206*	–61.8	–55.1	+3.6	+7.9	73.3	66.6	–0.6	–0.6	–0.4	–0.3	–0.4	–1.0
SONY SLH-180	–61.5	–54.2	+3.2	+6.8	71.5	64.2	+0.4	+0.9	+1.7	+2.4	+2.8	+2.8
TDK SD-150H	–60.7	–53.5	+3.8	+8.8	73.3	66.1	+0.2	+1.0	+1.8	+2.9	+3.3	+3.6

Table 2. Test results for tapes with recorder bias and equalization adjusted to "Low Noise" (Scotch 202 reference) tape. The two Soundcraft tapes could not be tested; before reaching 3% THD, they accepted a 400-Hz input in excess of 10.5 VU, at which point the recorder began to contribute its own distortion.

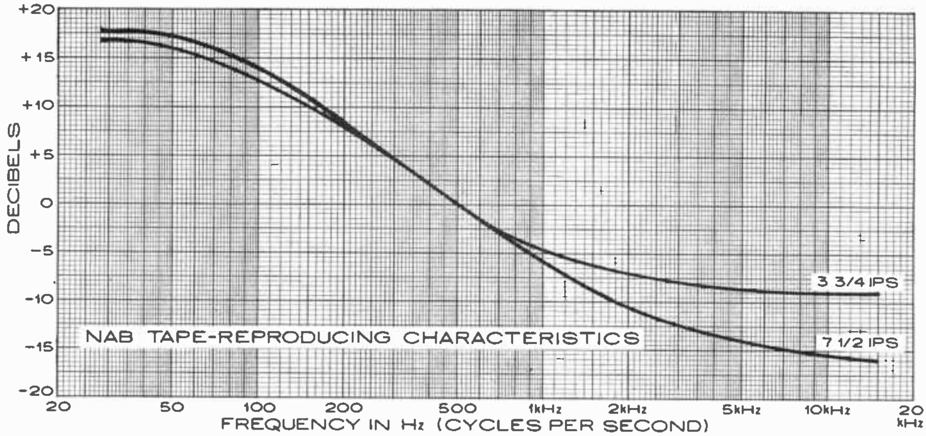


Fig. 1. The NAB tape-reproducing characteristic shows electronic equalization and takes into account the characteristics of the playback head being used. There is reduced treble cut at slow speeds to compensate for normal high-frequency dropoff.

sidered, these curves would continue to slope downward indefinitely. Instead, they level off as shown, departing by 3 dB from a straight-line treble cut at 3180 Hz at 7½ ips and at about 1750 Hz at 3¾ ips. At frequencies *higher* than these "turnover points," the playback head gradually re-asserts its natural rising treble response and helps to overcome extreme high-end losses.

When high-frequency record losses set in, they far exceed the 6 dB/octave slope that the playback head can supply. If overall flat frequency response is to be obtained, considerably more treble boost must be added in the form of "record equalization." This second approach to overcoming treble losses is made possible by the fact that, in music and speech, the very high overtones contain comparatively little power and can safely be "de-emphasized" in relation to the bass range.

There is a limit to the amount of record treble boost that can be safely applied before the tape recorder overloads. Furthermore, every time the treble range is boosted, amplifier circuit noise, most notably in the microphone preamplifier stage where the signal level is very small, is also amplified. By slightly reducing the bias level, less overall treble boost is needed, but this invites distortion. So, the third possible approach to the problem is to use a tape formulation that is "hotter" at the high end of the frequency spectrum than at the low end.

This is where "low-noise" tapes enter the picture. Their rising treble "sensitivity" (higher output for the same input signal) in comparison with standard tapes is not a defect but an asset. This can be easily understood by considering how you offset it in your hi-fi system by turning down the treble control to restore proper frequency balance and lower the audible level of tape hiss. A tape which at 15 kHz shows a +6 dB response is, all other things being equal, *potentially* 6 dB quieter (half as much hiss) at that frequency—*if* the proper adjustments are made to exploit its capabilities.

The correct way to do this for low-noise tapes is to increase the amount of record bias current by about 15 or 20 percent, coupled with perhaps a slight decrease in the amount of record equalization. These are not adjustments the home user can make unless the manufacturer has included a switch for this purpose. Since readers have purchased tape decks adjusted for *either* type of tape, our Tape Comparison Tables show measurements for all brands tested using a recorder set up alternately for optimal results with both standard and low-noise oxide formulations. While acceptable bias current requirements tend to fall into these two categories, within basic types, fine adjustments are needed to maximize the performance of any specific brand.

Regular low-noise tapes do not produce quite as much output for a given recording level as do standard tapes. This partially mitigates their low-noise potential. Recently, therefore, a third basic category, the true "low-noise/high-output" tape, has been developed. By using smaller oxide particles and packing them tightly into a given area, these tapes achieve a dramatic reduction in hiss. Much the same bias and equalization requirements of regular low-noise tape make the new tapes compatible with machines adjusted for low-noise formulations.

Interpreting the Results. To interpret properly the results given in the Tape Comparison Tables, some explanation of our test procedure is in order. Thanks to the generosity of Crown International, we were able to make all measurements on one of their superb SX-822 professional recorders. This greatly reduced machine-attributable errors to a minimum. For reference tapes, we adjusted the SX-822 for the venerable 3M-111 as the "standard" and for 3M-202 for low-noise types.

Our first tests (Columns 1 and 2) were for the noise level induced on the tape by recording it with no input signal at all. This constitutes the lower limit in any meaningful signal-to-noise ratio. We present it in both "weighted" and "unweighted" forms. While only the latter is often used, we feel that this is a mistake because meters respond equally to all frequencies. At very low levels where tape noise occurs, the human ear does not *hear* all frequencies at equal loudness. At low listening levels, the ear does not perceive hum and other low-frequency defects nearly as well as high-frequency hiss. For this reason, our second set of noise measurements was made with a "weighting" network (Fig. 2 ASA "A" curve) that matches human

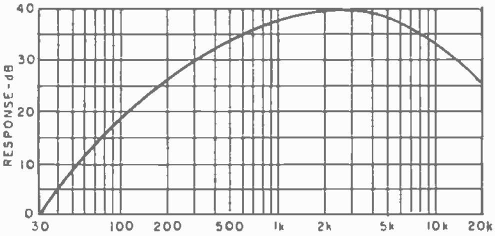


Fig. 2. Filter response follows ASA "A" weighting curve with high extension based on Fletcher-Munson curves.

hearing at low volume levels. This is a more realistic test of tape noise perceptibility. And, as Fig. 3 shows, an unweighted signal-to-noise measurement often contains more low-frequency equipment noise than hiss actually generated by the tape.

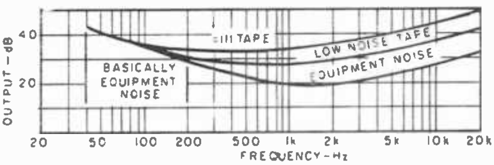


Fig. 3. One-third-octave band analysis of noise. Low-noise tape has S/N ratio 6 dB better than No. 111 tape.

Column 3 of Table 1 indicates the relative output of various tapes tested when all were recorded at the same 400-Hz mid-frequency level. This is important because we often rely on uncalibrated (for a particular tape) VU meters when setting record levels. So, if your recorder is adjusted for a standard oxide, you may tend to under-record a low-noise passage and lose some of its potential advantages. To determine if this is the case, look at the peak permissible (undistorted) recording level in Column 4, conveniently defined by the level which, at 400 Hz, produces 3 percent total harmonic distortion. For best results, your recorder's VU meters should be set to allow 6 to 8 dB "headroom" between the peak record level and a 0-VU indication. For example, if your machine is set for our standard reference tape, but you are using BASF SP-52 you could allow the meter to read up to +3 VU and still have 6.2 dB of headroom, since VU meters do not respond to the peak value of a transient pulse. In this case, recording at a maximum of 0 VU would lose a full 3 dB of signal-to-noise ratio.

The signal-to-noise ratios given in Columns 5 and 6 are the results of Columns 3 and 4 added to Columns 1 and 2. The remaining columns indicate the response of the tape in question compared to its output at the usual 1000-Hz measuring point. All frequency response measurements were made at 7½ ips at the customary −20 dB level.

Our comparison tables show that present day open-reel tapes vary widely in their characteristics. Once you select a brand, we recommend that you have your recorder adjusted for it. Even so, you can expect performance to vary by 1 dB or so from one reel to the next of any specific tape. Fortunately, this difference can be detected only by instruments more sensitive than the human ear. We conclude that, though not ideal, the quality of today's brand-name tapes is very high. ◈

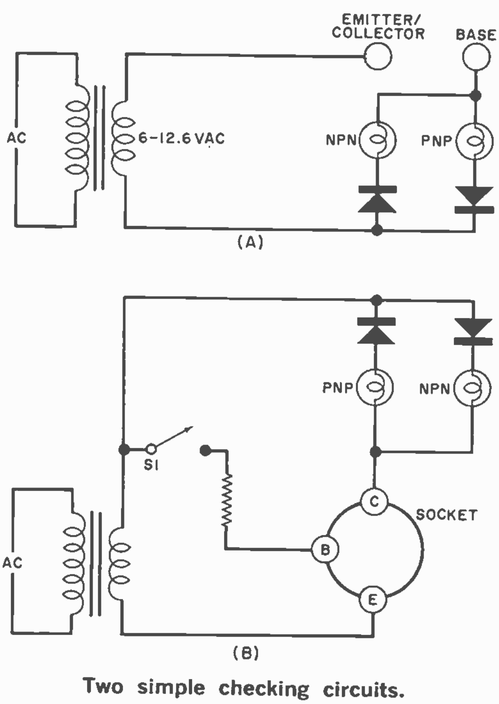
Versatile, Inexpensive SEMICONDUCTOR JUNCTION TESTER

CHECKS DIODES, TRANSISTORS, AND IDENTIFIES TYPES

BY IRA CHAYUT

FOR A FAST, inexpensive way to check the condition of a diode or transistor junction, use the circuit shown at A. The transformer should have a secondary rated between 6 and 12.6 volts (conventional filament type). The diodes can be any silicon rectifier types; and the lamps should be rated for 6 volts at low current.

The circuit can be constructed in any convenient manner. However, the two test contacts (Emitter/Collector and Base) should be about 1 inch apart on the front of the container. The lamp marked NPN should be adjacent to the Emitter/Collector contact, and the PNP lamp should be near the Base contact. Beneath and centered between the two test contacts, install the legend "Lamp Adjacent to Contact Indicates Cathode."



Two simple checking circuits.

To test a diode, connect it between the two test contacts. If neither lamp lights, the diode is open. If both lamps light, the diode is shorted; and if only one lamp lights, that lamp indicates the cathode end of the diode.

Transistor Tests. To test transistor junctions, connect the base lead to the Base test contact and either the emitter or collector to the other contact. The lit bulb indicates the type of transistor. If both lamps light, the transistor is shorted; and if neither lamp lights, the transistor is open.

The test circuit can also be used as a simple continuity checker by connecting a pair of leads to the test points. Note that this is a continuity checker, and even a low resistance in series with the tested circuit will not permit the lamps to light.

Go-No-Go Transistor Tester. If all you need is a simple transistor go-no-go tester, which will identify the type of transistor (npn or pnp) and whether or not it works, use the circuit shown at B.

Operation and components are similar to those in the A circuit. With a transistor plugged into the test socket and with *S1* open, if either one or both lamps go on, the transistor has an internal short. If neither lamp goes on, close *S1*. Then if the transistor is good, one lamp will come on and indicate the type. If neither lamp lights when *S1* is closed, the transistor is open. The base resistor can be any value from 680 ohms to a few thousand ohms.

Of course, you can connect insulated test leads to the three terminals on the socket and terminate these in insulated alligator clips. In this way, you can check transistors that will not fit into the socket. ◈

milestone in space communication

INTERNATIONAL REGULATIONS THAT WILL AFFECT EXTRATERRESTRIAL COMMUNICATIONS FOR YEARS

BY STANLEY LEINWOLL

ON January 1, 1973, a revised set of Radio Regulations assigning frequencies to all forms of space communication went into effect. Hammered out by some 750 delegates from 101 member nations of the International Telecommunications Union (ITU) in the summer of 1971, the Regulations will affect all space radio services, including television, telephone, telegraph, broadcasting, amateur, weather and meteorology, navigation, research, exploration, and radio astronomy.

The 1971 conference, convened as the World Administrative Radio Conference for Space Telecommunications (WARC-ST), and the frequency assignments it made, has been hailed by telecommunications experts as one of the most momentous ever held in the 106-year history of the ITU because it spells out the course of extraterrestrial communication for the remainder of this century.

The ITU is the specialized agency of the United Nations for telecommunications. It has 140 member nations responsible for drafting the rules and regulations that govern the allocation and use of the radio spectrum for international telecommunications.

In the more than 15 years since the Soviet Union launched *Sputnik I* on October 4, 1957, some 1000 spacecraft have left the surface of the earth to orbit our planet, on journeys to interplanetary bodies, and to carry men to the moon and back. In that, short time, space-borne scientific instruments have made and reported innumerable

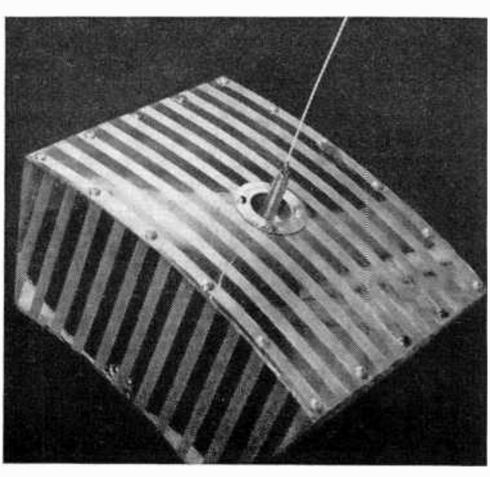
Some of the 750 delegates from 101 countries who attended the space telecommunications conference in Geneva under auspices of International Telecommunication Union.

observations about space and the bodies contained within it. At present, for example, a U.S. spacecraft is hurtling toward a rendezvous with the giant planet Jupiter, after which it will become the first man-made object to leave our solar system.

Frequencies for Communication. Without frequencies with which to communicate, as well as for protection from interference from other services, the spacecraft leaving our planet would be of little value. Communication in one form or another plays a vital role in every satellite departing earth. Scientific data is sent back; astronauts and cosmonauts speak to their ground controllers, giving them essential data; photos and TV pictures of the moon and near planets are beamed to earth via communication links; beacon transmitters on board spacecraft enable pinpoint tracking from earth stations; and even the most minute movements of satellites can be controlled remotely from earth by means of radio-controlled links.

Global communication has also come to rely more and more heavily on satellites. *Intelsat IV,* launched early in 1972, brought to 48 the number of TV channels open between the U.S. and other areas of the world. Communication satellites are currently the only means by which live TV can be transmitted or received from overseas locations. In addition, *Intelsat IV* can carry up to 6000 simultaneous two-way trans-oceanic telephone conversations under average conditions. This revolution in communication is

An OSCAR satellite built for radio amateurs. Six such have been orbited.



dependent upon frequency assignments, and the 1973 Regulations make ample provision for frequencies to be used by such services.

The following bands will now be used to transmit signals between communication satellites and the earth:

2500-2535 MHz	10.95-11.20 GHz
3400-4200 MHz	11.45-12.20 GHz
7250-7750 MHz	12.50-12.75 GHz

(GHz = MHz X 1000)

In addition, several bands have been allocated above 12.75 GHz for development in the distant future.

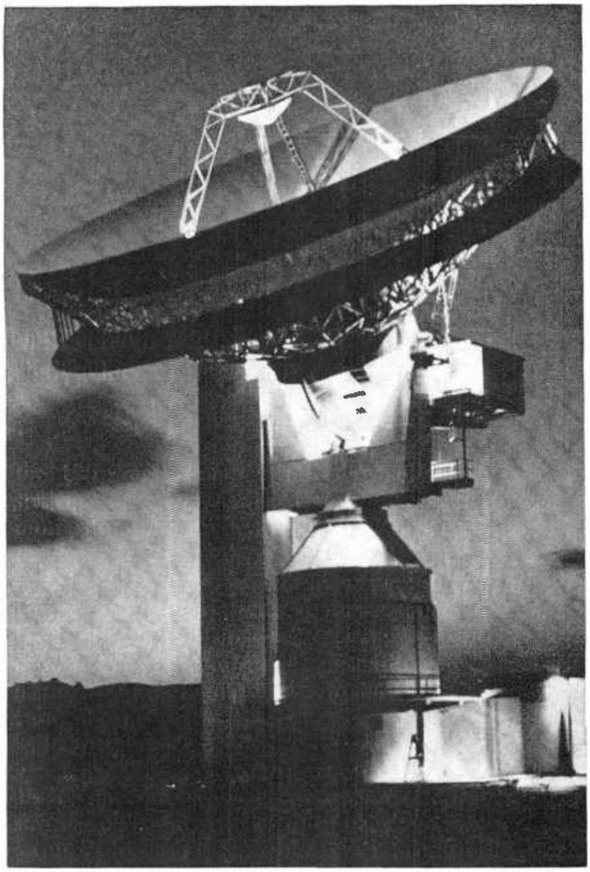
Although broadcasting from satellites *directly* to home installations is not yet technically feasible, the revised Radio Regulations allocate frequencies to the *broadcasting satellite service* in anticipation of its eventual development. In the western hemisphere, such transmissions were authorized, with certain technical limitations (i.e., frequency-modulated video), to protect terrestrial TV stations on uhf TV channels 39 through 66. This will permit the development of broadcasting satellites (probably not before the end of this century) on existing TV channels so that advantage can be taken of the large number of receivers now available in this range.

Another broadcasting allocation was made in the 2500-2690-MHz range to permit broadcasting to special receiving installations at schools and in community centers, primarily for educational purposes. The U.S. and India jointly plan to test community broadcasting from a satellite during 1974.

The new Radio Regulations also allocate 11.7-12.2 GHz (12.75 GHz in Europe and Africa) to the broadcasting satellite service. Since there are no TV stations operating in this range at the present time (and no receivers), this will eventually require the development of an entirely new TV system. This is probably the first step in the evolution of 21st century television.

Additional broadcasting allocations were made in several higher bands, but they amount to stake-outs for development in the very distant future.

Radio Amateur Frequencies. The radio amateurs came out very well under the new Radio Regulations. Always in the forefront of communications developments, six satellites (called OSCAR's for Orbiting Satellites Carrying Amateur Radio) designed and built by



This is a satellite earth station at Cayey, Puerto Rico. Some 70 similar stations in 50 countries link world by satellite. (Photo courtesy COMSAT).

hams have already been successfully launched. Allocations to the *amateur satellite service* were made on the following frequencies:

7.0-7.1 MHz	144-146 MHz
14.0-14.25 MHz	435-438 MHz
21.0-21.45 MHz	24-24.05 GHz
28.0-29.7 MHz	

A new satellite service was defined at the 1971 ITU conference. It was called the *earth exploration satellite service*. Satellites in this service, which include those employed for meteorological uses, will gather information relating to the characteristics of earth and its natural phenomena. These satellites should make possible more accurate weather forecasting and are expected to provide an accurate cataloging of the earth's resources. Allocations in 10 discrete bands from 137 MHz to 22 GHz were assigned to this service.

There were some additional allocations made for manned and unmanned satellites in the *space research service*. These are channels used to transmit telemetry data back to earth and for beacon and tracking signals. Some 24 different bands were allocated to this service on frequencies ranging from 2501 kHz to 8500 MHz. Still other assignments were made above 10 GHz.

Frequencies for Other Services. A standard frequency for satellites has been established at 400.1 MHz (± 25 kHz), and time signals will be transmitted from satellites on two additional standard frequencies —4202 MHz and 6427 MHz, ± 2 MHz.

Anticipating that manned spacecraft will someday require assistance during an emergency in space, the following frequencies were allocated for emergency transmissions and for search and rescue operations in space:

2182 kHz	14,993 kHz
3023.5 kHz	19,993 kHz
5680 kHz	121.5 MHz
8364 kHz	156.8 MHz,
10,003 kHz	243 MHz

The 1973 Regulations envision greater utilization of satellites for navigational purposes and the eventual development of satellite systems that will permit aircraft and ships to communicate via satellites. Some 13 bands have been assigned to the *navigational service* for these purposes.

In addition to signals transmitted from man-made space objects, there are other radio signals that originate deep in space. Among these are natural radio emissions originating in the sun, the planets, and stars (and other objects such as pulsars and quasars). To protect these extremely weak signals that reach our planet, the Radio Regulations set aside a large number of narrow slots throughout the radio spectrum for use in the *radio astronomy service*. Use of the frequencies set aside for this service is prohibited from spacecraft, and restricted use by terrestrial stations has been incorporated into the Regulations. Beginning in 1973, radio astronomers will be assured that signals heard in the bands set aside for their use are not man-made.

The 1973 Regulations that are an outgrowth of the 1971 conference represent a milestone in the history of telecommunications. Assignments made by the conferees will be used for the remainder of this century. ◈

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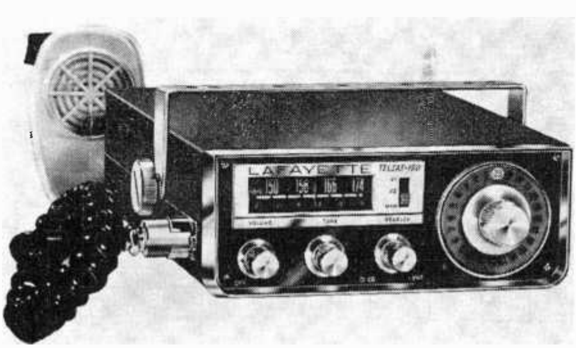
WHAT'S NEW IN

Improved designs and

EVEN if your CB gear is just a few years old, there's a good chance you are getting less performance than a newcomer to CB gets from his equipment; for the newcomer is using the latest in equipment, equipment with performance levels unheard and undreamed of just a few short years back. To be frank, with rare exceptions the high-performance and "gold-plated" gear of yesterday is mediocre vis-a-vis the latest in CB equipment, and that includes just about everything from the transceiver itself to the antenna—and the talk-power boosters, meters, and preamps connected between the two.

Your Signal Starts in the Transceiver. The really big news in transceivers is the mini-packaged SSB (single-sideband) rigs such as the Teaberry "Twin T" (Olson Electronics) and Pearce-Simpson "Cheetah," just to name two. Although the total number of components in an SSB rig is many times that of an AM rig—because strange as it might seem it takes a lot of hardware to get rid of the carrier and one sideband, and then put it back when receiving—you can now obtain *quality* SSB equipment no larger than a standard AM transceiver having a front-facing speaker.

Lafayette "Telsat 150" has built-in monitor for Public Service Band calls.



This puts SSB right up there with AM for all-around use because an under-dash-sized mobile SSB can be teamed with the Tram, Browning, SBE, and Lafayette single-sideband rigs used at the base station.

It's important to keep in mind that the mini-packaged SSB transceivers are not just stripped-down versions of larger base-station models—or models used in base stations although they can work off a 12-volt battery. Although mini-packaged, the new mobile SSB rigs include, among other features, power output metering, built-in SWR detectors, full-size speakers, and 23-channel coverage.

AM rigs have not been forgotten, for AM is still the backbone of CB. After many years of upgrading AM equipment with better noise limiters, noise blankers, and the latest in solid-state design, the new look is total miniaturization of *full-feature* 5-watt equipment. Many manufacturers now put out a full-5 transceiver actually small

CB EQUIPMENT?

unique circuits boost CB performance

BY HERBERT FRIEDMAN

enough to be concealed in an auto or truck glove compartment with the door closed. Typical examples of the miniaturized full-feature transceiver are Radio Shack's "Mini-23," Lafayette's "Micro-23," and Midland's 13-873.

Besides full 23-channel coverage and 5 watts input, these ultra-small rigs feature extremely low current requirements for standby, receive, and transmit; something on the order of 50 to 100 mA when receiving and 500 to 800 mA when transmitting. This means that a small battery pack made up of ordinary "C" or "D" cells will deliver several hours of full power operation; making them ideal for field use.

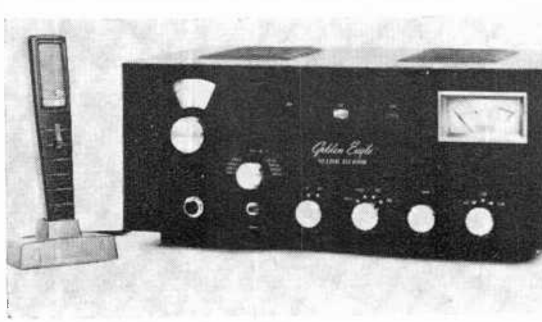
But, if you don't feel like rolling your own battery packs, the miniaturized transceivers are usually available with an optional battery pack that clamps to the transceiver itself, making an integral, fully portable "base" station.

Although the new SSB and AM transceivers have the most appeal because they're "different," don't overlook the improved performance from new models of standard-size and "deluxe" base equipment. Again we find the latest in solid-state design to improve both sensitivity and selectivity, as in the Browning "Golden Eagle" series, Courier's "Conqueror," Dynascan's "Cobra 132," E. F. Johnson's "Messenger 124-M," Mark's "Sidewinder 46" Pace's PBS-1, Regency's "Formula 23," and Tram's "Corsair"—just part of the list.

In addition to beefing up the performance of standard-sized transceivers, the newest models might also feature automatic clocks such as you'll find on the Pearce-Simpson "Simba," the SBE "Sierra," the Fanon SFT-500, and the Courier "Citation." The autoclocks are nothing more than digital readout clocks such as you would use at bedside, but they are connected to the transceiver's power supply so the rig can be turned on at a preset time to receive a scheduled call or to automatically warm-up for your shift at channel-9 monitoring.

Dual Receive Capability. Speaking of channel-9 monitoring, it was only natural that, with the opening of channel 9 as an "emergency only" frequency, more and more CB'ers would become active in the REACT program and in local emergency

Browning's "Golden Eagle" Mark III SSB transmitter is solid-state design.



Pearce-Simpson "Cheetah SSB" is one of new breed of "mini" transceivers.

teams. Naturally, it's hard to keep an ear on channel 9 if the rig is working on some other channel, so some transceivers are now available with *dual receive capability*, or DRC as it is more commonly termed.

DRC simply means that there are two independent receiver sections as part of the transceiver—there is only one transmitter. One receiver section is the main receiver which features maximum sensitivity and selectivity and it is ganged with the transmitter—just as it is in any standard transceiver. The second receiver is crystal-controlled only on channel 9 or possibly one other switch-selected channel. This receiver features moderate sensitivity and selectivity so that you do not receive a station beyond the range of your transmitter, or one that might be so far off the center channel it would get buried in the noise level of a super-selective receiver. The channel-9 receiver section has its own independent squelch control and a mode switch that determines in what manner you will be warned there is a signal on channel 9. In the override mode, the channel-9 signal breaks in on the main receiver's speaker either at a higher level than the main receiver's signal, or the main signal is completely switched out and only the channel-9 signal is heard. In the indicator mode the main receiver always feeds the speaker; in the event a signal is received on channel 9 a panel-mounted lamp glows to show channel 9 is in use. Since both receiver sections are connected to the same antenna connector and power supply, they are both made inoperative when transmitting; there is no feedback from the transmitter through the channel-9 monitor. Among the DRC transceivers are Lafayette's "Telsat 924" and the E. F. Johnson "Messenger 323-M."

If you have an unused transceiver lying around, you can easily use it for channel-9 monitoring by connecting it to the transmission line of your present transceiver through an *isolation switcher*, a device that couples two transceivers to a single antenna in such a manner that one receiver does not degrade the performance (sensitivity) of the other. (It works like a two-set TV coupler.) So far, the isolation switcher, or coupler, is available from Gold Line, but we should see several more models before long.

Another transceiver feature for those of you active in REACT and emergency teams is the full-feature CB rig with a built in vhf (police-fire-public service) monitor,

E. F. Johnson's "Messenger 323-M" mobile rig offers dual-receive capability which permits monitoring of channel 9 while continuing to operate normally.

Digital clocks which turn on the rig at preset time are proving popular with CB'ers. This is Pearce-Simpson "Simba SSB" model.

such as the Courier "Chief" and Lafayette "Telsat 150" (also available with a low-band monitor as the "Telsat 50"). The monitor sections are actually complete and independent receivers except for the audio amplifier, which is shared with the CB receiver section.

Of course, if you want just straight, dependable communications at low cost, there are the modern, late-version standard transceivers such as the Radio Shack "Navaho," Robyn "XL-ONE," Mark "Invader 23," and Pace "P123," to name several of the many, many low-cost models which offer either full 23-channel coverage or just a few "user added" channels.

Getting More Out Than You Put In. Paradoxically, as most transceivers get smaller the antennas get larger; at least the base-station antennas are getting larger. The mobile antennas—with a few exceptions—remain the same; they're just easier to mount.

The ground-plane and coaxial antennas are just about passé except in low-cost installations or where maximum working range is not of primary importance. Regardless of the available space or mounting requirements, there is now some kind of "power-boosting" antenna for just about every installation. By compressing the radiated power into a relatively narrow beam, the effective radiated power, or ERP, is many times that of a 5-watt rig working into a ground-plane or coaxial antenna. Simple stretched or oversized ground planes such as the Avanti "Astro Plane," Hy-Gain "Super CLR," Mini-Products CCB-1, and Antenna Specialists "Polecat M-417" boost your signal on the ground—where it does the most good—to the equivalent of a 10- or 12-watt transmitter. A highly directional antenna—which requires a rotator because it beams the signal in one specific direction, can boost your signal to the equivalent of a 100-watt rig or greater. As a general rule, the larger the antenna the greater the "forward gain," or ERP. Every major antenna manufacturer makes a line of directional beams priced to fit every budget. At the bottom end of the price range, about $35, you will pick up from 3 to 8 dB forward gain, while moving up to $100 will buy 10 dB or greater forward gain, even as high as 14 dB, and that's better than 100 watts equivalent input power.

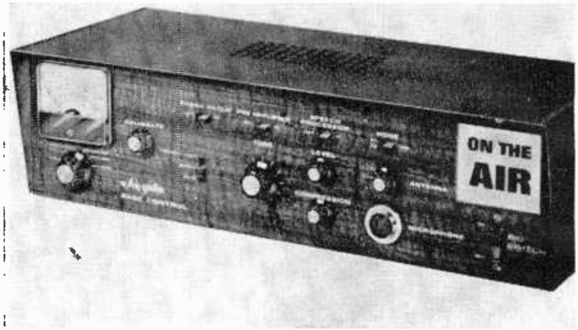
If you have no need to zap out your signal like a laser beam and are willing to get a little broader coverage with a little less antenna gain you can use the Antenna Specialists "Super Scanner MR-119," a directional antenna whose compass heading is changed by simply rotating a switch located adjacent to the transceiver. No antenna rotator is needed.

Beam antennas make such a startling improvement in signal coverage that we're starting to see mobile beams intended for installation on standard automobiles. Models such as the Shakespeare co-phased 464 and the Hustler "Double-Talk" are superior in mobile performance to the ordinary mobile whip, but you must pay for two antenna sections and the interconnecting

Dynascan "Cobra 132" is a compact single-sideband/AM mobile CB rig.

phasing transmission line that connects the two.

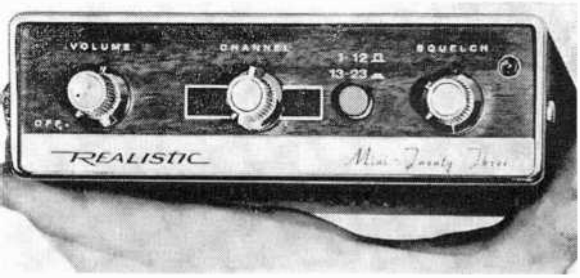
Besides mobile beams the other big news in mobile antennas is more models of the "no-holes" mounting variety. If Honest Tom, your friendly used-car evaluator, has been knocking a few dollars off your trade-ins because your car "looks like Swiss cheese with all them holes," you can beat him the next time out by using one of the "no-holes" mobile antennas such as the Shakespeare 173-2, Antenna Specialists "Quick-Grip", and Cush Craft "Squalo." These antennas and many others attach to the car body through ingenious clamps or suction cups, and leave no marks when they are removed.



To measure operating parameters, base station control from HY-Gain has meters, speech processor, preamp, etc.

Putting Out the Big Signal. Under the best of circumstances the signal from a transmitter-antenna combination can be improved by cramming extra talk-power on the carrier. After many years of picking up 6 dB or so of talk-power through speech compressors and processors, thanks to new solid-state devices, you can almost duplicate the 10 dB and greater talk-power boost of your local rock-and-roll station. And you can get the 10-dB boost without generating distortion or otherwise garbling the modulation. Several optional microphones such as the Turner M + 3 have a built in compression amplifier that just about duplicates the 10-dB and greater talk-power boost of rock stations. If you just want the compressor to use with your present microphone, there's the Raytrack "CB Autolevel"—among other optional talk-power boosters. Should you just want a little extra microphone gain with compression (because your rig has one built in), there are microphones with preamplifiers built into the base, such as the Pinto "Preamp Base Microphone."

Radio Shack "Mini-23" is full-5 but fits easily into a glove compartment.



To insure optimum performance from your equipment, there are low-cost devices which connect in series with the transmission line—between the transceiver and antenna—that measure just about every important operating parameter. There are add-on modulation meters to insure your talk-power booster doesn't cause overmodulation, SWR meters, and even power-output meters that indicate the power actually going into the antenna system, rather than the power the rig can deliver to a dummy load.

With these low-cost instruments you can instantly tell if something's gone wrong with the rig's modulation, if an antenna defect has caused the SWR to increase, or if the rig's output is slowly dying.

Should you need more than one of these in-line test instruments, you can obtain a "control console" such as the Hy-Gain "Base Station Control" that includes all the metering plus a speech processor and a receiver preamplifier. Also included is a phone patch and antenna control switches.

Don't overlook a phone patch even if you don't get a control console. With a phone patch, you can let the traveller stranded with a flat tire talk directly to the towing service through your transceiver and telephone. (An important item for channel-9 monitors.)

Although the list of CB equipment for '73 is extensive, if previous experience with CB manufacturers is any guide, new items will appear in the marketplace faster than you can keep track of them. And the plain fact is that regardless of how you operate your CB station and no matter what your particular CB interests, in '73 there's a new way to do it better. ◈

Electronic Wrist-watches

TINY QUARTZ CRYSTALS AND IC'S ARE REVOLUTIONIZING THE WORLD OF TIMEKEEPING

ELECTRONICS is currently creating a major revolution in the staid old world of timekeeping. Wristwatches designed to gain or lose no more than a minute a year are already beginning to take a prominent place in the market. Some are selling for less than $125, and the price is realistically expected to drop even lower in the near future. The new electronic timepieces require little or no cleaning or adjustment. Nor is it necessary for the wearer to wind his watch daily; the electronic watches operate a year or more on a single miniature battery.

The new generation of electronic timepieces is the offspring of a logical mating of the quartz crystal with newly developed solid-state devices—emphasis in the latter area being on COS/MOS (complementary-symmetry/metal oxide semiconductor) integrated circuits. Steering away from traditional mainsprings, gears, and cogs, the new timepieces keep time via a tiny bar of quartz crystal and an integrated circuit which provide an accuracy heretofore unattainable in even the most expensive mechanical movement in consumer watches.

The quartz crystal is the key to the precision timing in the electronic watch. But new developments in solid-state technology are what must be credited with bringing the electronic watch onto the consumer market according to Harry Weisberg of RCA's Solid State Division, pioneer of the new COS/MOS technology in IC's.

Mr. Weisberg explained: "The principle of using quartz as a time base is not new. It has long been employed in laboratories, by the U.S. Naval Observatory, and in other applications requiring precision timing. However, the introduction of quartz into consumer watches had to await a technology such as COS/MOS which could reduce the cost, size, and power requirements of the electronics associated with the quartz approach."

Indeed, COS/MOS technology has blossomed, and with it, the electronic wristwatch. More than a dozen U.S., Swiss, and Japanese firms are either developing or marketing electronic timepieces. Among them are the most prominent names in the industry; Hamilton, General Time, Patek Philippe, Omega, Timex, Longines, Bulova, and Seiko, to name just a few. Most of these employ COS/MOS-type circuits supplied by such top names in the field as RCA, and Motorola.

Operating Principles. All of the current batch of electronic wristwatches operate in basically the same manner. When power is applied to the quartz crystal, the crystal's piezoelectric property generates a high-frequency signal, commonly in the 30,000-to-50,000-Hz range. (The smaller the crystal, the higher the freqnency.) The high-frequency signal is then divided by an integrated circuit to yield a 1-Hz (1 pulse/sec) output signal which is used to drive either conventional mechanical hands or is decoded to drive seven-segment readouts.

The excellent stability of the quartz crystal—an attribute that has also made the crystal the frequency controlling device for broadcasting radio signals for decades—and its ability to produce the high-frequency signal account for the accuracy of the electronic watch. In effect, the quartz crystal splits a second into 30,000 to 50,000 parts as compared to the 360 parts produced by the tuning fork used in the most accurate conventional watches.

The greater the number of parts into which a second is split, the greater the obtainable accuracy. However, the electronic watch's frequency is determined by a cost/power tradeoff. A smaller high-frequency crystal is less expensive than a larger crystal of lower frequency, but it requires more power.

The greater accuracy of the quartz crystal approach also results from the elimination of the traditional mechanical parts whose precision is determined by the care exercised in their manufacture but deteriorate in normal use through wear. The substitution of solid-state parts for mechanical devices also means fewer malfunctions. And when repair is required, the problem in an electronic watch can quickly be isolated

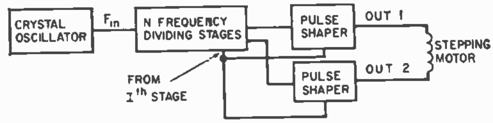


Fig. 1. Simplified block diagram of typical electronic watch with conventional hands. Circuit can be used to drive stepping motor, synchronous motor, or balance wheel. In any case, the motor or wheel drives the hands as found on the typical watch face.

to one of a few components. It is not difficult to foresee the day when component repair of electronic watches will be done away with altogether. Breakdowns will be so infrequent, and the working portion of the watch so inexpensive, that when a malfunction does occur, the entire timing unit will be discarded and replaced with a new one.

The COS/MOS circuit is an ideal teammate for the quartz crystal in an electronic watch. The large-scale integrated circuit COS/MOS chip can contain 1500 or more elements in a space the size of a matchhead and, therefore, fits in with the size requirements of the wristwatch. It also generates practically no heat and is highly immune to electrical noise. But perhaps the principal attribute of the COS/MOS IC for timing applications is its incredibly low power requirement, measured in microwatts (millionths of a watt), which is a tremendous advantage in situations where a small battery must last a long time.

ALL-ELECTRONIC DESK CLOCK

Ness Clocks, Ltd., of Palo Alto, Calif., is producing an all-electronic desk clock built around digital IC technology and liquid crystal readouts. The new $150 timepiece derives its time from a special LSI timing chip. The output of this chip drives a newly developed liquid-crystal readout system. The liquid crystal display is guaranteed for two years. Should it fail, the display can be unplugged from the clock and replaced with a working system in about the time it would take to change a light bulb. The readout is in minutes and hours, with an AM/PM indicator which pulses once each second. Clock accuracy is said to be within several seconds per month.

Analog & Digital Watches. The quartz crystal and IC keep the time. The manner in which the time is displayed falls under two basic categories: analog which retains the traditional moving hands, and all-electronic which displays electronically generated numbers.

In the analog watch, some mechanical features of conventional watches must be retained to control and operate the moving hands. One version employs a stepper motor (Fig. 1), another a tuning fork, and still another the traditional balance wheel. These mechanical devices are driven by the output from the quartz crystal/IC system to achieve electronic accuracy.

The major advantage of the analog electronic watch is its low cost. Hence, the lowest cost electronic watches, expected to be priced at about $50 within a year or two, will almost certainly use a moving-hands display. (An alternative analog movement employs mechanical wheels that display the time in a digital manner.) Whether it uses hands or the digital wheel, the analog watch still has moving parts that are subject to wear and require periodic cleaning, oiling, and adjustment.

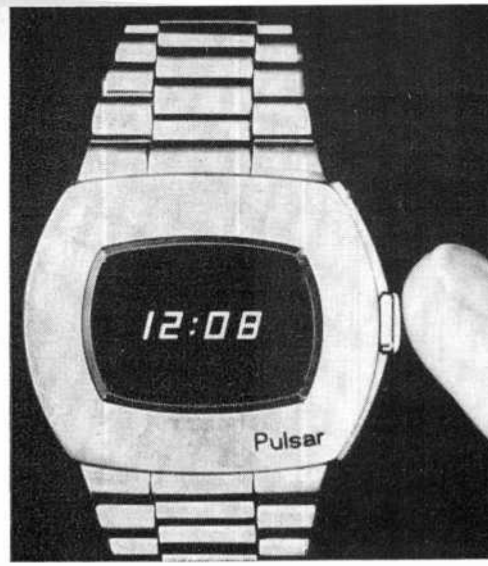
In contrast, the all-electronic watch contains no moving parts to wear out. The output of the IC triggers a display that flashes the time in discrete numerals (Fig. 2). Too, encapsulation of the electronic components eliminates the need for cleaning and oiling.

The readout display for all-electronic watches is a principal area in which technology is still undergoing development. One approach is to use light-emitting diodes (LED's). But LED's are basically power-hungry devices. Using them in a wristwatch with a continuous-duty display cycle is impractical when the only powering source is a small battery. In one LED-display watch on the market, for example, the wearer must push a button to activate the display for a few seconds, after which the display extinguishes. The LED's otherwise would drain the battery in short order.

Liquid crystals are the prime candidate for providing practical continuous-duty readout systems in electronic watches. They require very little driving power, and when teamed with micropower COS/MOS logic, can yield operating lives of a year or more from a single battery. Another advantage of LC's is that they are activated by ambient light. The brighter the light, the more visible and clearer the display. But by the same token, LC readouts cannot be read in darkness since there is no activating ambient light.

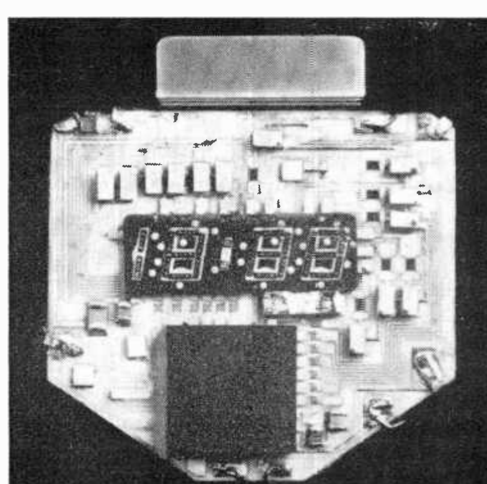
Regardless of the outcome of developments now under way to improve readouts, costs for all-electronic watches are already beginning to come down. As the watches gain in popularity and technical advances are made, major price reductions are envisioned.

Although the most dramatic and visible impact of electronic timekeeping has been in wristwatches, the technology is also



All-electronic Pulsar (Hamilton, HMW Industries) displays time digitally with light emitting diodes which are activated when wearer presses button.

Interior of Pulsar wristwatch. Gray bar at top is quartz crystal, black square is IC, LED readout at center.



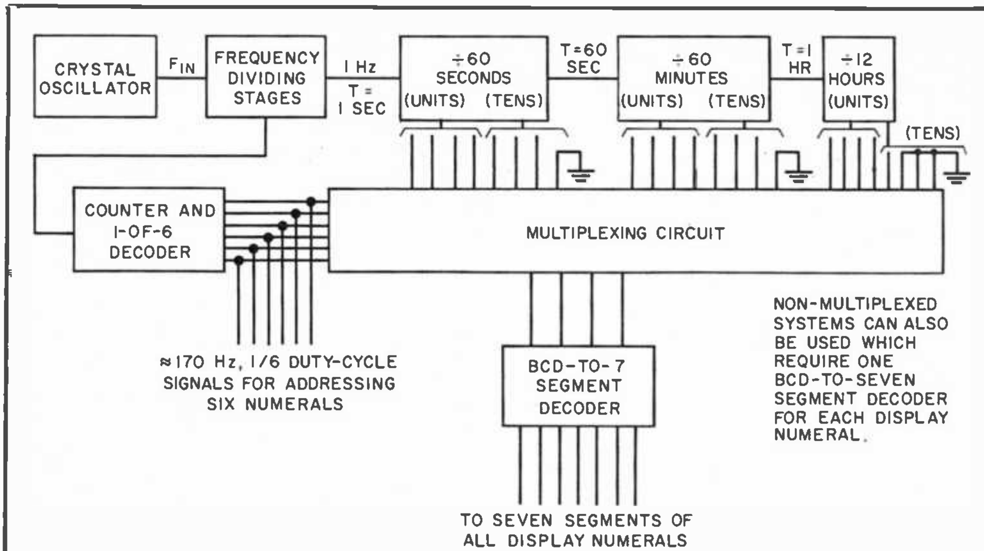


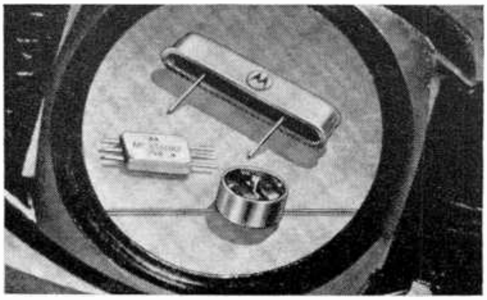
Fig. 2. Block diagram of multiplexed system for producing digital display of time. Non-multiplexed systems can also be used. They require one BCD (binary coded digital) seven-segment decoder for each display numeral.

being put to work in other areas. Desk and wall clocks are also employing the electronic approach. So are industrial timing systems and marine chronometers.

Patek Philippe, the noted Swiss watch and clock manufacturer, is employing COS/MOS circuits in a timing system whose clocks can automatically switch over to small batteries in the event of a primary power source failure. This assures continued operation and eliminates the need for resetting numerous clocks in a large facility. The system is designed for factories, schools, hospitals, and other facilities where uninterrupted precision timekeeping is a must.

Innovative applications such as this, combined with mass marketing of the electronic watch, are giving electronic timekeeping an increasingly important everyday role. It appears certain that by 1980 the electronic watch will dominate that part of the market consisting of watches in the over-$50 price range. In attaining this status, the electronic watch will enable solid-state technology to participate in a total worldwide market in which all types of watches are expected to sell at the rate of 300-million units annually by 1980.

Motorola package has quartz crystal, integrated circuit, and stepping motor.



How far the electronic watch sales penetrate into other segments of the market will depend to a large degree on how much the prices of electronic components can be reduced. Today, four-fifths of all watches sold in the U.S. are priced at $40 or less. Should component prices drop low enough to allow an all-electronic watch to appear on the market for $40 or less, there will be a corresponding increase in the electronic watch's segment of the overall market.

Electronic timekeeping is here now, but it is only recently on the scene. There is still much research and development to be undertaken before a "universal" electronic system is devised. Even so, the electronic watch has already established one fact of central importance to the consumer: The age of near-perfect timekeeping has arrived. Perhaps, if all goes well (and there is no indication that it will not), there is an electronic wristwatch in your future. ◈

UNDERSTANDING SHORTWAVE RECEIVER SPECS

Specifications are important—but also consider features, performance, and price.

BY LEONARD FELDMAN

MUCH has been written about specification "standards" for FM tuners and receivers. To an increasing degree, manufacturers have voluntarily agreed to publish performance specifications that enable the prospective buyer to evaluate the merits of a given tuner or receiver compared with its competition. To a lesser degree, even "broadcast-band" AM receivers are described using performance specifications that are fairly uniform—if they are described at all. Such organizations as the Institute of High Fidelity (IHF) and the old IRE (now IEEE) have promulgated standards for measurement and "spec writing" that are generally followed in part. if not totally.

This is not so in the case of communications receivers, better known as "multiband," "shortwave," or "global" receivers. There are no real standards for shortwave receivers for a variety of reasons. For one thing, there are so many "grades" of receivers, ranging from the inexpensive portables to the sophisticated "communications receivers" used by radio amateurs and more serious DX'ers (long-distance reception

Three representative SW receivers: top, Heath's SW-717 kit; center, Sony's CRF-160; bottom, Zenith's "Trans-Oceanic."

hobbyists) among the SWL (shortwave listening) fraternity. The least expensive of the portables may sell for $50 or less, while a truly fine communications receiver can cost as much as $1000. Small wonder, then, that many manufacturers offer little in the way of published specifications other than "number of transistors" and tuning range covered, while others provide a long list of performance specs and features, replete with technical jargon seemingly calculated to discourage the uninitiated prospective purchaser.

Our purpose here is to provide an interpretation of the published specifications and to enable you to understand some of the seldom-discussed features and "extras" that show up on shortwave receivers and nowhere else. To the extent that some of the "number" specs associated with this type of equipment may be stated in more than one acceptable way, we will explain the differences—and the similarities—so that you will not have to end up comparing the proverbial apples and oranges.

Frequency Coverage. While AM and FM broadcast stations (and, hence, receivers) are carefully regulated by the FCC insofar as their frequencies of transmission are concerned, this is not the case in shortwave or international broadcasting. Stations wishing to transmit over great distances use a variety of frequencies, often switching from one to another because of changes in worldwide reception conditions (brought about by sunspot storms, night-time versus day-time, etc.). Most international transmissions, however, use one of the so-called "International Shortwave Broadcast Bands." These, still archaically identified by their nominal "wavelengths" (meters rather than by the more familiar "frequency," expressed in kHz or MHz), are tabulated in the Table, along with the nominal center-frequency corresponding to the "meter" designation, as well as the frequency extremes of the given "band."

Often, a manufacturer's description lists many or all of these bands as being tunable on a given receiver but does not specify the frequency extremes for each band, which may or may not be as complete as the extremes shown in our Table. We specifically remember a rather expensive multiband portable that we tried to use a couple of years ago to receive a Middle-East transmission that was in the "31-meter band." To our disappointment, we found that the frequency of the transmission was 9.265 MHz, whereas our expensive receiver's "31-meter band" extended down only to 9.4 MHz.

One might suppose that a receiver equipped with fewer bands, each of which covers a wide, continuous frequency range, would be the solution to such problems; but, as we shall show, such is not the case. "Catalog specials" covering the range from "5 MHz to 24 MHz" in one or two bands should be avoided if you plan to do any serious listening. With that much "range" crowded into one or two bands, it is usually impossible to separate closely spaced sta-

THE INTERNATIONAL SHORTWAVE BROADCAST BANDS

NOMINAL WAVELENGTH	NOMINAL FREQUENCY	LOW FREQUENCY END	HIGH FREQUENCY END
13 meters	23.077 MHz	21.45 MHz	21.75 MHz
16 meters	18.75 MHz	17.70 MHz	17.90 MHz
19 meters	15.789 MHz	15.10 MHz	15.45 MHz
20 meters	15.0 MHz	13.85 MHz	14.50 MHz
25 meters	12.0 MHz	11.70 MHz	11.975 MHz
31 meters	9.677 MHz	9.20 MHz	9.70 MHz
41 meters	7.317 MHz	7.10 MHz	7.30 MHz
49 meters	6.122 MHz	5.95 MHz	6.20 MHz
59 meters	5.085 MHz	4.80 MHz	5.15 MHz
61 meters	4.918 MHz	4.60 MHz	4.90 MHz
80 meters	3.75 MHz	3.65 MHz	3.84 MHz

tions on the dial. Remember, international transmissions are numerous and often occur at identical or very close frequencies since there is no one regulatory body to assign specific frequencies to specific countries and every radio service tries to use those "bands" that best lend themselves to long distance reception at given times of the day, month, year, or sunspot cycle. Thus, the *more* bands supplied (and the greater their segmentation), the better, provided that each "band" covers the full range of frequencies assigned to it.

"Number" & "Feature" Specs. While an FM tuner or a hi-fi amplifier's performance can usually be pretty well defined in terms of "number" specs (with controls and other features far down on the list), in the case of shortwave receivers, specific circuits and control features are as important as the number specs and are often directly related to them. Accordingly, the following discussion is divided into two parts: the first dealing with number specs and the second describing optional features and explaining their relative importance and desirability.

Number Specs in SW Receivers. The following terms are used to describe the performance of a shortwave receiver: sensitivity, volume sensitivity, selectivity, frequency response, distortion, spurious responses, bandspread, drift, and calibration. (While most of these specs are equally applicable to a properly described AM broadcast receiver also, the "numbers" used may be different because of the inherent differences in objectives of the two types of receivers.) Let us examine each of the specs in detail.

The original method of specifying sensitivity in an AM receiver—and bear in mind that shortwave reception is basically AM reception, regardless of the frequency of the signal—involved listing the number of input microvolts required at the antenna terminals to produce "normal test output." Normal test output was defined differently for different types of receivers. Thus, a receiver having a maximum undistorted audio output capability of 1 watt or greater used 0.5 watt as the normal test output, while smaller portables having a maximum output capability of less than 1 watt (but greater than 0.1 watt) used 0.05 watt as normal test output. This method of expressing sensitivity, besides having these ambiguous normal test output ratings, has an additional disadvantage in that the results do not readily tell much about the listenability of the received signal. Today's ultrasensitive receivers are so sensitive that even random noise might be sufficient to produce normal test output in the complete absence of a real signal.

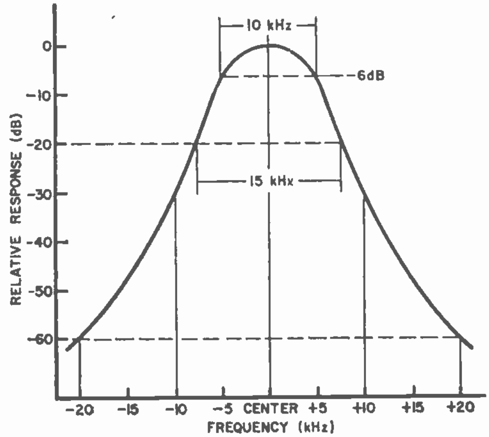


Fig. 1. Curve shows various points which express selectivity numerically.

For this reason, sensitivity now tends to be expressed as the number of microvolts needed to produce an output that is so many dB greater than the residual noise present in the absence of a signal. Some manufacturers use a 6-dB figure in this definition, others use 15 dB, and still others use 20 dB; but all are with reference to 30 percent modulation, which closely corresponds to "average" modulation of the r-f carrier by music or speech. Obviously, the lower the number of microvolts, the more sensitive the receiver, providing identical references have been used. Sensitivities of 1 microvolt or even less are not uncommon in good receivers today, using the 15-dB signal-plus-noise to noise ratio, $(S + N)/N$. It should be noted that, in a multi-band receiver, sensitivity on all bands is not likely to be the same—and differences should be noted by the manufacturer if he wants to tell the whole story.

As mentioned earlier, shortwave bands tend to be extremely crowded with many signals close to each other in frequency. Selectivity is simply a measure of the receiver's ability to pick one station from the many. The best way to present a picture of a receiver's selectivity is by means of a curve like that shown in Fig. 1, which shows the response of the receiver to frequencies slightly removed from the desired frequency. Short of that, most manufacturers either state the number of dB "down" that a receiver is 20 kHz or 10 kHz removed from the desired frequency, or they state how far away from the desired frequency the "down 6 dB" and "down 20 dB" or "down 60 dB" points are. Both systems will be clearly understood by examining the various points highlighted in Fig. 1. A good multi-band shortwave receiver might be expected to be "down 6 dB" at around 5 kHz from center frequency and "down 60 dB" at around 15 or 20 kHz from center frequency.

Often, special filters are included to improve selectivity, and there are even receivers that offer *variable* selectivity for use in trying to separate really close stations. It should be pointed out that the narrower the selectivity, the poorer the frequency response of the recovered audio signal. Normally, you cannot expect "high fidelity" from shortwave receivers; but since most listening is to voice transmissions, the problem is not as great as it would be if listening to music were the objective. Very little audio "bandwidth" is required for voice intelligibility. (Witness the home telephone that has a frequency response extending only from above 150 Hz to less than 5 kHz, at best.)

Harmonic distortion, too, can be tolerated to a much greater degree in shortwave receivers than in AM and FM "entertainment" receivers intended for musical listening. As a result, most manufacturers quote audio output power ratings in terms of 5 or even 10 percent distortion. Again, this is valid as long as the full story is disclosed in the specs.

As in AM and FM counterparts, the spurious responses referred to here are those arising from "image" frequencies (a signal removed from the desired one by twice the i-f of the receiver), response to signals at the i-f itself, and response to inordinately strong signals at any frequency other than the desired one. Rejection of such signals is expressed in dB, and the higher the number, the better. Image and i-f rejection figures in excess of 45 or even 50 dB are not uncommon in well-designed receivers these days.

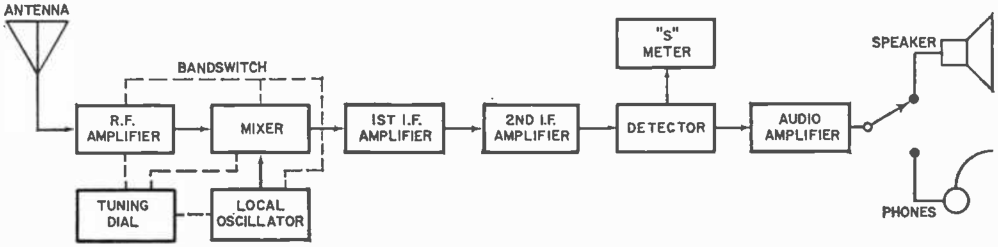
Bandspread, calibration, and drift are related to the number of distinct bands supplied in a given receiver. If each band encompasses, say, only 500 kHz, it will be much easier to "fine tune" to a given precise frequency than if each band contains several MHz. Of course, if dial calibration is inaccurate, the expanded scale will be of little use, and, for a spec to be complete, a statement should appear as to calibration accuracy (e.g., ± 2 kHz on the 12.0-12.5-MHz band, etc.).

Local oscillator drift is far less of a problem in solid-state receivers than it used to be when heat-producing vacuum tubes were used in shortwave receivers. Still, all but crystal-controlled local oscillators will exhibit some drift, particularly during the initial warmup period. This drift should be stated in kHz after one or two hours of warmup, starting one minute after turn-on. The smaller the stated number, the better this characteristic.

Feature Specs in SW Receivers. The progression of "extra features" associated with shortwave receivers will best be understood by referring to the block diagrams in Figs. 2, 3, and 4. The diagrams represent three levels of receiver design in ascending order of complexity and sophistication, and the specific features worth mentioning are highlighted in the captions.

Figure 2 represents the typical portable multi-band receiver and is really no different from a better-grade AM receiver intended for broadcast-band use. Of particular importance are the r-f stage, required for greater sensitivity (omitted in many AM re-

Fig. 2. Typical shortwave receiver will have the circuits and features shown here.



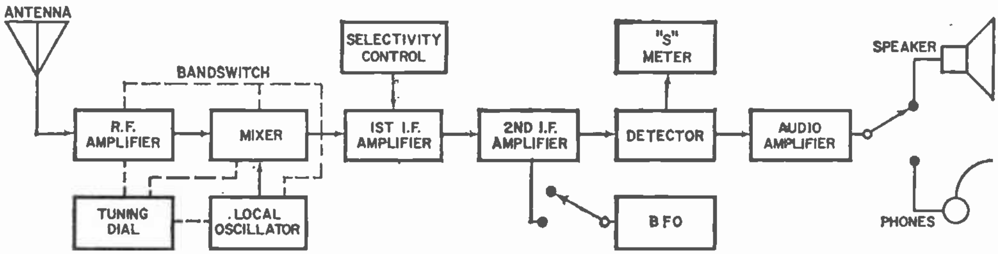


Fig. 3. Special circuits, such as selectivity control and bfo, are often included.

ceivers), the presence of more than one stage of i-f amplification (to narrow the selectivity curve shown in Fig. 1), provision for headphones, and the size and quality of the built-in loudspeaker. Headphones, by the way, can actually improve signal-to-noise ratio in the sense that they remove the listener from his local or ambient noise and usually enable him to hear signals that would be difficult to understand using a loudspeaker. The S meter shown is really nothing more than a signal-strength meter calibrated in arbitrary S units, usually from 0 to 9, providing some relative indication of received signal strength.

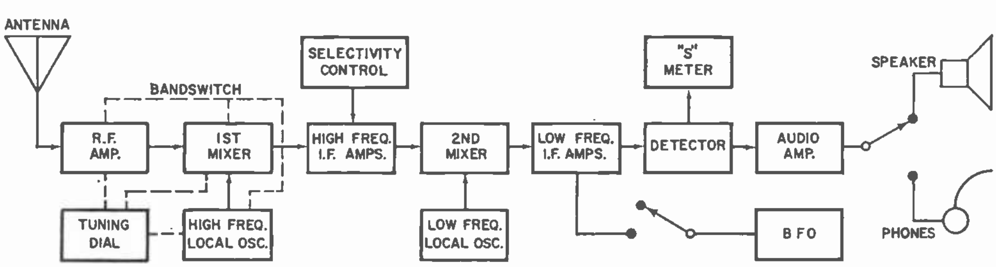
Figure 3 represents the first step up in receiver quality and can rightly be called the diagram of a communications receiver. While most of the blocks are the same, a bfo and variable selectivity control have been added. The bfo is an oscillator that produces a frequency close to the i-f. When switched in, a beat tone is heard as a carrier is approached in frequency. This is useful in receiving CW transmissions (code transmissions in which the carrier is keyed on and off, rather than modulated with audio information) that would otherwise be inaudible. The bfo feature is equally useful in searching for weak carriers, for the continuous "whistle" of the beating of two frequencies is more discernible than the sometimes erratic and fading speech on the remote station. Once the carrier is zeroed-in, the bfo can be switched out of the circuit. The variable selectivity control has already been described in terms of importance in separating closely spaced stations.

Figure 4 introduces another concept known as "dual-conversion." The first high-frequency local oscillator in such receivers is extremely stable, often crystal-controlled while a second local oscillator and mixer provide for a highly segmented tuning system, sometimes only 500 kHz wide per band. Dial readouts using double-conversion are readily made, even down to ±1 kHz. This system is particularly effective for high-frequency reception.

While the communications receiver diagrammed in Fig. 3 is also capable of multi-band, segmented tuning, you will often find that one or more of the higher frequency bands in this type of receiver will include the use of double conversion for that reason.

Most better-quality shortwave receivers have a provision for connecting an external antenna, cut to proper half-wave length for "hard to receive" signals of your choice. Such "outdoor" antennas, although a bit cumbersome to install, can often make the difference between an unusable and a satisfactory signal. Finally, one of the best ways to DX is to use a receiver that can operate on batteries as well as from a-c power sources. Get in your car some night, drive to a secluded hill-top away from man-made electrical noises, and tune in on the world. It is a most exhilarating experience. ◈

Fig. 4. More sophisticated sets use dual conversion with two oscillators/i-f amps.



CIRCLE NO. 17 ON READER SERVICE PAGE

BUILD THE

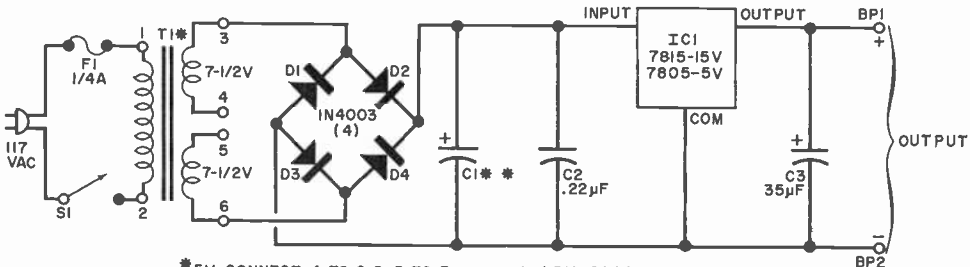
LITTLE GIANT POWER SUPPLY

ONE IC MAKES BLOW-OUT-PROOF SELECTABLE VOLTAGE SUPPLY

BY J. B. WICKLUND

INTEGRATED circuits available to the electronics experimenter usually require ±15 volts (for op amps) or +5 volts (for TTL digital logic). Anyone who has done much experimenting with these devices knows that they need a good regulated power supply.

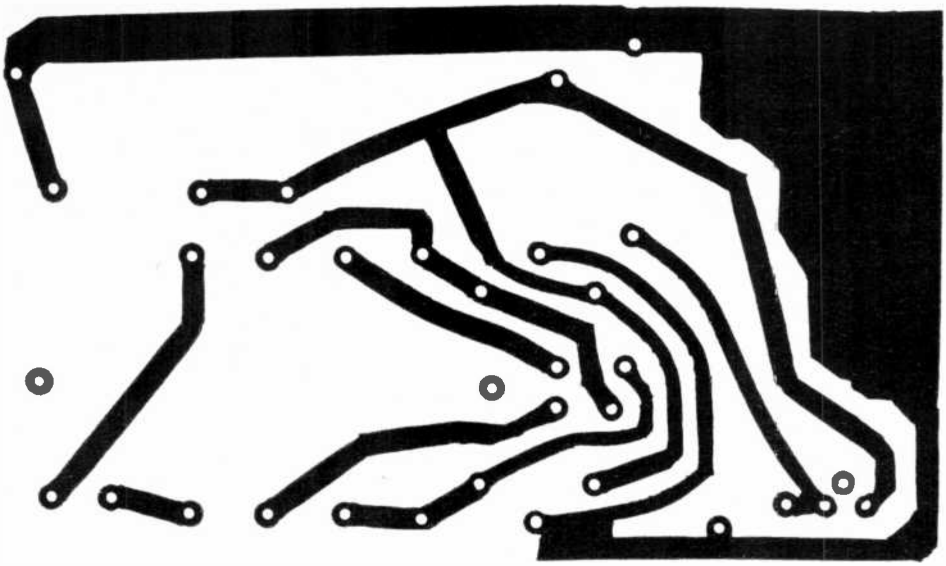
While it is not difficult to design and build a power supply for either of these voltages, the easiest and cheapest way to



PARTS LIST

BP1,BP2—Five-way binding post (red and black)
C1—2000-μF, 15-volt electrolytic capacitor (for 5-volt supply)
1000-μF, 25-volt electrolytic capacitor (for 15-volt supply)
C2—0.22-μF Mylar capacitor
C3—35-μF, 25-volt electrolytic capacitor
D1-D4—Silicon rectifier diode (1N4003 or similar)
F1—¼-ampere fuse and holder
IC1— 5 volts—7805 12 volts—7812
6 volts—7806 15 volts—7815
8 volts—7808
S1—Spst switch
T1—Dual 7½-volt ac secondary, 500-mA transformer (Triad F-152XP or similar)
Misc.—Suitable chassis, optional neon indicator lamp, line cord, mounting hardware.
Note: The following are available from Northwest Engineering, PO Box 70245, Seattle, WA 98107: printed circuit board (N004A-PCB) at $3.00; IC1 (N004A-REG) at $3.10; kit of board and board-mounted components, (N004A-FK) at $16.25 (specify voltage output). Kits are sent postpaid in continental USA.

Fig. 1 Same circuit is used for either supply. Components and jumpers must be changed.



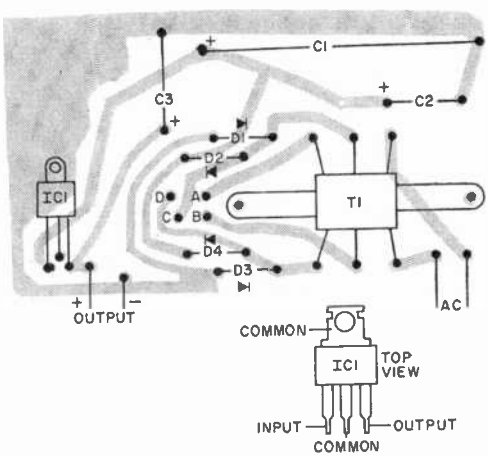


Fig. 2. Foil pattern and component layout. See text for mounting of IC1.

get a good supply is to use a new voltage regulator chip, the 78XX series made by Fairchild. This IC looks like a conventional three-lead plastic power transistor; and, when coupled with a bridge rectifier and filter capacitors, it can deliver 5, 6, 8, 12, or 15 volts at currents up to 1 ampere.

Besides providing excellent regulation, the IC is internally protected from excessive load current or heat dissipation. Even if a heat sink is not used, it will not burn out since it shuts off when it gets too hot and turns on again when it cools down.

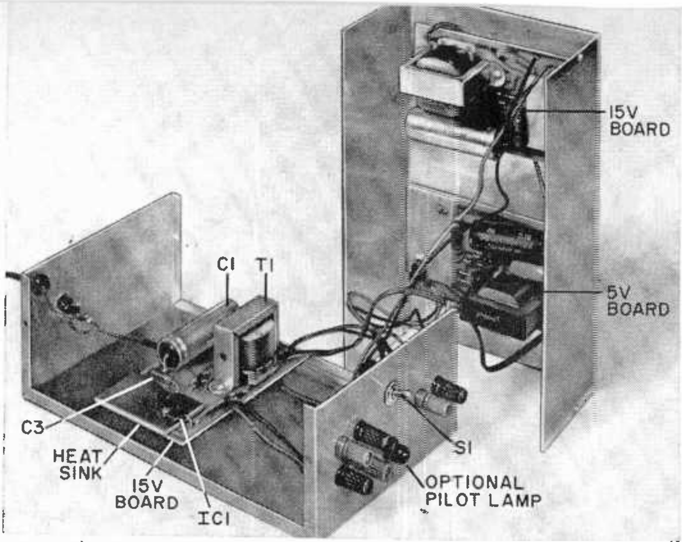
Circuit Design. The basic circuit is shown in Fig. 1. Note that transformer *T1* has two independent 7½-volt secondaries which can be connected either in series for the 15-volt supply or parallel for 7½ volts (at more current) for the 5-volt supply. Diodes *D1* through *D4* form a conventional bridge rectifier, with *C1* as a filter.

In the 15-volt version, the voltage at the input to the regulator is about 21 volts dc; in the 5-volt version, the dc input is about 10 volts. The output for the former is between 14.4 and 15.6 volts with variations of less than 0.15 volt for load changes of 5 to 500 mA. For a 5-volt output, the load can be 1 ampere, which can drive up to 50 TTL devices.

Construction. The printed circuit board shown in Fig. 2 is the same for either type of supply, with the following exceptions: For a 15-volt supply, connect a jumper between points A and B, use a 7815 IC, and use a 1000-μF capacitor for *C1*. For a 5-volt supply, connect jumpers between points A and D and between B and C, use a 7805 IC and use a 2000-μF capacitor for *C1*.

To assure stable operation, the input to the IC is bypassed by *C2*; *C3* improves the overall transient response of the supply.

When mounting the IC, bend it over so that the mounting lug (in electrical parallel with the common pin) can be attached to the negative portion of the foil pattern (the



Prototype supply had a 5-volt board and two of the 15-volt boards. The binding posts and optional pilot lamp were put on front of chassis.

large area). This is where a heat sink should be used to provide the best current rating. Use a 1½" by 3" piece of aluminum for the heat sink and attach it and the IC mounting lug to the PC board with a bolt going through a properly sized hole drilled in the board.

The prototype power supply used two 15-volt sections, and one 5-volt version with each terminated at its own 5-way binding posts on the front panel. Use a red binding post for the positive side and a black post for the negative. Do not use the chassis at any point as a common.

Fuse *F1* is mounted on the rear panel, with the power on-off switch on the front. If desired, a conventional 117-volt neon power indicating lamp can be connected across the primary of *T1*.

Any type of chassis can be used to support the three supplies. If you need 6-, 8-, or 12-volt supplies, use the 15-volt circuit and select the desired 78XX regulator integrated circuit. ◈

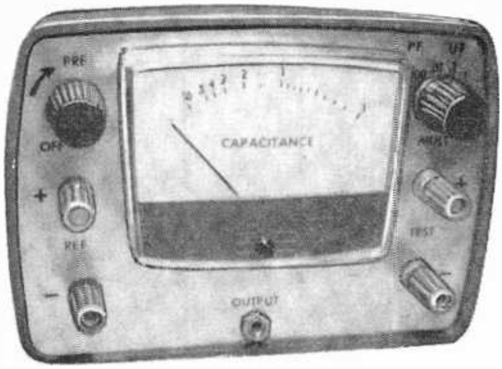
PLAY YOUR OWN GAMES ON TV

MAGNAVOX has introduced a unique new form of home entertainment for the whole family. Called Odyssey, it's an all-electronic game simulator that hooks up to a television set and provides the basis for a dozen different games of skill or chance.

Transforming any 18" or bigger TV into an electronic playground, Odyssey's hardware consists of a Master Control unit that contains all the electronics, two Player Controls, and an English Control that imparts english to the ball. An Antenna-Game switch is connected by the user to the vhf antenna terminals on the back of the set and 15 ft of cable goes from there to the Master Control. The switch can be left on the set permanently and the cable can be unplugged from the Master Control and put out of the way when not in use.

Odyssey is safe for youngsters. It is powered by six size C batteries, or an optional power supply is available.

Each Odyssey comes with a set of 12 game program cards and game overlays. To play one of the games (tennis, hockey, roulette, etc.) the appropriate game card is inserted in a slot on the Master Control and the corresponding overlay is taped to the TV screen. The overlay turns the screen into a game board or playing field and the screen lights up with counters, balls, or squares which the players control. ◈



Direct-Reading Capacitance Meter

MEASURES FROM 15 pF to 10 μF IN FIVE RANGES—
PLUS OPTIONS TO 100 μF

BY DALE HILEMAN

MOST electronics experimenters have boxes filled with all types of fixed capacitors; and, in most cases, the values are clearly marked. However, there may still be quite a number of perfectly good units whose identification has either rubbed off; or they may have special factory codings that can't be deciphered.

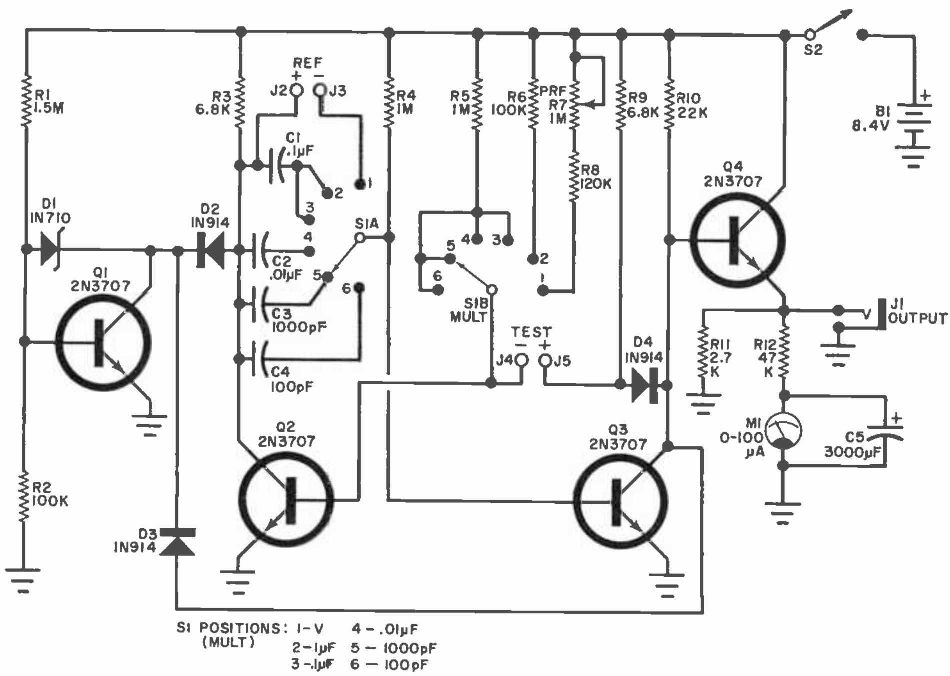
To determine unknown capacitance values, try building the direct-reading capacitance meter described here. (It can also be used as a pulse generator with controllable repetition rate and pulse width.) Capacitance can be read directly from 15 pF to 10 μF in five ranges; and capacitances larger than 10 μF can be measured by indirect means.

Power is provided by an 8.4-volt mercury battery. The battery has a rated life of 500 mA-hr; but since, in this case it provides only 2 or 3 mA, 200 hours of service can be expected.

How It Works. As shown in the schematic, the capacitance meter consists basically of a free-running multivibrator (*Q2* and *Q3*) with *Q4* driving the meter. Clamp *Q1* minimizes the effect of changing battery voltage. One of the cross-coupling capacitors in the multivibrator is the unknown, while the other is of a known precision value to which the unknown is compared. The unknown is connected to terminals *J4* and *J5*, while the precision value (*C1* though *C4*) is selected by switch *S1A*. The "off" times of *Q2* and *Q3* are determined by the ratio of the fixed and unknown capacitance values.

The output of *Q3* is coupled by emitter follower *Q4* to integrator *R12* and *C5*, which forms a low-pass filter for *M1* so that the meter reading is proportional to pulse rate or duty cycle (pulse width/pulse spacing). Thus, if the fixed and unknown values are equal, the duty cycle is 0.5 and the meter reads about midscale. As the capacitance of the unknown is increased or decreased, the duty cycle decreases or increases proportionately and the meter reading drops or rises accordingly. The extremes at which valid readings may be obtained represent fixed-to-unknown ratios of 0.1 and 10, which points on the meter scale are equidistant from the point representing a ratio of 1.

Since these relationships hold true over a wide range of capacitance values, to switch ranges, it is only necessary to change the fixed value by a convenient whole number. Accordingly, five decade ranges are provided. In the lowest capacitance range, fixed capacitor *C4* provides an output pulse width of about 60 microseconds. With each step of *S1*, the fixed capacitor is 10 times larger and the output pulse width is 10 times wider —except in the 1-μF position. A capacitance of 1 μF in the fixed-value position would result in a pulse width of 0.6 second, too long to be smoothed by the integrator. So the pulse width is held at 60 ms and the



PARTS LIST

B1—8.4-volt mercury battery (Burgess H146X or similar)
C1—0.1-μF 1% paper or Mylar capacitor
C2—0.01-μF, 1% paper or Mylar capacitor
C3—1000-pF, 1% mica capacitor
C4—100-pF, 1% mica capacitor
C5—3000-μF, 3-volt electrolytic capacitor
D1—1N710 zener diode
D2-D4—1N914 diode
J1—Phone jack
J2,J5—Binding post, red
J3,J4—Binding post, black
M1—0-100-μA meter
Q1-Q4—2N3707 transistor
R1—1.5-megohm, ¼-watt, 10% resistor
R2—100,000-ohm, ¼-watt, 10% resistor
R3,R9—6800-ohm, ¼-watt, 5% resistor
R4,R5—1-megohm, ¼-watt, 5% resistor (matched)
R6—100,000-ohm, ¼-watt, 10% resistor (see text)
R7—1-megohm audio taper potentiometer (with S2 attached)
R8—120,000-ohm, ¼-watt, 10% resistor
R10—22,000-ohm, ¼-watt, 10% resistor
R11—2700-ohm, ¼-watt, 10% resistor
R12—47,000-ohm, ¼-watt, 10% resistor (see text)
S1—2-pole, 6-position rotary switch
S2—Spst switch (on R7)
Misc.—Battery connector, perf board with clips, knobs (2, with indices), suitable chassis, mounting hardware, etc.
Needed for calibration:
Four 0.01-μF, 1% paper or Mylar capacitors
One 0.05-μF, 1% paper or Mylar capacitor
One 0.1-μF, 1% paper or Mylar capacitor
One 1-μF, 1% paper or Mylar capacitor
Needed for test (optional):
One 100-pF, 1% mica capacitor
One 15-pF, 1% mica capacitor

Meter circuit is basically a free-running multivibrator which compares capacitances.

charging time is reduced tenfold when *S1B* switches from *R5* to *R6*, the latter being selected during calibration.

When *S1A* is in position 1, a reference capacitor can be connected externally to *J2* and *J3* to determine pulse width. At the same time, *S1B* connects potentiometer *R7* to the charging circuit so that the pulse repetition rate can be adjusted. The rate range is then determined by the value of a capacitor connected to *J4* and *J5*. Resistor *R8* sets the upper limit of the rate range. It may be selected as described under calibration or as required to suit the needs of the user. However, it should be no smaller than 27,000 ohms.

Potentiometer *R7* is connected to provide higher repetition rate with clockwise rotation. If the builder is satisfied with the opposite direction of control, connecting *R8* to the counterclockwise terminal will spread out the high end of the rate range.

Diode *D4* isolates the collector circuit of *Q3* from the charging circuit of the unknown capacitor to improve the rise time of the output pulse.

Clamp *Q1* stabilizes the meter reading with changing battery voltage by holding the peak collector voltage of *Q2* or *Q3* to 5.7 volts. The clamp is coupled to the two collectors through isolation diodes *D2* and *D3*. Zener diode *D1*, though rated at 6.8 volts, actually begins conducting at about 4.7 volts and does not rise above this value because the zener current required to institute the regulating action is so small. The additional volt is accounted for in the forward drop of *D2* and *D3* in series with *Q1*. It is the conduction of *Q1* that provides the shunt regulating action.

Construction. The capacitance meter can be constructed in any enclosure and most of the circuitry can be assembled on perf board mounted on the meter terminals. To minimize stray capacitance effects, certain resistance values that might have been adjustable—specifically *R6* and *R12*—are individually selected. Long leads should be left on these resistors to minimize value changes due to soldering heat. If, however, you want to use potentiometers use 25,000 ohms for *R6*, in series with 91,000 ohms fixed; and for *R12*, a 50,000-ohm potentiometer in series with 27,000 ohms fixed.

Sometimes a 2N3707 or 1N710 may prove troublesome, so the builder is advised to obtain a few extra of both, preferably from a different supplier, to reduce the probability of drawing each lot from a marginal batch.

In the prototype, all common connections, except *J1*, were made to a ground bus which was connected to the chassis at the emitter of *Q3*. No ground loops were apparent from the direct connection of *J1* to the chassis.

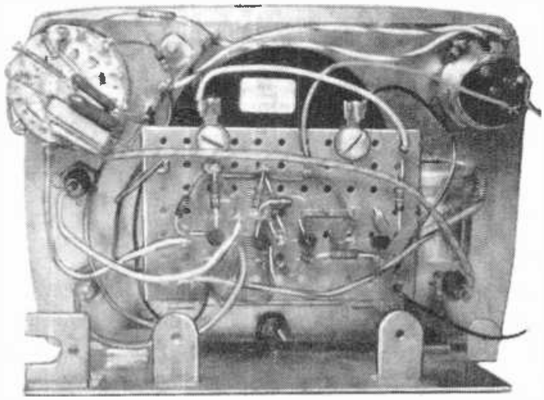
Calibration. Capacitors needed for calibration are given in the Parts List. Before starting calibration, note the following:

1. The terminal voltage of a new Burgess Type H146X 8.4-volt mercury battery is over 9 volts. Although the capacitance meter is quite stable with changing voltage, it is advisable to turn the instrument on for about 15 minutes so that the battery voltage settles down to 8.4.
2. Be sure the instrument is not in a draft from air conditioning or windows since the slightest breeze will affect needle position.
3. After changing each capacitance value, allow plenty of time for the needle to settle down as the RC constant of the integrator is quite high. Then, using the eraser end of a pencil, very gently tap the instrument once. Even the best D'Arsonval movements tend to stick a little with dc applied, and a tap will free the needle.
4. Mark each calibration point on the meter face lightly, in pencil, deferring final art work until satisfied with performance.
5. When replacing the meter cover, be especially careful to ensure that the mechanical zero adjustment finger properly engages its slot.

Calibrate as follows:

1. Set meter mechanical zero at mid-position.
2. Turn *S1* to the .1-μF position and connect an 0.01-μF calibration capacitor to *J4* and *J5*.
3. Select a value for *R12* that places the needle at full scale.
4. Remove meter cover and mark this point .1.
5. Successively increase calibration capacitance in 0.01-μF steps marking each point, and ending with 0.1 μF, to be labeled 1.
6. Add 0.05 μF for a total of 0.15 μF and mark this point. Remove the capacitors.
7. Place *S1* on .01 μF and connect a 0.01-μF capacitor to *J4* and *J5*. The needle should return to the last point marked in step 5.
8. Successively increase calibration capacitance in 0.01-μF steps, marking each point and ending with 0.05 μF (points to be labeled 2 through 5). Remove capacitors.
9. Connect a 0.1-μF capacitor to *J4* and *J5* and mark this point 10. Remove capacitor.
10. Place *S1* on 1 μF and connect a 1-μF capacitor to *J4* and *J5*. Select a value for *R6*

Perf board is mounted on meter terminals.



that places the needle exactly at the last point marked in step 5.

11. Turn off power. Allow needle to settle, and mark this point.

12. Double check the calibration by measuring a number of capacitance values on different ranges. If satisfied, remove meter face and perform final art work.

Different methods of measuring capacitance above 10 μF can be used, but here is one method of measuring values from 10 μF to 100 μF that does not require removing the meter cover. Although they are not included in the Parts List, a number of capacitor values in the 10-to-100-μF range will be needed. The selection of values and tolarances are left to your discretion. One 10-μF capacitor is required for the reference. Electrolytics should be thoroughly formed. Voltage ratings should be at least 6 volts. Be sure to observe polarities. The procedure is as follows:

1. Connect a 10-μF capacitor to *J2* and *J3* and 100 μF to *J4* and *J5*. Put *S1* on position 1.

2. Turn power on and set *R7* to its minimum resistance. The needle should swing back and forth across almost the entire scale.

3. Select a value for *R8* that places the left end of the swing as nearly as possible to 10. Then adjust *R7*, if necessary, to attain exactly this swing. Label this point 100 on *R7*. Remove the 100-μF capacitor.

4. Successively connect the large-value calibration capacitors to *J4* and *J5*. In each case, adjust *R7* to set the swing as described in step 3. Then label the corresponding point on *R7* with the capacitance value.

Operation. To measure capacitance values in the range of 15 pF to 10 μF, turn on the power, turn *S1* to the appropriate position, and connect the unknown to *J4* and *J5*.

Depending on your luck in selecting the 2N3707's, the instrument will indicate accurately to 10 pF. A value below 10 pF, however, may yield a spurious reading, usually just to the left of .1 on the meter. Unless you are sure that an unknown is above 10 pF, therefore, disregard any indications below 15 pF.

If the instrument has been calibrated for larger capacitors, use the following procedure (being sure to observe polarity):

1. Connect a 10-μF capacitor to *J2* and *J3*. Preferably use the same capacitor that was used in calibration.

2. Turn *S1* to position 1.

3. Connect the unknown to binding posts *J4* and *J5*.

4. Adjust *R7* to place the left end of the needle swing at 10. Read the unknown value from the *R7* calibration.

Values over 100 μF can be measured with a stop watch, timing the period between upward swings of the needle. Any such measurements, however, should be considered only as estimates because capacitors with very large values usually leak; and leakage affects the time constant.

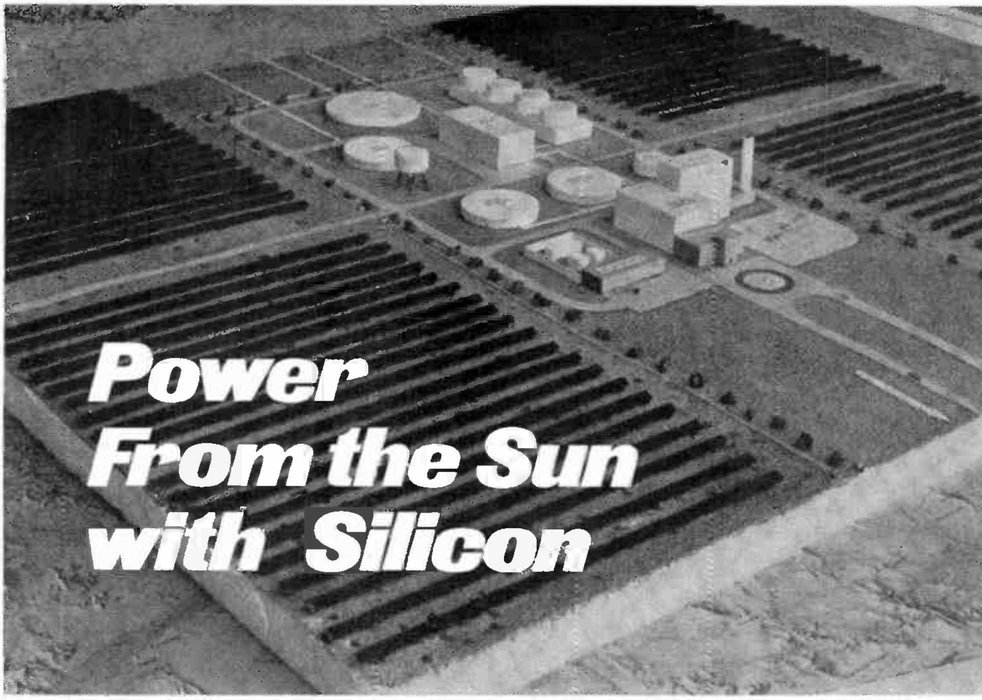
As an optional feature, the multivibrator output pulses are available from *J1* so that the unit can be used as a pulse generator. Pulse spacing is determined by the value of a capacitor connected to *J4* and *J5*, while pulse width depends on the setting of *S1*. For pulse generator operation, use position 1 of *S1*, where pulse width is determined by a capacitor connected to *J2* and *J3* and pulse spacing is adjusted by changing the setting of potentiometer *R7*.

In Case of Trouble. Any small drift that may occur due to aging of parts or imperfect performance of the circuit should be compensated for by adjusting the meter mechanical zero.

If inaccurate readings are obtained, especially on low capacitance ranges, either the common lead is not connected to the chassis base or there is a marginal transistor in the multivibrator. To evalute the performance of the multivibator, proceed as follows: Set *S1* to 100 pF and connect a 100-pF capacitor to *J4* and *J5*. Connect a scope to *J1* and measure pulse width. It should be about 60 μs. Now replace the 100-pF capacitor with one of 15 pF. The pulse width should not change. If it does, try replacing *Q2* or *Q3*.

If accuracy varies with battery voltage, the cause is probably a marginal zener diode at *D1*. The IN710 was not designed for this application but is used here because the more suitable low-current types are more expensive. Using the oscilloscope, check the peak output voltage of the pulse at *J1*. If it is higher than 5.3 volts, the regulating action will suffer at lower battery voltages; so try replacing *D1*. If the peak voltage is 5.3 volts or less but the problem persists, try replacing *Q1*. The meter indication should remain steady over a range of battery voltages from 7.2 to 9 volts. If the circuit is operating properly, more nearly perfect results may possibly be obtained by selecting the value of resistor *R1*. ◈

Scale model of 1000-megawatt solar power station proposed by researchers at University of Arizona. Parallel dark lines represent 3 square miles of solar energy collectors.



Power From the Sun with Silicon

PROPOSED SOLAR ENERGY STATION CAPABLE OF GENERATING 1000 MEGAWATTS OF POWER FOR SMALL CITIES

By DAVID L. HEISERMAN

SMALL children sometimes dream of catching a beam of sunlight in a box and releasing it to light their rooms at night. Sophisticated adults might scoff at this notion, but scientists and inventors have been working seriously on similar kinds of ideas since the beginning of the industrial revolution. The dream has been to capture some of the heat energy abundant in desert sunlight, store it in some kind of container, and release it at a controlled rate to operate machinery, generate electrical power, heat buildings, or distill sea water.

Until recently, solar energy conversion and storage schemes have been too complicated or inefficient for large-scale applications. It is one thing to build a solar furnace that will cook food and distill sea water for a single family and quite another to scoop up enough energy to meet the demands of a modern city. Dr. Aden Mienel, Marjorie Mienel, and Dr. Bernard Seraphin at the University of Arizona believe that they have the answer. They have already proposed construction of a solar energy station capable of generating 1000 megawatts of electrical power for small cities near the Mojave Desert.

The scheme employs a new kind of device that can be described as a "solar energy trap"—plates of thin-film materials that let solar energy enter a sealed chamber but will not let it out again. The device works surprisingly like the child's idea of capturing sunlight and releasing it at a later time. The only real difference is that the modern solar collector converts the incoming sunlight into heat energy, retaining all heat that might try to escape in the form of infrared heat energy.

Besides being a source of heat for generating electrical power, this scheme should interest people working in electronics because it takes advantage of some new ideas

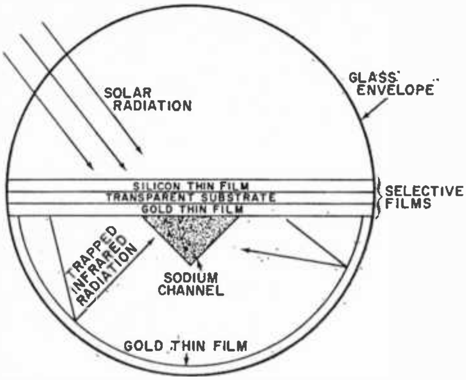


Fig. 1. The basic solar energy collector consists of evacuated glass envelope with sheets of selective thin films running through its center. Thicknesses of films have been greatly exaggerated. The silicon thin film absorbs solar radiation, converting it into heat energy. Since silicon is a poor radiator of infrared heat energy, the heat is trapped in bottom half of collector. Gold film improves the efficiency of device by acting as a perfect mirror to infrared. Channel of molten sodium metal carries away collected heat at the high temperature of about 1000°F.

and processes developed especially for the electronics industry. To understand exactly how the new solar collector works, electronics specialists might have to brush up on their knowledge of heat absorption and radiation.

How It Works. The common base materials for semiconductors (silicon, germanium, and gallium) have some special optical, as well as electrical, properties. These materials appear opaque to light in the visible part of the spectrum but quite transparent to the infrared wavelengths. Laser diodes and light-emitting diodes demonstrate this fact quite clearly. Since the human eye is tuned to the visible part of the spectrum, crystals of silicon have an opaque, blackish-gray appearance. Infrared light generated deep within these crystals, however, emerges from them as if the crystals were totally transparent. The semiconductor base materials, then, behave like selective optical filters; they are opaque to visible light in the 0.5-micron region but transparent to light in the 1.5-micron region of the spectrum.

Whenever visible sunlight strikes any dark-colored or opaque material, the latter absorbs most of the energy and converts it into heat. The material can dissipate this absorbed energy by way of convection currents in the air, heat conduction to other materials in close contact with it, or by infrared heat radiation. Under ordinary conditions, a sample of silicon placed in bright sunlight tends to get rather warm. Air convection currents and heat conduction carry away most of the absorbed energy, preventing the silicon sample from becoming unusually hot. However, if the silicon were suspended inside an evacuated glass container, these two cooling mechanisms would be defeated, and the only way the silicon could dissipate its absorbed energy is by infrared heat radiation.

Since silicon is a notably poor conductor of infrared heat energy, suspending it in a vacuum and placing it in intense desert sunlight makes it grow extremely hot in a very short time. Without resorting to any kind of lenses or parabolic mirrors, researchers at the University of Arizona have used thin films of silicon to produce temperatures in excess of 1000° F.

Applying the Film Concept. The basic "solar energy trap" consists of a thin film of silicon deposited onto one side of a 6"-wide sheet of some transparent substrate material. A thin film of gold, deposited on the other side of the substrate, enhances the efficiency of the device by acting as a mirror to trap infrared radiation. The substrate and its films fit in the center of an evacuated glass cylinder (see Fig. 1). The entire assembly, along with thousands of others like it, are put into an elaborate collector array in which the silicon films face the sky.

Solar energy striking the silicon films change into heat energy. Since the optical properties of the silicon prevent infrared radiation from returning to the sky, the absorbed heat builds up in the films and in the substrate material.

A channel of sodium metal, running along the underside of the substrate, absorbs much of the heat energy by conduction. When the temperature gets high enough, the sodium melts. An elaborate system of series and parallel high-temperature plumbing interconnects the sodium channels in all solar energy collectors. By pumping the

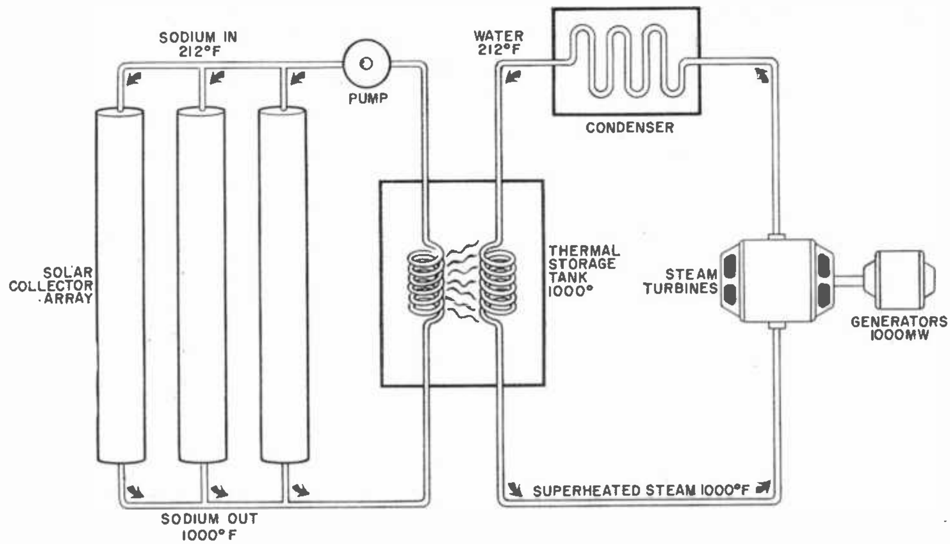


Fig. 2 Molten sodium metal, heated to 1000°F. in solar collectors, transfers most of its energy to thermal storage tank full of molten sodium and magnesium salts. Water passing through storage tank gathers up some of energy and emerges as superheated steam for turbines and electrical power generators. Thermal storage tank is large enough to supply superheated steam throughout the night as well as for several cloudy days at a time.

molten sodium through the solar collectors, it is possible to collect and store enough thermal energy to operate a steam turbine power plant on a 24-hour basis.

Proposed Solar Power Plant. The solar energy system proposed by the University of Arizona consists of three basic sections —an energy collection system, a thermal storage system, and a power generating system. The collection system includes approximately 3 sq mi of collector arrays and interconnecting plumbing. The thermal storage system is a 300,000-barrel tank of sodium and magnesium salts buried just beneath the surface of the earth. The power generating system is a conventional 1000-megawatt steam turbine station.

Molten sodium, leaving the collector arrays at a temperature of about 1000° F, gives up most of its thermal energy as it circulates through the storage tank. Pumps return the molten sodium, now cooled to about 200° F, to the collector array.

Another closed system, this one containing pure water, retrieves thermal energy from the storage tank in the form of superheated steam. At a pressure of 1200 psi and a temperature of about 1000° F, the steam operates a set of conventional power-generating turbines. After dropping most of its energy at the turbines, the steam cools and condenses to a liquid state before returning to the thermal storage tank at a temperature of about 212°F (see Fig. 2).

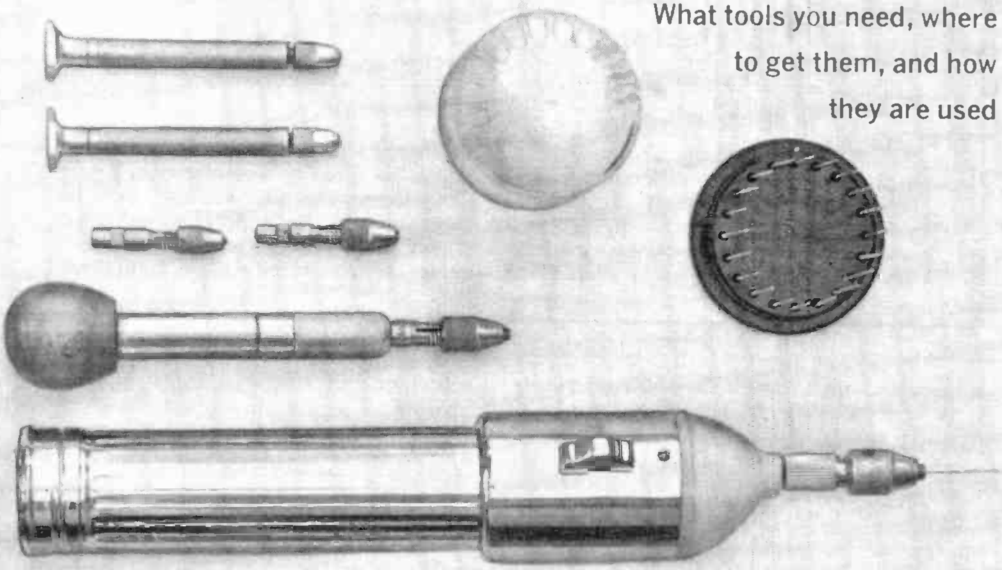
The University of Arizona researchers believe that the overall efficiency of the system will be close to 30 percent. Considering that the "fuel" costs absolutely nothing, the system promises to become the most inexpensive source of large amounts of power man has ever devised.

While the new system has some of the ecological disadvantages that plague other so-called "clean" power sources (in this case, thermal pollution), the problem can be minimized. To counter thermal pollution, researchers plan to use the excess heat to distill sea water. Rough calculations show that the 1000-megawatt solar energy station could produce as much as 50-million gallons of fresh water daily. This is enough fresh water to cause some people to think seriously about using areas around the desert power plants for raising crops and other agricultural purposes. ◈

BY FRANK H. TOOKER

Special Tools for the Electronics Workbench

What tools you need, where to get them, and how they are used



Shown are (top left) Moody pin vises, X-acto drill set (top right) and pin vise with interchangeable collets (center), electric drill (bottom).

TOOLS play an important role in the pursuit of the electronics hobby. Having the right tool for the job not only makes things easier, but it also usually makes for a neater and better performing project. But having the right tool does not necessarily mean that the user knows how to use it. Nor does knowing that a specialized tool is needed mean that the hobbyist will know where to find it.

While this article is concerned primarily with having the right tool for a given job, some attention is given to locating tools and how to use them. Emphasis is given to those tools of a special nature—those not ordinarily found on the electronics workbench but necessary to performing certain special operations.

General Purpose Tools. Printed circuits are used almost universally these days, and fine drills are needed for making the numerous small holes in a PC card. The average drill set contains drills from No. 1 to No. 60 (0.228″-0.040″ in diameter). All well and good, but for the most part, what are needed are drills much smaller in diameter than these. The most suitable ones for PC card work lie in the range of No. 61 to No. 80.

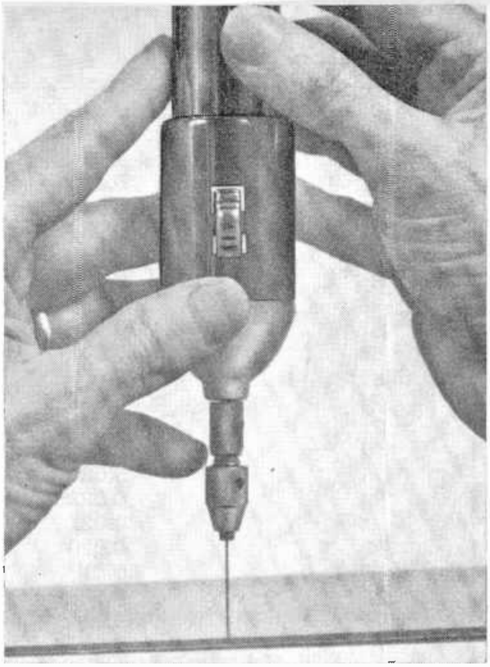


Fig. 1. To properly use battery-powered drill, when working on printed circuit boards, hold it perpendicular to work surface and apply minimal force.

You may never have heard of such drills, but if you plan to do PC jobs, you will need them—or at least enough of them to fill your needs.

X-acto Inc., famous as manufacturers of good hobby tools, make a set of fine drills. They are contained in a neat little stand, with drill size and diameter clearly labelled. The whole is topped by a clear plastic dome cover. You can buy X-acto drill kits from such dealers as Auto World Inc., 701 N. Keyser Ave., Scranton, PA 18508; E & H Model Hobbies, 160 W. Chelten Ave., Philadelphia, PA 19144; or from most well-stocked hobby department stores.

Individual drills, sizes 50 through 80, are available from America's Hobby Center, 146 West 22 St., New York, NY 10011 at 25¢ each plus shipping and handling. The size most frequently used for component lead holes in PC cards is a No. 67 drill.

Do not make the mistake of using the very fine drills in an ordinary ¼" electric hand drill. You will only break one drill after another if you attempt to do so. For hobbyist/experimenter work, these drills are best used in a hand-held collet, otherwise known as a pin vise, or in a small battery-powered electric drill.

Arranged in the photo on page 72 are various drilling devices. The small pin vises—made by Moody—shown at the upper left are available from E & H Model Hobbies; the larger one, shown center with three interchangeable collets, is made by X-acto Inc.; the battery-powered electric drill, bottom, is available from America's Hobby Center and from Auto World Inc. Some or all of these items might also be available locally from major hobby centers.

A pin vise is useful where only two or three holes have to be made in soft materials such as plastic or for drilling holes in thin metal. For operations that require drilling many holes, the battery-operated drill is your best bet. Figure 1 shows the proper method of using the electric drill when working on PC boards. The two-handed operation allows precise positioning of the drill point and rapid transit from one hole location to another. Prick punch the center point of the hole, position the work about 15 in. below eye level, and make certain the area is well lighted before you begin. Also, when performing the actual drilling, apply only enough pressure to insure that the drill point bites into the work.

Batteries last a surprisingly long time in the drill; so, you may want to use the drill for such diverse operations as deburring and wire brushing the copper foil on a PC board before soldering.

You cannot very well use an ax to sharpen a pencil. It is equally impractical to use an ordinary hacksaw for working on miniature electronic assemblies. The saw shown at the left in Fig. 2 is undoubtedly the finest available for the equivalent of a hacksaw, and no other saw can do what this one does. It is called a "Zona" saw. It has very fine teeth and a blade thickness of only 0.008"—extremely thin by any standards.

The Zona saw is made of Swedish steel, a material that is tough rather than brittle. It will cut through anything from plastic to soft brass with surprising ease and speed. The blades themselves are replaceable.

There are three grades of Zona saws available. The No. 200 (shown) has 32 teeth/in., is 4½" long, and makes a ⅝" deep cut. The No. 300 is coarser;

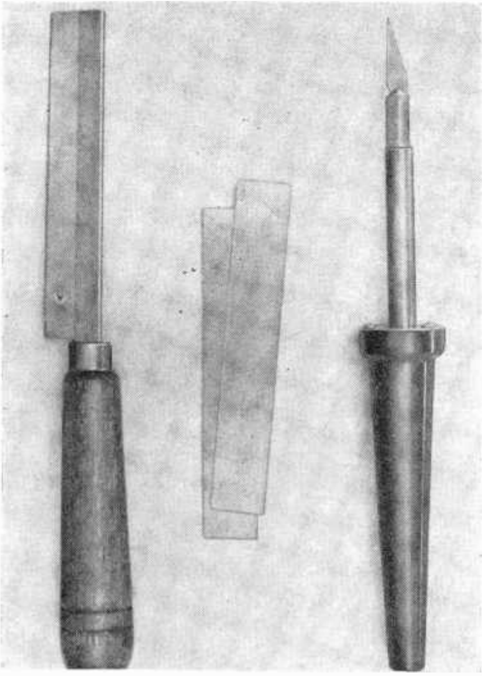
its blade has 24 teeth/in., is 0.015" thick by 6½" long, and cuts to a ⅞" depth. The No. 500 is a "big" saw; its blade has 32 teeth/in., is 0.010" thick by 6½" long, and cuts to 1$\frac{3}{16}$"

A Zona saw will handle perhaps 75 percent of all cutting chores in electronics.

Specialized Tools. Shown at the right in Fig. 2 is a particularly useful tool. In fact, it is the only tool known to this author that will loosen epoxy-cemented parts. With this tool, a miniature component can be removed from a chassis or PC card to which it is cemented without damaging either component or its mounting. The tool, a hot knife, is a soldering-iron-like device that is fitted with a chuck and a special stainless steel blade instead of a soldering tip.

The hot knife cuts thermoplastic quickly, easily, and accurately. The ease and neatness with which it works is truly amazing. Some of the jobs that can be performed with the hot knife are cutting and shaping styrofoam blocks used for thermal insulation in temperature-controlled crystal oscillators, acoustic insulation cutting for some speaker enclosures, and making clear plastic dial windows.

Fig. 2. Shown here left to right are Swedish steel Zona saw, replacement Zona saw blades, and hot knife tool.



DIAMETERS OF FINE DRILLS

Drill Size	Diameter (in.)
61	0.039
62	0.038
63	0.037
64	0.036
65	0.035
66	0.033
67	0.032
68	0.031
69	0.0292
70	0.028
71	0.026
72	0.025
73	0.024
74	0.0225
75	0.021
76	0.020
77	0.018
78	0.016
79	0.0145
80	0.0135

A couple of important points should be borne in mind when using the hot knife. First, make certain that the tool tip is up to temperature before attempting to make a cut. And, secondly, once you begin to cut, continue without hesitation until you are finished; if you stop, even for a second, you will produce a plastic blob that will mar the appearance of the work. Always clean the knife blade of any adhering plastic before allowing it to cool.

Do not attempt to use an ordinary hobby knife blade in the hot knife. Ordinary blades cannot bear up to the high operating temperatures without deteriorating.

Hot knives are available from such suppliers as Auto World Inc. and America's Hobby Center.

We have saved the best for last. Shown in Fig. 3 is the most unique, most diversified, and most useful and applicable tool to be found on any workbench. Compared to other power tools, its most unique feature is that it is so easy to make special accessories to fit it. Not only that, but this tool, plus the battery-operated electric drill discussed earlier, can make 95 percent of the average items used in miniature equipment—from scratch—including the cabinet that you use to house your electronic projects.

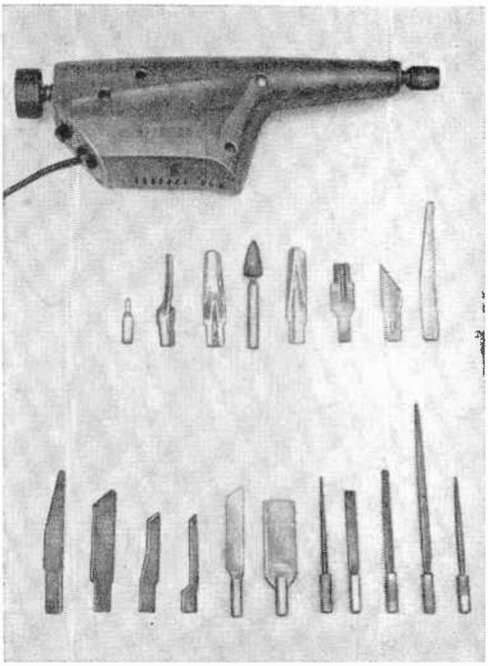


Fig. 3. Vibrator tool and accessories provided with it are shown arrayed above a row of homemade accessories.

This amazing tool is a reciprocating vibrator of the type used by jewelers for engraving jewelry. But it is much more powerful than the usual variety, and its stroke is continuously adjustable from zero to a full ⅛". It has two operating speeds—3600 and 7200 strokes/min. The slow speed is of special value to the electronics hobbyist and experimenter; the high speed is used for engraving.

Shown immediately below the vibrator in Fig. 3 are the accessories that are supplied with the tool. Using these accessories, the vibrator tool will engrave, gouge, cut-carve, saw, and grind. The tool's chuck will also accept a large number of X-acto accessories.

The eleven accessories shown in the bottom row were home made, designed specifically for use in electronics work. The four items at the left end of the row are saws, made from lengths of ordinary hacksaw blade and contoured on a bench grinder. Their shank ends were shaped to fit the chuck of the vibrator, while the cutting ends were shaped to fit special job requirements.

The fifth accessory is also a saw, but this time it is fabricated from a section of a Zona saw blade. It is shimmed, force-fitted, and soldered into a slot at the end of a ¾"-long by ¼"-diameter soft-brass shank. The accessory shown was made from a 0.008"-thick, 32 teeth/inch Zona blade.

The five accessories at the right end of the row are files. Intended primarily for working on metal parts, they are made from short or shortened Swiss needle files. The handles of each were cut off at the required length. Then the handle stubs were force-fitted into holes drilled in soft-brass shanks of the same dimensions used for the Zona blade.

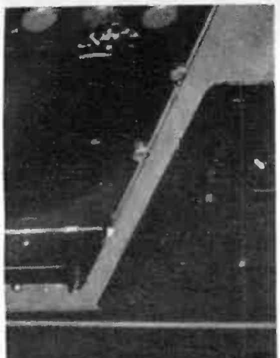
The most valuable feature of the vibrator tool is that accessories, like the homemade files and saws, can be accommodated quickly and easily. If a particular file or saw is needed for a special application, it can be fashioned in a matter of minutes.

The accessory in the center of the row is a sander. It consists of a 1¾" x ⅝" x 1⁄32" piece of mild-steel plate that was force-fitted and soldered into a slot cut across one end of a soft-brass shank. Normally, one side of the plate has a piece of medium-grit sandpaper cemented to it, while the other side has fine-grit paper.

The way you use the vibrator tool is of considerable importance. Bear down lightly, and move the tool slowly back and forth, all the while you are making a cut. If you hold the tool stationary or bear down too hard, you are likely to get nowhere.

The vibrator tool discussed here and shown in Fig. 3 is available from Sears Roebuck & Co., 4640 Roosevelt Blvd., Philadelphia, PA 19132.

No attempt has been made in this article to discuss such everyday, common tools as screw and nut drivers, soldering irons and guns, etc. These tools are all readily available from hardware stores and electronics parts dealers. Furthermore, they are so familiar to the hobbyist and experimenter that they need neither introduction nor instructions on their uses. One point, however, is an underlying credo of *all* tools: Use the correct tool at all times. Do not "substitute" one tool for another. Each tool was designed for a specific function; use it for that function and only that function. ◈



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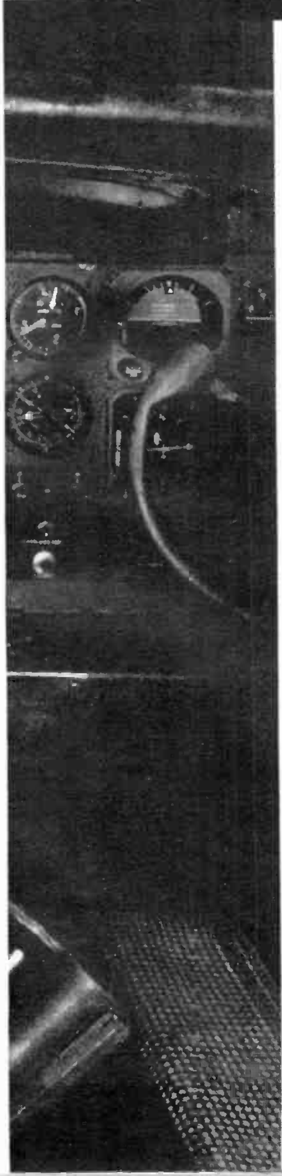

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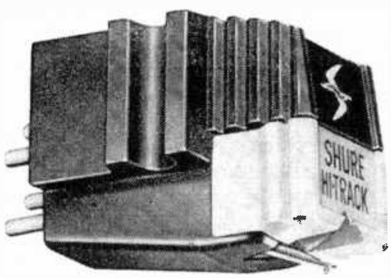
Product Test Reports

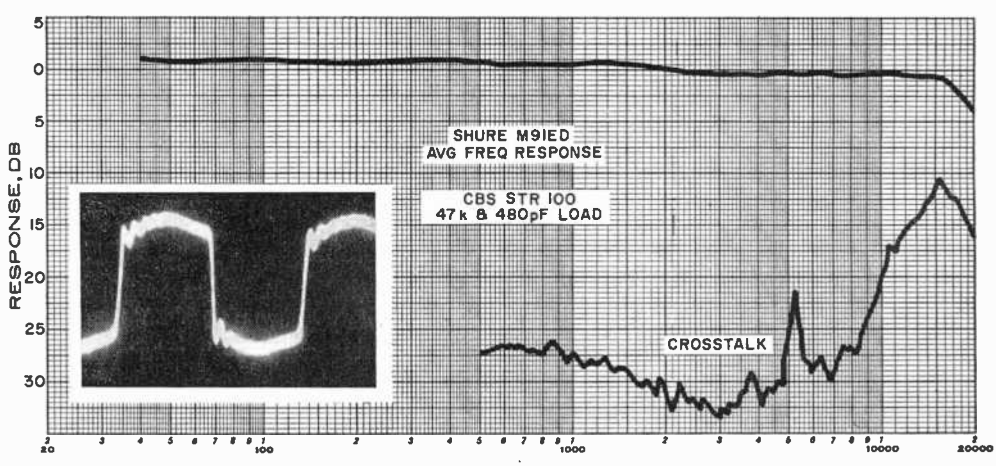
SHURE M91ED PHONO CARTRIDGE
(A Hirsch-Houck Labs Report)



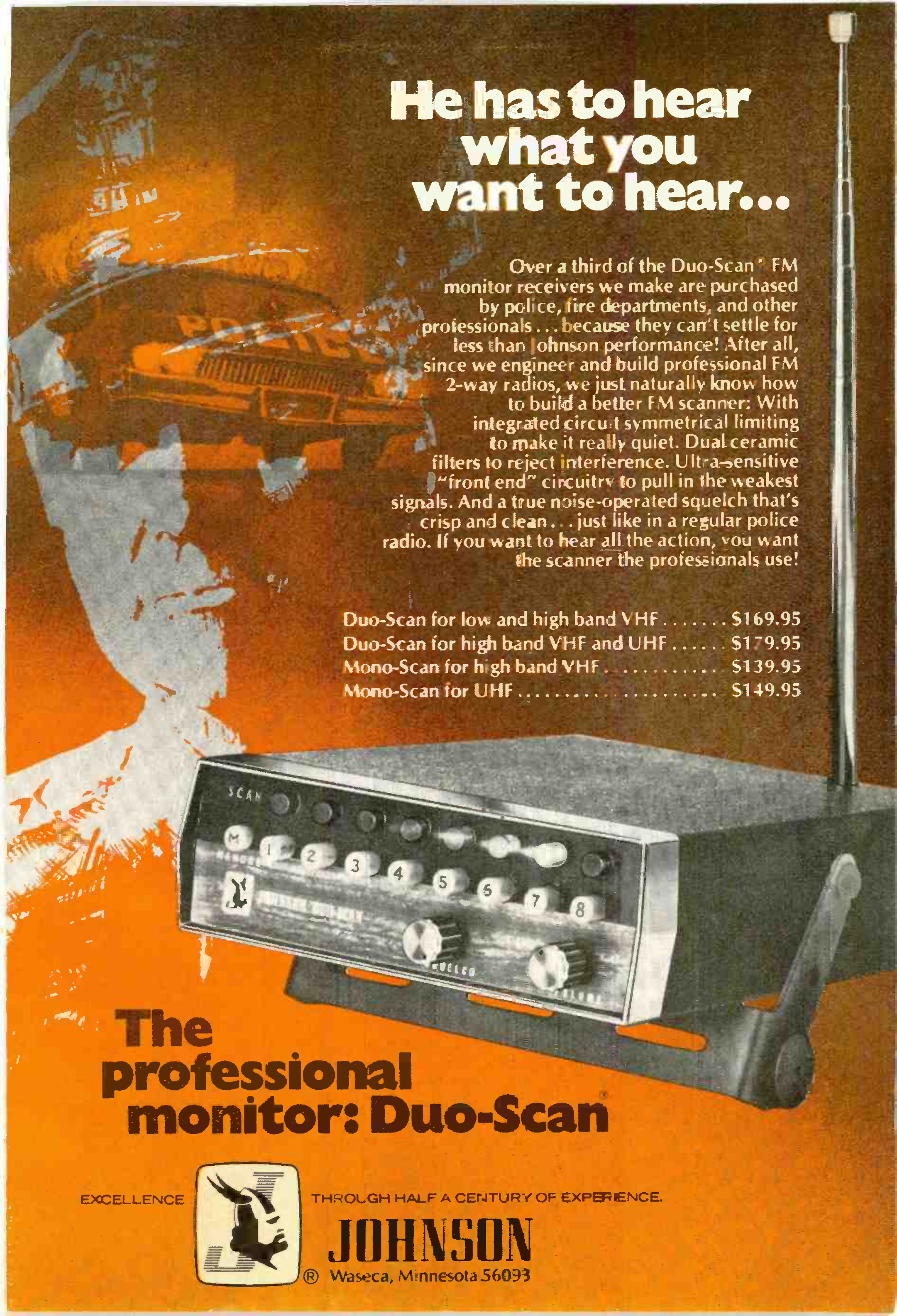
WITH little or no fanfare, Shure Brothers has improved their popular next-to-the-top-of-the-line cartridge, the M91E, with a reduction in stylus mass and a resulting increase in "trackability." The new version, called the M91ED, differs from the M91 only in its use of the new N91ED stylus. So, replacing the stylus of the older M91 cartridge with the new stylus auomatically converts it to an M91ED. The new stylus can readily be identified by its yellow plastic finger pull. (The older finger pull was black.)

Like the original cartridge, the M91ED is rated to track at ¾ to 1½ grams. However, its "trackability," or the maximum recorded velocity that can be tracked without distortion, has been increased by 10 to 15 percent at the middle frequencies and by about 5 percent at the high frequencies. All other specifications remain unchanged. The price of the M91ED cartridge is $54.95.

Laboratory Tests. In our laboratory tests, the Shure M91ED phono cartridge tracked the high-level 32-Hz bands of the Cook Series 60 test record at 0.7 gram and the 30 cm/s 100-Hz bands of the Fairchild 101 record at 1½ grams. We used a force of 1 gram for our frequency response tests, and shunted the 47,000-ohm cartridge load with a 480-pF capacitor (approximately the



Response of M91ED cartridge was 20-20,000 Hz, +2/−3 dB. Cartridge reproduced 1000-Hz square waves with only slight rounding and ringing (see inset photo).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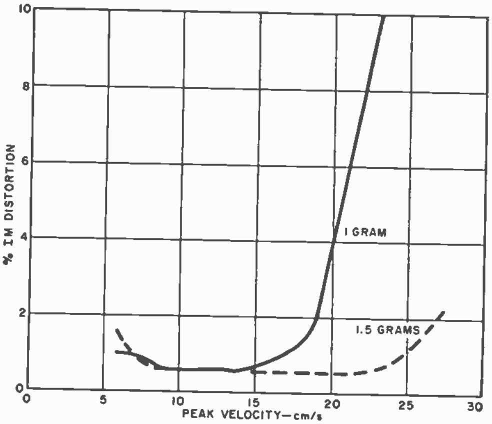


Graph shows IM distortion at tracking forces of 1 gram and 1.5 grams.

value recommended by the manufacturer for obtaining the flattest response).

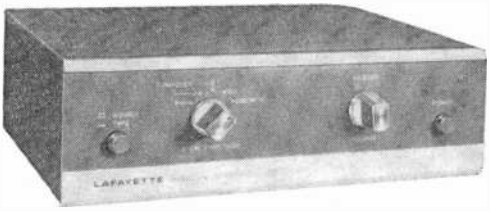
The frequency response of the cartridge was flat within +2 and −3 dB up to the 20,000-Hz limit of the CBS STR100 test record, with 20 to 30 dB of channel separation up to 10,000 Hz and about 12 dB of separation at 20,000 Hz (which is excellent performance for any cartridge).

At roughly 6 mV/channel at 3.54 cm/s, the M91ED had a relatively high output for a top-quality cartridge. A 1000-Hz square wave was reproduced with a slightly rounded top and a couple of cycles of low-level ringing.

The IM distortion was very low, measuring about 0.6 percent up to a 15-cm/s velocity (probably the residual distortion in the RCA 12-5-39 test record) with a 1-gram tracking force. At greater than 19 cm/s, the distortion increased rapidly. However, by increasing the force to the recommended 1.5-gram maximum, we were able to reduce the distortion to a very low 2.2 percent at the highest level of 27.1 cm/s.

Listening Tests. Listening to the Shure "Audio Obstacle Course" record, we found that the M91ED tracked without difficulty all the test bands except the highest levels of orchestral bells, bass drum, and piano, at a 1-gram tracking force. Increasing the force to 1.5 grams improved the bass drum tracking, but it did not affect the other selections. We repeated this test with one of the original N91E stylii, in the same cartridge body, and could not detect any difference. In view of the small increase (0.5 to 1.5 dB) in tracking ability in the new model, it is not surprising that it was audibly similar to the original version. However, in marginal cases, very heavily recorded discs should be playable with less distortion using the new stylus.

LAFAYETTE SQ-L QUADRAPHONIC DECODER
(A Hirsch-Houck Labs Report)



THE Lafayette Radio Electronics SQ-L is a "universal" quadraphonic decoder for use with program sources using CBS SQ and other matrix encoding. It contains a partial "logic" circuit that improves the front-to-rear separation of the SQ matrix at the cost of a slight, undetectable, reduction in side-to-side separation. Rear channels can be derived from ordinary 2-channel stereo material to simulate 4-channel stereo sound.

The SQ-L is a compact unit measuring 8¾" wide by 3" high by 8⅞" deep. Its woodgrain-finish metal cabinet and all necessary connecting cables are included in the base price of $79.95.

The input signal is taken from the tape output jacks of a stereo amplifier or receiver, and the front channels are returned to the amplifier's tape monitor inputs. The rear-channel outputs of the SQ-L drive a second stereo amplifier to produce the rear speaker signals.

The decoder's function switch offers a choice of several operating modes. Three different decoding matrices are provided and are identified as SQ, COMPOSER A, and COMPOSER B. In the F+R position, the original stereo program is supplied to all four speakers, with the two speakers on each side carrying the same signal. The DISCRETE input accepts an external 4-channel program and passes it, unaltered, to the output jacks. A SOURCE/TAPE switch supplies either the normal 2-channel signal input, or the playback output of a 2- or 4-channel tape recorder, to the signal processing circuits in the decoder. The original tape monitoring facilities of the main amplifier are no longer available for use when the SQ-L is connected; so, they are duplicated on the decoder's rear panel.

A master volume control on the front panel affects all four channels simultaneously. To accommodate input signals of widely differing levels, there are two sensitivity slide switches on the rear panel. The HIGH position is recommended when the associated amplifier or receiver is a Lafayette product, but some other makes may have more output at their tape jacks and require the use of the LOW position. There is also an unswitched ac outlet on the rear of the SQ-L.

With the master volume control set at maximum, the decoder is rated at 1-volt output with a source or tape input of 100 mV or 500 mV, depending on the setting of the sensitivity switches. The discrete inputs are not affected by the sensitivity switches and require a 500-mV input to obtain a 1-volt output.

Our measurements confirmed these specifications. Depending on the operating mode, from 440 mV to 570 mV was required for a 1-volt output in LOW and from 80 mV to 100 mV in HIGH sensitivity settings. The maximum undistorted output was 8 volts, and inputs of up to 5 volts could be accommodated without clipping at reduced settings of the master volume control.

The rated distortion at the 1-volt output level is 0.2 percent, but our measurement yielded only 0.049 percent. The unweighted noise was 65 dB below 1 volt (exactly as rated) at maximum volume, reducing to −77 dB at minimum volume.

Quadraphonic Performance. We evaluated the performance of the SQ-L as a quadraphonic decoder in the most direct manner—by playing quadraphonic discs through it. Almost 50 discs were used (all commercial releases), most of them recorded with the SQ matrix by Columbia and Vanguard. A number of other discs were used to check the compatibility of the SQ-L with other matrix systems, including the Electro-Voice system on Project 3, Ovation, and Crewe labels, and the Sansui QS system on Project 3 and Sansui discs. Stereo FM program material was used to judge the effectiveness of the SQ-L as a rear-channel synthesizer. A 4-channel preamplifier and

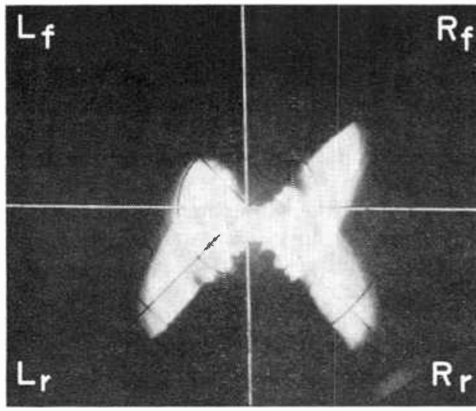


Fig. 1 Butterfly pattern shows strong signal in all but left-front (L_f) channel; smearing represents crosstalk.

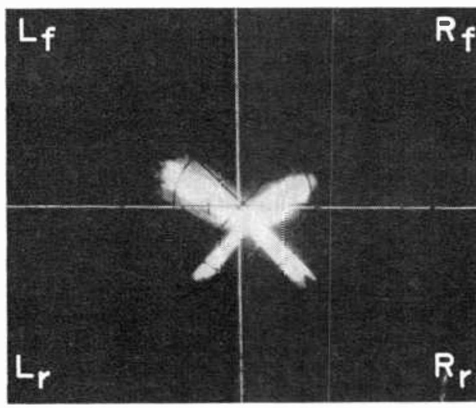


Fig. 2 Distinct X pattern represents ideal output of discrete 4-channel signal.

separate 4-channel power amplifier were used for our listening tests.

We were aided in our analysis by the unique Pioneer Model SD-1100 Stereo Display, a versatile oscilloscope capable of displaying the full spatial distribution of a 4-channel signal. The CRT screen of the scope can be considered as representing the listening area, with the center of the room in the center of the screen. A dot in the center of the screen, with no signal present, expands to a line whose length is proportional to peak signal level and whose angle represents the direction of the quadraphonic signal source. A vertical line going up from center (0°) is a center-front signal, while a downward line is center-rear. Similarly, a 45° line is right-front (R_f), and a 135° line is right-rear (R_r), etc.

When playing most musical records, the display is an amorphous "blob" that dances around according to the music, in which case, it is quite difficult to analyze. However, some records have specific notes or instruments recorded at dicrete angular positions, and these can be seen quite clearly on the screen of the SD-1100. One of our sources was a series of special test discs made by United Recording Companies of Hollywood, Calif., but we also found an ideal recording of "Chase" (Epic EQ-30472). The opening trumpet blasts on this disc come in succession from left-front (L_f), right-front (R_f), right-rear (R_r), and left rear (L_r). On the scope display, assuming an ideal decode, a time exposure covering all four notes would appear as an "X". Any smearing or "fill-in" across the arms of the "X" would represent crosstalk or lack of separation.

Although the SQ-L did not produce a true "X" pattern from our test, it's "butterfly" pattern (Fig. 1) was the best we observed for any of several SQ decoders tested in this manner (except for a very expensive model with complex "full logic" circuits). Our photograph of the display shows a strong separation between the left and right channels, both in front and rear, and some blending along the sides between the front and rear. This effect is typical of SQ decoders with front-to-rear logic; simple unaided SQ decoders have only 3 dB of front-to-rear separation and a much less defined shape.

COMPOSER B is supposed to add a small amount of ambience to stereo recordings by driving the rear speakers with a difference signal. It did this, but the rear-channel levels were so low as to be inaudible, and the scope display was essentially that of a 2-channel stereo signal with a small amount of "scatter" outside the usual stereo speaker area.

According to the instructions provided, COMPOSER A can be used to synthesize quadraphonic effects with stereo material or to decode other unidentified recording matrices. In the first application, it did a very satisfactory job (as do almost all matrix decoders). When we attempted to decode some of our discs in this mode, we discovered that this matrix is an ideal Sansui QS decoder. With the Sansui-encoded portion of our test records, the tones from the four speaker channels produced an ideal "X" pattern as shown in Fig. 2.

The Lafayette SQ-L is the only general-purpose matrix decoder that we have used which is capable of properly decoding Sansui QS material (an SQ matrix completely alters the directionality of QS material, and vice-versa). Since there are a number of commercial recordings with Sansui decoding, such as the popular Enoch Light productions on Project 3, this could be an important consideration for many people.

Considering the fact that the SQ-L is a better-than-average SQ decoder and can get better separation from Sansui material than we would have believed possible, it is clearly an outstanding value.

E. F. JOHNSON MESSENGER 323-M CB TRANSCEIVER

THE Messenger 323-M is a solid-state 23-channel, crystal-synthesized AM CB transceiver. It features added facilities for monitoring two other selected channels while normal operation is maintained on any other channel.

The 323-M is essentially the same as the company's Model 124-M, reported on previously in this column, except for its styling and size, the latter reduced for mobile installation to 9½" × 8" × 2½". Overall weight is 6 pounds. The larger 124-M, on the other hand, is designed primarily for base station use.

Standard with the 323-M are: individual adjustable squelches for the normal or monitor receiver sections; PA operation with external speaker; receiver monitoring with external speaker; a meter indicating received signal strength or the transmitter's relative output power; and full legal power with high modulation maintained by audio compression and clipping.

Since most of the details, including much of the circuitry, are similar to those described in the earlier writeup of the 124-M, we will give only a brief rundown of some of them.

The Circuitry. Dual conversion is employed in the normal receiver. Selectivity is obtained with a four-pole crystal-lattice filter. Single conversion with a single-crystal filter is employed in the monitoring section. Besides the crystal-controlled synthesizer for the normal receiver, a separate crystal for channel 9 is supplied in the monitor section. This crystal is selected by a switch that has a second position for selecting a crystal for any other CB channel. Also, if channel-9 monitoring is not desired, a different crystal can be put in its place for monitoring another channel.

A switch located on the rear of the 323-M has an AUTO position at which any signal on the monitored channel takes over from any normal-receiving channel already in use. In the ALERT position, the monitor-channel signal only lights a warning lamp, while leaving the normal receiver in operation.

Unlike the meters used in most mobile rigs, the one in this transceiver is of good size, providing easier readability than is usual. The receiver "S" units and the transmitter output indications are automatically obtained, obviating any need for manually switching the meter.

An individual automatic noise limiter for each receiving section operates full time; there is no on/off switch. However, good a-f quality is maintained with it at all times with extremely effective impulse-noise reduction. There is no "delta" tune in this rig, but this is a superfluous frill for AM operation. Nor does the 323-M have an a-f tone control.

A special plug at the rear of the unit enables the CB'er to employ a tone-alert accessory with the transceiver. The speaker is installed on the left side of the cabinet. This provides somewhat better intelligibility than is usually experienced with a downward-facing speaker.

An optional accessory that can be used with the 323-M is a 117-volt ac power supply that enables the transceiver to be employed as a base-station rig, thus enhancing its utility. This power unit is housed in a tilt-stand pedestal on top of which the transceiver can be fastened to form a single integral unit.

Lab Tests. The performance of the 323-M was as good as that experienced with its 124-M big brother. Evidence of this is its receiving sensitivity of 0.5 μV for 10 dB (S + N)/N and adjacent-channel rejection of 60 dB while still maintaining a 7-kHz-wide bandpass for excellent intelligibility of the received signal. Blasting by a strong signal is minimized by a relatively flat agc that holds the a-f output to within 4 dB with input-signal changes of 100 dB (5-500,000 μV). The squelch threshold can be adjusted for signals as low as 0.3 μV.

The squelch for the monitor section can be adjusted to activate the monitor with signals as low as 3 μV. A good feature here is that the selectivity is such that it takes a pretty hefty off-channel signal to cross over sufficiently to take over the monitor setup. In this case, signals of up to about 3300 μV, ±20 kHz from the monitored channel, can be held off.

Operating at 13.8 volts dc, the transmitter carrier output was found to be 4 watts. This along with a good voice punch sustained by the compression and clipping setup, the effectiveness of the noise limiter, and the monitoring features (especially for road emergencies) make the 323-M an ideal transceiver for mobile service.

The Model 323-M CB transceiver (which is FCC Type Accepted) is list priced at $290.00, complete with all synthesizer crystals, channel-9 monitor crystal, push-to-talk ceramic microphone, and mobile mounting hardware. The Model 239-0122 auxiliary ac power supply is priced at $33.00. All are American-made products of the E.F. Johnson Company.

RCA WR-515A COLOR-BAR GENERATOR

IF YOU service color TV receivers, a color-bar/pattern generator is a must. Although most of the available color generators provide all of the functions you would normally use or need, the new RCA Model WR-515A Master Chro-Bar IC Color-Bar Generator/Signalyst ($179.00 at your local RCA distributor) has a few extra features.

Employing 13 IC's (10 digital and 3 linear), the WR-515A generates all r-f and pattern signals from crystal oscillators that never need adjustments in the countdown circuits. The patterns provided include a blank raster for purity adjustments, a choice of either 3 or 10 vertical lines of crosshatch or dots, and horizontal or vertical lines alone. The conventional 10 bars of color are also generated, except that narrow brightness pulses have been added to the edges of each color bar as an aid in checking the "fit" or registration of the luminance (Y component) and chroma signals. A special color-bar MARKER switch can be operated to place a brightness line on the third, sixth, and ninth color bars for quick identification in the displayed pattern. This latter function is useful in performing afpc (automatic frequency and phase control) alignment in overscanned TV receivers and in setting the tint control range.

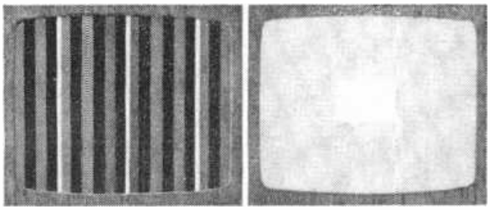
An additional pattern, called the "Superpulse," consists of a white rectangle centered on the screen. This pattern comes in handy for setting drive and screen controls and for checking picture brightness problems such as smearing, ringing, and improper video peaking.

All patterns are available with three switch-selectable outputs—crystal-controlled r-f, 45.75 MHz as used in the i-f strip, and as either positive-going or negative-going video available at 75 ohms impedance. With all these signals available, you can now connect the generator at any point in a color TV receiver circuit.

Accessories. Among the accessories provided with the WR-515A are a shielded output cable that is terminated in BNC connectors, a 75-300-ohm matching transformer for the r-f output, a direct output connector for i-f and video applications, and a set of three leads with insulation-piercing alligator clips for the switch-selectable gun killers.

Besides the complete operating manual, RCA also supplies three manuals of its "Test Point" series, covering troubleshooting of TV receivers, checking and aligning color-TV afpc circuits, and color-TV receiver installation and setup procedures, all using the WR-515A generator.

The new generator measures 10″ × 8″ ×



Special features in RCA color generator include white accent on color bars (left) and Superpulse (right).

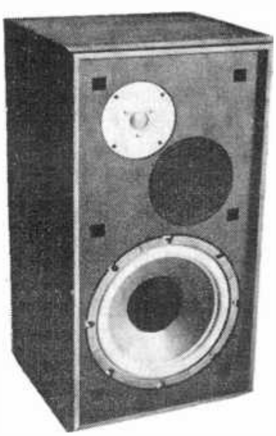
4″ and weighs 6 pounds. The electronics are housed in a metal case that has a rugged aluminum panel and a combined tilt-stand/carrying handle. With the exception of the chroma level, vertical line/dot brightness, video and r-f level controls, which are rotary type controls, all pattern functions are set up by punching the appropriate pushbutton switches. Five separate pushbutton switches are used for inserting the color-bar brightness marker, changing the output to the i-f frequency, and the three gun killers.

Test Results. Having tested the WR-515A extensively we come to the conclusion that it is a very good instrument of this genre. The sync and line/dot stability is excellent. The i-f and video-level outputs have been put to a lot of use, especially the video signal that we used to troubleshoot a couple of closed-circuit TV systems.

By now, we are getting used to the Superpulse, having found this pattern to be a good signal for general observation of the display. Any smearing or ringing that might exist certainly shows up in this test pattern. Those TV receivers provided with video peaking controls can really be set on the head with the aid of the Superpulse. Considering what and how much you get for the money, the WR-515A color-bar/pattern generator is a very good buy.

Circle No. 68 on Reader Service Card

JENSEN MODEL 4 SPEAKER SYSTEM
(A Hirsch-Houck Labs Report)

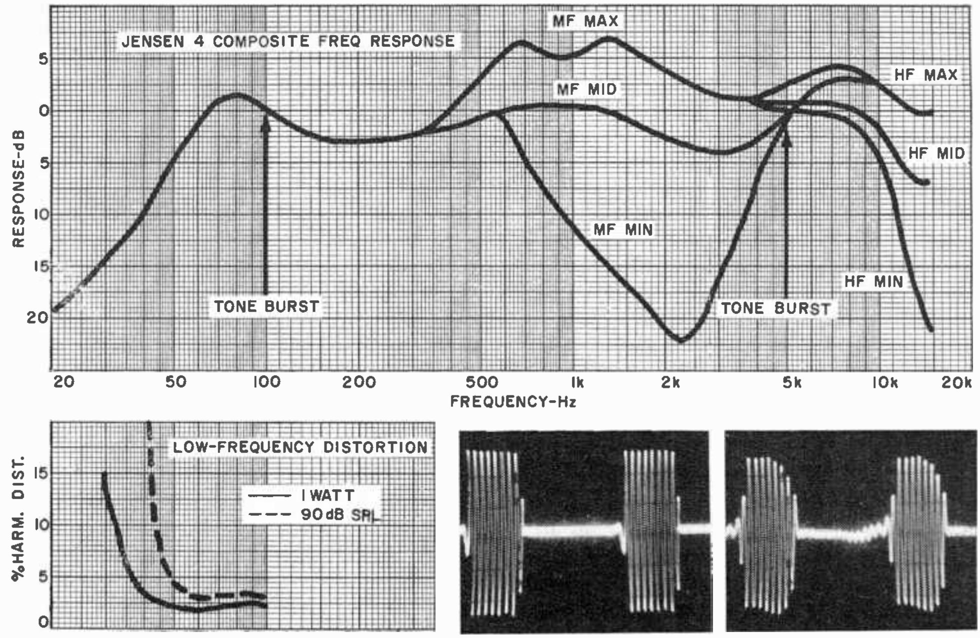


THE Model 4 is one of a line of six speaker systems produced by Jensen Sound Laboratories (a pioneer in the field). Just above the "middle" of their product line, the Model 4 is a three-way bookshelf system, contained in a walnut enclosure 24″ wide, 13″ high, and 12″ deep and weighs 35 pounds. The suggested retail price of the system is $99.00.

The 10″ acoutic suspension woofer in the system has a foamed plastic rolled edge-surround and a four-layer voice coil. The first crossover, to a 5″ cone driver, takes place at 500 Hz. At 4000 Hz, there is a second crossover to a hemispheric dome tweeter whose hard phenolic dome is 1″ in diameter. The midrange and high-frequency speakers are acoustically isolated from the woofer and from each other by means of separate tuned chambers. Separate controls on the rear of the cabinet provide for wide adjustment of the midrange and tweeter levels. The connectors for hookup to an amplifier or receiver are spring-loaded push-type binding posts. The nominal system impedance is rated at 8 ohms.

Revised Laboratory Tests. The Jensen Model 4 was one of the first speakers we tested with a revised procedure. A single microphone, located about 15′ from the speakers in a normally "live" room, was used from 100 to 15,000 Hz. A "warble" tone was swept over this range, smoothing out the effects of standing waves from 100 to 1000 Hz. For bass measurements, the microphone was placed approximately in the plane of the grille cloth (centered on the woofer opening), and the output of the test speaker was compared with that of a calibrated reference speaker we tested in the same manner. From these measurements, covering 20 to 300 Hz, we were able to derive a bass response curve that was largely independent of room resonances.

The two frequency response curves, which overlap for more than one octave, were



Response with controls at various points (top). Low-frequency distortion (above left). Tone-burst photos taken at frequencies of 100 and 5000 Hz.

spliced to form a smoothed composite curve that was corrected at high frequencies for the response of our calibrated microphone.

Tone-burst response and low-frequency harmonic distortion were measured with a microphone spacing of 12″. The low-frequency distortion was measured at a 1-watt drive level and also with the drive adjusted to produce a constant sound pressure level (SPL) of 90 dB at 1 meter at all frequencies.

Our final response curve approximates the total energy output characteristic of the speaker. Although this method is still not entirely free from room effects, it is a substantial improvement over our former multi-microphone system.

The Model 4 midrange driver is more efficient than are the woofer and tweeter so that the flattest response was obtained with the midrange level control set to mid-position and the tweeter level control at or near maximum. Overall, the Model 4 had a very uniform response, within ±3.5 dB from about 50 Hz to 15,000 Hz. The dispersion of the "Sonodome" tweeter at high frequencies was very good. And the tone-burst response was excellent throughout.

The low-frequency distortion at 1 watt was low, reaching 5 percent at 36 Hz and 10 percent at 32 Hz. However, the output is falling rapidly at these frequencies and cannot be "forced" very far by equalization. At a constant 90-dB SPL, distortion was 5 percent at 48 Hz and 10 percent at 44 Hz.

The electrical impedance varied between 4 ohms at 500 to 600 Hz and 12 ohms between 3000 and 6000 Hz, except at bass resonance (52 Hz) where it was 35 ohms. The speaker system is moderately efficient, for an acoustic-suspension design, requiring only about 0.3 watt in the octave centered at 1000 Hz for a 90-dB SPL at 1 meter.

Listening Tests. In listening tests, the Model 4 rated a B+ in its ability to simulate the original program in a side-by-side comparison.

The overall sound of the speaker system was very well balanced with no particular emphasis—or lack of emphasis—in any part of the frequency range. Although this system does not produce as much very low bass (below 50 Hz) as do some more expensive systems, it is capable of generating a satisfyingly clean bass from almost any musical program material. The uniform output, wide dispersion, and uncolored sound quality of the Jensen Model 4 speaker system should earn it a solid position in the popular under-$100 category. ◈

MAC'S SERVICE SHOP

Electrostatics At Work

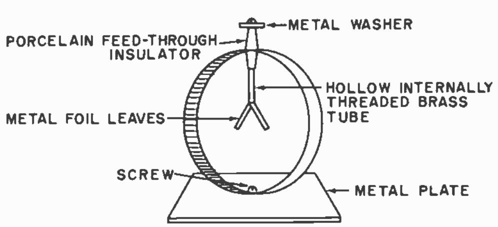
By John T. Frye, W9EGV, KHD4167

THE sparkling cold winter morning lifted the heart but numbed the fingers as Barney sprinted quickly over the squeaking snow from his car to the service shop. There he found Mac, his employer, seated at a service bench bearing some strangely assorted paraphernalia: a red-handled tooth brush, a ten-inch-long glass rod, one square of rough brown woolen cloth and another of pink silk, a couple of coathanger-wire stands shaped like bridge lamps and carrying-pea-sized little white balls suspended by silken threads from the ends of their horizontal arms, and a gaily decorated round tin candy container.

"Okay, I give up," Barney said after a puzzled examination of these objects. "What the heck are you doing?"

"In the parlance of the day, I'm trying to 'get it all together,'" Mac answered with a teasing grin. "I'm going back to where our line of work really started when Thales of Miletus, about 600 BC, observed that a piece of rubbed amber, called "elektron" in Greek, attracted bits of matter. All the millions of uses for electricity and electronics in our modern civilization can be traced back to that casual observation of electrostatic, or triboelectric, charge. Deciding a review of basic electrostatic principles would not hurt me, I got some books from the library, made those little balls from pith gouged out of the center of branches lopped off trees of paradise, or stink trees, growing in my back yard, made the simple leaf electroscope contained in that candy tin with chewing gum wrapper foil, invoked the spirit of Ben Franklin, and started experimenting, trying to explain everything I saw happen in terms of what I know about electron theory. Never before did I get so much thought-provoking pleasure from such simple home-made apparatus."

"Aw, I did all that stuff in high school physics," Barney scoffed. "Electrostatic experiments are interesting but of little practical value except to explain how lightning rods work."



The leaf electroscope is made from a 5" in diameter round candy tin with the bottom cut out. A small porcelain feed-through insulator goes through a hole in one side of the can, and a brass tube with internal threading is screwed onto the bottom end of the insulator. The bottom end of this small-diameter tube is split, and two leaves of foil 1/4" by 2" have their ends clamped in the split. I used thin metal foil from chewing gum, and beat it even thinner. Gold leaf, obtainable from a sign painter, would have been better. Plastic wrap is stretched over both ends of the can to allow the leaves to be seen while protecting them from air currents. A brass ball could well replace the metal washer on top of the insulator. When a charge is placed on the washer, either by contact with a charged object or by induction, like charges on the leaves cause them to spread apart. They then collapse when the charge is subsequently taken away.

"How easy it is to be so cocksure—and so wrong—when you are young!" Mac marvelled. "Did you learn that, on a clear bright winter day such as this, the downward electrostatic charge in the atmosphere may carry up to 500 volts per vertical meter?"

"Don't believe it," Barney answered promptly. "That would mean there would be almost 1,000 volts from my head to feet. That would electrocute me."

"Not so. You constitute a grounded conductor, and your skin is an equipotential surface that warps the electric field and makes you unaware of it, even when a thundercloud moves overhead and reverses the field polarity and increases the potential up to 10,000 volts/meter."

"That's when the lightning strikes," Barney interrupted.

"It's not that simple. You need 300 times that voltage, or 30,000 volts/cm, to break down the resistance of air. Actually a 'leader' stroke develops stepwise inside the cloud and comes to ground; then there is a main upstroke along the ionized path of the leader containing tens of thousands of amperes. By the way, did they tell you about earthquake-lightning in your physics class?"

"Nope. We didn't believe in compounding catastrophes."

"Nature apparently does. Flashes of light in the sky often accompany earthquakes. During the Japanese quake of 1930 some 1500 such flashes were recorded. That quake area is characterized by quartz-rich lava, and it has been suggested that, with the right kind of crystalline order and the right kind of seismic waves, millions of volts of electrostatic energy might be generated by the earth's movement of the rock formation through the piezoelectric effect—the same effect that produces the weak voltage across the output of a crystal phono cartridge when the stylus vibrates in the record groove. Perhaps if any quartz-bearing areas can be found along the San Andreas fault, stations for continuous monitoring of the atmospheric electric field can be set up and their recordings correlated with ground tremors. If these coincide, this might lead to an earthquake early warning system."

"You still haven't shown me that electrostatic electricity is practical."

Practical Applications. Before answering, Mac rubbed the toothbrush handle with the woolen cloth and then held the handle near one of the pith balls. The ball was attracted to the handle and clung to it for a few seconds and then leaped violently away and swung over to a metal meter panel and clung to it.

"That should suggest one very practical use: a precipitator for removing air-polluting fly ash and other liquid and solid particles from flue gases," he said. "All we need do is put an electrostatic charge on the particles, such as I put on the pith ball, and subject them to a field so they will move toward and cling to an oppositely charged or neutral surface. In practice, this can be done by running a thin wire, carrying a negative potential of 100,000 volts, down the center of a cylindrical duct 20 cm in diameter. The charge produces an average radial field strength of 10,000 volts/cm, but the field strength is much less near the duct wall and much more near the wire. In fact, in the immediate vicinity of the wire, it is far above the 30,000 volts/cm I mentioned as being necessary for breaking down the resistance of air. This results in a corona discharge, or zone of ionization, around the wire. Electrons surging off the wire attach themselves to oxygen molecules of the air, converting them into negative ions that are repelled by the wire so they move outward toward the grounded duct wall in a veritable ionic current.

"If a flue gas loaded with waste particles flows up the duct with a velocity of less than ten feet a second, the ionic current charges the particles and makes them move across the gas stream by the billions to collect on the walls of the duct. If the particles are dry, the duct is rapped so the ash falls downward and is collected in a hopper. Liquid particles simply run down the duct walls. Industrial precipitators operate on a negative corona, while home air cleaners use a positive corona. It's estimated such devices trap more than twenty million tons of fly ash a year. I'd call that a practical use."

"So maybe there is *one* practical use," Barney admitted.

"There's much more. The principle of corona discharge is also used to separate granular mixtures in which the two kinds of particles differ in conductivity so one might be called a conductor and the other an insulator. Remember conductivity is always a relative term. In one form, the mixture comes down from a hopper and spreads out in a thin layer on top of a grounded rotating drum. The drum passes under a wire generating a corona discharge. Ions flood through the mixture to the drum. They pass through the conducting particles to the drum and there is no adhesion; so these particles simply fall off into bin #1 as the drum turns. The charges of ions that strike the insulating particles coat the particle surfaces with a charge that pins them to the metal drum while it moves past bin #1, and they are scaped off in bin #2. This kind of separator is used extensively to separate iron ore, but it is also used to remove rodent excreta from rice, extract garlic seeds from wheat, and to separate nut meats from shells.

"In the handling of continuously moving sheets of paper or film, one surface of which is coated with a sticky substance, the 'web' can be pinned to the surface of a single roller to supply tension by charging the outer surface with ions supplied by a corona discharge.

"Still another important use of the corona discharge is electrocoating, a process used to apply various coatings such as wet paint, grit particles, dry powders, and even short fibers. A spray gun equipped with a corona point emits a fine mist of paint particles that gather the field lines to themselves and attract ions from the corona, thus acquiring a charge. The charged particles are so strongly attracted to the grounded target that they actually curl around it and coat the sides and back surface. It's estimated the saving in paint alone from electrocoating amounts to $50 million a year.

"Flocking is a variation of electrocoating. If you want a velvet wall, you first paint it with conductive aluminum paint to which an adhesive is applied. Then you fill a hopper with short fibers and shake it in front of the wall. As the fibers fall out they are charged from a set of corona points mounted on the hopper, and three things happen: (1) the fibers are driven toward the wall by the Coulomb force of repulsion of like charges, (2) the mutual repulsion of like charges on the fibers keeps them apart, and (3) the fibers align themselves with the lines of force so they arrive end-on at the adhesive, permitting more than 200,000 fibers per square inch to be applied. This process is used to make artificial suede, cover the interior of instrument cases, or put pile on carpeting. A similar process is used in the $200 million a year business of coated abrasives, such as sandpaper and emery paper."

"Okay! I'm convinced. Electrostatic electricity is more than a toy," Barney conceded.

"There's more," Mac said relentlessly.

"Let's talk about the dry-copy imaging process known as xerography. The operation of a Xerox machine depends on the fact that a selenium-covered plate can be charged by a corona discharge, and then the charge can be removed by exposure to light. In actual operation a selenium-coated drum is charged in the dark from a corona, and then an image of the page to be copied is focussed on the drum. The charge is removed in the light areas but retained in the dark areas. Next a 'toner,' a mixture of black dust and tiny glass spheres, is spread over the image. The opposite-charged glass and dust stick together until the mixture reaches the image; then the glass is repelled and the dust clings to the dark areas.

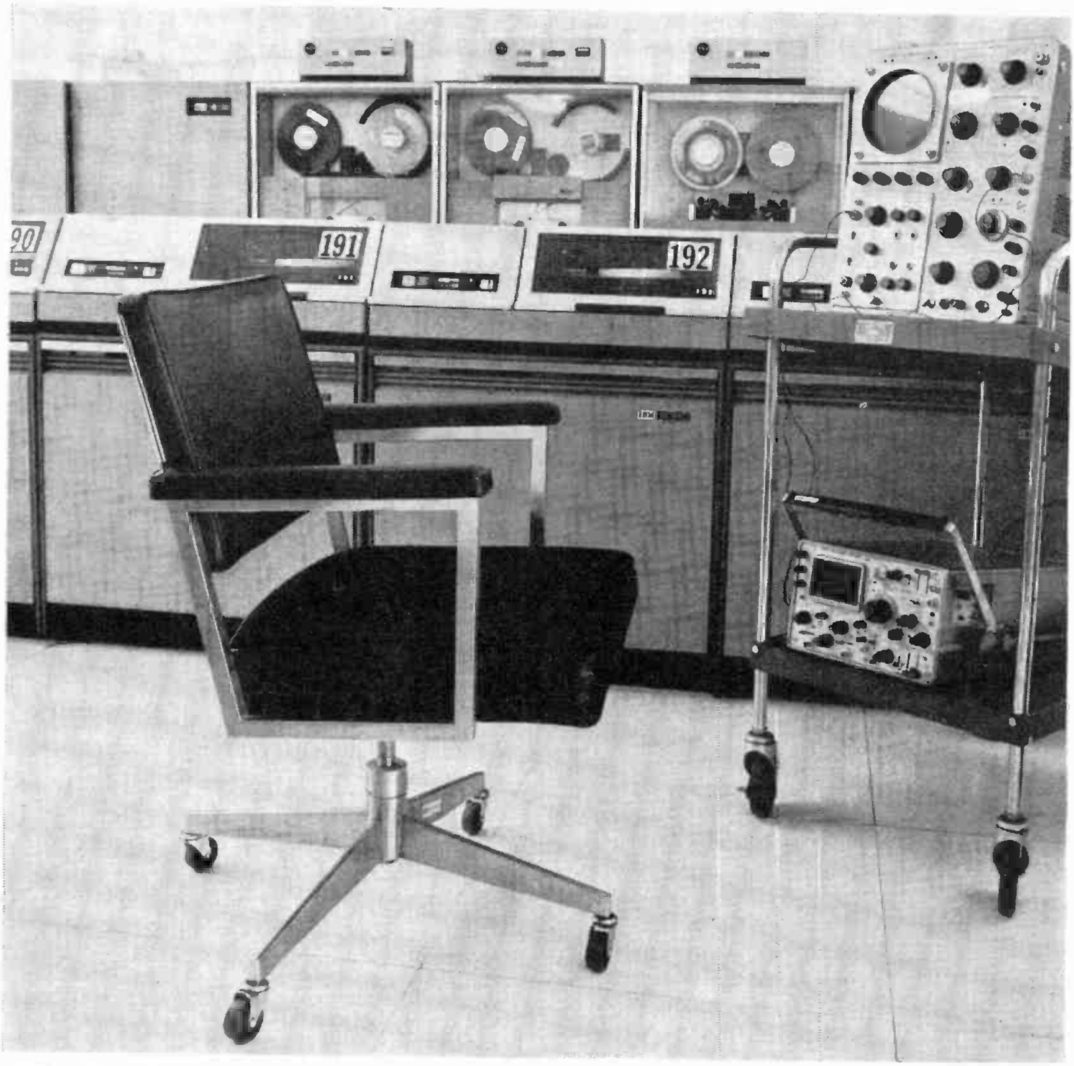
"Now paper that has been charged is spread over the image on the drum and attracts the toner to itself. Finally this paper moves through a rapid-heating stage that fuses the toner to itself and makes a permanent copy. This is a simplified explanation, of course, but I'm sure that you will get the idea."

"By the way, where did you learn all this stuff anyway?"

"From various books and magazine articles. One of the best sources was the work of A.D. Moore, professor emeritus of electrical engineering at the University of Michigan. Two of his books are *Electrostatics* and *Invention, Discovery and Creativity*. He was working on another that may be published by this time called *Electrostatics and its Applications*. In an article in the March, 1972, issue of *Scientific American* he points out that Ben Franklin invented the first electric motor, an *electrostatic* motor; and he goes on to say interest in this type of motor has been revived recently, chiefly by Oleg Jefimenko of West Virginia University. One of his corona motors about five inches long developed a tenth of a horsepower. Recently he put up a wire by balloon and ran one of his motors by energy from the atmosphere's electric field."

"That does it!" Barney exclaimed. "I'm going home tonight and dig out my physics books. How about borrowing those playthings—excuse me, that apparatus—of yours?"

"*Con mucho gusto*," Mac replied, grinning. "That was the whole idea. You'll have fun, and, as a bonus, I'll guarantee it will be much easier to understand solid-state electronics after you've reviewed your electrostatic electricity." ◈



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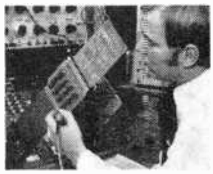

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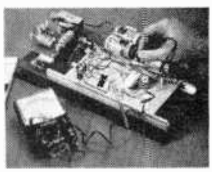

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CIRCLE NO. 5 ON READER SERVICE CARD

Solid-State Scene

By Walter G. Jung

Complementary MOS Logic

THIS month, we are highlighting (instead of a specific product) a significant trend. There is a big swing among logic designers toward complementary metal oxide semiconductors (CMOS) for digital logic—and for very good reasons. Pioneered by RCA in its CD4000 and CD4000A COS/MOS line, this logic family has many features which, for logic elements, are nearly ideal: they have very low standby power, low output impedance in either the "1" or "0" state, high input impedance, wide operating supply range, and high noise immunity.

A basic circuit illustrating the CMOS concept is the inverter shown in Fig. 1. Here p- and n-channel MOS transistors are connected in series between supply voltages V_{DD} and V_{SS}. The former is usually a positive potential, while the latter is common. Since *Q1* and *Q2* are complementary devices, a voltage which turns one on turns off the other, and vice versa. When either transistor is off, its impedance is hundreds of megohms; when it is on, impedance is a few hundred ohms. Since the two are in series, there is no significant static power dissipation.

For a 1 input (V_{DD}), *Q2* is on and *Q1* is off, so the output is zero (or V_{SS}). When the input changes to a zero, *Q2* switches off and *Q1* turns on pulling the output up to the 1 state.

Along with near ideal switching characteristics (including virtual immunity to changes due to temperature and operating voltage variations), CMOS has other salient advantages. Its structure is basically "all transistor;" and, since MOS transistors are smaller than bipolar counterparts, this means that they are potentially less expensive.

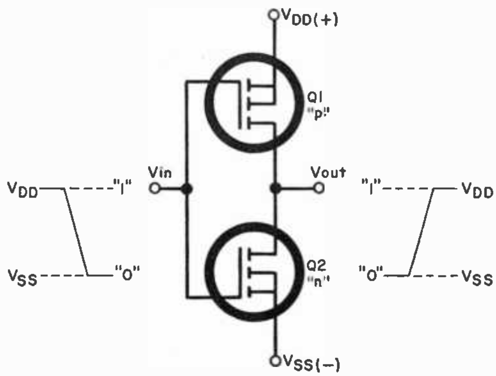


Fig. 1. Schematic of a basic complementary MOS logic inverter circuit.

CMOS logic promises to be the logic of tomorrow due to its excellent characteristics and flexibility. Its only drawback is a relatively low speed of 5 to 10 MHz; but this characteristic is being improved.

RCA has published a book on its COS/MOS line, "COS/MOS Integrated Circuits Manual CMS-270," available for $2.50 from distributors or:

RCA Solid State Division
Somerville, NJ 08876

Other manufacturers of CMOS are:

Motorola Inc.
Technical Information Center
Semiconductor Products Div.
PO Box 20924
Phoenix, AZ 85036

National Semiconductor
2900 Semiconductor Dr.
Santa Clara, CA 95051

Solitron Devices

8808 Balboa Ave.
San Diego, CA 92123
Solid State Scientific
Montgomeryville, PA 18936

Dielectrically Isolated CMOS. Harris Semiconductor has joined the move toward CMOS logic with their own unique contribution of dielectrically isolated processing for a number of logic devices compatible with the CD4000A series, plus proprietary devices of their own. The outstanding virtues of DI/CMOS (as Harris calls it) are greater speed and an improvement on CMOS's inherently low power.

The HD-4000, dual-3 NOR gate, for instance, has a 10-ns propagation delay while dissipating only 1 nW. Similarly, the HD-4013, dual D flip-flop has an 18-MHz toggle rate, with 50 nW of power. Supply voltage range is from 3 to 18 volts with a noise margin typically 45% of supply voltage.

Devices are available in two temperature ranges: −40°C to 85°C and −55°C to 125°C.

Harris has also entered the growing field of phase-locked loops with two new proprietary devices which offer improved flexibility and stability. Key features of the devices are the separation of the locking and demodulation phase detector outputs, which allows independent adjustment of loop bandwidth and demodulator bandwidth, and accessibility to the detector/vco interface.

The devices differ in basic frequency range, the HA-2825 being usable from 0.01 Hz to 3 MHz over a temperature range of 0 to 75°C with a stability of 100 ppm/°C vs temperature, and 0.1%/V supply voltage sensitivity. The HA-2800/2805 are high-frequency devices operating from 1 kHz to 25 MHz with an oscillator temperature coefficient of 250 ppm/°C and 0.1%/V supply sensitivity.

Two temperature ranges are available: the HA-2800 for −55 to 125°C and the HA-2805 for 0 to 75°C.

Prices are: HA 2825, $8.63; HA2800, $30.90; HA2805, $13.40; all for 1 to 24 pieces.

For further information on these devices contact:
Harris Semiconductor
PO Box 883
Melbourne, FL 32901

Three-Terminal Voltage Regulators. Voltage regulators are the news these days, and simplicity is the key. National Semiconductor has recently introduced the LM120 series of 3-terminal negative regulators with preset output voltages of −5, −5.2, −12, and −15 volts, with current capacity of 1.5 A (see Fig. 2). The devices are protected against short circuits and thermal overloads. They have 50-mV load regulation and 0.5-mV/V line regulation and are offered in TO-5(H) and TO-3(K) packages. Prices begin at $5.50 (1 to 24) for the LM320XXH and $5.95 for LM320XXK.

National is also supplying fixed-output, 3-terminal, positive regulators rated at 5, 6, 8, 12, 15, 18, and 24 volts. The LM340 series has 1-ampere current capability, with thermal and short-circuit protection. They are available in both TO-220(T) and TO-3(K) packages with prices for 1 to 24 of $2.65 for LM340XXT and $3.40 for LM340XXK.

In the area of noise improvement, National has made big news with the introduction of their LM381 series of preamplifiers. Designed for optimum performance in low-signal environments, these devices all have less than 1 μV rms typical input noise, 110 dB gain, 15 MHz bandwidth, 120 dB

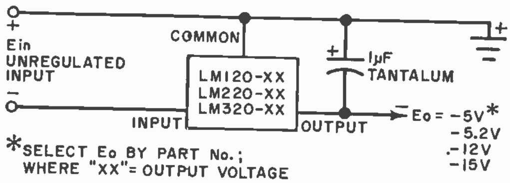


Fig. 2. Basic hookup for a regulator using an LM120 integrated circuit.

power supply rejection and operation from 9 to 40 volts. The LM382 has an internal resistor matrix for simplified gain adjustments, while the LM381 and LM381A may be operated either differentially or with single-ended inputs for even lower noise. In this mode, an LM381 has a 1.0-μV maximum noise specification, while an LM381A is rated at 0.7 μV maximum. An ultra-low-noise circuit from National using the LM-381A is shown in Fig. 3. It has 437 nanovolts of input noise!

All devices are in 14-pin dual inline packages (N) and 1 to 24 pieces are $7.45 for LM381AN, $3.50 for LM381N, and $3.40 for LM382N. Two application notes and a data sheet are available from:
National Semiconductor

2900 Semiconductor Drive,
Santa Clara, CA 95051

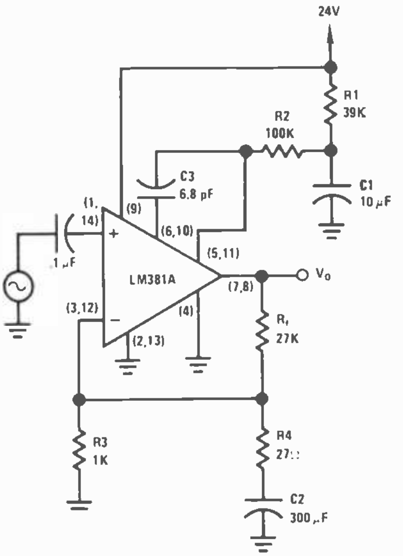


Fig. 3. Low-noise amp using LM381A.

New VCO and Waveform Generator. A good example of an exciting new IC is Intersil's high-stability vco and waveform generator with high-level sine, square, and triangle output. Stability of the vco is an impressive 50 ppm/°C maximum (A version), while linearity is 0.1% and sine-wave total harmonic distortion is less than 1%. Square-wave duty cycle ranges from 2 to 98%. The vco frequency can be swept or digitally programmed with resistors and capacitors from 0.001 Hz to 1 MHz and sweep range of 1000/1.

Devices are available in temperature ranges of 0 to 70°C and −55 to 125°C. in both ceramic and plastic DIPS. Prices for the 8038CC start at $3.75 for 1 to 24.

For further information, write:
Intersil
10900 N. Tantau Ave.
Cupertino, CA 95014

Summing It Up. This month we have taken a look at a variety of useful IC's with CMOS as the highlight. Watch the activity in the CMOS area as this logic family expands, and watch CMOS fill other roles as the technology matures. In the consumer field, there is much more activity going on in the wings—particularly from two of the biggest manufacturers. Those new whisper-quiet National preamps might be just the beginning. ◈

I F YOU are guessing at enlarger exposures to save time, chances are you probably are wasting quite a bit of projection paper. On the other hand, you may be spending too much time running test strips to avoid wasting the paper.

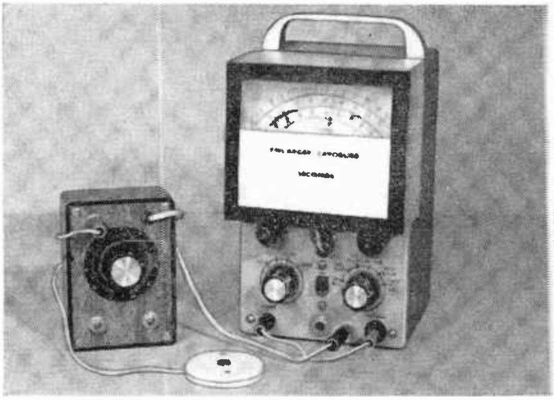
In either case, you will want to consider building an adapter for your VTVM or TVM that indicates exposure times from 1 to 100 seconds using the ohms scale on the meter. You have to add one connector and one lead within the meter, but this will not affect conventional operation.

With linear operation for maximum versatility, the 10,000:1 range of the meter adapter covers almost any situation. You can use the adapter for integrated light or the spot method. A variable-sensitivity control permits programming the meter to accommodate different paper speeds and alternate modes of operation. The meter also provides a direct readout of negative contrast.

Theory of Operation. The adapter can be used with any VTVM or TVM having a 10 at the center of the ohms scale and an RX1 megohm range. The basic ohmmeter circuit usually includes a range resistor (*R* in the schematic) selected by the ohms-range switch.

The resistance of *PC1* decreases in direct proportion to the applied light level. The photoresistor called for in the Parts List has a very high dark resistance, fast response, and a flat color temperature response over a wide range, so substitutions should be made accordingly. Potentiometer *R1* and resistor *R2* are connected across the ohmmeter range resistor to provide the variable sensitivity. It is this that makes possible the calibration of the meter for direct readout of exposure time on the ohms scale. Pushbutton switches *S1* and *S2* facilitate the zero and full-scale meter adjustments.

Construction. The adapter can be mounted directly on the cover of a small plastic case, with *R1* at the center and the two switches on the bottom corners. Mount *J1* at another corner, while the three-wire cable should exit through a grommeted hole at the fourth corner. With an ohmmeter, check that resistance variation of *R1* is smooth for its entire range. A 0-100 dial plate is used in conjunction with a marked knob to set *R1* to any desired point. Index the pointer to zero with *R1* set fully counterclockwise.



Photosensitive resistor *PC1* is mounted between two small pieces of insulating material such as plastic or insulation board with the sensitive surface exposed through a hole. After connecting the cable to *PC1*, and closing the "sandwich," paint the enclosure (not the sensitive *PC1* surface) white.

If you want to illuminate the meter face for darkroom operation, use cardboard or sheet metal to form a slip-on meter hood as shown in the photo. To illuminate the meter face, use a #49 pilot lamp, tinted red and in series with a 72-ohm resistor, connected in parallel with the existing meter pilot lamp. Or you can use an external transformer to provide the necessary power for the lamp.

Checkout. You can verify cell linearity and meter scale tracking using the enlarger aperture control to change light levels by known ratios. Set the meter to OHMS in the RX1 megohm range. When the meter is warmed up, depress *S1* to zero the meter. Release *S1* and depress *S2* to set the meter to full-scale.

PARTS LIST

J1—Miniature phono jack
PL1—Miniature phono plug
PC1—CdS high-speed linear photoresistor (Clairex CL704HL, or similar)
R1—5-megohm audio taper potentiometer
R2—47,000-ohm, ½-watt resistor
S1—Spst, normally open pushbutton switch
S2—Spst, normally closed pushbutton switch
Misc.—Small plastic case with cover, 0-100 dial plate, pointer knob, length of three-conductor flexible cable, length of two-conductor flexible cable, plastic for PC1 mount, rubber grommet, optional meter hood and illuminator.

BUILD AN

ENLARGER TIMER

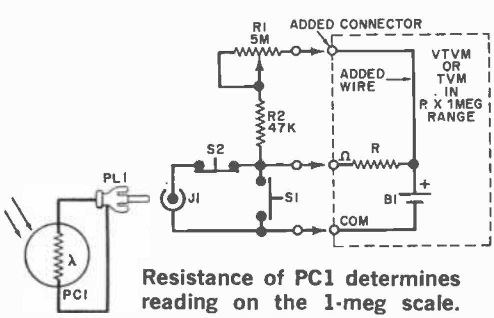
PUT YOUR VTVM TO WORK IN THE DARKROOM

BY ADOLPH A. MANGIERI

With *R1* set to maximum resistance and with enlarger and all darkroom lights off, the meter should indicate near infinity after the cell stabilizes. Avoid exposing the cell to strong room light during calibration and use. If necessary, position the meter so that stray light from the illuminator has little or no effect on meter indications.

Place a normal contrast negative in the enlarger. For a 35-mm negative, allow about 14 inches between lens and easel. Move the lens aperture lever from maximum to F/5.6 to take up any backlash. With *R1* set at about ¾ rotation, position the cell so that the meter indicates 4 seconds. Move the lens aperture lever to F/8 and F/11 and observe meter indications of about 8 and 16 seconds. Similarly, with lens at F/5.6 and meter initially set to 16 seconds, move the lever to F/8 and F/11 and observe indications of about 32 and 64 seconds.

Calibration and Application. To calibrate the exposure meter, find and record the setting of *R1* for the projection papers in use by means of conventional test prints. Record paper data and *R1* settings in a notebook.



Resistance of PC1 determines reading on the 1-meg scale.

Select a negative of normal contrast and make the best possible print by the conventional test-strip method. Let's assume the best print was exposed for 15 seconds at F/8.

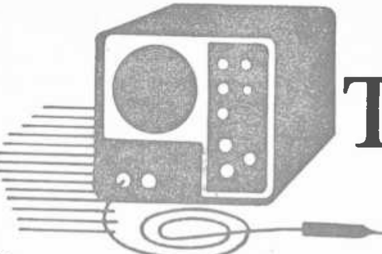
For the integrated light method, place the cell at the center of the projected image. Hold a ground glass plate at the enlarger lens to scatter the light. Adjust *R1* until the meter indicates 15 seconds and record the setting. To use the meter at any print magnification or lens aperture, set *R1* as recorded, use the light scatterer, and expose for the indicated time.

Next, set the lens aperture to F/5.6 or one stop larger. Find a second setting of *R1* for a meter indication of 15 seconds. To use the meter at this setting of *R1*, measure the exposure time at a chosen aperture, close down one F stop, and expose for the measured time. Or, you may halve the indicated time and expose at the same aperture. Similarly you can calibrate *R1* for measurements at two stops larger and close down two stops before exposing at the measured time. If needed, use these alternate calibration points to accommodate large blowups of dense negatives. They are also useful with enlargers having unusually small lamps.

A second mode of operation bases exposure time on a single spot measurement at the shadow area of the print. Reset lens aperture to that of the test print (F/8). Place the cell at the bright portion of the image and adjust *R1* for an indication of 15 seconds. It's best to avoid measurements at blocked-up blacks which appear as blank areas on the negative.

As an aid in selecting paper contrast grade, check negative contrast as follows. Place the cell at the bright portion of the image. Adjust lens aperture and *R1* until the meter indicates 1 second (reference point). Position the cell at the dark portion of the image and note the indication, say 12 seconds. Directly, negative contrast is 12. By test prints, establish your own correlation between contrast measurements and required paper contrast grade. Negatives with contrasts of 8 to 16 will print on normal contrast paper.

You may prefer to devise other calibration procedures. For portraits, calibration can be based on measurements at important areas such as the subject's face. Or, you can base calibration on the average of highlight and shadow measurements. ◈



Test Equipment Scene

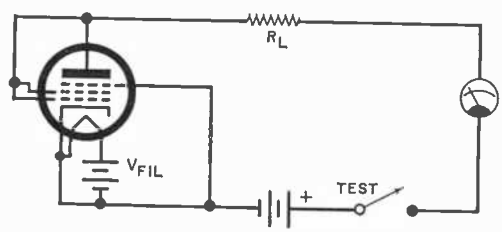
Are Tube Testers Dead?

By Leslie Solomon, Technical Editor

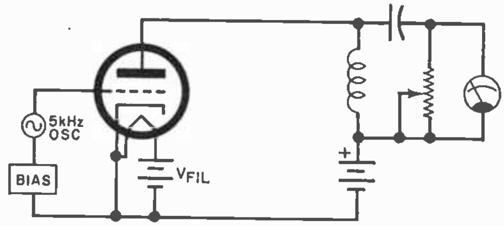
MARK TWAIN once said, "The reports of my death have been greatly exaggerated." So it is with vacuum tubes. If you read the latest papers and magazines and listen to all the advertisements, it would appear that the whole world is solid-state. This seems to differ, however, with a recent survey that showed that, in 1964, vacuum tube sales amounted to $118 million; and in 1972, the projected sales hit $151 million. Either the price of tubes is sky-rocketing, or someone is still using a heck of a lot of them. At any rate, we all know that vacuum tubes still exist; and will continue to exist for a long time in the replacement market.

Sometimes tubes seem to act strangely for no apparent reason. They may look good when tested, but don't work properly in a circuit; and sometimes they burn out. More than likely they have to be replaced at least once during the life of the equipment. It is with these things in mind that we are taking a look at tube testing and testers, and some of the important things you should know about them. You may also discover why the tube tester you have may be limited in use in that it doesn't tell you the whole story about the tube you are testing.

Emission Testing. This test essentially checks the ability of the tube's cathode to supply adequate current to make the associated circuit work properly. Basically a rectifier test, it involves applying the correct filament voltage and plate voltage through some form of metering system (see circuit A in diagram). The emission current is then compared with a "standard" for that particular tube. Here is where we touch on the first problem.



EMISSION TEST
(A)



BASIC Gm TEST (AS USED BY HEATH)
(B)

Keep in mind that the cathode structure may have only one good emission area on its surface, so that it will "test good" under the limited current supplied by some testers. However, under actual operating conditions, where the current demand may be much higher (maybe up to several hundred milliamperes for some tubes), the so-called "good" tube may be borderline or may not even work at all.

Transconductance Testing. This is a measure of the possible gain of the tube (beta, to you semiconductor fans). The transconductance (G_m) is most critical in the front ends of TV and FM receivers, i-f strips, and chroma sections of color receivers.

There are two types of transconductance testing. The first, called "static testing," applies the approximately correct dc voltages to the tube being tested, with the transconductance read on a meter. A much better test, called "dynamic testing," also requires that the tube be supplied with the approximately correct dc voltages, in conjunction with a high-frequency ac signal applied to the input electrode (see circuit B). The dynamic test shows how the tube is operating under signal conditions, almost as it would in a working circuit.

This is where we run into tubes whose G_m seems to change for no apparent reason. A major cause of this is that internal heating from the filament (which is supposed to heat only the cathode) makes the various elements move about slightly due to heat expansion. If you don't think that a tube gets hot enough to singe the internal electrodes, try pulling out a tube with your bare fingers. The constant heating and cooling cycles sometimes cause the elements to warp permanently. Thus, although the emission and leakage tests show a good tube, in the actual working circuit, things are different. The gain and/or bandwidth of the stage are drastically changed due to the change in G_m. On the other hand, a change in G_m can occur if the tube is simply dropped so that the tube does not shatter but the internal elements are displaced.

Leakage Testing. If you check the ohmic values of grid resistors used in many circuits, you will note that they often are in the range of several megohms. Now, if you assume a 1-megohm resistor and a vacuum tube grid leakage of a minuscule 25 microamperes, Ohm's law will show that 25 volts is developed across the resistor. As you can surmise, this will wreak havoc with the grid bias.

What causes grid leakage? One major factor is the outgassing of the tube due to the heat generated. Another common cause is a result of the electrostatic stress from the plate voltage, which forces tiny bits of cathode material to be ripped off and propelled outwards. Many of these fragments, which emit a number of electrons, stick to the control grid. As the tube is operated, all the electrodes warm up, including the control grid; and soon the cathode material deposited on the grid starts emitting electrons.

Now, a new circuit comes into existence. The control grid, which is emitting electrons, "looks" like a cathode, with the electrons going to the plate, around through the power supply, and back through the grid resistor. This, of course, produces a positive voltage at the control grid—the value of the voltage depending on the amount of electrons flowing through the phantom diode circuit.

Such leakage shows up after the tube has been operating for some time. The leakage produces distortion in audio systems, sync clipping or reverse pictures in TV, color shifts in chroma sections, and faulty i-f alignment on the bench. As the tube heats up, the bias point begins to shift; and, although all passive components check out, the stage simply does not operate properly.

Look for a tester that checks leakage down in the 1-microampere range—or less. A tester with lower sensitivity may need up to 15 minutes of tube warmup before the leakage even becomes apparent.

Miscellaneous Tests. The tester should also include a few conventional tests, such as whether the tube can compensate for varying line voltage. Without such compensation, both filament and dc voltages may be off so that any testing is borderline.

Then there is the interelement leakage test (as opposed to grid leakage) which usually uses a flashing neon lamp to indicate a short between selected (usually switched) tube elements. It is always nice to know that there are no interelement shorts before going through the trouble of making a series of other tests.

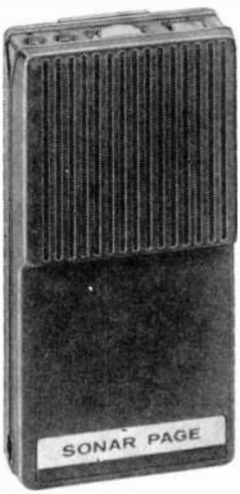
The life test is also useful. In this case, the applied filament voltage is reduced (usually about 10%) so that the tube may be checked after an artificially induced long life. If the emission drops very much in this test, the tube is approaching the end of its life.

One very important item is the tube manual that accompanies the tester. Purchasing a name-brand product will usually insure that, as new tubes turn up, their testing parameters will either appear as new pages for the old manual or you will be furnished with information that can be included in the old manual as a form of updating. ◈

New Products

SONAR VOICE & TONE POCKET PAGER

A basic necessity that has become indispensable to the man on the move, Sonar Radio's Model SP 2518 Page adds hours of productivity and eliminates costly delays. It has features such as Anti-Falsing tone reed circuitry,



non-directional antenna, low battery drain, Hi-Q tuned antenna, "Voice Fidelity" audio, and highly sensitive interference-proof reception for weak, noisy fringe areas. Compatible with existing two-tone sequential vhf systems, the Page operates between 148 MHz and 174 MHz and has a modulation acceptance of ±5 kHz. Channel spacing is 30 kHz. The total weight of the $4\frac{13}{16}$" x $2\frac{3}{8}$" x $1\frac{1}{8}$" unit, including battery, is only 7 ounces.

Circle No. 70 on Reader Service Card

MITS SCIENTIFIC CALCULATOR

While most electronic calculators now available are designed for simple arithmetic calculations, the new MITS Series 7400 scientific and engineering calculator is actually a desk-top minicomputer. In addition to the add, subtract, multiply, and divide functions, the calculator has trigonometric, logarithmic, and exponential functions. Other keys permit polar-to-rectangular, rectangular-to-polar, degrees-to-radians, and radians-to-degrees conversions; entry of pi; changing of signs; entry of exponents; roll-up and roll-down to and from the built-in memories; and storage. Three versions are available: 7400A has three registers in the operational stack; 7400B, five registers; and 7400C, seven registers. Otherwise, the models are the same. All three are available in either kit or factory-wired forms.

Circle No. 71 on Reader Service Card

HEATH DIGITAL ELECTRONIC CLOCK KIT

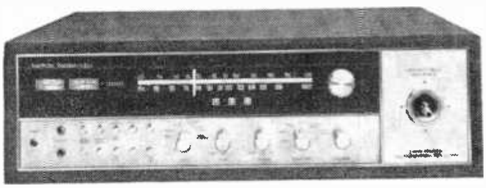
A kit-form electronic clock that employs digital circuitry and gas-discharge readouts for indi-

cating hours, minutes, and seconds is available from the Heath Co. The Model GC-1005 clock is built around a single LSI chip, while secondary solid-state circuits drive the cold-cathode readout tubes. Designed into the clock is a 24-hour "beeper" alarm with a 7-minute "snooze" button and provisions for wiring in either a 12- or a 24-hour readout display.

Circle No. 72 on Reader Service Card

HARMAN-KARDON MULTICHANNEL RECEIVERS

Recently introduced by Harman-Kardon are four new "Multichannel" receivers designated Models 50+, 75+, 100+, and 150+. Each is capable of functioning in either the 4- or



the 2-channel stereo mode. In the "twin-powered" 75+, 100+, and 150+ receivers, a unique method of bridging the four amplifier sections into two amplification modules permits the amount of power/channel available in the stereo mode to more than double when compared to the 4-channel mode. The new "Multichannel" receivers contain SQ matrix circuitry, discrete 4-channel tape facilities, and stereo/quadraphonic headphone jacks.

Circle No. 73 on Reader Service Card

JERROLD ALL-CHANNEL COUPLER

A high-efficiency 82-channel, four TV/FM receiver coupler made by Jerrold Electronics is on the market. The Model MF-84 features a unique circuit (patent pending) that is said to provide the coupler with unusual efficiency, resulting in 90 percent signal transfer with correspondingly low loss. The MF-84 passes all vhf/FM/uhf channels. Insertion loss is a low 7 dB, while isolation between receivers is said to be at least 15 dB. The MF-84 coupler is housed in a weather-resistant high-impact plastic case, making it suitable for indoor and outdoor mounting.

Circle No. 74 on Reader Service Card

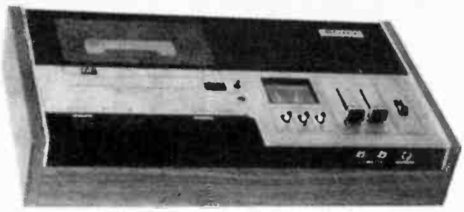
LAFAYETTE DECODER/AMPLIFIER

A versatile combination SQ-L decoder and 33 watts per channel 2-channel stereo amplifier on a single chassis are featured in Lafayette Radio Electronics' Model LR-975 decoder/amplifier. The SQ-L decoder employs logic circuitry for precise decoding of CBS SQ records and SQ FM broadcasts. The system will also convert present 2-channel stereo systems to discrete 4-channel capability, or it can be used as a completely independent amplifying system.

Circle No. 75 on Reader Service Card

SONY "DOLBY" CASSETTE DECK

One of the newer items being marketed by Superscope, Inc., is the Sony deluxe Model



TCV-134 S/D stereo cassette deck. Designed to give open-reel sound quality, the deck features the famous Dolby Noise Reduction System and very long life Ferrite and Ferrite (F & F) head. The precision-molded F & F head improves frequency response and stereo separation. An automatic shut-off system turns off the deck at the end of the tape, while during record, Sony's peak limiter monitors and holds the recording level well below saturation to prevent accidental distortion. Other features include an illuminated dual VU meter, coded stop, and a switch for standard and CRO2 tape formulations.

Circle No. 76 on Reader Service Card

ANTENNACRAFT CDX ANTENNA LINE

A new expanded line of patented CDX vhf/uhf/FM antennas has been introduced by Antennacraft Co. The line has seven antenna models, highlighted by the all-channel Model CDX-1150—an extreme fringe area antenna with 60 elements on a 15.5′ boom with exclusive gold bonded acrylic finish. Other CDX features are new uhf design with high-Q linear incremental drive and parasitic system for high gain on all uhf channels convertability from 300-ohm to 75-ohm coax cable, and a uhf/vhf splitter included with every model.

Circle No. 77 on Reader Service Card

PACE 23-CHANNEL CB TRANSCEIVER

Pace offers with their new Prestige Model 2300 23-channel CB transceiver a guarantee to outperform all other models in receiver sensitivity,

noise limiting, and transit modulation in a two-year factory service guarantee on all performance specifications. A special six-section tuned filter is said to provide exceptional noise limiting beyond that normally provided in ceramic or crystal filtering so that extreme sensitivity is available in remote areas. Upward modulation provides improved talk range.

Circle No. 78 on Reader Service Card

AUDIOVOX IN-DASH STEREO SYSTEM

An advanced "in-dash" eight-track AM/stereo FM tape player for custom mobile installation has been announced by Audiovox Corp. The Model C976 is designed to meet a customer need for a quality theft-proof car stereo player that can be easily installed in the dashboard of most American cars. Five pushbuttons are provided for AM and FM selection and preset tuning on each band. The audio section is rated at 8 watts/channel. Featured are a local/distance switch, front-rear and left-right balance controls, and indicator lights to tell at a glance which program is being played. The player is designed to operate from any 12-volt dc power source.

Circle No. 79 on Reader Service Card

REALISTIC 4-CHANNEL SYNTHESIZER

Now you can enjoy the effect of 4-channel sound from your present car stereo player or stereo FM receiver with the new Realistic "Auto

Quatravox" synthesizer from Radio Shack. The 4-channel effect is created through the ambience-recovery technique. The synthesizer places the rear speakers out-of-phase with the front to eliminate sound common to both stereo channels, leaving only ambient sound for the rear channel speakers to reproduce. The front panel contains a real-channel volume control, synthesizer in/out switch, and a pair of balancing controls.

Circle No. 80 on Reader Service Card

JBL "STEP-UP" BOOKSHELF SPEAKER SYSTEM

James B. Lansing Sound, Inc., has added a new "step-up" bookshelf speaker system—the 88 Plus—to their line of quality home sound reproduction products. The system consists of a long-excursion 12" low-frequency transducer and a 1.4" direct radiator which can be quickly and easily converted to the three-element system used in JBL's Century by installing the M12 expander kit. The M12 kit contains a 5" midrange speaker and the additional dividing network components required to make the 88 Plus identical in performance to the L100 Century.

Circle No. 81 on Reader Service Card

BUILD A

LOW-COST SQUELCH CIRCUIT

USEFUL ADDITION FOR RECEIVERS WITHOUT BUILT-IN SQUELCH

BY JOHN G. RAMSEY

MOST modern vhf monitors include an adjustable squelch to quiet the annoying hiss that is usually present when a signal is not being received. However, many of us have either older (non-squelch) sets or homemade versions that do not include this ear-saving circuit addition. Now, if you build the adjustable squelch shown here—at a cost of about $2.50—you can add this feature to any solid-state vhf/FM (police, fire, etc.) receiver.

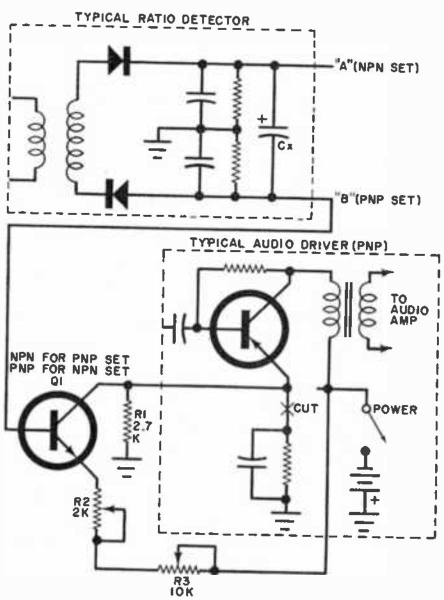
Although the circuit shown is for a set using pnp transistors, simply by changing the type of transistor used for Q1 and the connection to the ratio detector, you can use this circuit on a set with npn types.

Theory of Operation. As shown in the diagram, the emitter resistor of the set's audio driver is cut out of the circuit and replaced by *R1*. The potential at the top of *R1* is controlled by *Q1*. When a signal is not being received, the voltage across *Cx* (ratio detector capacitor in the set) is very low so that *Q1* is turned on. In this case, the audio driver emitter is reverse biased; and that stage will not be in operation. When a signal is received, *Cx* is charged up, which turns *Q1* off, allowing *R1* to complete the audio driver emitter circuit and turn on the stage.

Incidentally, using a squelch will lengthen battery life because the current-consuming audio output stage is not operating when there is no signal.

Construction. First, determine whether your receiver uses npn or pnp transistors. If the majority of them are black epoxy, the receiver is npn. If most of the transistors are in metal cases, the receiver is pnp. Select the transistor for *Q1* accordingly.

Now locate the ratio detector circuit in the receiver. The ratio detector consists of two i-f transformers inside the same case or just located very close to each other. Next to these are two diodes and two resistors, the latter having values between 220 ohms and 1500 ohms. To one side of these resistors, you will find an electrolytic capacitor with a value usually about 10 microfarads. The positive side of the capaci-



PARTS LIST

Q1—For pnp receivers: most any npn switching transistor (2N5129, 2N706, HEP55)
For npn receivers: most any pnp switching transistor (2N5139, 2N3638, HEP52)
R1—2700-ohm, ½-watt resistor
R2—2000-ohm, linear taper potentiometer
R3—10,000-ohm, linear taper potentiometer

Circuit, with minimum of parts, can be added easily to existing receiver. The emitter resistor of the set's audio driver is cut out of the circuit and replaced by R1. Potential at the top of R1 is controlled by Q1. With no signal, Q1 is on and the audio stage is off. When a signal is received, Q1 is turned off by charge on Cx and R1 completes driver stage.

tor is point A for npn receivers; the negative side is point B for pnp sets.

Next, locate the audio driver stage and the resistor-capacitor combination in the emitter circuit. Cut this lead and connect the proper side of *Q1* and *R1* to the emitter side of the cut connection. Connect the slider of *R3* to the negative of your receiver, but remember to connect it after the switch.

There is usually sufficient room in most receivers to mount the additional transistor and resistor. Ideally, the controls (at least *R3*) should be mounted on the front panel. Although two potentiometers are shown for the squelch adjust, it is possible to get away with using only *R3*.

Adjustment. To adjust the squelch circuit, set *R2* so that its rotor is nearest *R3*. Then adjust *R3* until you hear noise from the receiver. Now, set *R2* to its half-way point, and adjust *R3* until the noise is just barely audible. After this adjustment, *R2* becomes a fine squelch adjust and can be set till the noise disappears; and when the signal comes in, the receiver will not be squelched. The spot where the squelch is most sensitive is where the background noise just disappears. ◈

NEA PLANS COURSE FOR TV TECHNICIANS

AT A MEETING of service association leaders and electronics manufacturers' training directors recently, plans were made to try to find a better method of training today's practicing TV-electronics service technicians.

The meeting was called to seek a solution to today's training problems. Dick Glass, Executive Vice President of NEA (National Electronic Associations) stated at that time: "Upgrading training (teaching new design features, new circuitry, advanced servicing methods) directed at the country's 200,000 service technicians has been unsatisfactory in the past, and is now our most pressing training problem."

Apprenticeship and other "entry" programs were conceded to be doing a fairly good job of supplying current needs for new service manpower. Also, the concensus was that EIA (Electronic Industries Association) and other programs for updating vocational and college instructors for electronics technicians are headed in the right direction. Therefore, the training directors have set in motion a program to improve the effectiveness of upgrading training. The name of this new program is JESUP, a one-year-old brainchild of NEA—as yet untried. JESUP is an abbreviation for Joint Electronics Service Upgrading Program.

A single pilot session of the JESUP Program will be conducted in Indianapolis in March. Some 200 service technicians will attend the two-day pilot session and will have a chance to get firsthand technical information on eight brands of new model TV receivers. They will also receive instruction in the latest general trouble-shooting techniques. Both hands-on sessions with individual manufacturers and general lectures will be part of the two-day program.

For the initial program the 200 servicers will all come from the central Indiana area. These technicians will be invited to attend the session by direct mail and telephone. The only cost for the two-day session will be the price of the luncheons.

Manufacturer training directors who have agreed to support the trial program are from Admiral, GE, Magnavox, Motorola, Philco, RCA, Sylvania, and Zenith. ◈

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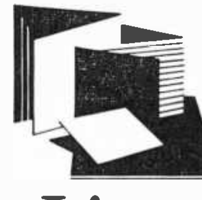

New Literature

BIRD CATALOG SUPPLEMENT

An eight-page supplement to the 1971 general catalog lists more than 30 new Thru-line r-f directional wattmeters, Termaline r-f load resistors, and a 100-watt attenuator made by Bird. New entries are 75-ohm wattmeters for uhf-TV and 75-ohm loads, Ham-Mate and Marine-Mate wattmeters, a 51,000 BTU/hr heat exchanger, and an instant-output wideband 150-watt r-f power source. Address: Bird Electronic Corp., 30303 Aurora Rd., Cleveland (Solon), OH 44139.

TOYO SHORT-FORM CATALOG

Toyo's new 24-page short-form catalog describes the company's entire line of 4-channel tape cartridge players and stereo and portable equipment. Highlighted are such items as the Model 740 4-/2-channel player-decoder-stereo receiver, Model 680 8-track tape player with AM/FM stereo FM receiver, and Model 902 AM/FM stereo tape player with fast forward wind. Address: Toyo Radio Co. of America, Inc., 1842B West 169 St., Gardena, CA 90247.

G/P SERIES CATALOG FROM TRIPLETT

A data sheet that describes the G/P Series of 29 portable panel instruments available in 59 standard ranges and functions (ac, dc, ohms, r-f, watts, and temperature) can be obtained on request from *Triplett Corp.* The detailed specification and price sheet was developed for use by vocational and technical schools, test labs, experimenters, and industrial firms that custom design their portable instruments or wish to construct their own from a kit. Address: Triplett Corp., Dept. PR, Bluffton, OH 45817.

RCA COMMERCIAL THYRISTOR CHART

Quick reference information in a convenient, easyto-use form for more than 300 RCA triacs and SCR's is given in "Thyristor Product Matrix" chart No. TPM-510. Each device listed is tabulated by voltage and current ratings. The package configuration for each device is shown adjacent to its electrical data. Suitable for mounting on a wall or for filing in a notebook, the chart also carries information on thyristor applications. Address: RCA Solid State Div., Box 3200, Somerville, NJ 08876.

OLSON ELECTRONICS 1973 CATALOG

The first annual Olson Electronics catalog features dozens of brand names in addition to the company's own private brands, Teledyne and Olson. Listed in the 1973 catalog are audio components, CB equipment, radio and TV receivers, kits and hobby items, antennas, tools and hardware, parts, books, etc. Address: Olson Electronics, 260 S. Forge St., Akron, OH 44327.

B&K TEST EQUIPMENT CATALOG

Dynascan Corp. has announced the availability of a new 28-page mini-catalog which describes the full line of B&K test equipment. The pocket-size catalog contains basic specifications and features, plus an illustration, on 26 B&K oscilloscopes, color bar/dot generators, tube testers, digital and analog multimeters, capacitor and transistor testers, analyzers, and r-f and square-wave generators. Address: Dynascan Corp., 1801 W. Belle Plaine Ave., Chicago, IL 60613.

1973 ALLIED ELECTRONICS CATALOG

Considered by many to be *the* comprehensive buying guide for everything in industrial electronic parts and supplies, the 1973 Allied Electronics catalog is now published in a new 9" x 11" format. Compiled to meet the needs of the industry, it is also the catalog for everyone looking for one dependable source of hard-to-get items in quantities from one to a thousand. Address: Allied Electronics, 2400 Washington Blvd., Chicago, IL 60612.

NU-CONCEPT DIGITAL PROBE BROCHURE

A four-page brochure describing their new pocket-sized digital test probe, the Dy-Nos-Stick®, is available from Nu-Concept Computer Systems, Inc. The brochure details applications, features, benefits, and specifications for the new DTL/TTL service device. Address: Nu-Concept, 306 Logan St., Philadelphia, PA 19401.

WHITE'S METAL/MINERAL DETECTOR CATALOG

Everything a treasure hunter or professional prospector needs to know about using metal and mineral detectors, the art of electronic search, how-to-do-it tips, and where to get more information is covered in a new 64-page catalog now available from White's Electronics, Inc. Geologists and prospectors will be interested in the pages devoted to radiation and anomaly detectors. Address: White's, 1011 Pleasant Valley Rd., Sweet Home, OR 97386.

TEKTRONIX COAXIAL CABLE NOTE

Tektronix, Inc., has just published Application Note #2 that covers some fundamentals of coaxial cables. The eight-page, four-sheet Note is written in an easy question-and-answer format that leads the reader through some of the old mysteries related to coaxial cables. It covers such items as how to figure losses in a line and how to determine the optimum impedance of a cable. These and other questions are answered using very little mathematics. Address: Tektronix, P.O. Box 500, Beavertown, OR 97005.

GENERAL RADIO STROBOSCOPE GUIDE

A 16-page pamphlet that includes detailed specifications and applications information on a broad selection of electronic strobe equipment is available from General Radio. Nine different strobe models, as well as a wide variety of accessories, are fully described. Address: General Radio, 300 Baker Ave., Concord, MA 01742.

CIRCUIT SPECIALISTS COMPANY CATALOG

Listed in a fascinating catalog titled "Semiconductor Supermart" put out by Circuit Specialists Co. are literally thousands of semiconductor devices ranging from diodes through state-of-the-art linear and digital IC's, all "surplus" priced. More than half of the catalog is given over to semiconductor listings. The remainder lists and describes resistors, capacitors, chokes and coils, CB and ham radio equipment, marine depth finders, metal locators, etc. Address: Circuit Specialists, P.O. Box 3074, Scottsdale, AZ 85257.

ABOUT YOUR SUBSCRIPTION

Your subscription to POPULAR ELECTRONICS is maintained on one of the world's most modern, efficient computer systems, and if you're like 99% of our subscribers, you'll never have any reason to complain about your subscription service.

We have found that when complaints do arise, the majority of them occur because people have written their names or addresses differently at different times. For example, if your subscription were listed under "William Jones, Cedar Lane, Middletown, Arizona," and you were to renew it as "Bill Jones, Cedar Lane, Middletown, Arizona," our computer would think that two separate subscriptions were involved, and it would start sending you two copies of POPULAR ELECTRONICS each month. Other examples of combinations of names that would confuse the computer would include: John Henry Smith and Henry Smith; and Mrs. Joseph Jones and Mary Jones. Minor differences in addresses can also lead to difficulties. For example, to the computer, 100 Second St. is not the same as 100 2nd St.

So, please, when you write us about your subscription, be sure to enclose the mailing label from the cover of the magazine—or else copy your name and address exactly as they appear on the mailing label. This will greatly reduce any chance of error, and we will be able to service your request much more quickly.

Electronics Library

SOLID-STATE ELECTRONIC PROJECTS

by Charles D. Rakes

Many stores are selling both new and surplus solid-state components at very low prices, and this book takes advantage of the transistor and IC boom by bringing to the reader a number of useful projects built around them. Such projects as basic burglar alarm systems; solid-state alarm circuits; solid-state alarm sounders; metal locators; and electronic music, noise, and sound effect circuits are discussed in detail. Each project presented is accompanied by a schematic diagram, parts list, and helpful construction hints. A long-range microphone and a dual-trace transistor curve tracer are also included.

Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, IN 46268. Soft cover. 128 pages. $3.95.

VHF PROJECTS FOR AMATEUR & EXPERIMENTER

by Wayne Green, W2NSD

More than 50 construction projects are included in this book for the amateur looking for an inexpensive way to get into vhf communications. Each project goes into detail to make construction simple and easy. Some projects describe how to build a complete fixed or portable station; others relate to more specific gear which will augment an existing facility. There are also antenna projects to aid the reader in achieving more effective communication on vhf. Projects included are transmitters, receivers, linear amplifiers, vfo's, converters and transceivers for 6 and 2 meters, equipment for 220-MHz operation, and more.

Published by Tab Books, Blue Ridge Summit, PA 17214. 224 pages. $7.95 hard cover; $4.95 soft cover.

ELECTRONIC CONCEPTS

by Vester Robinson

This is a self-teaching, programmed course in the basic principles of electronics. The programmed format is easy to follow and actively helps the reader to develop his understanding of electronic concepts. The course begins with the age of electronics, followed by electron tubes, transistors, lasers, and masers. The text develops technical information in easy-to-comprehend and assimilate steps, keeping mathematical development to a minimum. The result is a lucid flow of ideas, each reinforcing the other to firmly fix in the reader's mind the principles discussed.

Published by Reston Publishing Co., Inc., Reston, VA 22070. 465 pages. $9.95 hardbound; $6.95 soft cover.

THEORY AND DESIGN OF DIGITAL COMPUTERS

by Douglas Lewin

This book describes the theory and engineering design of logic circuits and systems with the overall emphasis on the hardware-software complex. A basic knowledge of logical design, electronic circuitry, and high-level computer languages are assumed in the text format. The textbook is written for final-year courses in computer engineering and digital systems. As such, numerous problems with worked-out solutions and references for further reading are provided.

Published by Halsted Press, Div. of John Wiley & Sons, Inc., 605 Third Ave., New York, NY 10016. Hard cover. 383 pages. $15.75.

Surplus Scene

By Alexander W. Burawa, Associate Editor

MORE DEALERS TO ADD TO YOUR LIST

THE Surplus Scene dealers have begun to respond to our note that appeared in the October 1972 installment of this column. Consequently, we are taking time out this month to introduce you to a handful of them from all over the country.

The first name on our list is Wallen Electronics Co., Inc. (46 North Manchester St., Brockton, MA 02420). Their compact 61-page catalog is literally packed with listings ranging from laboratory-type test gear, to radar, aircraft, and marine equipment, to special-purpose tubes. While the catalog lists only selling prices, Wallen also rents and leases out their equipment.

Military gear of all kinds from test equipment to sophisticated communications and radar setups is the sole stock in trade of Space Electronics Co. (76 Brookside Dr., Upper Saddle River, NJ 07458). In 16 pages of catalog, the company has managed to list virtually every electronic item currently on the active list of the Army, Air Force, and Navy, including some items that have been around for a while but have always been as rare as duck's teeth on the "open market." All of the offerings are claimed to be in like-new condition. While the catalog does not list prices, interested parties are invited to write to the company for quotes.

A few months back, R.E. Goodheart Co., Inc. (P.O. Box 1220, Beverly Hills, CA 90213) was nice enough to send us a couple of photo-copied sheets that listed hundreds of items under the company's admittedly arbitrary "category numbers." Needless to say, while specific model numbers of electronic gear were not listed, the categories were as inclusive as one could ask. This company does a brisk buy-and-sell business; so, any catalog you might request will not be forthcoming since it would be obsolete by the time you received it. Nevertheless, you can query the company on any device.

Edwards Electronics (P.O. Box 465, Glen Ellyn, IL 60137) is working the solid-state components market with some nice buys in transistors and IC's, readout tubes, and basic analog and digital kits. Other listings in the current flyer include resistors, capacitors, PC board materials, etc. A whole page in the flyer is devoted to a detailed schematic of a power supply designed to deliver +170, −15, +/−15, and +5 volts dc at various outputs.

Star-Tronics (Box 17127, Portland, OR 97217) sent us a packet of sheets that listed basic items like resistors, capacitors, switches, and the like. These were limited-time-only offerings, good for about a month. Sheets listing new offerings are issued periodically.

KA Sales (1312 Slocum St., Dallas, TX 75207) has a nice selection of the ever-popular 7400 and 74100 series of digital TTL IC's, neon-glow and Luminetics readouts, and quite a full lineup of resistors, capacitors, transistors and diodes, panel lamps, etc. All in all, from the completeness of their listings, KA might be a good place to place an order for all your needs in your next project.

Somehow or other, we have been goofing for more than a year now in not introducing our next dealer sooner. We are referring to Solid State Systems, Inc. (P.O. Box 773, Columbia, MO 65201). This company's commitment is, obviously, to solid-state items. And while they offer the usual lineup of 7400 and 74100 series of TTL IC's, they are the only company doing business on the Surplus Scene (to our knowledge) that is offering the sophisticated 74S00 series of Schottky TTL devices—and at bargain prices no less. In addition to their IC offerings, the company's current listing also includes 7-segment readouts, DIP sockets and Soldercons, resistors, capacitors, etc. ◈

ELECTRONICS MARKET PLACE

NON-DISPLAY CLASSIFIED: COMMERCIAL RATE: For firms or individuals offering commercial products or services, $1.60 per word (including name and address). Minimum order $16.00. Payment must accompany copy except when ads are placed by accredited advertising agencies. Frequency discount: 5% for 6 months; 10% for 12 months paid in advance. **READER RATE:** For individuals with a personal item to buy or sell, $1.00 per word (including name and address.) No minimum! Payment must accompany copy. **DISPLAY CLASSIFIED:** 1" by 1 column (2⅝" wide), $200.00. 2" by 1 column, $400.00. 3" by 1 column, $600.00. Advertiser to supply cuts. For frequency rates, please inquire.

GENERAL INFORMATION: First word in all ads set in bold caps at no extra charge. All copy subject to publisher's approval. All advertisers using Post Office Boxes in their addresses **MUST** supply publisher with permanent address and telephone number before ad can be run. Advertisements will not be published which advertise or promote the use of devices for the surreptitious interception of communications. Closing Date: 1st of the 2nd month preceding cover date (for example, March issues closes January 1st. Send order and remittance to Hal Cymes. **POPULAR ELECTRONICS** Including **ELECTRONICS WORLD**, One Park Avenue, New York, New York 10016.

FOR SALE

FREE! bargain catalog. Fiber optics, LED's, transistors, diodes, rectifiers, SCR's, triacs, parts. Poly Paks, Box 942, Lynnfield, Mass. 01940.

GOVERNMENT Surplus Receivers. Transmitters, Snooperscopes, Radios, Parts, Picture Catalog 25¢. Meshna, Nahant, Mass. 01908.

ROCKETS: Ideal for miniature transmitter tests. New illustrated catalog. 25¢. Single and multistage kits, cones, engines, launchers, trackers, rocket aerial cameras, technical information. Fast service. Estes Industries, Dept. 18-F, Penrose, Colorado 81240.

LOWEST Prices Electronic Parts. Confidential Catalog Free. **KNAPP,** 3174 8TH Ave. S.W., Largo, Fla. 33540.

ELECTRONIC PARTS, semiconductors, kits. **FREE FLYER.** Large catalog $1.00 deposit. **BIGELOW ELECTRONICS,** Bluffton, Ohio 45817.

WE SELL CONSTRUCTION PLANS. TELEPHONE: Answering Machine, Speakerphone, Carphone, Phonevision. Auto Dialer, Touch Button Dialer, Central Dial System. **TELEVISION:** $35.00 Color Converter, Video Tape Recorder. $25.00 Camera. **HOBBYIST:** Electron Microscope, 96 Hour Tape Music System, Ultrasonic Dishwasher, Radar-Oven. Plans $4.95 each. **NEW ITEM:** $75. Electronic Pocket Calculator, $7.50. **COURSES:** Telephone Engineering $39.50. Detective Electronics $22.50, Integrated Circuit Engineering, $49.50. **NEW SUPER HOBBY CATALOG** plus year's subscription to Electronic New Letter **AIRMAILED** $1.00. Don Britton Enterprises, 6200 Wilshire Blvd., Los Angeles, Calif. 90048.

RADIO—T.V. Tubes—36¢ each. Send for free catalog. Cornell, 4213 University, San Diego, Calif. 92105.

MECHANICAL, ELECTRONIC devices catalog 10¢. Greatest Values —Lowest Prices. Fertik's, 5249 "D", Philadelphia, Pa. 19120.

SENCORE, B&K Test Equipment Unbelievable Prices. Free Catalog and Price Sheet. Fordham Radio, 265 East 149th Street, Bronx, N.Y. 10451.

CONVERT any television to sensitive, big-screen oscilloscope. Only minor changes required. No electronic experience necessary. Illustrated plans. $2.00. Relco-A33, Box 10563, Houston, Texas 77018.

METERS—Surplus, new, used, panel or portable. Send for list. Hanchett, Box 5577, Riverside, CA 92507.

PYROTECHNICAL chemicals, casings, tools, supplies, fuse, literature. Giant, illustrated catalogue/handbook includes formulas, instructions—50¢, with samples—$1.00. Westech, Box 593, Logan, Utah 84321.

ELECTRONIC COMPONENTS—Distributor prices, Free catalog. Box 2581, El Cajon, California 92021.

ANTIGRAVITY, experiment and theory, Rushed—$2.00. U.S. Inquiries. Intertech 7A5, Box 5373, Station-F, Ottawa, Canada.

JAPAN HONG KONG DIRECTORY. World products information. $1.00 today. Sekai Shogyo Annai, Hillyard, Washington 99207.

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1301 BROADWAY **ATV Research** DAKOTA CITY, NEBR. 68731

EUROPEAN and Japanese bargains catalogs. $1 each. Dee, P.O. Box 9308, North Hollywood, Calif. 91609.

FREE Catalog. Parts, circuit boards for Popular Electronics projects. PAIA Electronics, Box C14359, Oklahoma City, OK 73114.

GET "Music Only" FM Programs. SCA Adaptor fits any FM tuner or receiver. Free list of stations with order. Kit $14.50 (with Squelch $19.50) Wired and Tested $25.00 (with Squelch $29.95). All plus postage and insurance. Thousands Sold. SWTPC, Box E32040, San Antonio, Tex. 78284.

FREE Kit Catalog: Shortproof powersupply $39.50. Ultrasonic Alarm $37.25. SWTPC, Box B32040, San Antonio, Tex. 78284.

MECHANICAL ELECTRONIC devices catalog 10¢. Greatest Values —Lowest Prices. Fertik's, 5249 "D", Philadelphia, Pa. 19120.

AMATEUR SCIENTISTS, Electronics Experimenters, Science Fair Students . . . Construction Plans—Complete, including drawings, schematics, parts list with prices and sources . . . Robot Man — Psychedelic shows — Lasers — Emotion/Lie Detector — Touch-Tone Dial—Quadrasonic Adapter—Transistorized Ignition —Burglar Alarm—Sound Meter . . . over 60 items. Send 25¢ coin (no stamps) for complete catalog. Technical Writers Group, Box 5594, State College Station, Raleigh, N.C. 27607.

LATEST snooping countermeasures: Manual $10.00. Negeye, Box 1036X, Anderson, Indiana 46015.

WE SELL CONSTRUCTION PLANS—gold recovery unit!—silver recovery unit—infra-red scope—x-ray fluoroscope—alternator adapter—200 watt inverter—electronic insect tap—burglar alarm system—chemical formulary—plans $5.00—plus many more!—ask for **FREE** catalog—Airmail 30¢. Creative Products, 1551 East Loop 820, Dept. E-273, Fort Worth, Texas 76112.

DIGITAL ELECTRONICS! Complete schematics, parts lists, theories —Discrete Component Digital Clock, $3.00—Sound Sensitive Switch, $1.50. Increase technical competence, hobby skills—Complete Course in Digital Electronics is highly effective, $10.00. Free literature. DYNASIGN, Box 60A7, Wayland, Mass. 01778.

CONSTRUCTION PLANS: Laser . . . $2.00. Missile Tracker . . . $2.00. Catalog 25¢. ESP Experimenters Kit . . . $2.00. Howard, P.O. Box 35271, Detroit, Michigan 48235.

ELECTRONIC IGNITION: Boosts Voltage. Only $19.95. Box 2002, Huntington Beach, Calif. 92647.

SURPLUS electronics for everyone. Free catalog. U.S. Inquiries. ETCO, 464 McGill, Montreal, Canada.

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Catalog Number	Any Quantity Per Item (Mix) 1-99	100-999	1000 up	Multiples of 10 Per Item (Mix) 100-990	1000-9990	10000 up
7400	.26	.25	.23	.22	.21	.20
7401	.26	.25	.23	.22	.21	.20
7402	.26	.25	.23	.22	.21	.20
7403	.26	.25	.23	.22	.21	.20
7404	.28	.27	.25	.24	.22	.21
7405	.28	.27	.25	.24	.22	.21
7406	.52	.50	.47	.44	.42	.39
7407	.52	.50	.47	.44	.42	.39
7408	.32	.30	.29	.27	.26	.24
7409	.32	.30	.29	.27	.26	.24
7410	.26	.25	.23	.22	.21	.20
7411	.28	.27	.25	.24	.22	.21
7413	.58	.55	.52	.49	.46	.44
7416	.52	.50	.47	.44	.42	.39
7417	.52	.50	.47	.44	.42	.39
7418	.32	.30	.29	.27	.26	.24
7420	.26	.25	.23	.22	.21	.20
7421	.26	.25	.23	.22	.21	.20
7423	.80	.76	.72	.68	.64	.60
7425	.50	.48	.45	.43	.40	.38
7426	.33	.32	.31	.29	.27	.26
7430	.26	.25	.23	.22	.21	.20
7437	.56	.53	.50	.48	.45	.42
7438	.56	.53	.50	.48	.45	.42
7440	.26	.25	.23	.22	.21	.20
7441	1.73	1.64	1.55	1.46	1.37	1.27
7442	1.27	1.21	1.14	1.07	1.01	.94
7443	1.27	1.21	1.14	1.07	1.01	.94
7444	1.27	1.21	1.14	1.07	1.01	.94
7445	1.71	1.62	1.53	1.44	1.35	1.26
7446	1.24	1.17	1.11	1.04	.98	.91
7447	1.16	1.10	1.04	.98	.92	.85
7448	1.44	1.37	1.29	1.22	1.14	1.06
7450	.26	.25	.23	.22	.21	.20
7451	.26	.25	.23	.22	.21	.20
7453	.26	.25	.23	.22	.21	.20
7454	.26	.25	.23	.22	.21	.20
7459	.26	.25	.23	.22	.21	.20
7460	.26	.25	.23	.22	.21	.20
7470	.42	.40	.38	.36	.34	.32
7472	.38	.36	.34	.32	.30	.29
7473	.50	.48	.45	.43	.40	.38
7474	.50	.48	.45	.43	.40	.38
7475	.80	.76	.72	.68	.64	.60
7476	.56	.53	.50	.48	.45	.42
7480	.76	.72	.68	.65	.61	.57
7482	.99	.94	.88	.83	.78	.74
7483	1.64	1.55	1.46	1.38	1.29	1.20
7485	1.43	1.35	1.28	1.20	1.13	1.05
7486	.58	.55	.52	.49	.46	.44
7490	.80	.76	.72	.68	.64	.60
7491	1.43	1.35	1.28	1.20	1.13	1.05
7492	.80	.76	.72	.68	.64	.60
7493	.80	.76	.72	.68	.64	.60
7494	1.18	1.12	1.05	.99	.93	.87
7495	1.18	1.12	1.05	.99	.93	.87
7496	1.18	1.12	1.05	.99	.93	.87
74107	.52	.49	.47	.44	.42	.39
74121	.56	.53	.50	.48	.45	.42
74122	.70	.67	.63	.60	.56	.53

Catalog Number	Any Quantity Per Item (Mix) 1-99	100-999	1000 up	Multiples of 10 Per Item (Mix) 100-990	1000-9990	10000 up
74123	1.21	1.06	1.00	.94	.89	.83
74141	1.63	1.55	1.46	1.38	1.29	1.20
74145	1.41	1.33	1.26	1.18	1.11	1.04
74151	1.20	1.13	1.07	1.01	.95	.88
74153	1.63	1.55	1.46	1.38	1.29	1.20
74154	2.43	2.30	2.16	2.03	1.89	1.76
74155	1.46	1.39	1.31	1.23	1.16	1.08
74156	1.46	1.39	1.31	1.23	1.16	1.08
74176	1.62	1.53	1.45	1.36	1.28	1.19
74177	1.62	1.53	1.45	1.36	1.28	1.19
74180	1.20	1.13	1.07	1.01	.95	.88
74182	1.20	1.13	1.07	1.01	.95	.88
74192	1.98	1.87	1.76	1.65	1.54	1.44
74193	1.98	1.87	1.76	1.65	1.54	1.44
74199	2.81	2.65	2.50	2.34	2.18	2.04
SCHOTTKY TTL						
74S00	.88	.84	.79	.75	.70	.66
74S01	.88	.84	.79	.75	.70	.66
74S03	.88	.84	.79	.75	.70	.66
74S04	1.00	.95	.90	.85	.80	.75
74S05	1.00	.95	.90	.85	.80	.75
74S08	.88	.84	.79	.75	.70	.66
74S09	.88	.84	.79	.75	.70	.66
74S10	.88	.84	.79	.75	.70	.66
74S15	.88	.84	.79	.75	.70	.66
74S20	.88	.84	.79	.75	.70	.66
74S22	.88	.84	.79	.75	.70	.66
74S40	1.00	.95	.90	.85	.80	.75
74S50	.88	.84	.79	.75	.70	.66
74S51	.88	.84	.79	.75	.70	.66
74S64	.88	.84	.79	.75	.70	.66
74S65	.88	.84	.79	.75	.70	.66
74S74	1.82	1.73	1.63	1.54	1.44	1.34
74S74	1.82	1.73	1.63	1.54	1.44	1.34
74S112	1.82	1.73	1.63	1.54	1.44	1.34
74S113	1.82	1.73	1.63	1.54	1.44	1.34
74S140	1.00	.95	.90	.85	.80	.75
LINEAR IC'S						
NE501	2.99	2.82	2.66	2.49	2.32	2.16
NE526	3.59	3.38	3.17	2.95	2.74	2.53
NE536	7.31	6.88	6.45	6.02	5.59	5.16
NE537	7.54	7.09	6.65	6.20	5.76	5.32
SE540	4.48	4.20	3.92	3.64	3.36	3.08
NE560	3.57	3.36	3.15	2.94	2.73	2.52
NE561	3.57	3.36	3.15	2.94	2.73	2.52
NE562	3.57	3.36	3.15	2.94	2.73	2.52
NE566	3.57	3.36	3.15	2.94	2.73	2.52
N5111	.90	.86	.81	.77	.72	.68
N5558	.80	.76	.72	.68	.64	.60
N5595	4.30	3.20	3.00	2.80	2.60	2.40
N5596	1.87	1.77	1.66	1.56	1.46	1.37
709	.42	.40	.38	.36	.34	.32
710	.42	.40	.38	.36	.34	.32
711	.44	.42	.40	.37	.35	.33
723	1.00	.95	.90	.85	.80	.75
733	1.90	1.80	1.70	1.60	1.50	1.40
741	.44	.42	.40	.37	.35	.33
748	.48	.46	.43	.41	.38	.36

TRANSISTORS & DIODES

1N270	.15	.14	.13	.12	.11	.10
1N751A	.30	.28	.26	.24	.22	.20
1N914	.10	.09	.08	.07	.06	.05
1N4001	.10	.09	.08	.07	.06	.05
1N4002	.11	.10	.09	.08	.07	.06
1N4004	.13	.12	.11	.10	.09	.08
1N4006	.15	.14	.13	.12	.11	.10
1N4154	.15	.14	.13	.12	.11	.10
2N3866	.25	.23	.21	.19	.17	.15

All IC's are supplied in 8—, 14—, 16—, or 24— pin DIP (Dual in-line) plastic or ceramic package except for NE533, NE536, NE537, and NE540 which come in TO-5 package.

We give FREE data sheets upon request, so ask for those data sheets that you NEED, even for those listed IC's that you are not buying. On orders over $25.00 we'll send you a new 270-page COMPLETE TTL IC data book FREE. Or, you may obtain a new 240-page LINEAR data book instead. Orders over $50.00 will receive both books. Orders over $100.00 will receive a complete LIBRARY of DIGITAL & LINEAR data & application books totaling 1,000 pages FREE. PLEASE NOTE: Data books are shipped separate from your order. Please allow two weeks for delivery.

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1. Easy to read single plane LED or Filament-type Readout with wide angle viewing.
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4. Molex Sockets for all IC's and Readout.
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6. Your choice of 1 to 6 decades on one P. C. Board.
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10. 60 MHZ typical toggle rate with 74196.
11. Operates from 5 Volt TTL compatable single supply.
12. First in a series of Universal plug in modules for frequency counting, time measurement, event counting, DVM, magnitude comparison, etc.
13. P. C. Boards only are available for $3.00 per decade.

Price (Per Decade):

Basic Unit consisting of 7490, 7447, Filament-Type 7-Segment Readout, ... $9.00

Options:
For LED Readouts instead of Filament-Type, add $2.00
For 7475 Latch, add $1.25
For 74176 instead of 7490, add $0.50
For 74192 instead of 7490, add $1.00
For 74196 instead of 7490, add $0.75
For Fully assembled and tested unit add $2.50

LED 7 SEGMENT DISPLAY

$1.95 Each

50-99	$1.75
100-999	$1.50
1000 +	$1.25

Large ¼" 7-segment LED readout similar to the popular MAN 1 but with improved brightness. Has left-hand decimal point. Fits in a DIP socket. Expected life: Over 100 Yrs. Regularly $12.95 in single Lots. These are BRAND NEW with full data sheet and 4 page MULTIPLEXING Application Note. Needs a 7447 for driver and ONE CURRENT-LIMITING RESISTOR PER SEGMENT. We can supply you with one or ten thousand FROM STOCK. Also available, ±1 OVERFLOW digit at the same prices. Mixing of Regular & Overflow digit allowed.

Package of 8, ¼W Limiting R's .... 30¢

Incandescent Type of 7-segment display. With right-hand decimal point. Rated 8mA per segment at TTL supply of 5V. Design life of 50,000 hours. Needs a 7447 as a driver. In DIP Package. Each $3.25

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EACH .... 10¢ | 0.02µF, EACH .... 12¢
0.01µF, EACH .... 11¢

LOW VOLTAGE DISCS, Type UK.

1.0µF, 3V .... 25¢	2.2µF, 3V .... 30¢
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0.47µF, 3V .... 25¢	0.01µF, 16V .... 10¢

ELECTROLYTIC CAPACITORS:
All values are available in both axial or upright (PC Board) mount. PLEASE INDICATE YOUR CHOICE

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50µF, 15V .... 10¢	2µF, 50V .... 10¢
100µF, 15V .... 10¢	3µF, 50V .... 10¢
220µF, 15V .... 15¢	5µF, 50V .... 10¢
500µF, 15V .... 20¢	10µF, 50V .... 15¢
1000µF, 15V .... 40¢	20µF, 50V .... 20¢
20µF, 25V .... 15¢	50µF, 50V .... 20¢
40µF, 35V .... 20¢	100µF, 50V .... 20¢
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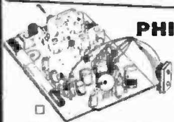

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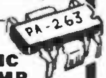

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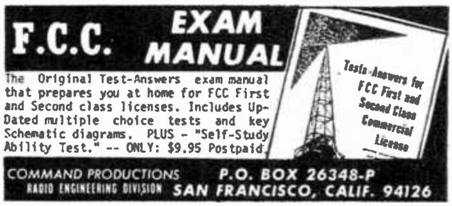

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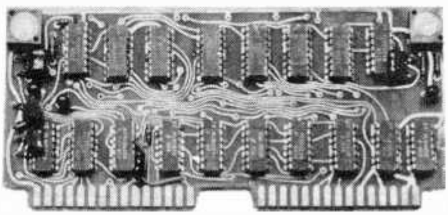

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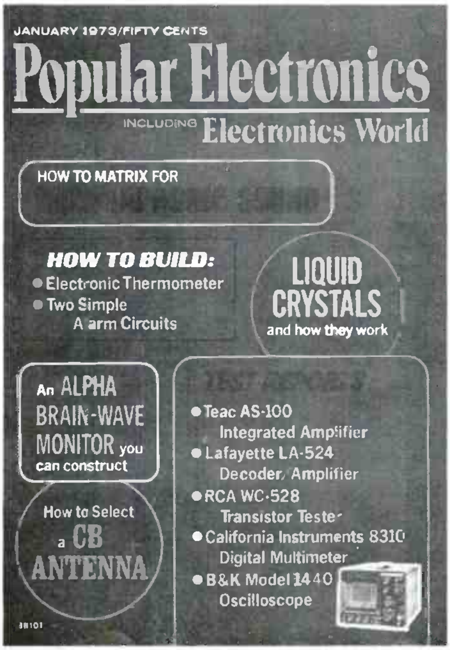

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