40-CHANNEL CB
NEW FCC RULES
see page 6

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Radio-Electronics

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THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

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add dancing lights

ready now
AM STEREO
broadcasting

how they work
CB SYNTHESIZERS
use fewer crystals

new tape format
"ELCASET"
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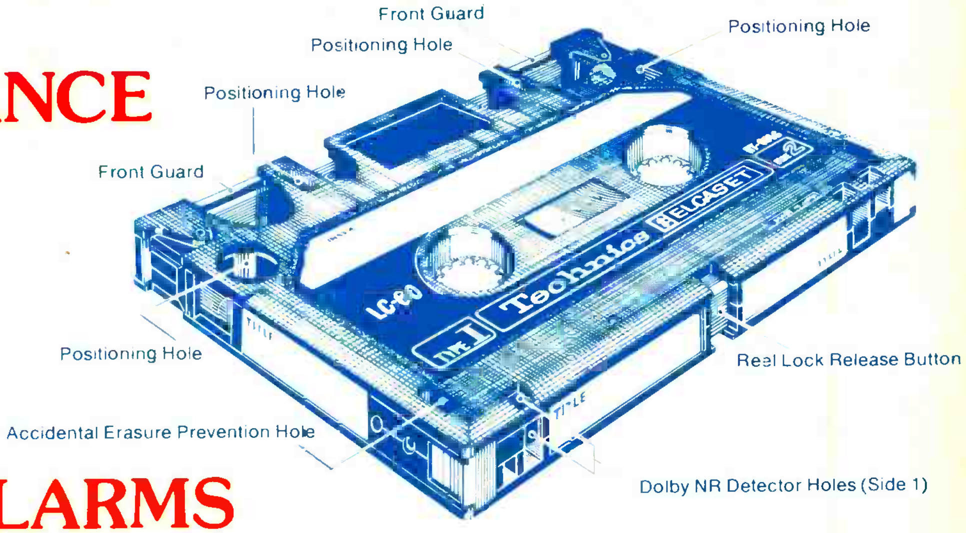

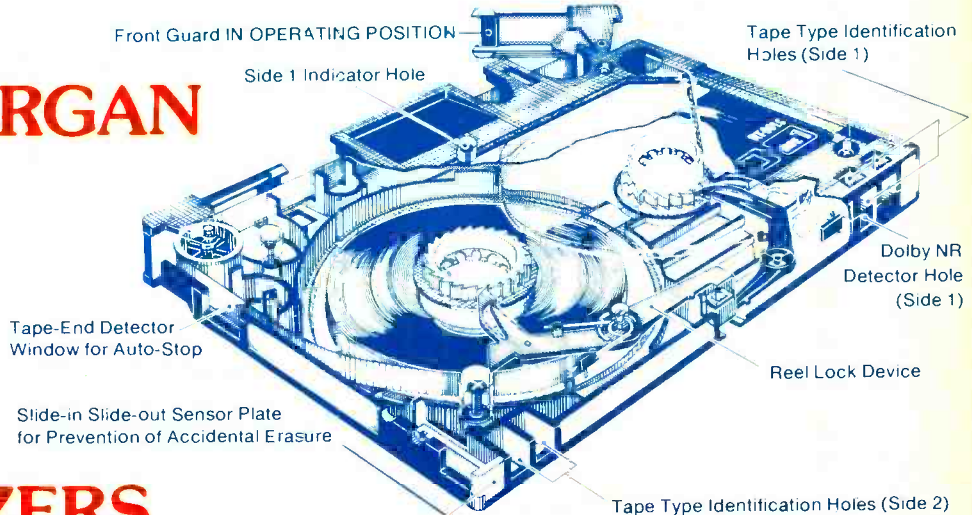

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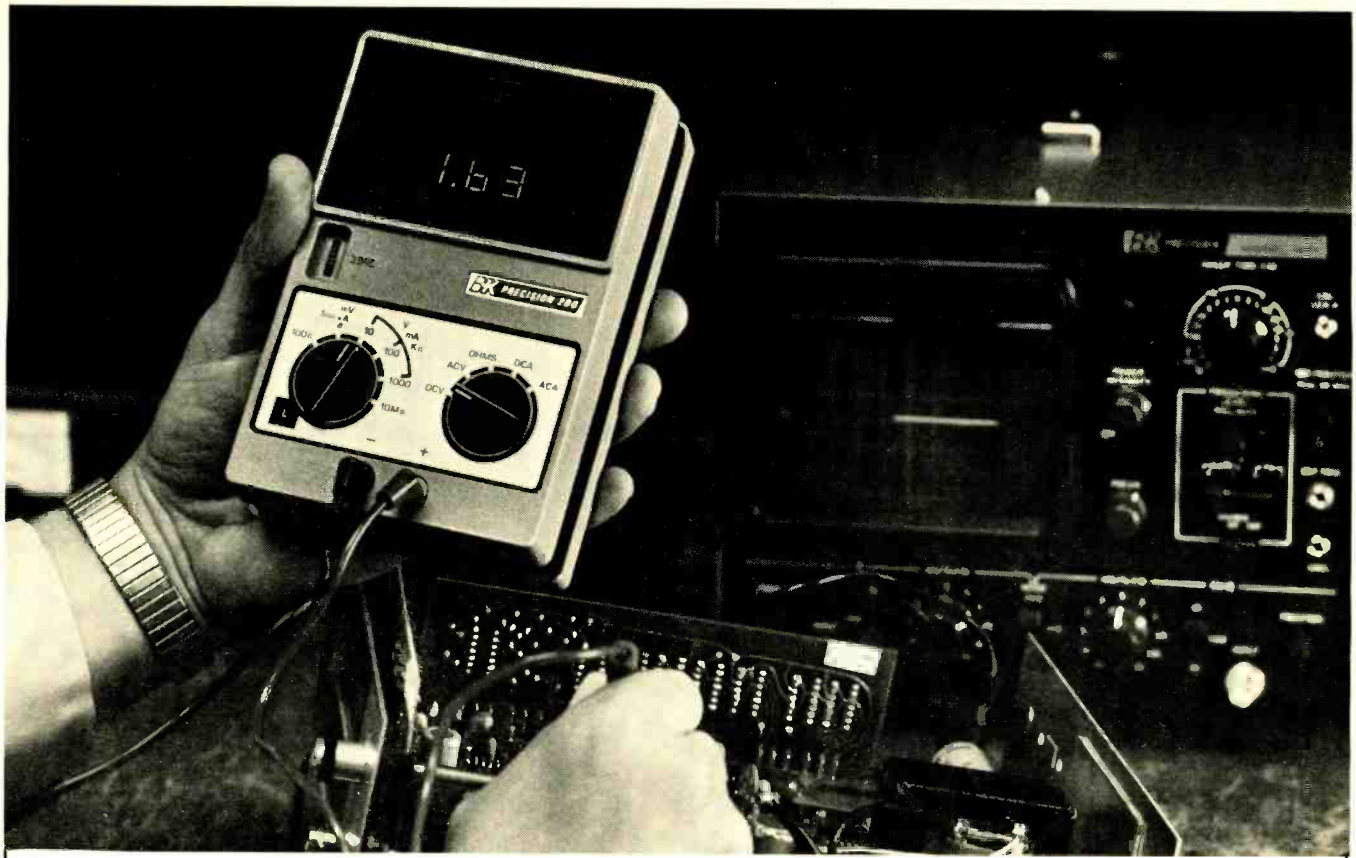

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Measuring just 11" wide x 11" deep x 5" high, and weighing a mere 7 pounds, the Altair ™ 680b is a complete, general-purpose computer.

The secret to this revolutionary, small computer is its CPU board. This double-sided board fits along the bottom of the Altair case and plugs directly into the front panel board. It contains the new 6800 microprocessor, 1,024 bytes of RAM memory, a 256 byte PROM monitor, provisions for 768 bytes of additional PROM or ROM, and a single Interface port with a Motorola ACIA serial interface adapter which can be configured either RS-232 or TTY. A five level Baudot interface option is also available.

The Altair 680b can be programmed from front panel switches, or it can be interfaced to a video display terminal, or teletypewriter. Three additional circuit boards can be plugged inside the Altair 680b for further memory and interface expansion. The first of these boards is a 16K static RAM memory board.

Software already developed includes Altair 680 BASIC with all the features of the 8K BASIC previously developed for the Altair 8800. These include Boolean operators, the ability to read or write a byte from any I/O port or memory location, multiple statements per line, and the ability to interrupt program execution and then continue after the examination of variable values. This software takes only 6.8K bytes of memory space and a copy is **included free with the purchase of the Altair 680 16K memory board.**

Other software includes a resident two pass assembler.(also free with 16K board) The Altair 680b is also compatible with Motorola 6800 software.

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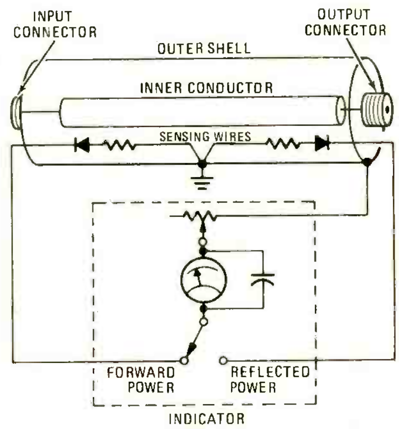
OCTOBER 1976 Vol. 47 No. 10

ON THE COVER

Another new tape system. "Elcaset" puts ¼-inch tape in an easy loading package. Three manufacturers have already announced equipment—Technics, Sony and Teac. For the whole story, turn to page 48.



SWR is vital to effective CB communications. Measure it and adjust it for best performance from your set. .... **see page 82**

Synthesisers reduce the crystal count in CB transceivers.................................. **see page 41**

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looking ahead

Obsolete CB's?

Expansion of the 23-channel Citizens band will *not* render current equipment obsolete. FCC Chairman Richard Wiley made that clear in answer to newspaper reports to the contrary. "No present CB sets will in any way be made obsolete," he said. "The FCC is very disturbed by any suggestions to the contrary." FCC Chief Engineer Raymond Spence suggested that currently available 23-channel sets are an especially good buy, since there will be less congestion on the existing channels after the new channels are opened up. There have been suggestions that 23-channel CB's are especially worth buying now because expanded-channel transceivers inevitably will cost more.

Note: The public doesn't seem to be worrying about obsolescence. As of last July, the FCC was processing 500,000 licenses a month and falling further behind each day. That compares with 30,000 licenses a month just two years ago.

Cost of safety

The federal Consumer Product Safety Commission has a minor revolt on its hands. It commissioned Underwriters Laboratory to develop a mandatory TV safety standard—and the public-industry advisory committee voted overwhelmingly that the standard should be voluntary, not mandatory. Here's why: A mandatory safety standard covering such risks as shock, fire, portable TV handles and sharp edges, would add $73 to $92 to the cost of the average color set in 1977, according to the UL study, and $12 to $19 to the cost of a monochrome set. This works out to about $1 billion added to TV price tags next year for safety. At the same time, past experience indicates that the damage caused by television sets without the new safety standards would be somewhere between $1,200,000 and $9,700,000. This means that the proposed standard would cost 100 times more than it saves, in its first year alone.

Of course, the intangible and unfigurable part of the standard is the saving in human life. It's not known in any detail how many lives were lost as the result of unsafe TV's, or how many could be saved by the new safety measures. In total, it's known to be extremely small. But how much value do you put on a human being's life?

Color tube sweepstakes

The war of the color tubes continues. Ever since Zenith announced a new tube using a completely new glass bulb designed for automated manufacture (**Radio-Electronics,** June 1976), other picture tube manufacturers have been manning the gunboats. Zenith and Corning (Corning designed the glass for the tube) had expressed hope that the new tube would become the industry standard.

But other tube manufacturers were not convinced. Sylvania embraced two aspects of the new tube—the 100-degree deflection angle and the tri-potential gun (which makes possible a small electron spot size with a slot mask), as described here last month. Now big RCA has made the rejection complete. RCA announced it will adopt the tri-potential gun in future 25-inch slot-mask tubes, but will stay at the current deflection angle of 90 degrees. Sylvania promptly announced that it would stay at 90 degrees and make the RCA-type tube if its set-making customers wanted it. Both Sylvania and RCA pointedly rejected the new "standard" glass that now seems to be the exclusive property of Zenith.

Such infighting is common in the picture-tube industry. If Zenith and Corning can prove that the new glass makes possible a considerably less expensive picture tube, it wouldn't be surprising to see RCA and Sylvania go along—eventually. As Zenith President John Nevin put it, "it's not unusual for people not to be impressed with a design and later adopt it. They pooh-poohed Chromacolor for three years and then they all came out with copies of it."

Fiber optics in TV

Fiber optics are in everyday use as a substitute for coaxial cable at Teleprompter Manhattan Cable TV, the first known use in the United States. Teleprompter has installed 800 feet of glass fiber to feed Home Box Office pay-TV programming into its cable system. The fiber being used has a loss of 16 dB per mile, compared with 62 dB for coax. One fiber could carry as many as 167 video channels. Teleprompter is using a light-emitting diode as the source for the modulated light, although presumably a semiconductor laser eventually will be used. Optical fibers have been in use for some time in the Netherlands for cable TV. Bell Telephone Laboratories is experimenting with fiber optics for carrying telephone communications near Atlanta. The fiber being used by Teleprompter is only 90 microns in diameter. A bundle of six of these could carry more than 1,000 TV channels. Most coaxial cable today has the capacity to carry only 20 channels.

Projection TV

Fad or wave of the future? whatever it is, projection TV is being promoted by at least 30 manufacturers and assemblers, many of them local or regional.

Projection home TV isn't new—about 40,000 projection sets were sold from 1946 to 1949, in the days of television's infancy. The new sets, of course, are in color, but many of them use the same principles as those earlier sets. What has been added is brighter picture sources and highly reflective screens, making it possible to view some sets in rooms that aren't totally darkened.

Advent Corporation has been the leader in home projection sets, and now has introduced its second three-tube model, at $2,495. Most of the other manufacturers of home projection sets have single-tube units. A single-tube set generally consists of a small-screen color set (usually a Sony or a Toshiba) with an added lens system and special Kodak Ektalite highly reflective light-concentrating screen. Most of these single-tube units have 32 × 40-inch screens, in contrast to the 41 × 60-inch (six feet diagonal) used by Advent. Prices of the single-tube sets vary from about $895 to $3,000.

In addition to the already-assembled projection sets are the projection-TV kits that let you build your own projection set using a small-screen color set, lens and screen. These vary in price from $39.95 for one of dubious merit up to $895 without TV set. (**Radio-Electronics** will have a feature article covering projection TV in our December, 1976, issue.—*Editor*)

The crying need in home projection TV is more brightness, to do away with the necessity of turning out the lights and using special light-amplifying screens. This probably means a substitute for the cathode-ray tube as a picture-and-light source. Some work is being done in this direction, but there's no timetable for any concrete results.

Total sales of home projection-TV systems probably will be less than 50,000 units—maybe far less (nobody's keeping track)—this year, and maybe 100,000 to 150,000 next year. Even the highest figure is about equal to one week's sales of direct-view television sets.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

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new & timely

more on page 12

IT'S 40 CHANNELS FOR CB EFFECTIVE JANUARY 1, 1977

Seventeen new CB (Class D) channels will be added to the present 23 by new FCC rules. They become effective January 1, 1977. The only effect on the current channels is that 27.085 MHz (Channel 11), now a "calling only" channel, loses that restriction.

The new channels begin at 27.235 MHz and end at 27.405 MHz, with uniform spacing at 10-kHz intervals. Non-CB licensees that are now authorized to use this band—about 4000 land-mobile stations with authorized power up to 30 watts—will have to shift to other frequencies no later than December 1, 1979 when their existing licenses expire. During the three-year transitional period, these non-CB licensees will not receive CB-interference protection nor will CB stations be protected against the relatively high-power land-mobile gear.

The existing Channel 9 remains reserved for emergency use. All 40 channels can be used for SSB operations—either upper or lower sideband operation is OK. Channel number designations have been removed from the rules by the FCC. They state that, effective January 1, each channel will be identified by its authorized center frequency only. The reason is that two channels have been added between the existing Channels 22 & 23. The EIA has proposed that these two channels be labeled Channels 24 & 25 so the numbers would run 22-24-25-23-26-etc.

The FCC also said that no action to reallocate the existing 27-MHz Class-C channels to Class D will be made at this time. Eventually, however, alternate channels must be found to supplant the present 27-MHz Class-C channels because of the increasing problem of interference by Class-D users to Class-C radio-control operations. Since no such alternate frequencies are presently available and because of significant investment in 27-MHz radio-control equipment by modelers, reallocation now is premature.

The suppression requirement for harmonic radiation is increased to 60-dB for all *new* transmitters sold. Compliance must be demonstrated both with and without the connection of all permissible attachments for use with such transmitters. This includes external speakers, microphones, power cords and antennas. A further reduction of harmonic radiation will be needed in the future and the FCC has proposed a minimum of 70 dB with some groups recommending that it should be as high as 100 dB. In the meantime, if an individual CB licensee causes interference to a neighbor's reception on TV channels 2, 5 or 6 because of insufficient harmonic attenuation, the CB operator will have to obtain additional suppression by inserting a low-pass filter between the RF output connector and the antenna feed-line.

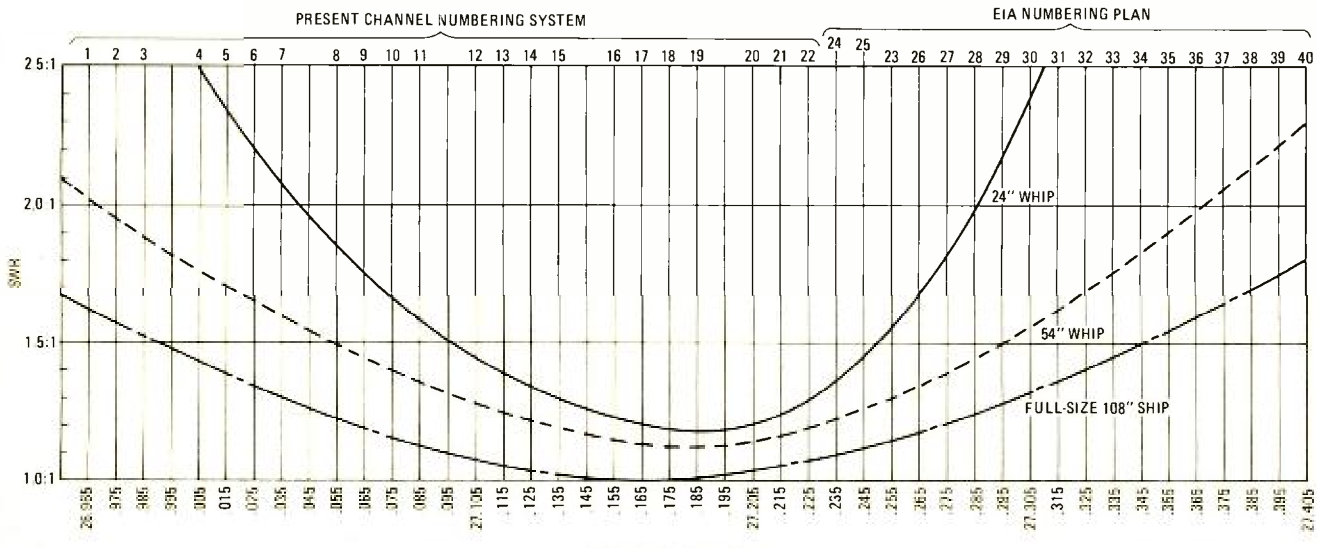
A copy of part 95 of the FCC rules and forms 505 (CB application form) and 55-B (temporary CB license) must be included with each new Class-D transmitter sold.

It will not be possible under the new rules to modify existing equipment to cover the additional channels. The manufacture, sale or attachment of any device, whether it is internal or external to the transmitter, that is intended to extend the frequency coverage of a Class-D transmitter beyond its original frequency range is prohibited. This includes kits, installed by a technician or even if installed by the factory. Manufacturers can, however, modify units before sale if the modified units are type accepted.

Frequency selectors are no longer limited to a single front-panel control. This means that keyboards, thumbwheel switches, etc., are OK to use.

No equipment built to operate on the new frequencies can be sold before January 1, 1977. No applications for type acceptance will be accepted by the FCC before September 10, 1976. All applications submitted before November 1, will be assigned an effective date of January 1, 1977. Applications submitted after November 1, will be given an effective date in order of grant. As a result, there

continued on page 111



EXPANSION OF THE CITIZENS BAND will make greater demands on antenna design and performance. Some antennas, particularly the shorter mobile whips, perform best over just a few channels on each side of resonance. SWR and losses rise as you tune away from the channel to which the antenna is tuned. The curves compare the SWR's of a full-length quarter-wave whip and two shorter coil-loaded types.

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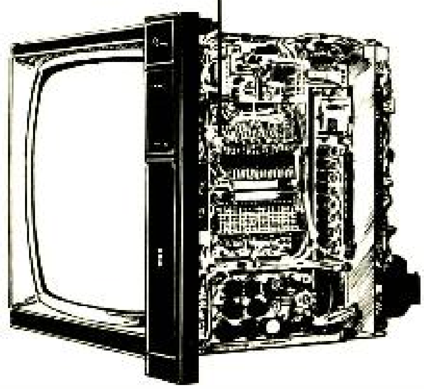

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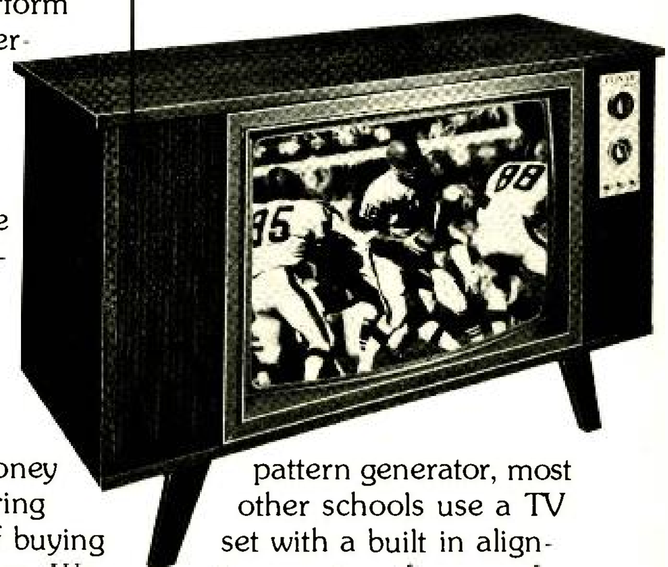

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new & timely continued from page 6

Heating effect of radio waves reduces or destroys cancers?

Work carried on by Dr. Harry LeVeen at the Veterans Administration Hospital in Brooklyn indicates that radio waves can reduce the size of malignant tumors and destroy cancerous tissue. Using a frequency of 13.56 MHz, Dr. LeVeen reduced the size of malignant tumors in 21 cases of advanced cancer and destroyed the cancerous tissue in some of them. As the cases were all far advanced, none of the patients were permanently helped, however.

The effect, Dr. LeVeen explains, is due to heat. The tissue in the cancer was heated to an average of 119 degrees Fahrenheit, more than hot enough to kill either cancerous or normal tissue. The reason normal tissue in the area was not damaged is that blood circulation is better in normal tissue. Thus the blood carried the heat away and the normal tissues remained at a temperature considerably below that of the cancerous ones.

Attitude of cancer authorities appears to be that the experiments are encouraging, but that carefully controlled clinical tests will be required to determine what role, if any, the new technique will play in cancer therapy.

Citizens band radio service helps the country mailman

Rural mail carrier Chet Lane, who operates the 47-mile Route 3 out of Boise, Idaho, finds a CB radio a valuable help in his work, and the families along his route are getting better parcel post service and other advantages because of it.

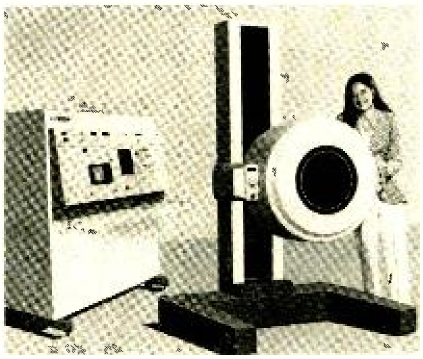
More than a third of the 460 families along RR 3 have CB radios in their homes, Chet Lane estimates, and the number is growing. When he has a parcel too large for the rural mailbox, Lane calls the house and lets the family know he will be coming with a package. He can also let a customer know the amount of a COD shipment while he is still a few minutes from the home, giving the family time to get the funds together. Or he can notify the recipient of a piece of certified mail.

CB-equipped families along the route also make occasional use of the CB link. Families might ask Lane to drop off a roll of stamps.

New gamma-ray camera assures high resolution

A new generation of gamma cameras was unveiled by Raytheon at the Dallas summer meeting of the Society of Nuclear Medicine.

A gamma camera is one that senses radiation (short X-rays) from a patient's body. Certain organs have an affinity for particular radioactive materials. The patient is injected with a small amount of radioactive material that is then detected by the camera and converted to an image that can be read by nuclear physicians.



THE RAYTHEON CAMERAY XL-91 with its control console in the background

The *Cameray* XL-91 has a 16.5-inch undistorted field of view. This extra-large field can often mean the difference between complete and incomplete views of an organ or whole-body images. Former wide-field cameras have not had as fine image resolution as smaller ones. The XL-91 uses 91 tubes instead of the 37 tubes of earlier types, assuring resolution equal in all respects to cameras with a smaller field of view.

New system to make more calls on fewer lines

Bell Labs, together with AT&T's Long Lines system, is testing between New York and Boston a technique that should make possible a great increase in the information carrying capacity of a telephone voice channel.

The system, known as Time Assignment Speech Interpolation (TASI), takes advantage of normal pauses in telephone conversations in an "occupied" communications channel. The ordinary phone conversation is full of pauses, sometimes occupying more than half the time of the conversation. TASI routes another conversation over the line during those "unused" periods. When the person who paused starts speaking again, the conversation goes over the first available open line.

An earlier TASI system, introduced in 1960, effectively doubled the capacity of underseas cables between the United States and Europe. That system worked with ordinary voice conversations and an individual voice processing circuit was needed for each channel. In the new system, the voice signals are converted into digital form, and a single high-speed digital circuit can process a large number of voice channels. **R-E**

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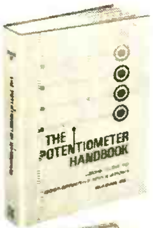

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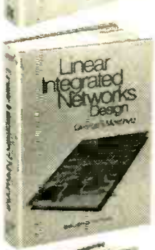

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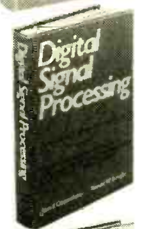

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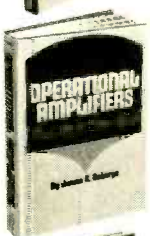

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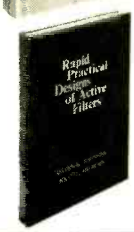

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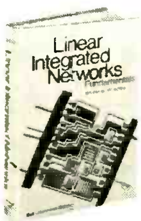

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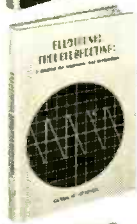

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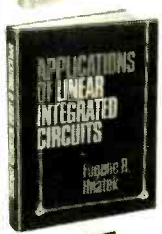

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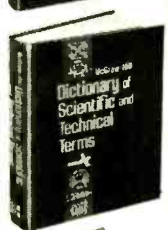

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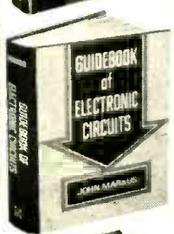

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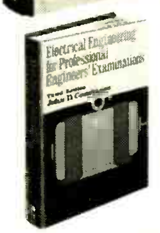

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letters

TVT-I UART RS 232 INTERFACE

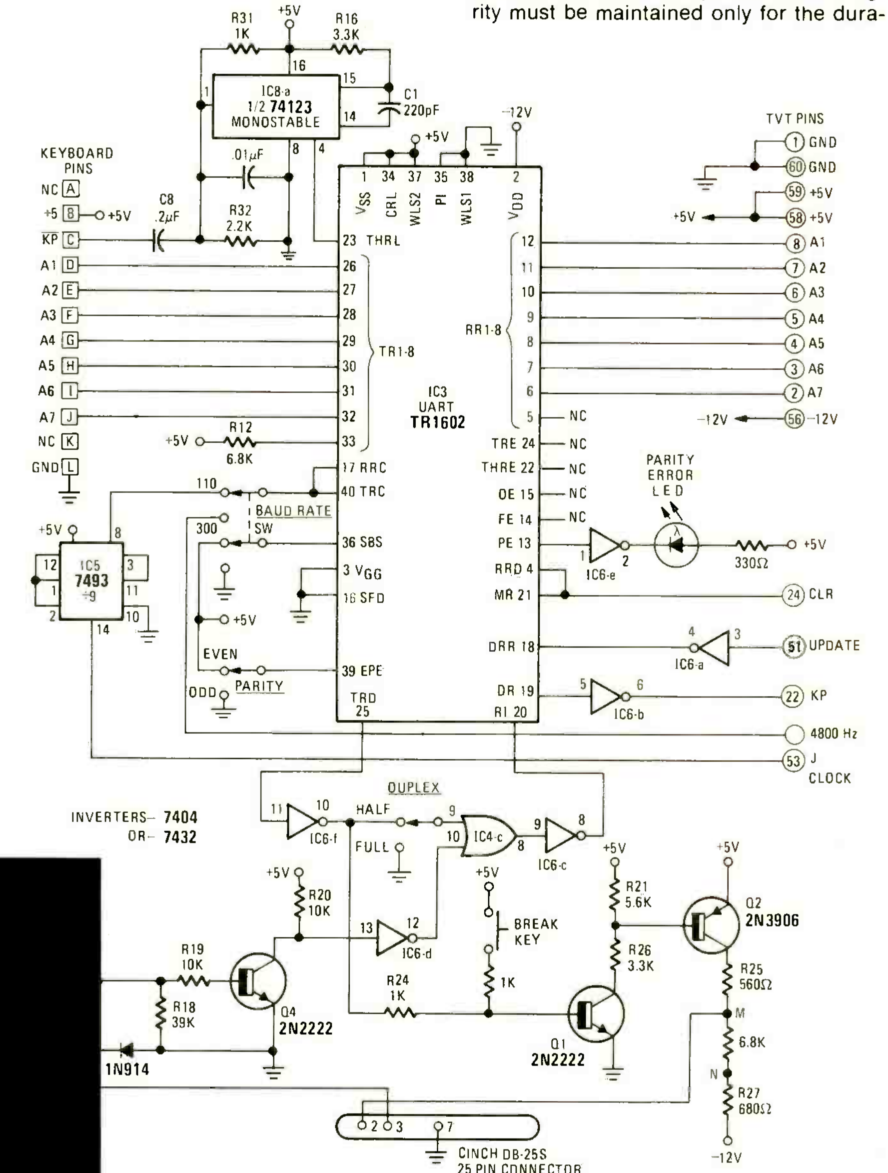
I further modified Raymond Crandell's modification of Roger Smith's TVT-I UART board (February 1975) to provde an RS-232 compatable interface. I have also added selectable band rate, even/odd parity, half/full duplex switches, a break key, and a received parity error light. This has enabled the use of the terminal with a [redacted] modem on a large timesharing [redacted]d also with an Altair 8800 with [redacted]2 option on its serial interface [redacted] modifications are shown in the [redacted]

[redacted]ginal IC4 (7400) on the board [redacted]ced with a 7432 quad OR gate, [redacted] the same pin assignments. Also [redacted] the positive supply voltage for Q1 and Q2 is now +5V rather than the original +12V. With this change, the 6.8K resistor added to the Q2 collector circuit, and the signal inversions, the transmit voltage levels are −3.5V for mark and +3.5V for space.

The TVT-I actually performs better with the UART located between the keyboard and the memory because it acts as an input buffer and the keyboard data integrity must be maintained only for the duration of the IC8 stobe, rather than for the full screen refresh time as previously required.

The TV Typewriter has been the most interesting electronics construction project that I have encountered and I am very happy with the results.

LARRY L. KENAN
Phoenix, AZ



continued on page 16

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CIRCLE 31 ON FREE INFORMATION CARD

GOLKA PHOTOGRAPH

I was interested to read of my friend Robert Golka's lightning experiments in the June issue of **Radio-Electronics,** and to see the photograph I took of the scientist playing lightning rod to a 12 million volt discharge.

Mr. Golka is to be commended for his single minded inquiry into the mysteries of ball lightning, a pursuit that has taken him far from the comforts of Brockton, Massachusetts, to the relative barrenness of Wendover, Utah, where he is known locally as the "mad scientist." As for the so-called Golka associates, I have met only two: a flop-eared mongrel dog named Captain Proton and a borderline canine that answers to the grandiloquent title of Commander Klystron.

I don't know whether anyone will be interested in technical details about the photo, but just in case; I shot it with a Bronica and a 135-mm lens, set up on a tripod and aimed at the top of Golka's Tesla coil. While the power was off, Robert sat on the top of the ladder and I snapped him with a couple of strobe lights. Then I removed the film back, rewound the shutter and made a second exposure of about a minute at f/8 with the sparks flying and all of us at a safe distance. So I ended up with a double exposure on Ektachrome, which we transferred to a negative and then to a print.

A note that may be of some interest: the cavernous hangar where Mr. Golka conducts his lightning experiments was originally built to house the Enola Gay, the B-29 that dropped the atom bomb on Hiroshima. Should the scientist ever succeed in harnassing nuclear fusion, it would be an event of historical significance equal to, I hope, the dawn of atomic warfare. And a brighter milestone in human progress, I might add.

RICHARD MENZIES
Salt Lake City, UT

NEW SQ DECODER?

I would like to apprise you of a most interesting discovery I made in the early days of SQ but whose time appears to have arrived only now: listening to an SQ quadriphonic record played in the stereo mode through binaural earphones gives an unmistakable impression of hearing a decoded quadriphonic program—the human head appears to act to a notable extent as an SQ decoder.

This phenomenon occurs with any good pair of binaural earphones—currently I am using the AKG-K240. The SQ record is not played through a decoder—it simply is reproduced like any stereo record in the binaural earphones. Naturally, the more "discrete" the SQ record, the greater the effect. For example, if you play Side-A Band-7 (*Channel Identifieation Signals*) of the SQT-1100 Quadriphonic Test Record, you hear the pink noise tones walk around your head. The Boulez/Bartok MQ32132 is equally startling in this effect. And the Freiburg MQ32933 is a delight with its spatiality.

continued on page 18

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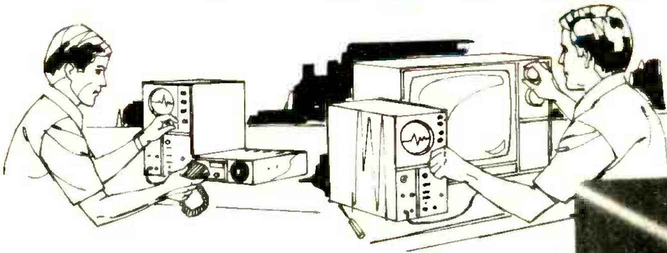

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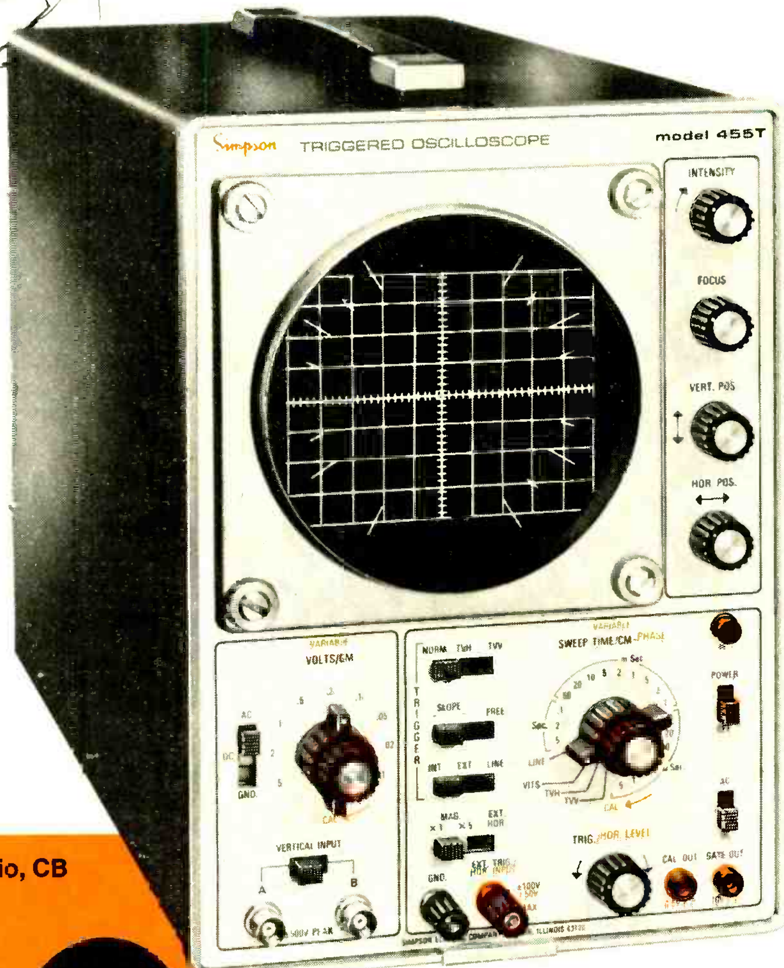

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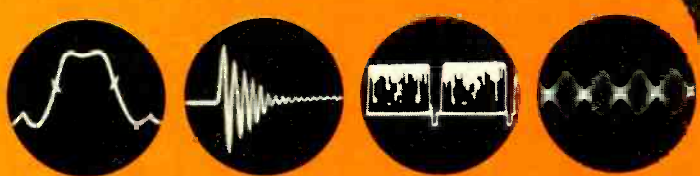

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LETTERS
continued from page 16

I call this *SQ dichophony*. I have found that perception of SQ dichophony varies from individual to individual but about 90% of those tested unmistakably experienced it. It appears, therefore, that SQ dichophony is bound to have a significant influence upon the enjoyment of reproduced sound.

A good measure of harmony exists between what the Germans call "Kunzkopfsterephonie"—listening binaurally with a dummy head—and SQ dichophony. Those who seek spatial effects through the use of dummy heads will find an equal or greater measure of enjoyment by listening to SQ records played undecoded into binaural headphones.

Now that we know of SQ dichophony, the concern of headphone manufacturers that the growing popularity of quadriphony may require them to produce special headphone designs is groundless; rather, SQ dichophony enhances the use of conventional high-fidelity stereophonic headphones.

Naturally, SQ dichophony cannot replace quadriphonic listening with loudspeakers—it is not possible to equate earphones with the live sensation of the quadriphonic space. But as a means of simple, low cost, personal, non-disturbing enjoyment of music, I believe you will find SQ dichophony a significant advance.

BENJAMIN B. BAUER
Vice President and General Manager
CBS Technology Center
Stamford, CT

A NEW FORCE?

A very important concept was brought out in the June 1976 article about Golka and "12-Million Volts." The idea of "re-creating the past to solve future needs" caught my attention.

Over 150 years ago, Oersted discovered a tiny force that causes a permanent magnet to turn at right angles to a current-carrying conductor. He didn't know it but he could have substituted an iron wire for the compass needle although he would not have been able to determine North from South. In all this time we have not been able to produce a permanent magnet that has a magnetic field similar to the one around a current-carrying conductor.

Anytime we find a new force, no matter how tiny, big things begin to happen. Modify Oersted's experiment. Obtain a straight iron-wire 12-inches long that has the same diameter as a current-carrying conductor and suspend it 1/16-inch below and in parallel with the current-carrying conductor with three loops of thread. No matter which way the current flows in the current-carrying conductor, the iron wire is always lifted. How can we describe and use this new force?

We know if current flows in the same direction in two parallel conductors, they attract each other. Reverse the current in one conductor and they repel each other. There is no current in the iron wire yet it is always attracted. Why?

JOHN W. ECKLIN
Alexandria, VA

LOW-FREQUENCY METER

In reference to a letter that appeared in your July, 1976 issue, Fluke has another way to make low frequency measurements (10 Hz to 10 kHz) fast and accurately. It is the Fluke 1920A frequency counter with option -06 (Resolution Multiplier Option).

With this unit, period measurements and taking reciprocal numbers is not necessary. Using a one second gate-time will yield a 60.000-Hz reading with the 1920A-06. The 1920A-06 uses a phase-locked loop to multiply the incoming signal by ×1000.

DON TUTTLE
Regional Sales Engineer
John Fluke Mfg. Co., Inc.
Mountlake Terrace, WA

ELECTRONIC STOPWATCH

I built the Electronic Stopwatch from the article that appeared in the November, 1975 and February, 1976 issues of **Radio-Electronics.** Rather than use another case as stated in the article, I used the original calculator case but with an edge spacer that I formed from a strip of plastic (1/8 × 11/16 × 15 1/2-inches) using a heat gun (actually a modified hair dryer) and soldering iron for bending, molding and joining the expander between the two

halves of the original calculator case. This worked out well for me and I am quite happy with the results.

I used a Novus Mathbox model 650. In so doing I ran into a few problems. The Mathbox has a different hook-up on the 75492 digit driver from that shown in your schematics. Except for making allowance for the modified digit driver hook-up, I followed your schematics with the result of good functioning stopwatch.

A.M. LACAVA
Tustin, CA

CANADIAN COMPUTER CLUB

Will you please list our computer club in your magazine? The name of our club is TRACE (*T*oronto *R*egion *A*ssociation of *C*omputer *E*nthusiasts) and we have over 50 members in the greater Toronto, Hamilton, and Kitchner, Ontario areas. We meet once a month, usually on the first or second Friday. Details are in our newsletter.

HAROLD MELANSON
President, TRACE
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Sure I will.—Editor **R-E**

KOMPUTER KORNER

JONATHAN A. TITUS, PETER R. RONY AND DAVID G. LARSEN*

OOOOPS!

The Komputer Korner that appeared in the July 1976 issue was mistakenly credited to Jonathan A. Titus. Peter R. Rony and David G. Larsen.

We would like to extend our deepest apologies to Tim Barry. He, in fact, actually authored that column.

WHEN DATA IS TRANSMITTED BETWEEN A microcomputer and an input/output device, three actions must simultaneously occur:

1. The microcomputer must select the specific input/output device that will either receive or transmit eight bits of data.
2. The microcomputer must indicate to the specific input/output device when the bidirectional data bus is available for data transmission.
3. The data must be transmitted between the microcomputer and the input/output device in a very short period of time, typically of the order of microseconds.

In preceding columns, we have discussed *accumulator I/O*, in which data is exchanged between the accumulator and an external I/O device. There is a significant disadvantage associated with such an interfacing technique: there exists only a single origin or destination for data. A typical microprocessor chip, such as the Intel 8080, has in addition to the accumulator a variety of internal general-purpose registers that can exchange information with memory. These registers include the B, C, D, H and L registers, each of which is an 8-bit register. From a programming standpoint, it would be very useful to be able to exchange data between any of these registers and any external I/O device. This is the subject of this month's column.

If you desire to exchange data between a general purpose register and an external I/O device, you employ an exciting interfacing technique called *memory I/O* or *memory mapped I/O*. The basic gimmick behind this technique is quite simple: *you treat the input/output device as if it were one or more memory locations*. By doing so, you provide yourself with the opportunity to employ memory instructions in the 8080 microprocessor instruction set. These instructions transfer data between registers and memory locations.

The differences between accumulator I/O and memory I/O can be best understood

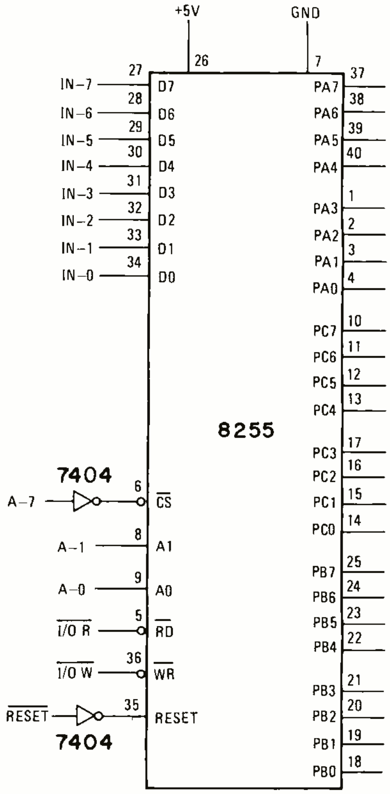

FIG. 1

with the aid of a specific example of an interface between an 8080-based microcomputer and an external I/O device. In this case, the "device" is the Intel 8255 programmable peripheral interface (PPI) integrated circuit. This IC has 24 I/O pins that are shown as PA, PB, and PC in either Fig. 1 or Fig. 2. These pins can be wired directly to any digital device that has TTL-compatible signals.

An 8255 IC appears to an 8-bit microcomputer as either four different external I/O devices or else four different memory locations. Within the IC there are four 8-bit registers that are addressed by the microcomputer:

- Port A—an 8-bit port that can be configured as either an input port, an output port, or a bidirectional I/O port.
- Port B—an 8-bit port that can be configured as either an input or output port.
- Port C—an 8-bit port that can be configured as an input or output port or a pair of control ports—one for port A and the other for port B.
- An internal 8-bit control register that determines the specific I/O

continued on page 24

* Mr. Titus is president of Tychon, Inc., a microcomputer consulting firm in Blacksburg, Virginia. Dr. Rony, Department of Chemical Engineering, and Mr. Larsen, Department of Chemistry, are with the Virginia Polytechnic Institute & State University.

KOMPUTER KORNER
continued from page 22

configuration of the 8255 IC and can be altered at any time by the microcomputer.

As can be seen in Figs. 1 and 2, the 8255 IC contains, in addition to the three I/O ports, an 8-bit bidirectional data bus (D0 through D7) that communicates directly with the 8080 IC: six control inputs—$\overline{CS}$, A1, A0, $\overline{RD}$, $\overline{WR}$, reset, and two power inputs.

Accumulator I/O

In accumulator I/O, you employ the $\overline{I/O\ R}$ and $\overline{I/O\ W}$ function pulses to read from and write into the 8255 chip.[1] The IC is addressed with the aid of bits A0 through A7 (or A8 through A15) on the 16-bit memory address bus of the 8080 microprocessor. In Fig. 1, we use A7 as the IC-select input and A0 and A1 to select one of the four different registers present within the IC. For example, the following program writes information from the 8080 IC into port A.

- 323_8 Enable the register for port A and allow it to accept data from the accumulator register
- 200_8 Device code for port A

The port is treated as an I/O device and an accumulator I/O instruction, 323_8, is used. A simple change in the control register will turn port A into an input port and permit the use of the program to read information into the 8080 IC from port A.

- 333_8 Enable the register for port A and allow it to send data to the accumulator register
- 200_8 Device code for port A

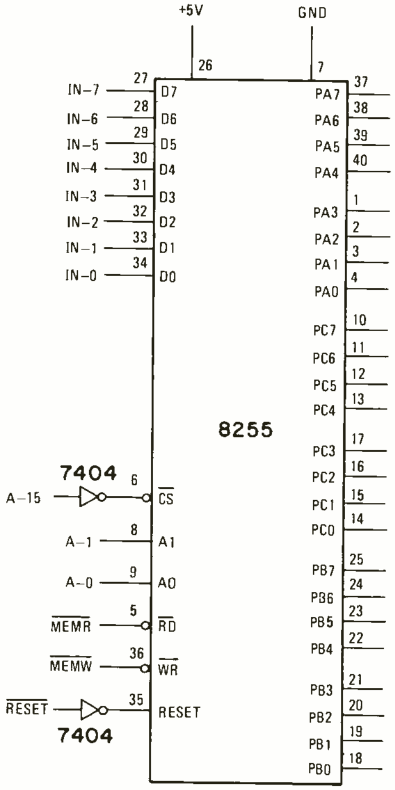

FIG. 2

Memory I/O

In memory I/O, the $\overline{MEMR}$ and $\overline{MEMW}$ memory read/write function pulses are used to exchange data between the internal registers within the 8080 IC and the 8255 registers.[1] The entire 16-bit memory-address bus can be used to address the IC. As shown in Fig. 2, bit A-15 is used as the IC-select input and bits A0 and A1 as the register-select inputs. To output data from register B to port A, the following program can be used:

- 041_8, 000_8, 200_8 Set the 16-bit memory address pointer register within the 8080 microprocessor chip to the memory address of port A
- 160_8 Move the contents of register B to port A

Once port A has been selected, you can successively output data from other registers in the 8080 microprocessor:

- 161_8 Move the contents of register C to port A
- 162_8 Move the contents of register D to port A
- 163_8 Move the contents of register E to port A
- 167_8 Move the contents of the accumulator to port A

Each additional transfer of data requires only 2-ms execution time, which is quite a bit faster than the 5 ms required for successive accumulator I/O data.

We have demonstrated that both the accumulator I/O and the memory I/O techniques are applicable to the 8255 IC. The specific application will determine the best

continued on page 26

When you install a B-T Booster outside, you get a lot of new boosters inside.

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KOMPUTER KORNER
continued from page 24

I/O technique. In some cases, accumulator I/O is best; in others, memory I/O simplifies programming and speeds the transfer of large quantities of data to or from memory. It should be noted that some microprocessors only permit memory I/O interfacing techniques. Such IC's frequently possess special memory addressing instructions that speed execution time for memory I/O addressing.

The principal advantage of the 8255 IC is not in programming or execution time, but rather in the ease of wiring of an interface to an external I/O device such as an analog-to-digital converter, a digital-to-analog converter, a digital panel meter, or a digital multimeter. No flip-flops, decoders, or gates are required for the interface; they are all contained within the 8255 IC. In most cases, only SN7404 inverters may be needed to match logic levels between port C, which is usually employed as a control port, and the control pins on the external digital I/O device. It is possible that in the future manufacturers of these semiconductor devices will provide I/O interfaces that will permit a digital instrument to be tied directly to a programmable peripheral interface IC. **R-E**

[1] The accumulator I/O pulse abbreviations, $\overline{I/O\ R}$, $\overline{I/O\ W}$, $\overline{MEMR}$, and $\overline{MEMW}$ are those used by the Intel Corporation, Santa Clara, California. $\overline{I/O\ R}$ and $\overline{I/O\ W}$ respectively correspond to $\overline{IN}$ and $\overline{OUT}$, which we have used in preceding columns.

KOMPUTER KORNER 2

TIM BARRY

NOW THAT WE HAVE HAD SOME ARTICLES INTRODUCING the basic 8080 hardware features, we can begin to study its instruction set and programming characteristics. This is the first of three columns in which we will present some of the basic concepts of all computer instruction sets. These concepts will then be illustrated with the 8080 microprocessor.

The instruction sets of all general purpose computers can be broadly divided into four groups:

1. Data Transfer Instructions
2. Arithmetic/Logic Instructions
3. Control Transfer Instructions
4. Processor Control Instructions

Each of these general groups can then be broken down into sub-groups based upon the architecture of the processor being used. This month we will look at the data transfer instructions and their operation.

Data transfer instructions

Instructions that are used to transfer data from one location in the computer to another without modifying it are all considered to be members of this group. The versatility of a computer's instruction set is directly related to the number of direct data-transfers that can be performed; the more direct data-transfers possible, the easier the computer will be to use.

When analyzing a computer's data transfer instructions, it is useful to think of the entire computer as a collection of *data resources*. A data resource is considered to be any register, memory location, or I/O device. A data resource whose contents can be moved by a data transfer instruction is considered to be a *data source*. A data resource that can receive the data transferred by a data transfer instruction is considered to be a *data destination*. In most computers, any given data resource can be either a data source or a data destination depending upon the instruction being executed. The exception to this occurs with the I/O devices. An I/O device is generally only a data source or a data destination. Thus, an I/O address used for both read and write operations with the same device will probably be communicating with two physically different registers. For example, if you have your teletypewriter hooked up to input port 10 and output port 10, input port 10 would be the data source and output port 10 would be the data destination.

Data transfer notation

When examining a computer's data transfer instructions, we will use a notation designed to illustrate the action performed by the transfers. These notations are defined here and they will be used from now on whenever we need to illustrate a data transfer.

Notation	Meaning
$\longrightarrow$	Data transfer
$\longleftrightarrow$	Data exchange
( )	Contents of a data source
[Addr]	Memory location addressed by Addr

continued on page 28

KOMPUTER KORNER

continued from page 26

([Addr]) Contents of memory location addressed by Addr

The following are some examples of how the above notations would be used and their meaning:

(A) ⟶ B would denote a transfer of the contents of A into B.

(A) ⟷ (B) would denote an exchange of the contents of A and B.

(A) ⟶ [100] would denote a transfer of the contents of A into memory at location 100.

([100]) ⟶ A would denote a transfer of the contents of memory location 100 into A.

8080 data resources

Data transfer instructions in the 8080 may use any of the following data resources as either data sources or data destinations:

1. An 8-bit register (A, B, C, D, E, H, L)
2. A 16-bit register or register pair (BC, DE, HL, PSW, SP, PC)
3. A memory location addressed by a 16-bit immediate address or a 16-bit register
4. Immediate data
5. An I/O device

In the presentation of the 8080 instructions we will use the following notations to represent these data resources:

Symbol	Data resource
S or D	An 8-bit register (A, B, C, D, E, H, or L)
M	The contents of memory as addressed by the HL register pair
RP	One of the 16-bit registers BC, DE, HL, or SP
RS	One of the 16-bit registers BC, DE, HL, or PSW, where PSW is composed of A and the processor flags
RD	One of the 16-bit registers BC or DE
Addr	A 16-bit memory address
IO	An 8-bit I/O address
D8	8-bit immediate data
D16	16-bit immediate data

In addition, some instructions will make reference to specific 8080 registers. These will be pointed out as required. All instructions introduced in the following sections will be presented using the standard mnemonics introduced by Intel Corporation when they first released the 8080. The number in parenthesis next to the instruction is the number of bytes of memory occupied by the instruction. Thus MVI D,D8(2) would be the mnemonic representing the two-byte instruction used to transfer an immediate data value consisting of 8 bits into one of the 8-bit destination registers (A, B, C, D, E, H, or L).

Register to register data transfers

The first group of data transfer instructions we will consider are those that use internal processor registers as both the data source and data destination. The 8080 allows us to transfer the contents of any 8-bit register into any other 8-bit register. In addition, there are a limited number of transfers that use the 16-bit registers. The following are the register-to-register-data transfer instructions listed by their mnemonics (in bold type), the operation performed in transfer notation and the meaning of the instruction.

MOV D,S(1)
Operation performed: (S) ⟶ D
The contents of the source register are transferred into the destination register.

XCHG(1)
Operation performed: (HL) ⟷ (DE)
The contents of the HL register are exchanged with the contents of the DE register.

PCHL(1)
Operation performed: (HL) ⟶ PC
The contents of the HL register are transferred into the program counter.

SPHL(1)
Operation performed: (HL) ⟶ SP
The contents of the HL register are transferred into the stack pointer.

Memory data transfers

This class of instruction uses an internal register or register pair as one data source or

continued on page 30

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KOMPUTER KORNER
continued from page 28

destination and a memory location or locations as the other.

LDA Addr(3)
Operation performed: ([Addr]) ⟶ A
The contents of memory as addressed by the 16-bit address included with the instruction are transferred into the A register.

STA Addr(3)
Operation performed: (A) ⟶ [Addr]
The contents of the A register are transferred into the memory location specified by the 16-bit address included with the instruction.

LHLD Addr(3)
Operation performed: ([Addr]) ⟶ L,
([Addr + 1]) ⟶ H
The contents of memory as addressed by the 16-bit address included with the instruction are transferred into the L register. The contents of memory at Addr + 1 are transferred into the H register.

SHLD Addr(3)
Operation performed: (L) ⟶ [Addr],
(H) ⟶ [Addr]
The contents of the L register are transferred into the memory location specified by the 16-bit address included with the instruction. The contents of the L register are transferred into memory at Addr + 1.

MOV D,M(1)
Operation Performed: ([HL]) ⟶ D
The contents of the memory location whose address is specified by the HL register pair is transferred into the destination register.

MOV M,S(1)
Operation Performed: (S) ⟶ [HL]
The contents of the source register are transferred into the memory location whose address is specified by the HL register pair.

LDAX RD(1)
Operation Performed: ([RD]) ⟶ A
The contents of the memory location whose address is specified by the register pair is transferred into the A register.

STAX RD(1)
Operation Performed: (A) ⟶ [RD]
The contents of the A register are transferred into memory at the address specified by the register pair.

POP RS(1)
Operation Performed: ([SP]) ⟶ RS_L,
([SP + 1]) ⟶ RS_H,
(SP) + 2 ⟶ SP
The contents of the memory location addressed by the stack pointer are transferred into the low-order register of the register pair (ie., C, E, L or A). The stack pointer is incremented and the contents of the memory location now addressed are then transferred into the high-order register of the register pair (ie., B, D, H or Flags). The stack pointer is then incremented again.

PUSH RS(1)
Operation Performed: (RS_H) ⟶ [SP-1],
(RS_L) ⟶ [SP-2]
(SP)-2 ⟶ SP
The stack pointer is decremented by one. The contents of the high-order register of the register pair are then transferred into the memory location whose address is specified by the stack pointer. The stack pointer is then again decremented by one and the contents of the low-order register of the register pair are then transferred into the memory location now addressed by the stack pointer.

XTHL(1)
Operation Performed: (HL) ⟷ ([SP])
The contents of the HL register pair are exchanged with the contents of the top (last entered) elements in memory as addressed by the stack pointer.

Immediate data transfers

Immediate data transfers use data that is included with the instruction as the data source and an internal register, register pair or memory location as the data destination. By "included with the instruction", we mean data that is located in the memory location(s) immediately following the instruction. (Using this definition, the addresses included with some of the memory data transfers could be considered to be immediate addresses.)

MVI D,D8(2)
Operation Performed: D8 ⟶ D
The 8-bit immediate data is transferred into the destination register.

MVI M,D8(2)
Operation Performed: D8 ⟶ [HL]
The 8-bit immediate data is transferred into memory at the address specified by the HL register pair.

LXI RP,D16(3)
Operation Performed: D16 ⟶ RP
The 16-bit immediate data is transferred into the selected register pair.

I/O data transfers

I/O data transfers use input devices addressed by an I/O address as data sources and output devices addressed by I/O addresses as data destinations. As mentioned earlier, most individual I/O devices are either a data source or a data destination.

IN IO(2)
Operation Performed: (IO) ⟶ A
The data byte supplied by the input device specified by the I/O address is transferred into the A register.

OUT IO(2)
Operation Performed: (A) ⟶ IO
The contents of the A register are transferred to the output device specified by the I/O address.

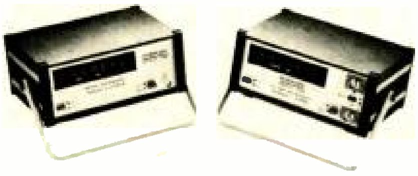
Summary

The 8080 provides a large selection of data-transfer instructions for use in programming (97 unique machine codes). We will use these instructions to maneuver data and addresses around inside the computer.

In the next column in this series we will continue our discussion of instruction sets and the 8080 with a look at the important arithmetic/logic instructions. **R-E**

equipment reports

Hickok 380-Series Frequency Counters



CIRCLE 83 ON FREE INFORMATION CARD

THE HICKOK ELECTRICAL INSTRUMENT CO. HAS come out with a new frequency counter. There are actually four models—the *380*, *380X*, *385* and *385X*. The *380* series will read frequencies up to 80 MHz with an accuracy of 10 parts per million (PPM). The *385* and *385X* are basically the same instrument, but will read frequencies up to 512 MHz. These have a built-in prescaler. The *380* and *385* instruments have a crystal oscillator timebase with an accuracy of 10 PPM. The "X" versions of both use a TCXO (Temperature-Controlled Crystal Oscillator) unit, with a stability and accuracy of 1 PPM. Interconnection facilities are provided so that the "plain" versions can be operated from the TCXO of one of the "X" versions. Up to four *380* or *385* counters may be simultaneously operated from the timebase of one "X" unit.

The *380*'s are all very compact instruments. A 7-digit LED readout is used, visible for quite a distance. These counters are all auto-ranging. All you do is hook it up and turn it on. The input frequency is instantly displayed. The display updates automatically, depending on the frequency. Automatic IC switching in the instrument selects either a 1.0 second or 0.1 second gate-period. This also positions the decimal point so that the reading can be read as either "kHz" or "MHz".

Normally, all frequencies below 10 MHz will be shown in kHz; above 10 MHz, in MHz. If you push the SPEED-READ switch, all frequencies will be read out in MHz.

If you want to, you can use the SPEED-READ button to give automatic gating at 0.1 second at all times. This updates the display a little faster. Actually, this pushbutton is the *only* control on the front panel, aside from the on-off switch! Everything else is done automatically by the IC's.

In the UHF models, the *385*'s, one more control is added. There are two BNC connectors on the panel. The lower connector is used for frequencies from 1 Hz to 10 MHz, and the upper for frequencies from 10 MHz on up to 512 MHz. The added switch selects the proper input jack. The high-frequency input is then switched to the input of the prescaler, which in turn feeds the basic *380* counter. This is all done with only one special IC and a group of gates.

On both of the basic models (*380* and *385*), a selector switch on the back panel allows the use of an external timebase. This can be a high-accuracy signal generator or the TCXO oscillator from one of the "X" version instruments. This switch can also be used, without an external timebase, if you want to freeze the display reading for any reason. The instrument will display the last reading until the switch is thrown to INTERNAL again, or the power is turned off.

The display accuracy in all models is ± 1 count (least significant digit) ± the timebase accuracy. Incidentally, the crystal oscillator in the 10-PPM instruments can be calibrated to an accuracy of 0.1 PPM, if a high-accuracy standard signal generator is available.

What can you do with a frequency counter in a service shop beside checking CB transmitter frequencies? Lots of things. For one, you can set any ordinary RF signal generator

continued on page 34

GE 19"diagonal MODULAR Solid State Set gets 91.7% serviceability rating from panel of NESDA members.

This high rating is another example of our continuing commitment to make your business easier.
It's based on a comprehensive checklist of items considered by NESDA (National Electronic Servicing Dealer Association) to be key factors in allowing service technicians to quickly and easily diagnose and repair a TV set.
According to Dick Glass, Executive Vice-President of NESDA, the panel found the overall serviceability of GE's 19" diagonal model WYC7608WD was "excellent".

The YC chassis is modular in design . . . Seven module subassemblies contain approximately 85% of all set components. But, like all General Electric modular chassis, it's designed to be serviced with or without modules. Its swing-away design provides easy access to module components and each module has abundant, clear markings.

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CIRCLE 37 ON FREE INFORMATION CARD

EQUIPMENT REPORTS

continued from page 32

right on the button for aligning a CB receiver. The counter can be left hooked up so that any drift can be detected. You can set the RF generator to any frequency you need for TV sweep alignment. You can check the actual frequency of the 3.579545 crystal oscillator in a color TV set, and on and on. This one can be very handy, as I found while trying to work out a puzzle in the color sync. Turned out that the oscillator crystal could *not* be brought to the right frequency. A new crystal could, and the case was solved.

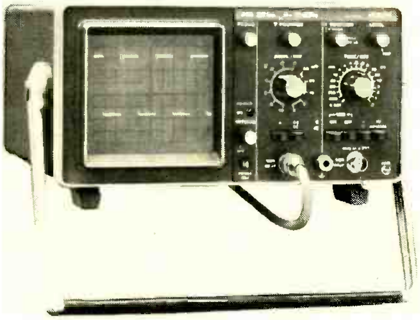
The sensitivity of the *380* series counters is very good. Average, about 25 millivolts for a solid reading. There are upper limits, of course. You shouldn't feed in more than about 40-50 volts, DC plus peak AC, on the medium frequencies, up to about 10 MHz. You can loosely couple the counter input to many circuits and get good readings. For checking radio transmitters, even CB's, a "signal pickoff" and terminating circuit should be used. This takes only a sample of the RF signal voltage, and also terminates the line properly to eliminate standing waves, etc. You will find circuits for these in the instruction manual for the 380 series, complete with parts values. (See; I told you to read the instruction book!)

Another handy use, as suggested by the Hickok, is to play a 1,000 Hz test tape through a player and read the frequency of the output! A 1% error in speed can be detected! It'll read 1,010 kHz!

A nice heavy plastic carrying-case is included with each instrument. This case will hold the counter and all cables, etc.

For more information contact: Hickok Electrical Instrument Co., 10514 Dupont Avenue, Cleveland, OH 44108 **R-E**

Philips PM3225 Oscilloscope



CIRCLE 84 ON FREE INFORMATION CARD

THE PHILIPS NAME IS WELL-KNOWN IN EUROPE, Asia, Africa and the U.S. Their Test and Measuring Instruments Division has just sent us a sample of their new line. This is the *PM3225* oscilloscope. It is a single-channel triggered-sweep scope with a 15-MHz bandwidth and a risetime of 25 nanoseconds.

The sweep can be triggered from the AC line, an external trigger pulse or from either the horizontal or vertical sync pulses of a TV signal. The selection of TV horizontal or vertical trigger is automatic, controlled by the setting of the TIME/DIV selector switch. Incidentally, in our tests the triggering action was

continued on page 36

The new Sansui

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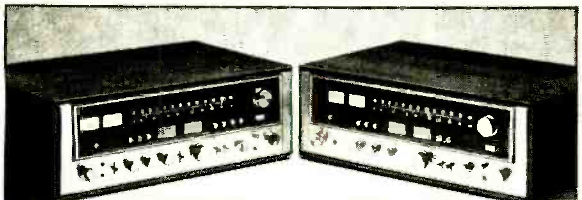
Power, features and performance. That's what the new Sansui 9090 and 8080 stereo receivers are all about.

Listen to what the new Sansui 9090 at under $750.00* has to offer: • A whopping 110 watts minimum RMS power per channel with both channels driven into 8 ohms over the 20 to 20,000 Hz range with no more than 0.2% total harmonic distortion. • Twin power meters to monitor the output for each channel • Advanced PLL IC Multiplex Demodulator for improved channel separation, eliminating distortion and reducing detuning noise • Twin signal meters for easy, accurate tuning • 7-position tape play switch for total creative versatility in dubbing and monitoring • and many other exciting features. Cabinet finished in walnut veneer.

All in all the Sansui 9090 represents what is probably the most advanced receiver available today. Watt for watt, feature for feature, dollar for dollar, an almost unbelievable value.

Also available is the Sansui 8080 at under $650.00* with 80 watts of continuous RMS power under the same conditions with almost all the same features. Cabinet in simulated walnut grain.



Sansui 9090 Sansui 8080

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EQUIPMENT REPORTS
continued from page 34

very solid, holding the most difficult waveforms very steadily.

The horizontal amplifier can be switched to an external input for use with sweep alignment equipment. The sweep can be set from 200 milliseconds-per-division to 0.5 microseconds-per-division in 19 ranges. An expander switch increases the sweep by ×5 on all ranges. The vertical amplifier has a calibrated attenuator from 10 volts-per-division down to 2.0 millivolts-per-division in 12 steps. The input can be either AC or DC coupled. The amplifiers are all solid-state. The CRT used is a Philips 10-160 (which I think has something to do with the screen size; it is about 160-mm diagonal without measuring it). It's a flat-face type, rectangular, with a P31 (light greenish) phosphor. Both amplifiers have a high impedance input—1 megohm shunted by 25 pf.

Six pushbutton switches on the front-panel select TV or NORMAL triggering, + or − slope trigger, EXternal or INTernal trigger, and AC or DC coupling. Last, at the left is a push-push switch marked "O". (Hint for technicians: this does not mean "oh" but "zero"! After some confusion, I finally took the ultimate step and read the instruction manual. This opens the vertical input and grounds it for centering the trace when using the DC coupled input.) The pushbutton switches are big enough so that you can get the one you want without hitting the ones on each side at the same time.

The "human-engineering" of the front panel is very good. All of the positioning controls and the focus control are at the very top along with the trigger-level control. The intensity control and power switch are down at the lower left corner, leaving the ones we use most often in a clear space in the center. Probes plug-in at the bottom, out of the way.

A set of PM-9326 probes comes with the instrument. This includes a direct probe and a low-capacitance probe with 10:1 attenuation. These have push-on connectors for the coaxial cable, and BNC connectors for the input. Several screw-on tips are included; one fits banana jacks, another is a very short (and very sharp!) needle type and the last is a lightweight spring-loaded hook (retractable) type.

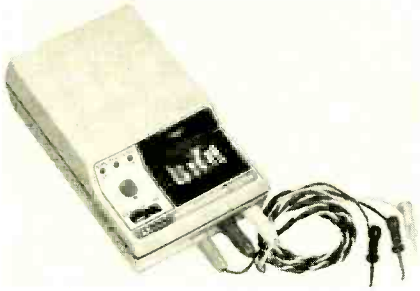
The frequency compensation of the low-capacitance probe is adjusted in a novel way. There is a lock-nut at the back of the probe that is loosened. The probe tip is then touched to the PROBE ADJ terminal on the front panel after pushing both of the EXT and INT trigger buttons at once. This does not display a set of squarewaves; all you'll see will be a single line on the screen. If the line is perfectly straight, the frequency compensation is good. If the left end of the line curves either up or down, just turn the barrel of the probe itself until the line is straight. Now tighten the locknut and the job is over.

We gave it the regular source of sprouts on the bench. It performed very well holding all of the waveforms that you need to see very solidly. This included my pet toughie, the color bar pattern swept at a vertical rate. Due to the large number of pulses of almost the same height, this one is hard to get hold of. The TV position of the trigger selector did the job well.

A complete instruction manual is provided, including servicing and a full circuit description as well as full disassembly instructions. The manual is printed in English, French and German; so is the manual on the probe set with the addition of Dutch (nothing unusual, since the original Philips Co. is in the Netherlands). You'll find out that a low-capacitance probe is a verzwakkerkop, which is geschroefd onto the meetkopkabel. Bet you didn't know that; I didn't. Also, be very sure to geschoven de aardkabel on the verzwakkerkop or your ground connection will be left open!

A nice piece of equipment, up to Philips standards which have always been high. I enjoyed using it. Auf wiedersehen, au revoir. **R-E**

B & K Precision Model 510 Transistor Tester



CIRCLE 85 ON FREE INFORMATION CARD

continued on page 38

EQUIPMENT REPORTS
continued from page 36

THE B & K PRECISION CO., 6460 W. CORTLAND, Chicago, IL 60635 (They've moved!), have come out with a self-contained "pocket" version of their "Dynapeak" transistor tester (fair-sized shirt pocket, that is. In fact, it comes with a neat leatherette case with a belt-loop, so that you could do a "quick-draw" test. With a little practice, you might be the "Fastest Transistor Tester in the West".)

This is their *model 510.* It uses the same digital-pulse test circuitry as the larger industrial tester, the *model 520.* A high-current, low duty-cycle pulse will check transistors in circuits with heavy shunting, down to as low as 10 ohms with the front-panel switch in the HI position, or 1.5K ohms in the LO position. All leads of the transistor will be positively identified in the LO position. Due to the very low duty cycle of the pulses, only 2%, a base-drive pulse of 250 mA can be used in HI position, and only 1.0 mA in LO.

The pulses are developed and detected by digital circuitry. LED indicator lamps identify the transistor as NPN or PNP. A TEST lamp blinks all the time when the tester is on. When this stops blinking, either the NPN or PNP LED will light meaning that the transistor is good. If the transistor is open or shorted, the TEST lamp blinks in all positions of the selector switch.

To test and identify a transistor, just hook up the three color coded test prods in any order. Then, move the 6-position selector switch through the whole range. Color-coded segments on the front-panel show which leads are connected to base, emitter and collector if the transistor is good.

The 510 comes with three of the most *practical* test prods you ever saw! I was fascinated by the ease with which you can hook them up to any transistor in-circuit, even if only a wee bit of the leads are showing. They have a completely insulated, spring-loaded retractable hook that permits one-hand operation. The hook is only 1.0 *millimeter* wide. When you let go, the hook is almost completely covered so that even very closely spaced leads will not short to each other. If they have thoughtfully jammed the transistor case right-down to the board, you can still get at it from the underside. The tiny hooks will grab the little pieces of wire left sticking out. So, we don't have to use the "three-handed" method we did with old type test prods.

The model 510 is completely self contained. It comes in a neat carrying case with space to store the test prods inside. Four AA-cells are used. Two very simple tests are given in the manual for checking out the battery and the instrument. All you need is a good general-purpose transistor and two 10-ohm resistors.

Bipolar transistors, FET's and SCR's can be checked in or out of the circuit. When making in-circuit tests in the HI position, you may find that the transistor shows "Good" on two positions of the selector switch. You'll note that this will always be with the same color test lead on the base. This is fully explained in the manual: practically all bipolar transistors will show *some* gain with emitter and collector reversed. This happens only when the 510 is in HI. Move the selector switch to LO and you should see only one position of the switch with a "good" indication. The transistor leads will then be correctly identified by the colors shown. The manual thoughtfully adds that in rare cases, some very high-frequency transistors may read good in two positions on LO. However, if this happens, the transistor *is* good. As usual with all transistor testers, if a transistor reads bad in-circuit, it should be rechecked after it has been taken out (which we'd have to do anyhow).

Most junction FET's are interchangeable. Drain and source are the same. The 510 will always identify the gate-lead and check the device for quality. To test SCR's out of circuit, use the HI position. A good SCR will indicate PNP in one position and NPN in another, but these two must *not* show the same base-lead color. If the SCR meets these three conditions, it's good. For identification, when the NPN lamp glows, the base-color is the *gate* lead. When the PNP lamp glows, the indicated base color is the *cathode* lead.

Testing for intermittent transistors is easy with this instrument. Hook up the leads. If you get a good indication, you can heat, cool, jar or move the transistor and watch to see if this causes it to read bad.

As is customary, I have found a way to foul it up. If you're testing a new transistor out of circuit with long leads and it reads bad, look the connections over carefully. If two of the leads are touching, it'll indicate bad. Separate the leads.

This is a very compact and very easy to use little instrument, and I'm still amazed by those test clips; they're SO handy! **R-E**

If you can see a difference, imagine what you'll hear.

Magnified, you can see record vinyl wearing away.

With same magnification, record vinyl shows no wear.

You're looking at the solution to one of the oldest problems in audio—how to protect records from wear, while at the same time preserving full fidelity.

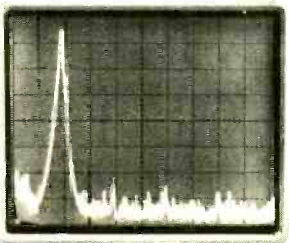
It's called Sound Guard,* and it's remarkable.

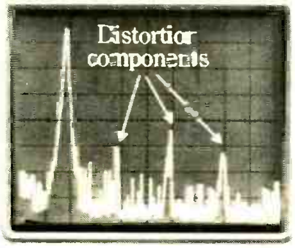
Independent tests show that discs treated with Sound Guard preservative played 100 times display the same full amplitude at all frequencies and the same absence of surface noise and harmonic distortion as "mint condition" discs played once.

A by-product of dry lubricants developed for aerospace applications, Sound Guard preservative is so smooth it reduces friction, yet so thin (less than 0.000003") it leaves even the most fragile groove modulations unaffected.

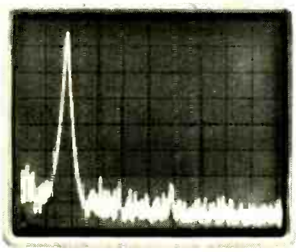
Len Feldman in Radio Electronics reports "At last! The long awaited record-care product has arrived. It preserves frequency response while reducing distortion and surface noise." It's effective and safe for all discs, from precious old 78's to the newest LP's.

Sound Guard preservative, in a kit complete with a non-aerosol pump sprayer and velvet buffing pad, is available in audio and record outlets.


Test record played first time.



After 100 plays without Sound Guard.

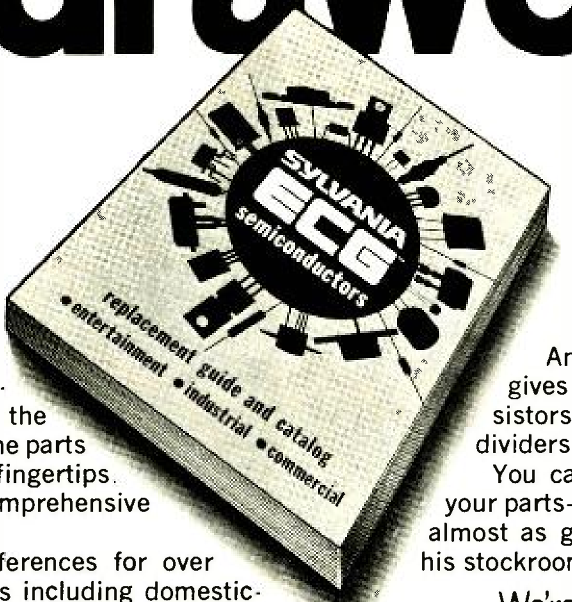

Identical test record after 100 plays with Sound Guard.

Sound Guard™ keeps your good sounds sounding good.

*Sound Guard is Ball Corporation's trademark for its record preservative. Copyright © Ball Corporation, 1976.

CIRCLE 65 ON FREE INFORMATION CARD

How to fit 119,000 parts in your desk drawer.



Our 1976 ECG™ Semiconductor Replacement Guide is the compact way to keep the parts you need right at your fingertips.

It's the most comprehensive book in the industry.

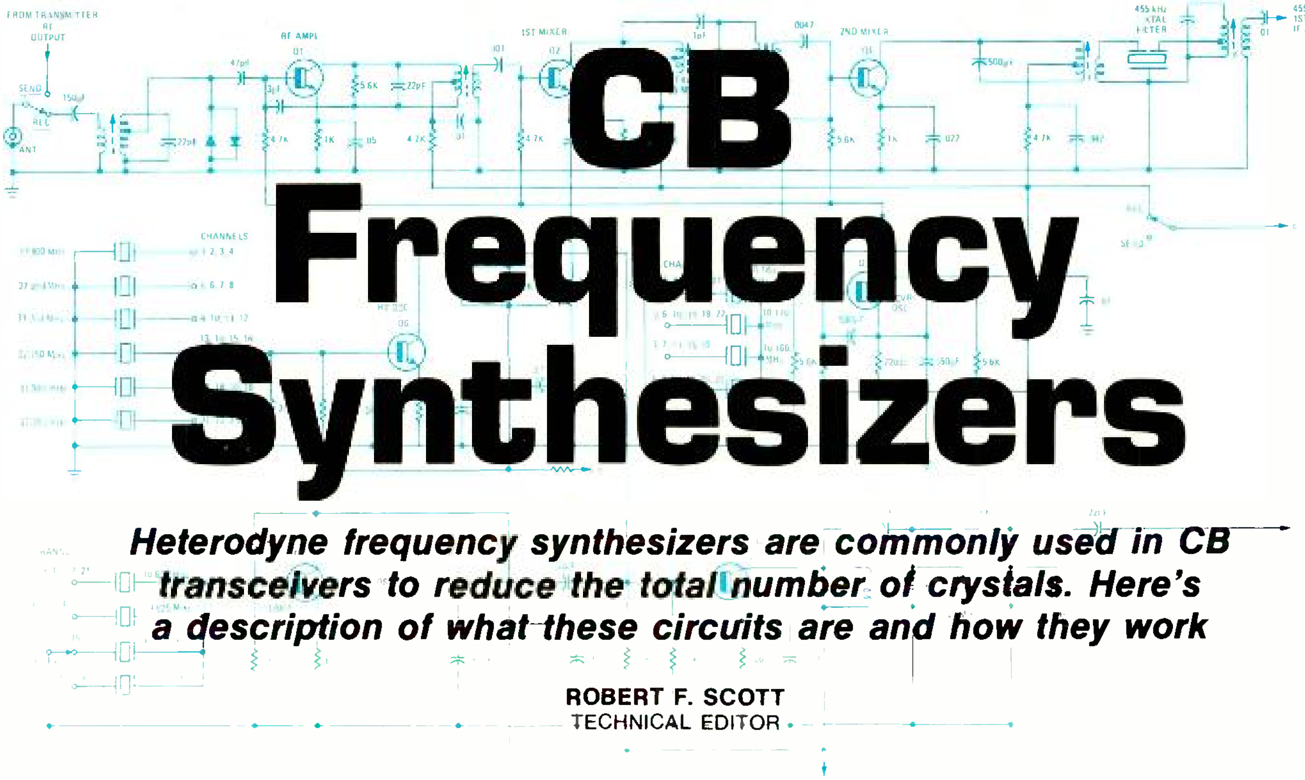
There are cross-references for over 119,000 part numbers including domestic-and-foreign entertainment, commercial and industrial types. Plus a brand new section on CB radio replacements.

An expanded technical data section gives you detailed specs on new transistors, ICs, rectifiers and high-voltage dividers in the ECG line.

You can get your copy where you get your parts—at your Sylvania distributor. It's almost as good as having your own key to his stockroom.

We're helping you make it.

GTE SYLVANIA



CB Frequency Synthesizers

Heterodyne frequency synthesizers are commonly used in CB transceivers to reduce the total number of crystals. Here's a description of what these circuits are and how they work

ROBERT F. SCOTT
TECHNICAL EDITOR

CRYSTAL CONTROL OF THE CB-TRANSCEIVER transmit and receive circuits must be used to insure that the rig meets the frequency precision and stability requirements imposed by the FCC. Nearly all modern transceivers are equipped to operate on all 23 channels so the basic transceiver will require 46 crystals. (Each channel requires a crystal for the transmit circuits and a crystal for the receive circuits.) *Frequency synthesis*—first applied to CB transceivers nearly 14 years ago—permits the circuit designers to use far fewer than the 46 crystals for crystal-controlled reception and transmission on all CB channels.

One method of frequency synthesis uses from ten to twelve crystals in various combinations to develop all the precision frequencies needed by heterodyning. Although the heterodyne method of synthesizing frequencies may save as many as 35 crystals per set; the world-wide shortage of frequency control crystals has led to the development of synthesizers using from *one* to *three* crystals in a phase-locked loop (PLL) circuit. The PLL approach to frequency synthesis in CB radios will be covered in a future article.

The heterodyne frequency synthesizer

Some synthesizers use the *sum* frequency developed by two crystal oscillators to generate either the direct transmitter output frequency or the receiver heterodyne oscillator frequency. Other synthesizers use the *difference* frequency developed by the two oscillators to accomplish the same results. Whichever frequency (the transmitter or receiver oscillator) is developed by the synthesizer, the other frequency is developed by beating the synthesized frequency with the output of a third crystal oscillator.

Three frequency-synthesizer circuits of the heterodyne-type from three manufacturers are typical examples.

Kris XL-23

Figure 1 shows the frequency synthesizer and pertinent receiver and transmitter circuits in the Kris *model XL-23* transceiver.

The channel selector switch has been redrawn in simplified operational form. There are three switch-sections. Two select one of four crystals and one selects one of six crystals. For example, S1-a selects the 37.650-MHz crystal for Channels 5 through 8 and the 37.858 crystal for Channels 21, 22 and 23. Similarly, S1-b and S1-c select the 10.635 MHz and 10.180-MHz crystals, respectively when the radio is operated on Channels 1, 5, 9, 13, 17 and 21.

Let's imagine the transceiver is set on Channel 19 (27.185 MHz) and see how the transmitter output and receiver heterodyne oscillator frequencies are generated. The high-frequency oscillator (Q6) generates a 37.800-MHz signal and feeds it to the base of mixer Q14 where it is combined with the 10.615-MHz output of the transmit oscillator. Both the sum and difference frequencies are generated in Q14's collector circuit but only the difference frequency (37.800 − 10.615 = 27.185) is passed by the three 27-MHz cascaded tuned-circuits. This low-level signal is amplified and modulated and fed to the antenna.

KRIS *model XL-23*

The receiver uses dual-conversion superheterodyne circuitry with the first IF around 10.5 MHz and the second IF at precisely 455 kHz. The incoming 27.185-MHz Channel-19 signal is amplified in Q1 and then fed the Q2 (the first mixer) where it is combined with the 37.800-MHz output of oscillator Q6. The 10.615-MHz difference frequency (37.800 − 27.185 = 10.615) is fed to the second mixer where it is heterodyned with the 10.160-MHz output of receiver oscillator Q7. The resulting 455-kHz difference frequency is fed through a crystal filter to the IF amplifier circuits.

To get the hang of how this particular synthesizer scheme works, get a pencil and paper and work out the transmitter and receiver oscillator frequencies for some of the other channels. A table listing the CB channel frequencies is included to help you along.

How E. F. Johnson does it

Figure 2 shows the synthesizer and

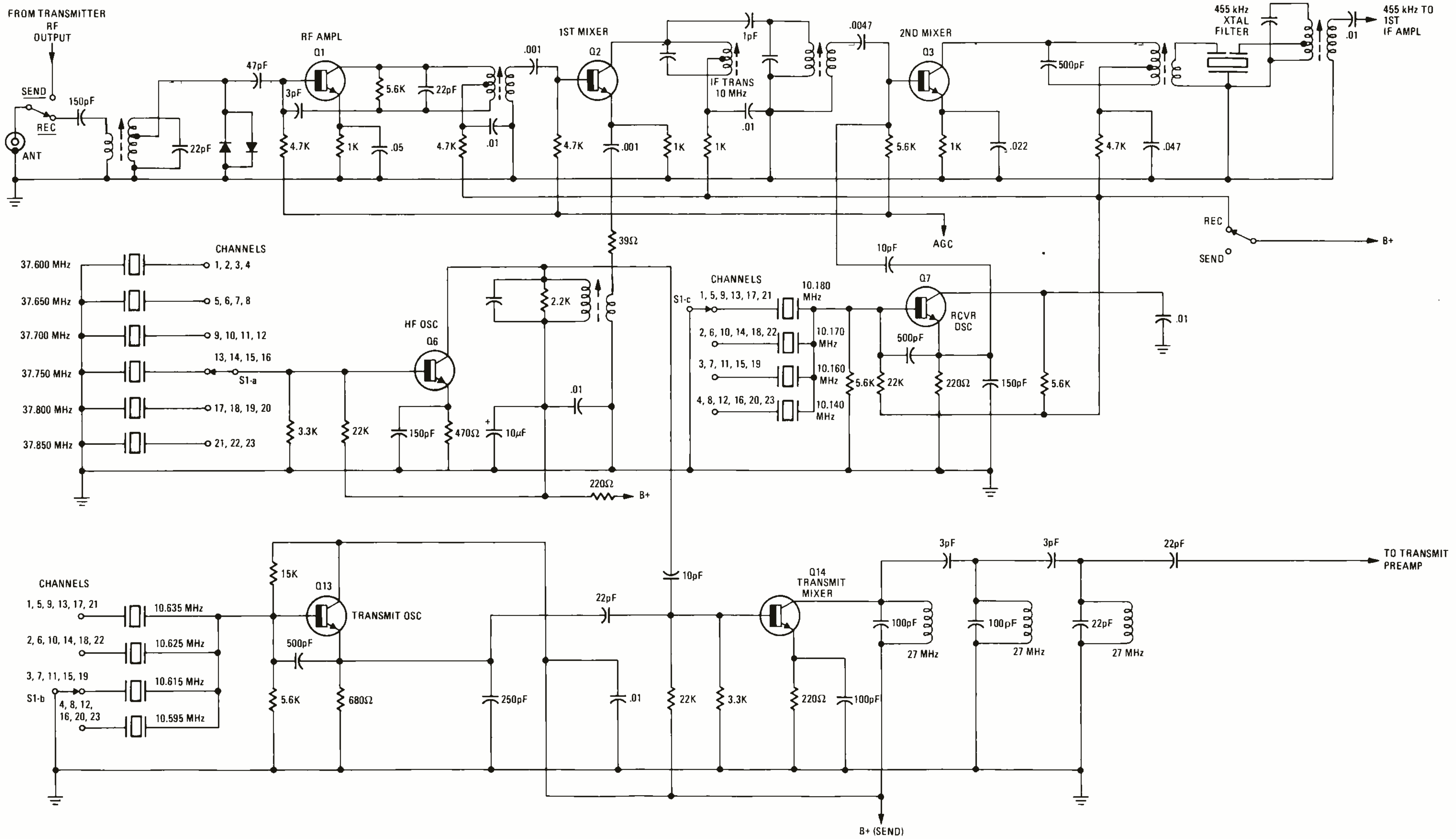


FIG. 1—FREQUENCY SYNTHESIZER and pertinent receiver and transmitter circuits in the KRIS *model XL-23* CB transceiver.

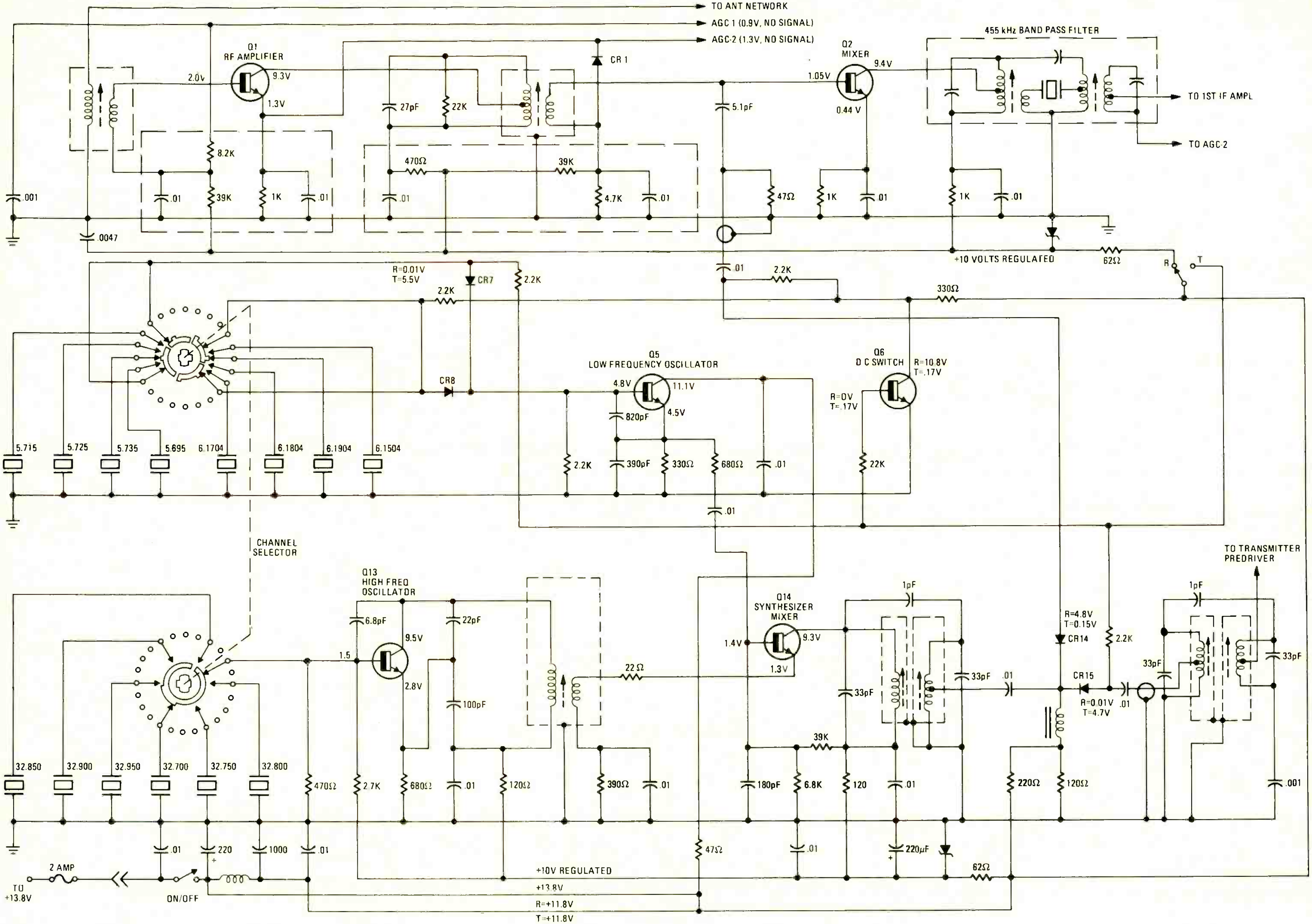


FIG. 2—FREQUENCY SYNTHESIZER consists of a high-frequency oscillator with a bank of six crystals and a low-frequency oscillator with two banks of four crystals each in the E. F. Johnson *models Messenger 122 and 123-A*.

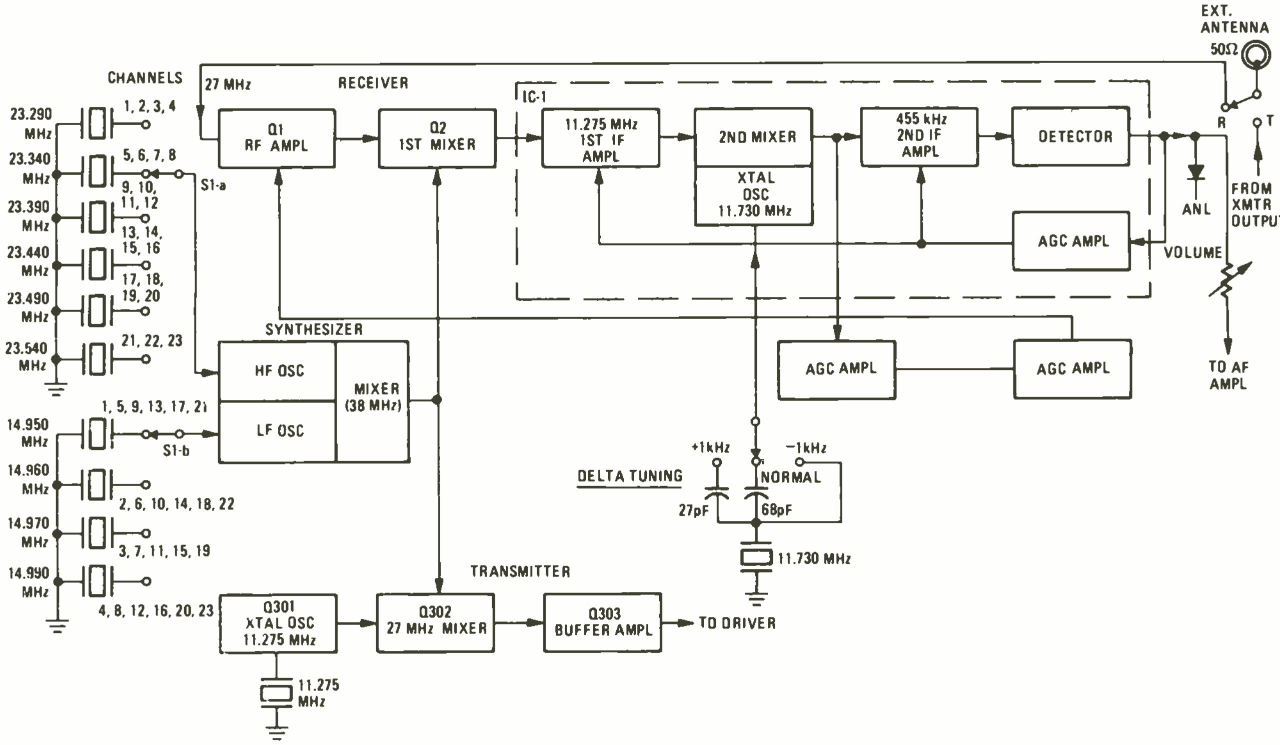


FIG. 3—RECEIVER AND TRANSMITTER RF circuits of the Sharp *model CB-800 CB* transceiver.

pertinent circuitry used in the *Messenger 122, 123-A* and similar models. The frequency synthesizer consists of a high-frequency oscillator with a bank of six crystals and a low-frequency oscillator with two banks of four crystals each.

E. F. JOHNSON *Messenger 123-A*.

Diodes CR7 and CR8 form a solid-state single-pole double-throw switch. When the transceiver is in the receive mode, CR7 is blocked and CR8 is forward-biased so the selected 6-MHz crystal is connected to the low-frequency oscillator. When transmitting, CR8 is blocked and CR7 is forward-biased to connect the selected 5-MHz crystal to the low-frequency oscillator.

Let's again use Channel 19 as our example to see how this synthesizer works. The high-frequency oscillator operates at 32.900 MHz. The low-frequency oscillator operates at 6.1704 MHz when receiving and 5.715 MHz when transmitting. The high- and low-frequency oscillator signals are fed to the emitter and base, respectively, of the synthesizer mixer.

The bandpass circuit in the mixer output selects the *difference* frequencies in the range of 25.510 MHz (455 kHz below the Channel 1 frequency) to 27.255 MHz (the output frequency of Channel 23). The output of the bandpass network goes to a second solid-state switch consisting of CR14 and CR15. (CR14 feeds the synthesizer mixer output to the receiver mixer in the receive mode while CR15 conducts to pass the synthesizer output to the transmitter RF amplifier circuits when in the transmit mode.)

When the transceiver is in the transmit mode, the synthesizer mixer's 27.185-MHz output (32.900 − 5.715 = 27.185) is fed through forward-biased CR15 to a second bandpass network to the input to the transmitter pre-driver. This signal cannot feed into the receiver's mixer because it is blocked by back-biased CR14.

In the receive mode, the 26.7296-MHz synthesizer output (32.900 − 6.1704 = 26.7296) goes through forward-biased diode CR14 to the receiver mixer. In this stage, the difference frequency generated by mixing the incoming 27.185-MHz signal and the synthesizer output is 455.4 kHz. This signal goes through a crystal filter to the 455-kHz IF amplifier circuits.

The Sharp variation

The Sharp *model CB-800* uses frequency synthesis and includes an LED digital channel indicator and other interesting circuit innovations that we hope to take a look at in another article. Now, let's look at Fig. 3—a functional block diagram of the receiver and transmitter RF circuits.

The output of the synthesizer in this circuit is 11.275 MHz *above* the channel frequency and is used as the injection frequency for the first mixer in the receiver. The resulting difference frequency (11.275 MHz) is used as the first IF in the dual-conversion superhet. A second mixer and 11.730-MHz crystal oscillator develop the 455-kHz second IF signal.

SHARP *model CB-800*

CB CHANNEL NUMBERS AND FREQUENCIES

Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	26.965	13	27.115
2	26.975	14	27.125
3	26.985	15	27.135
4	27.005	16	27.155
5	27.015	17	27.165
6	27.025	18	27.175
7	27.035	19	27.185
8	27.055	20	27.205
9	27.065	21	27.215
10	27.075	22	27.225
11	27.085	23	27.255
12	27,105		

When transmitting, the synthesizer mixer and a 11.275-MHz crystal oscillator feed signals into a 27-MHz mixer that generates difference frequencies on

continued on page 112

BUILD FOR YOUR CAR

Over-Speed Alarms

The versatile CD4001 IC is the heart of these practical over-speed alarm circuits that you can build and connect to any vehicle with a 6- or 12-volt electrical system

R. M. MARSTON

IN THE APRIL 1976 ISSUE, WE SAW HOW a single CD4001 COS/MOS digital IC can be used to make an inexpensive but highly efficient precision tachometer or RPM meter. In this concluding part of the story we show how additional CD4001's can be used to expand the basic tachometer circuit so that it also acts as a red-line or over-speed alarm system, which activates an audio/visual alarm when the engine or vehicle speed exceeds a preset limit. This alarm system can be fitted to any gasoline-powered vehicle having a 12-volt electrical system.

The red-line alarm

Fig. 1 is a block diagram of the red-line or over-speed alarm circuit, and Fig. 2 shows its relevant waveforms at low and high engine speeds. The circuit comprises three main sections. These are the red-line or over-speed detector, an alarm-pulse conditioner, and an alarm-condition response unit.

The input signal to the unit is taken from the vehicles ignition breaker points. This signal is passed through an input conditioner circuit, and is then used to trigger monostable multivibrator 'A', so that a pulse of fixed amplitude and duration is generated each time the points open. This monostable has two outputs, one normally-high and the other normally-low (see Fig. 2). The normally-high output feeds a 1-mA moving-coil meter or RPM indicator, in the same way as the tachometer circuit described last month, and is also used to trigger monostable multivibrator 'B': The normally-low output of monostable 'A' is fed to one of the two inputs of a diode AND gate. Monostable multivibrator 'B' has a single normally-low output, which is fed to the remaining input of the diode AND gate.

The action of the monostable multivibrators is such that the normally-low output of monostable 'A' triggers high for a pre-set period at the moment that the points first open, and the normally-low output of monostable 'B' triggers high for a pre-set period at the moment that the 'A' monostable pulse terminates. The output of the AND gate is normally low, and goes high only if both of its inputs are high at the same moment.

Suppose, then, that the engine speed is "low", or below the red-line level. Under this condition the repetitive periods of the circuit's input trigger pulses (derived from the vehicle's breaker points) are long relative to the sum of the two monostable pulse periods, so one or other of the inputs to the AND gate are low at all times, and the gate gives zero output. The alarm is inoperative under this condition.

Suppose, on the other hand, that the engine speed is "high", or slightly above the red-line level, and that under this condition the repetition periods of the input trigger pulses equal 9.9 ms, and each monostable generates a pulse with a duration of 5 ms, thus giving a total pulse period of 10 ms.

Under this condition the 'A' monostable fires as soon as a trigger pulse is generated by the breaker points: 5 ms later the 'A' monostable pulse

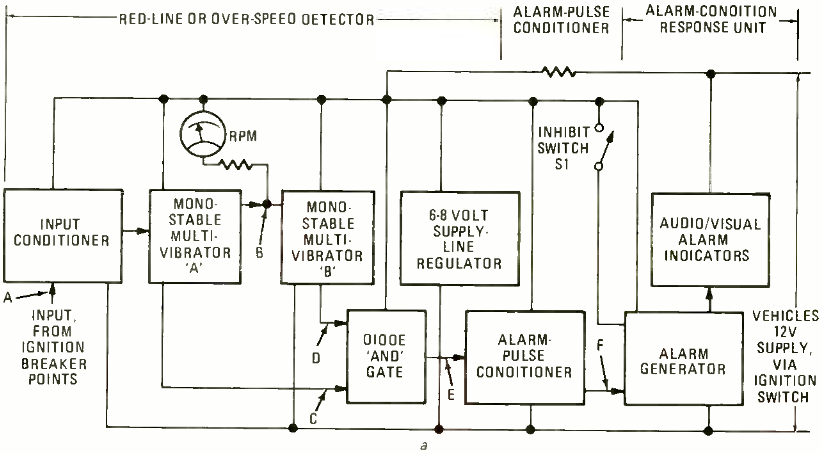


FIG. 1—RED-LINE or over-speed alarm system.

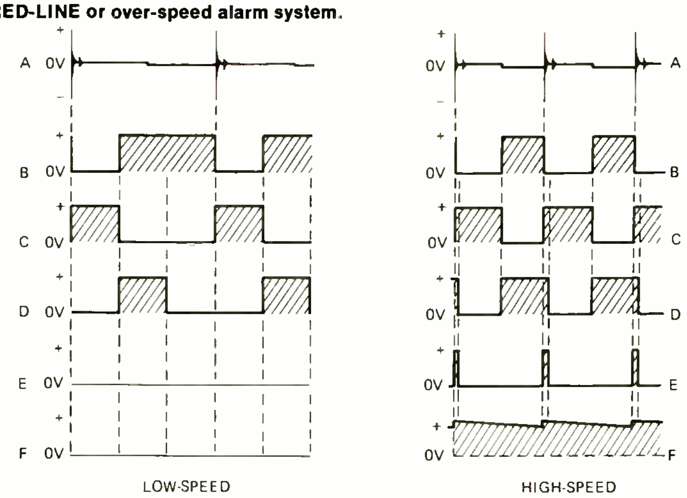


FIG. 2—WAVEFORMS of the circuit. A—Waveform of action at the breaker points. B—Intervals between triggering pulses. C—High outputs of monostable 'A'. D—High outputs of monostable 'B'. E—The pulses due to overlapping of 'A' and 'B'.

terminates, and the 'B' monostable triggers on: 4.9 ms later the 'A' monostable is again turned on by the input signal, and 0.1 ms later the 'B' monostable pulse terminates at the completion of its 5 ms period. Thus, a period of 0.1 ms occurs during each 9.9 ms switching cycle in which both inputs to the AND gate are high at the same time, so a 0.1 ms "alarm-condition" pulse is generated at point E of the circuit. This alarm-condition pulse is fed to a simple peak-reading "conditioner" circuit, and is then used to activate an audio/visual alarm-condition indicator.

Thus, the alarm can be made to activate at any pre-set engine speed by simply adjusting the total period of the two monostable pulses so that they are fractionally greater than the period of the signal derived from the breaker points at the desired RPM value. In practice, the alarm system is very accurate and sensitive, and will reliably respond to changes in engine speed of less than 0.5%.

If required, the basic circuit can be used as a vehicle over-speed alarm, which activates when the vehicle speed exceeds a pre-set limit. This operation is possible (on vehicles with manual-change gear boxes) because of the fixed ratio between engine and road speeds, so RPM is directly proportional to vehicle speed under normal driving conditions. Vehicles usually exceed regulation speed limits only when they are in top (high) gear, so the circuit can be fitted with an inhibit switch, which is open in top gear only, and the alarm can then be preset to activate at a RPM value corresponding to the desired road speed in top gear. A multi-position switch can be fitted to the circuit, if desired, so that a number of pre-set over-speed alarm settings are available.

A practical over-speed alarm

The practical circuit of a complete red-line or over-speed alarm is shown in Fig. 3-a. Here, the input signal is picked up from the vehicle's breaker points via R1, and is shaped into a neat trigger pulse by Q1 and its associated circuitry. The resultant pulse is used to trigger the IC1 'A' monostable via R6, and the monostable pulse is fed to a 1-mA moving-coil RPM meter via R8. Up to this point the circuit is identical to the tachometer circuit described last month, except that R8 is increased to 5.6K.

The output of the 'A' monostable, taken from pin 11 of IC1, is used to fire monostable 'B', which is designed around IC2. Part of the output of monostable 'A' is also fed to the D5-D6-R10 diode AND gate via a spare inverter-connected gate of IC1, and the output of the 'B' monostable is taken to the AND gate via a non-inverting pulse amplifier stage made up from two spare gates of IC2.

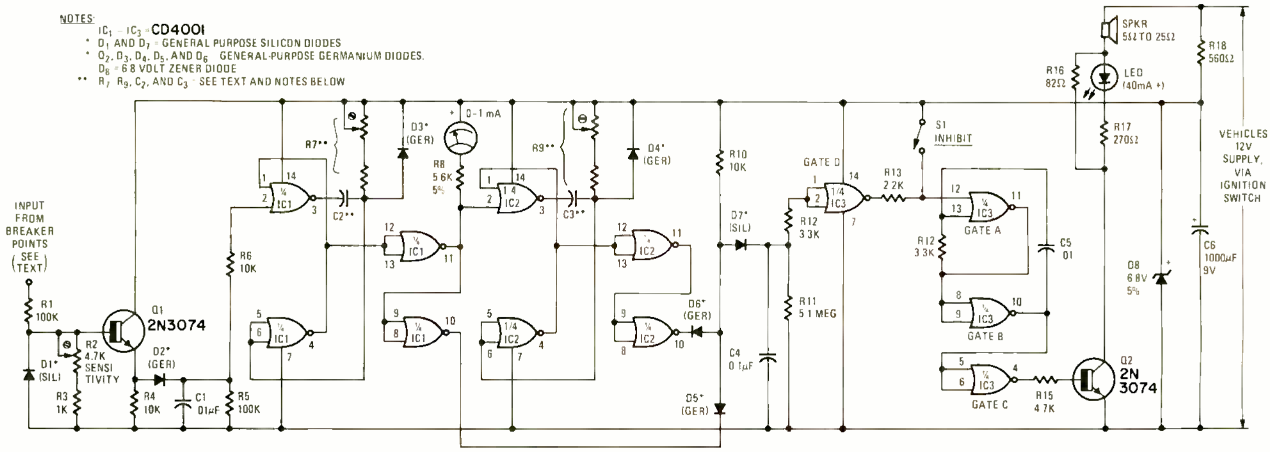
The output of the AND gate is fed to a simple peak-detecting "alarm-pulse conditioner" circuit comprising D7-C4-R11 and R12, and the output of the conditioner is fed to an alarm-condition response unit which gives an audio/visual alarm output and is designed around IC3 and Q2. The response unit operates as follows:

Gates A and B of IC3 are wired as a gated 1.5-kHz astable multivibrator or square-wave generator, and the output of the astable is taken to the base of Q2 via gate-C of IC3. Q2 uses a speaker, an LED, and current-limiting resistors R16 and R17 as its collector load. The action of the astable is such that it is disabled when pin 12 of IC3 is high, and is operative when pin 12 is low. The input to pin 12 is taken from the output of the alarm-pulse conditioner circuit via inverter-connected gate-D of IC3. Consequently, the astable can be enabled by a "high" output from the conditioner network, but can be disabled by a "low" output from the conditioner or by the closure of INHIBIT switch S1.

Thus, at low engine speeds the output of the conditioner is low, so the alarm-condition response circuit is disabled and Q2 is cut off. At high engine speeds, on the other hand, the output of the conditioner is high, and pin 3 of IC3 is driven to zero volts: If INHIBIT switch S1 is closed under this condition, the response unit remains disabled, but if S1 is open the response unit is enabled and Q2 pulses on and off at 1.5 kHz, so the LED illuminates and a 1.5-kHz tone is generated in the speaker: An audio/visual alarm output is thus given under this condition.

Note that the supply lines to the major parts of the Fig. 3-a circuit are stabilized at 6.8 volts via R18, D8 and C6, and that the circuit can be used on any vehicles fitted with 12-volt positive- or negative-ground electrical systems.

Also note that the Fig. 3-a circuit is shown as having only a single "alarm condition" setting, as would be the case in RPM red-line applications. If required, a multi-position RANGE switch can be fitted to the cir-



NOTES:

$R7 \geq \frac{125{,}000{,}000}{f}$, WHERE f = f.s.d (FULL SCALE DEFLECTION) FREQUENCY OF TACHOMETER (SEE FIG 8)

$R9 \geq \frac{150{,}000{,}000}{f_{trig}} - R7$, WHERE f_{trig} = TRIGGER FREQUENCY OF ALARM (SEE FIG 8)

WHERE C2 AND C3 = .01µF

EXAMPLE:

f.s.d. = 8000 RPM ON 4 CYLINDER 4-CYCLE ENGINE, f = 267Hz AND
R7 = 470K WHEN C2 = .01µF

TO TRIGGER AT 7000 RPM, f_{trig} = 232 Hz, R9 = 646K − 470K = 176K
TO TRIGGER AT 6000 RPM, f_{trig} = 200 Hz, R9 = 750K − 470K = 280K
TO TRIGGER AT 4000 RPM, f_{trig} = 133 Hz, $\left(= \frac{8000\ RPM}{2}\right)$, R9 = 1120K − 470K = 650K

WHEN C3 = .01µF

NOTE: ACTUAL R7 & R9 VALUES CAN BE REDUCED BY A FACTOR OF TEN BY INCREASING C2 & C3 to 0.1µF.

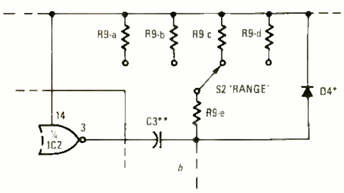


FIG. 3—COMPLETE TACHOMETER and over-speed circuit is shown in a. Modification for multirange indication is shown in b.

cuit, as shown in Fig. 3-b, so that the alarm can be made to activate at a number of pre-set RPM values which correspond to top-gear road speeds, as in the case of vehicle over-speed applications: In this case INHIBIT switch S1 can take the form of a microswitch that is automatically opened in top gear only.

If desired, the moving-coil RPM indicator of the Fig. 3-a circuit can be replaced by a short-circuit, so that the design is used simply as a red-line or over-speed alarm, without the tachometer facility.

A "slave" alarm output stage

A simple extra facility that can be added to the basic Fig. 3-a circuit is a slave alarm output, which operates a 12-volt lamp or relay when the main alarm activates. The circuit of this device is shown in Fig. 4.

TACHOMETER AND OVER-SPEED ALARM CIRCUITS (2).

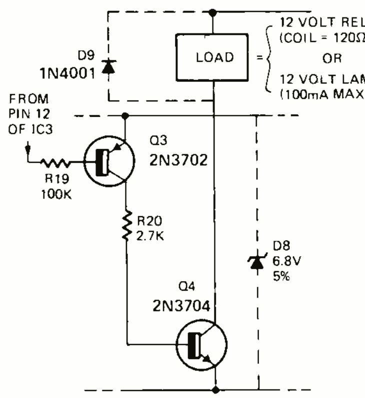


FIG. 4—OPTIONAL SLAVE ALARM.

Here, the relay or lamp is used as the collector load of Q4, which has its base current derived from the collector of Q3. The base current of Q3 is derived from the pin-12 signal of IC3 via R19. Normally, pin 12 of IC3 is at the full 6.8-volt positive potential of the circuit, so Q3-Q4 and the load are all cut off. Under the "alarm" condition, on the other hand, pin 12 of IC2 is effectively shorted to the low bus of the circuit, so Q3-Q4 and the load are driven fully on.

The load of the Fig. 4 circuit can be a 12-volt lamp, with a maximum current rating of 100 mA, or 12-volt relay, with a minimum coil resistance of 120 ohms: If a relay load is used, suppression diode D9 should be wired across its coil as shown dotted in the diagram.

Construction notes

The final setting up of the red-line or over-speed alarm circuit is slightly involved, since the final values of R7 and R9, and possibly C2 and C3, have to be chosen to suit the specific vehicle and application in which the system is used. The actual construction, however, should present few problems, since the physical layout of the design is in no way critical, and the circuit should initially be built up complete except for the four components mentioned above.

When building the circuit, note that the speaker can have any impedance in the range 5 to 25 ohms, and that the LED can be any type with a peak current rating of 40 mA or greater.

When the unit is completed, except for R7, R9, C2 and C3, it can be given a simple functional check by connecting it to a 12-volt supply and checking that 6.8 volts is developed across C6. Then briefly short together pins 1 and 14 of IC3 and check that an audio/visual alarm output is available. When these checks are complete, the values of R7 and R9, each of which are made up of a fixed and a variable resistor in series, and also the values of C2 and C3, can be determined:

To find the R7 and C2 values: If the alarm circuit is to be provided with the tachometer facility, first decide what full-scale RPM reading is required on the meter: If the circuit is not to have a tachometer, decide or guess the highest RPM figure that is likely to be available from your own particular vehicle. Now look at the graph of Fig. 5 and find the frequency that corresponds to that value. Thus, a frequency of 267 Hz corresponds to 8,000 RPM on a 4-cylinder 4-cycle engine. Given this frequency, f, calculate the value of R7 (in ohms) on the basis of:

$$R7 = \frac{125{,}000{,}000}{f}$$

when C2 = .01 μF.

In the example given above, where f = 267 Hz, this gives R7 a value of 470 K, when C2 has a value of .01 μF. Note that, if preferred, the value of C2 can be raised to 0.1 μF. The R7 value can then be reduced by a factor of ten, to 47 K.

Once the R7 and C2 values have been determined, C2 can be wired permanently into the circuit, and R7 can be made up from a fixed and a variable resistor in series and fixed into the circuit on a temporary basis: Note that the R7 value given above is approximate only, and represents the value with the variable resistor at its mid-setting. When R7 is in place, its precise setting, and the calibration of the tachometer, can be determined as follows:

First, wire a 1-mA moving-coil meter into the tachometer position, on either a temporary or permanent basis, and connect the circuit to a 12-volt supply. Now apply a square wave or pulse of the calculated frequency, f, with an amplitude of roughly 6.8 volts, across the R2-R3 combination via a 1K limiting resistor, after first setting R2 to its maximum value. Now adjust

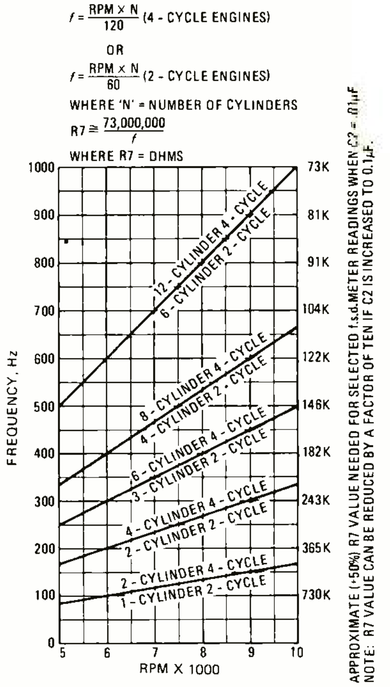


FIG. 5—RELATIONSHIP between frequency, RPM and the value of R7 needed to provide full-scale readings for different types of engines. The value of C2 is .01 μF.

the variable part of R7 so that a reading of precisely full scale is obtained on the meter: If necessary, modify the value of the fixed part of R7 so that a full-scale reading can be obtained at the specified frequency. Once the setting of R7 has been finalized, wire it permanently into place in the circuit, and make a note of its effective value *when used with an .01-μF value of C2*. The calibration of R7 and the tachometer is then complete, and the values of R9 and C3 can next be determined.

To find the R9 and C3 values: At this stage the tachometer section of the alarm system should be given a quick functional check in the actual vehicle. Simply connect the unit's supply leads to the vehicle's battery via the ignition switch, and connect its input terminal to the breaker points on vehicles fitted with conventional ignition, or to the high-voltage output point of the C-D unit on vehicles fitted with capacitor-discharge ignition. Next, start the engine, and adjust R2 to slightly above the minimum value at which stable RPM readings can be obtained on the tachometer.

If the alarm system is to be used simply as an RPM red-line alarm, it will suffice at this stage to merely check that the tachometer is functional. If, on the other hand, the system is to be used as a vehicle over-speed alarm, the vehicle should be driven at this stage and a careful note made of the RPM readings that correspond to the desired top-gear "alarm" road speeds. When these checks are

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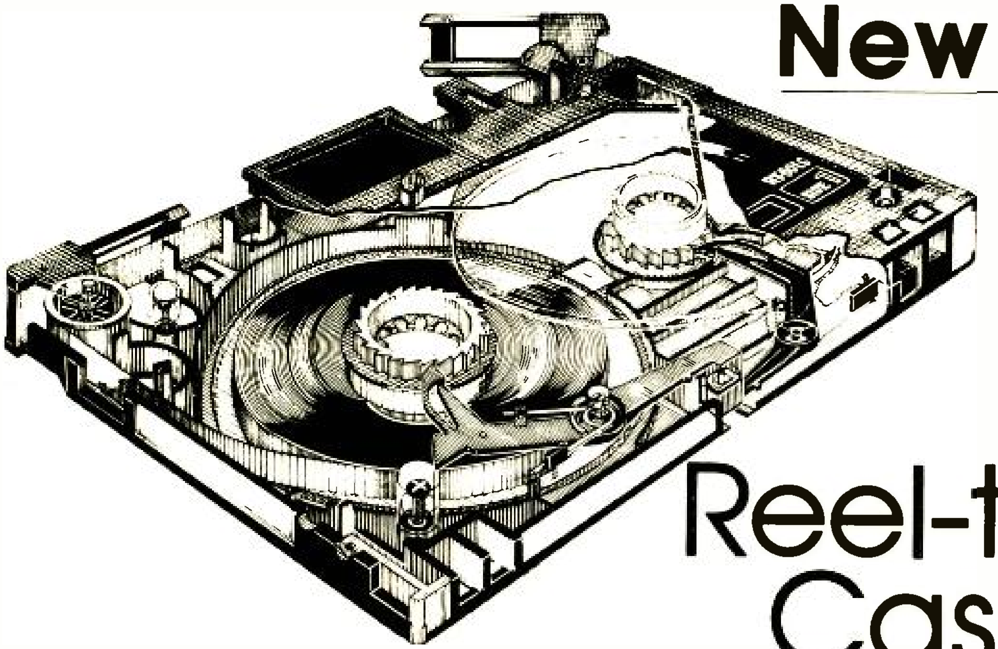


New For HI-FI

Reel-to-Reel Cassette

At first glance it looks like an overgrown cassette, and it is! This new tape format has the same advantages and performance as the reel-to-reel format with the handling ease of a cassette

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

ON APRIL 21, 1976, THREE WELL KNOWN Japanese electronic firms announced jointly that they had developed and formulated standards for a new tape system called Elcaset. The three companies behind the project are Matsushita Electric (better known in the U.S. for its Panasonic and Technics by Panasonic products), TEAC Corporation, and Sony Corporation. Those of us who read that first trade announcement were somewhat puzzled. We wondered if some sort of masochism had infected these three giant companies. After all, the standard cassette tape (developed in the 1960's by Philips Company) had been very good to these very same companies. All of them produce a variety of stereo cassette decks in all price categories and the stereo cassette itself had reached new levels of performance, both in software (better tape formulations) and in hardware (better tape transport mechanisms, more precisely manufactured tape heads, etc.) Dolby noise-reduction systems, now almost universally incorporated in high-fidelity stereo cassette decks, had tamed the residual tape hiss level of cassettes down to acceptably low levels and all seemed right with the world. Why, then, would three companies such as these introduce yet a fourth tape format beyond presently available 8-track cartridges, standard cassettes and open-reel?

A brief quotation from an announcement distributed by Sony Corporation may shed some light on the motives of the three firms involved. "In the field of tape recorders, for example, the cassette tape recorder that was originally developed by Philips for general use has become immensely popular for recording hi-fi, as a result of its operational simplicity, convenience, and great technical improvement. However, there are still quite a number of people who are dissatisfied with the cassette tape recorder and find that open-reel tape recorders are more advantageous than the cassette for their purposes."

"Against such a background, the appearance of a new system that has the advantageous characteristics of both open-reel and cassette has long been awaited. The Elcaset was developed to meet this requirement".

Limitations of cassettes

Before examining the new Elcaset, let's examine one of the limitations of existing standard cassettes. Certainly, thanks to the technical improvements mentioned in the announcement, cassettes used in well designed machines are capable of delivering good frequency response way out to 20,000 Hz. The slow speed (1⅞ IPS) of standard cassettes requires, however, that a great deal of high-frequency equalization be incorporated in the electronics of the cassette deck. Thus, while it is possible to get 20,000-Hz signals from a cassette recorded on a top-grade machine, if the recording level is kept low (at around −20 dB or so), attempts to record high-frequencies at higher recording levels causes tape saturation and treble roll-off is experienced. The frequency sweeps shown in the scope photo of Fig. 1 illustrate this effect dramatically. The

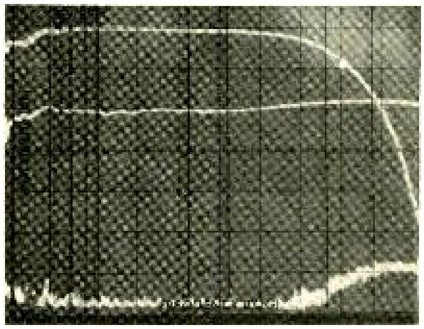


FIG. 1—FREQUENCY RESPONSE of a standard cassette. Upper-trace recorded at 0-dB, middle-trace recorded at −20 dB. Lower-trace is residual tape noise.

upper trace was recorded at 0-dB level, while the lower trace was recorded at a level of −20 dB. In effect, the dimensions of the tape and its low-speed limit the useful dynamic range. The lower ragged trace represents the residual tape noise, and the distance between it and the upper trace is a direct measure of

FIG. 2—ELCASET shown next to standard cassette.

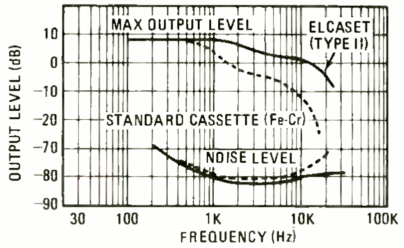


FIG. 4—FREQUENCY RESPONSE and noise level of the new Elcaset vs. the standard cassette.

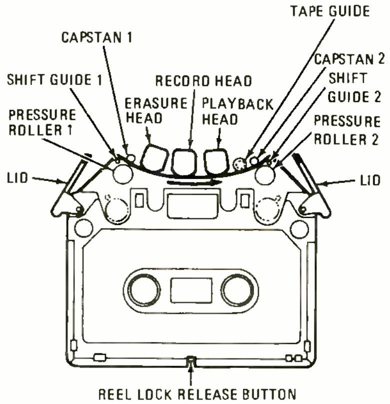
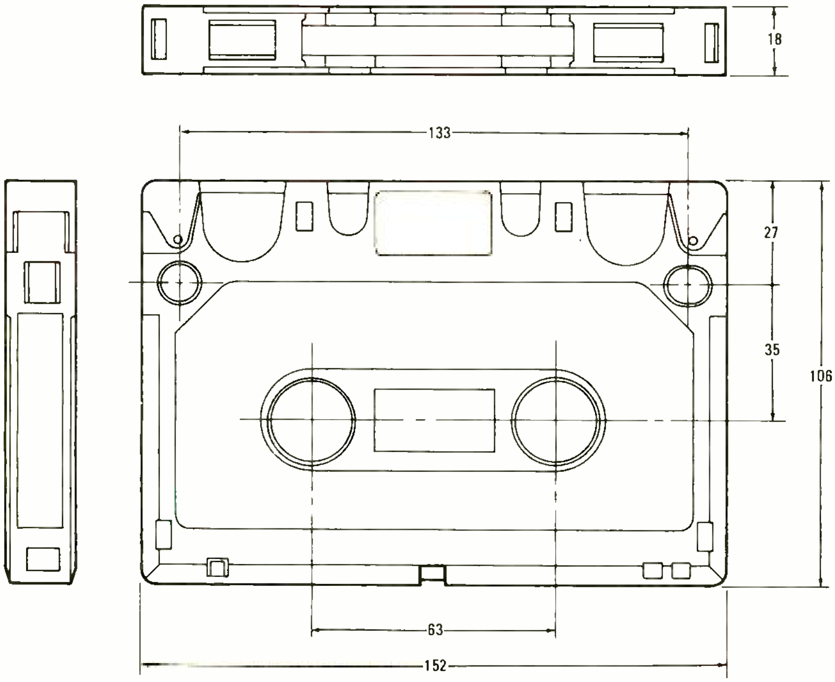


FIG. 5—TRANSPORT MECHANISM opens protective lids and pulls the tape out of the Elcaset housing.



NOTE: ALL DIMENSIONS IN MILLIMETERS

FIG. 3—DIMENSIONS of the new Elcaset.

usable dynamic range with this particular cassette. At 10 kHz it is only 40 dB. (Each vertical division equals 10 dB in the scope photo.)

Elcaset

Now consider the new Elcaset, shown alongside a standard cassette in Fig. 2 for comparison purposes. Its actual dimensions are shown (in millimeters) in Fig. 3 and in more familiar inches work out to be just under 6 inches by 4.17 inches by 0.71 inches thick. The standard tape-speed of the Elcaset is 3¾ inches per second, twice the standard cassette speed. Tape width is one-quarter inch, the same width used in open-reel tape decks. While we have not conducted lab tests on any Elcasets as yet (machines that can handle them are just coming off production lines now), the sponsoring companies have published a dynamic-range comparison graph that is shown in Fig. 4 and is similar in presentation to our scope photo of Fig. 1. Notice that the dynamic range available at 10 kHz claimed for the Elcaset is nearly 15-dB better than that for a ferri-chrome cassette.

Another important feature of the new Elcaset system is that it employs an external tape guide method that pulls the tape out of the housing and transports it across the tape heads, as shown in Fig. 5. In the case of ordinary cassettes, the record or playback head as well as the erase head push against the tape within the cassette shell so that precision of tape speed depends upon the precision of the cassette shell. In addition, the size, location and number of heads used in a cassette recorder are restricted by the limitations of the cassette into which the heads must be positioned. Only recently were a few ingenious manufacturers able to develop "three headed" cassette decks that permit the same kind of tape monitoring that is possible with open-reel decks. Since the Elcaset system employs an external tape-guide method, stable tape operation is possible and independent of the precision of the Elcaset housing. Furthermore, units with multiple heads can be more easily designed since there is virtually no restriction in the number and physical location of the heads.

Track arrangement

The track arrangement of the Elcaset is similar to that of the standard cassette, in that the tape is divided into upper and lower halves. As shown in Fig. 6, compatibility between mono and stereo players and recorders is maintained just as it is in the case of standard cassettes. That is, a mono machine will "play" both stereo tracks of an Elcaset that might have been recorded on a stereo deck, while a stereo deck will play

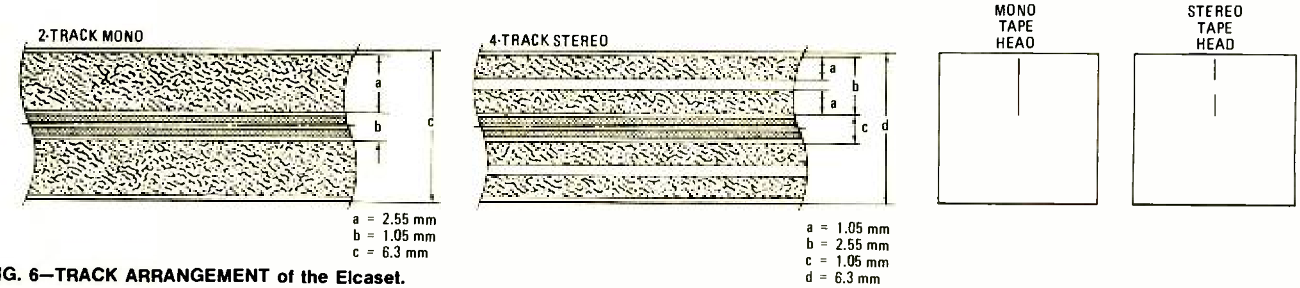


FIG. 6—TRACK ARRANGEMENT of the Elcaset.

back mono recorded programs over both channels. The standard track width assigned to the four audio tracks (two stereo pairs) is 1.05 millimeters, compared with 0.6 millimeters on the standard cassette. This provides greater area of magnetization and accounts, in part, for the greater dynamic-range capability of the new format. The guard-band between channels is 0.5 mm compared with 0.3 mm for the ordinary cassette which should improve or reduce cross-talk between channels, all other things being equal.

New control tracks

In addition to the four normal audio

FIG. 7—CONTROL TRACKS may be used for automatic selection, synchronization or other purposes.

tracks, space has been assigned near the center of the width of Elcaset tape for a pair of narrow control tracks, one for each playing "side" of the tape. The dimensions of these special control tracks are shown in Fig. 7. According to the Elcaset's developers, a system for the automatic selection of recorded musical selections is being established as one possible use of these control tracks. Other uses suggest themselves, such as synchronizing signals for slide shows, signals that might even permit lip-synchronization with movie film and more. These control tracks will undoubtedly play an important part in future applications of the Elcaset system, especially if digital technology is coupled to the system.

TABLE I—Comparison chart.

	Compact Cassette	Elcaset	Open-Reel
Size	102 x 64 x 12mm (approx. 4" x $2\frac{1}{2}$" x $\frac{1}{2}$")	152 x 106 x 18mm (approx. 6" x $4\frac{1}{8}$" x $\frac{3}{4}$")	7" (5", 10") diameter
Tape Speed	$1\frac{7}{8}$ IPS (4.8cm/s)	$3\frac{3}{4}$ IPS (9.5cm/s)	$3\frac{3}{4}$, $7\frac{1}{2}$ or 15 IPS (9.5, 19 or 38cm/s)
Tape Width Thickness	$\frac{5}{32}$" (3.81mm) 0.5 mils (0.012mm) with C-90 tape	$\frac{1}{4}$" (6.3mm) 0.5 mils (0.013mm) with LC-90 tape	$\frac{1}{4}$" (6.3mm) 1.5 mils (0.038mm) with long playing tape
Accidental Erasure Prevention	Yes (permanent)	Yes (defeatable)	None
Automatic Detection	CrO_2 Tape only	3 Types of Tape + Dolby NR	None
Automatic Program Selection	Starting Point only	Any Particular Program	Starting Point only (some decks)
Mono/Stereo Compatibility	Yes	Yes	No
Adaptability to Multi-Head Configuration	Possible	Easily Possible	Easily Possible
Tape Threading	Unnecessary	Unnecessary	Necessary

Types of Elcaset tapes

Three types of Elcaset tapes are envisioned for the new system. These are designated as Type I, Type II and Type III. Type I tape is low-noise high-output ferric oxide tape. Type II is equivalent to Ferrichrome tape while Type III will be equivalent to chromium dioxide tape.

The larger shell size of the Elcaset permits the incorporation of three types of detector notches or cavities within the shell mold itself. The first of these is a detector for the prevention of accidental tape erasure. This erasure protection scheme is a separate slide-device for side A and side B of the Elcaset that can be opened or closed easily, unlike the tabs on ordinary cassettes that cannot be restored once they are broken off.

A second detector notch in the shell was provided in anticipation of future machines that will automatically detect Types I, II and III tapes and adjust equalization and/or bias to suit the tape used.

The third detector is applicable to Dolby noise-reduction systems (or equivalent noise-reduction systems). This detection system consists of a tab located at the front of the Elcaset that, when removed, automatically indicates that noise reduction is being used. The absence of this tab could provide the necessary "instructions" to a future machine to switch in the Dolby circuitry.

Tape protection

As we mentioned earlier, when the tape is in use it is automatically pulled out of the Elcaset shell, but to prevent tape from spilling or popping out, a lid is attached to protect it. The lids are shown in their open position in Fig. 5 and in their closed positions in the photo of Fig. 2. In addition, to prevent tape slack from developing during transport of Elcasets, a reel lock makes contact with the tape reels themselves (see Fig. 5). Both the lids and reel locks are arranged to enable correct release action when the Elcaset is inserted into an Elcaset tape deck.

Just in case you are curious (as we were) regarding the derivation of the term Elcaset, we are told that it is a composite word derived from "L-Cassette", where "L" stands for "Large". Rather a straightforward derivation, but then again, the Elcaset seems to be a very straightforward and well thought out system from all early indications.

Elcaset's future

In attempting to predict just what role the new Elcaset tape format will play in the coming years as far as high-fidelity applications are concerned, several questions immediately arise. As of this writing, Elcasets (in LC-60 and LC-90

continued on page 113

AM STEREO
its time has come

Two systems are being presently proposed for the broadcast of compatible AM-stereo signals. One system—the Kahn system—has had extensive field testing for the last three years.

HARRY MAYNARD

BEFORE STEREO, MONOPHONIC FM RADIO limped along for years in genteel poverty with a small audience, largely of hi-fi connoisseurs and lovers of classical music. Early sales of stereo recordings and equipment were modest too, until stereo FM radio became the listening booth for the stereo–LP recording, booming the sales of stereo recordings and stereo reproducing equipment. Today, in the top fifty U.S. markets, you'll find many a stereo FM station among the top five—sometimes with an FM staton leading the pack.

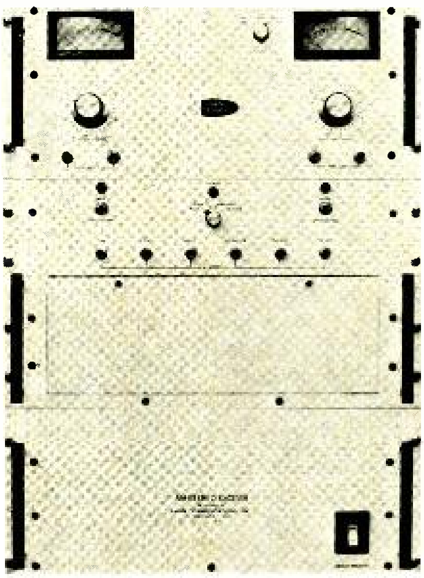
Daniel Yankelovich, one of America's high priests of market research, reported a few years ago that among the 15 to 30-year-olds, an expensive stereo hi-fi receiver with stereo earphones and stereo tape recorder had actually surpassed the automobile (our largest industry) as a status symbol. The youth of America have made stereo FM radio their listening medium.

AM broadcasters who have watched the steady erosion of much of their musical listening audiences, have switched their formats to talk, sports, dialogue radio, news, and all-news to hold audiences. Only in automobile listening has AM radio held its own. Here, the difficulty of receiving excellent stereo has held FM radio back. Drivetime is a crucial audience—it represents more than 35% of the total radio audience. Over 100 million car radios (mostly AM) are used in 62.47% of drivetime.

Belatedly, AM radio is now demanding equal sonic broadcasting rights—the right to broadcast in both stereo and quadriphonic sound. In the late '50's, when the National Committee for Stereophonic Broadcasting came up with an FCC-approved system for FM stereophonic broadcasting, the electronics and broadcasting industries showed so little interest in AM stereo or stereo TV that it asked the FCC to defer or drop for an indefinite period its inquiry into stereo sound for either.

Now the pressure for AM stereo among AM radio stations is so great that the FCC requested the Electronic Industries Association, in cooperation with the National Association of Broadcasters and the Institute of Electrical and Electronic Engineers Group on Broadcasting, to organize the National AM Stereophonic Radio Committee (NASRC) to study various AM radio stereophonic broadcast systems. The first meeting of the committee was held in Washington, DC, September 25, 1975. The committee announced: "Anyone interested in proposing an AM stereophonic broadcast or receiving system is encouraged to attend".

AM stereo is not a new idea. As early as 1925, an AM radio station, WPAJ in New Haven, made the first off-air AM stereo transmission using two separate AM transmitters broadcasting at different frequencies. Since then, many



AM-STEREO EXCITER developed by Kahn Communications, Inc., independently modulates both AM sidebands to broadcast the stereo information.

different stereo systems for generating AM stereo signals from a single transmitter have been proposed and demonstrated using independent sideband modulation, frequency modulation, phase modulation, and quadrature modulation. Westinghouse, G-E, RCA, EMI, AT&T, Philco, and CBS Labs were only a few of the companies that have proposed compatible AM stereo broadcast systems in the past.

In 1926, Potter received the first patent for an AM stereo system. It put a single carrier on two modulators, maintaining the original phase on one channel, shifting the phase 90° on the other, and combining the two linearly. The result is a waveform that varies in both phase and amplitude, a single modulated carrier with sum and difference modulations that contained all the sidebands within assigned limits. Unfortunately, a special AM stereo receiver is necessary for synchronous detection.

In 1959, RCA, over WNBC in New York City, demonstrated an AM-FM system for stereo reception using a 50-kW transmitter. Since then, RCA has, at NAB and other broadcast meetings, demonstrated their system with low-powered experimental transmissions. Figure 1 shows a block diagram of RCA's compatible AM stereo transmitter system, and Fig. 2 shows the compatible AM-FM AM stereo receiver.

Currently, to my knowledge, only two AM stereo systems are seriously being proposed—the RCA AM-FM system and the Kahn system. The recent request by the NASRC may bring forth other systems in the near future.

The Kahn system (see Fig. 3) has for the last 3 years had extensive field testing in Mexico, on XETRA, a 50-kW station in Tiajuana covering the Southern California area. Kahn Communications, in Freeport, N.Y. is widely known in the electronics industry for many developments in radio, telephone, and other fields. Currently, with FCC

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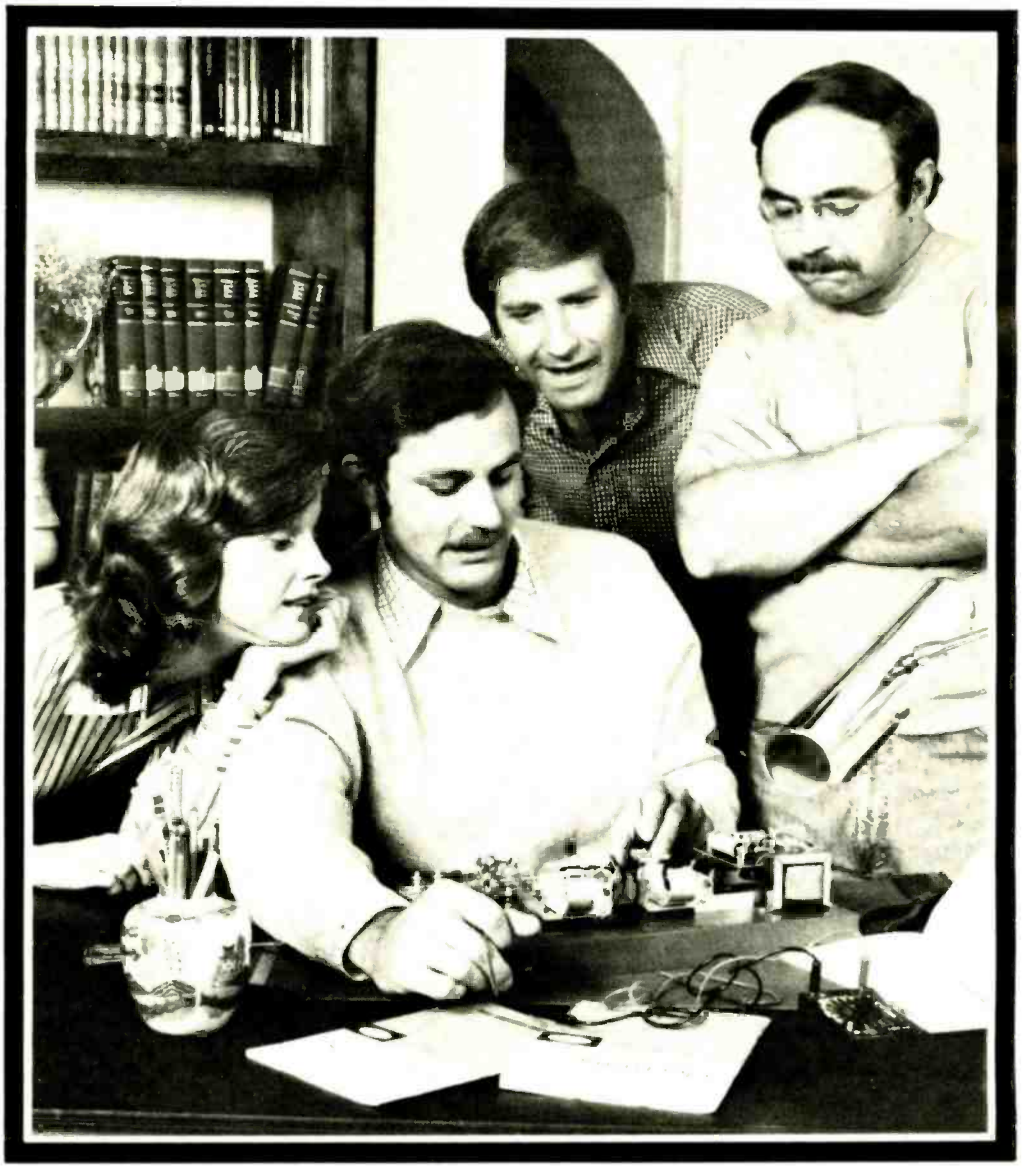

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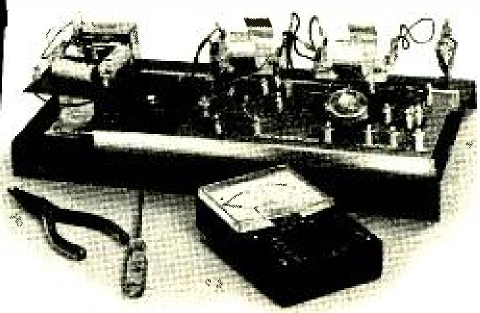

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approval, the Kahn system has been extensively tested on station WFBR, a leading station in Baltimore, Maryland, since late April 1975.

The Kahn system allows the AM broadcaster to transmit stereo programs over a conventional AM transmitter—using independent sideband signals with left-channel information on one of the AM sidebands and right-channel information on the other. Sum and difference signals are, before modulation, shifted 90° with respect to each other. Kahn is very careful to point out that his system is not the same as most conventional single-sideband systems, which introduce excessive envelope distortion when the sideband systems are not symmetrical. As Kahn, an expert in single sideband, puts it, "you cannot take a conventional sideband and use it for AM stereo without introducing considerable distortion".

In the Kahn system, the two sidebands are independently modulated by the two stereo channels. The resulting envelope has the same spectrum requirement and is theoretically free of distortion. In actual practice, the stereophonic transmitter adapter invented by Kahn, is claimed to not add more than 1 percent total harmonic distortion to any of the better AM transmitters built in the last 10 years. This statement is confirmed by Floyd Daisey, chief engineer of station WFBR in Baltimore, who says, "I'm not for any AM system per se, but I like the Kahn system because it's here now, and lives up every one of its claims that I have been able to measure. For example, if I switch from mono to stereophonic reception, it cannot be detected on any existing AM monophonic receiver. On a specially constructed AM stereo receiver I'm currently measuring over 27 dB of separation with no appreciable gain in distortion".

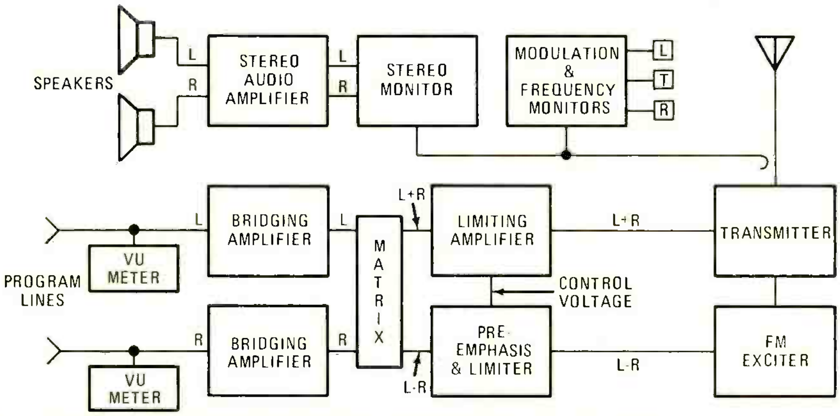


FIG. 1—COMPATIBLE STEREO BROADCAST TRANSMITTER FOR AM RADIO.

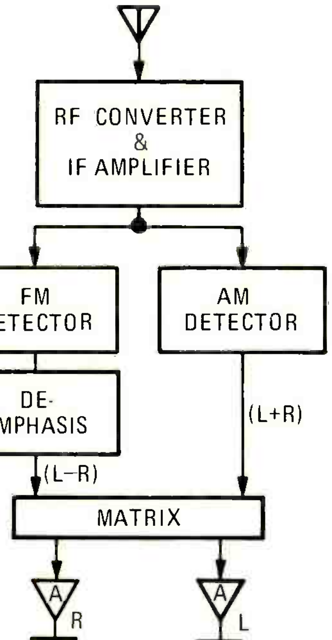


FIG. 2—RCA STEREO AM RECEIVER.

One of the great virtues of the Kahn system is that a modest separation (up to 9 dB) can be achieved using two modestly priced AM receivers and slightly detuning each AM receiver. Placed several feet apart, with the left receiver detuned slightly below the carrier frequency, the left channel can be received. With the right radio detuned slightly above the carrier frequency, the right channel can be received.

When I first heard about this ability of the Kahn system my first reaction was to dismiss it as a gimmick, but having heard the results, I was pleasantly surprised with the considerable improvement in sound over the conventional monophonic receiver. Leonard Feldman (and others) in conjunction with tests he has run in the field of quadriphonic experimentation has discovered that 7 dB or over is enough to achieve stereophonic reception.

Floyd Daisey reports that members of the FCC who have heard "two-receiver AM reception" have been equally impressed. The implication is that the millions of Americans who for one reason or another have not seen fit to listen in the stereophonic mode, could be persuaded to try stereo in this way. Perhaps eventually they would then move up to more sophisticated AM stereo single-receiver systems. There are over 400 million radios in the hands of U.S. consumers, the largest percentage of them equipped to receive AM signals. The average household in the U.S. has 5.5 sets. More than 74 percent of teenagers, 53 percent of adult women and 55 percent of adult men own battery-powered radios for their personal use. Radio penetration in U.S. homes has now reached a total of 98.6 percent.

Recently, I invited Leonard Kahn on my "Men of Hi-Fi" program [broadcast on WNYC-FM (93.9)] in the New York area), to discuss and demonstrate, *on FM stereo, AM stereo.* This was done by broadcasting four off-air recorded stereo tapes. The first tape was a recording of a broadcast from a quality AM stereo receiver tuned to a transmitter that was approximately ten miles away. The other three were off-air low-powered broadcasts, attempting to simulate actual broadcast conditions in every way, made in the Kahn Laboratories. One tape was made by using two small transistor table radios, another with small table radios of moderate quality, the final tape with a state-of-the-art AM tuner, the kind that any quality AM-FM radio manufacturer could make with relatively little added expense or extensive modification of his existing AM-FM stereo receiver. Many experts I've talked to suggest that a high-quality AM stereo IC could be produced for less than $2.00 after an AM stereo system is approved, since AM detection is so much cheaper.

How does AM stereo sound? Surprisingly good—particularly when com-

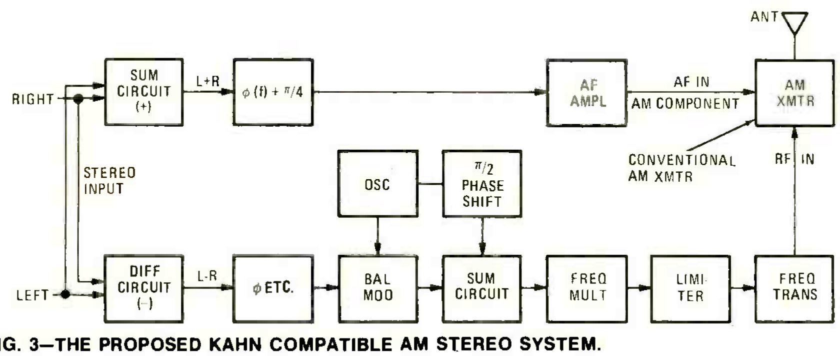


FIG. 3—THE PROPOSED KAHN COMPATIBLE AM STEREO SYSTEM.

pared to its AM monophonic counterpart. What has surprised even sophisticated listeners is how important the extra dimensionality of stereo is, even on two relatively inexpensive radios that would hardly qualify as hi-fi by today's standards. But even though millions have heard good sound on stereo FM radios and good hi-fi systems, there are also millions whose AM radios' monophonic sound is still the standard for their radio listening.

Stereo on AM radio confirms the considerable research that was done in the past in psychoacoustics. This research has demonstrated—and the history of FM's development confirms—that an improvement in dimensionality is more quickly appreciated by the general public than an improvement in bandwidth (sometimes called high fidelity).

Studies at CBS and later at Ohio State in 1945 by Roger Kirk, showed that the general public (then) voted against high fidelity 5 to 1. Other studies have confirmed (even among musicians) that appreciating a wideband, distortion-free response is, for most people, a learned response. Roger Kirk demonstrated that when members of the general public were exposed to three systems of musical frequency response: a relatively wide-range response of 40 to 10,000 Hz, a moderate range of 80 to 7,000, and a restricted range of 180 to 4,000 Hz, most people (in 1945) prefered the restricted range. Later, Kirk went further when his tests elicited a howl of protest from hi-fi buffs (I was one of them). For six weeks, Kirk exposed one group to a considerable amount of widerange listening, another group to the midrange listening, and a third group did no test listening. Afterward, the widerange group preferred its (then) wideband listening, the midrange group preferred its wide bandwidth, but the third group had not changed its opinion.

Certainly if these tests were run today, the results might be different because millions of people have been exposed to wideband systems. My own research, among 500 people who have actually bought and lived with quadriphonic sound systems, shows that 95 percent of this 500-person panel would not want to return to even stereo listening, now that they have had extensive exposure to quad.

Roger Kirk's research at Ohio State highlights that once people have been conditioned to something better, they don't want to return to a lesser mode of listening. More recent research by the Australian Institute of Electronic Engineers among the general public, shows that people more quickly appreciate stereo on narrow-band systems than on wideband systems.

When an AM stereo system is adopted, most AM broadcasters will probably not broadcast much beyond 10,000 Hz and some will use even less bandwidth. WFBR in Baltimore currently tops off at about 8,000 Hz, according to its chief engineer Floyd Daisey. However, some clear-channel stations could—if they wished—broadcast flat out to 15,000 Hz. Much AM transmitting equipment today can transmit a remarkably clean and distortion-free signal flat from 50 to 15,000 Hz.

It is a myth that all AM stations are assigned a low-fi role. The reasons for poor quality AM sound are varied, but probably the most important one is the poor quality of most AM receivers. The quality of AM transmission depends on how crowded the band is in a given area. In some areas, stations are separated by 30 kHz, which allows a frequency response of up to 15,000 Hz to be transmitted. Most good AM stations go to at least 7,500 Hz, and many a clear-channel station goes up to 10,000. There are now over 75 clear-channel AM stations in the U.S.

What seems clear to me is that current manufacturers of AM-FM receivers could adapt their current FM stereo receivers by installing a high-quality detector IC. The biggest expense of receiving AM stereo has already been met in the AM-FM stereo receiver, in the stereo preamplifier and stereo amplifier stages. My engineering friends tell me that AM detection circuits are far less complicated and not as expensive as FM detection circuits. Certainly, both AM and FM have their respective virtues and their deficiencies.

FM is relatively static-free, and has an inherently superior signal-to-noise ratio. Its capture ratio, with its ability to exclude a weaker signal at the same frequency, is well known. FM radio sounds equally good night and day. But one of the deficiencies is that an FM signal will not reach out much more than 150 miles on this earth, being essentially a line-of-sight medium. Good in-car stereo reception drops off rapidly under most conditions—particularly for in-car listening 25 miles or more from the transmitter. Multipath is a continual problem, along with the phenomenon of "picket fencing" (good sound one second, bad the next).

AM stereo has a much greater reach—not the usual 23 dB signal-to-noise loss that FM stereo has as compared to FM monophonic reception (a 200 to 1 power loss when FM stereo is used over FM monophonic reception). Leonard Kahn and others who have worked extensively with AM stereo tell me there is very little loss in signal-to-noise for AM stereo, and no degradation of signal when AM stereo is being transmitted for AM monophonic listening.

I don't see AM stereo as being anti-FM stereo, but a case of improving the breed of an important form of broadcasting (65 percent of the total radio audience is AM) where billions of dollars have already been invested by both AM stations and their listeners. There are close to 4,500 AM stations in the United States. The car audience alone is huge, representing over 100 million potential listeners.

The cost of adding AM stereo broadcasting capability, according to Floyd Daisey at station WFBR, will be no more than the cost of existing FM stereo transmitting capability and can be added in less than an hour to any AM station—if that station has reasonably modern transmitting equipment bought in the last 10 years.

Most of the AM radio operators I have talked to see AM stereo as catalyst to improved AM transmission and reception. Many point out that AM radio does not have to be a low-fi medium. Perhaps the most pertinent comment comes from James Gabbert, president of the National Association of FM Broadcasters (which has just changed its name to the National Broadcasters Association). Gabbert is also head of the successful KIOI-FM in San Francisco, one of the first FM stations to go stereo in the U.S.

Gabbert, in recently addressing his fellow FM broadcasters, said, in pushing for discrete quadriphonic broadcasting, "Some broadcasters will look at quadriphonic as a passing fad or a flash in the pan, as many FM broadcasters thought of stereo in 1961. Few stations wanted to convert to stereo because of the investment involved. The considerations (that there weren't enough receivers, people wouldn't care and it was too expensive) proved false. Would anyone of you be willing to return to mono broadcasting today?"

"Discrete quad is a whole revolution for FM broadcasting. *Another revolution on the horizon is AM stereo. This will change the entire complexion of AM radio, making it competitive with FM, in terms of musical dimensionality and realism*".

I agree with Gabbert on all but one count, that the only way to broadcast quad is via a discrete system. He saw what stereo could do for his station and FM radio, long before most of his fellow FM broadcasters did—he is ahead of them again in seeing what quad will do for FM radio in the future. The question I'd like to put to him is, "How long will it be before AM radio wants to broadcast in quad?"

We need both matrix and discrete quadriphonic systems for many reasons too involved to go into here. But one reason is that the only way that AM radio can have quad is via a matrix system. If I disagree with Gabbert that discrete is the *only* way to go for quad, many AM radio operators can agree with him that AM stereo's time has come. R-E

MYSTERY OF THE

Even though a speaker systems may be far greater than of an amplifier, tweeters

OVER THE LAST SEVERAL YEARS, WE HAVE heard from an increasing number of audio enthusiasts who have had to replace the high-frequency drivers in their multi-element speaker systems. Often, they complain that their speaker's power rating (clearly specified in the owner's manual and even occassionally on the connection plate at the rear of the speaker system) was well beyond that of their amplifier's power output capability. So, how come the tweeters "blew out?"

We decided to do a little investigating—especially since we ourselves have more than once had to replace an ailing or dead tweeter. The first thing we learned (and it came as no great surprise) is that *most* tweeters in *most* multi-speaker systems cannot handle anywhere near the input power that the woofer, or even the mid-range driver (if the system includes one) can handle. For example, a system with a power input rating of 50 watts of continuous power may include a tweeter that can handle no more than 10 watts of continuous power, or even less.

Of course, not all speaker manufacturers rate the power handling of their products in terms of continuous power (even though amplifier manufacturers are now required to do so, in accordance with FTC rules). Most makers of speaker systems continue to rate power handling of their products in terms of "program power"—a term which has never been properly defined but which suggests some sort of average music power that most experts concede is around 10 dB (one tenth the power) lower than "momentary peak power" that may occur under music signal input conditions. On that basis, our so-called "50-watt speaker" would be able to handle only about 5 watts of continuous sinewave power if you were to apply that sort of test tone to it for an extended period of time. If the five-to-one power handling capability between woofer and tweeter holds true, that means that the tweeter in question could, in theory, be destroyed if you fed a high-frequency tone to it at a level of more than 1 watt for a long period of time.

Why do manufacturers seemingly skimp on tweeter power handling capacity? One reason, of course, is the physical difficulty (and cost) of manufacturing a small tweeter (with its tiny voice coil and narrow-guage voice-coil winding) that would be able to handle as much power as the more ruggedly fabricated woofer, which can use heavier wire in its voice coil. The theory is—and always has been—that tweeters in "real life" are never required to handle as much power as woofers or mid-range elements simply because "music doesn't happen that way."

Figure 1 shows the approximate frequency distribution for a classical symphony orchestra, averaged over some period of time. The graph was prepared in 1959 by L. J. Sivian, H. K. Dunn and S. D. White and published in the IRE *Transactions* of that year, volume AU-7.

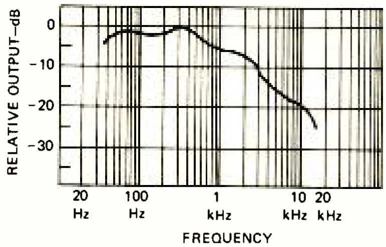


FIG. 1—FREQUENCY DISTRIBUTION, 75-piece orchestra, time-averaged. Peaks may be 10 to 20 dB greater at any instant.

According to this statistical analysis, most of the energy content is in the frequency range from about 50 Hz to 1 kHz, rolling off rather rapidly at higher frequencies, so that at 10 kHz (the frequency region where most tweeters would be reproducing sound actively in a multi-driver speaker system), average energy content is 20 dB lower than at mid-frequencies. Allowing for 10-dB peaks, which may occur in short bursts, we would still have a difference of 10 dB between the maximum energy level of music at 10 kHz and the *average* energy level of music at low and mid-frequencies. But 10 dB represents a power difference of ten to one. Thus, if an amplifier delivers peak signals of 50 watts at mid frequencies where most of the musical energy is concentrated, a tweeter might be expected to receive some 5 watts of energy at those frequencies where it is active. On that basis, the manufacturer who installs a tweeter that can take 10 watts of continuous power is actually providing a safety factor of two to one. So why the burned out tweeters?

Yesterday's and today's music

We decided to perform some experiments, using a modern high-fidelity component system to reproduce music and speech of various kinds. The output of our system (or at least the output of one channel) was connected to a spectrum analyzer that is capable of sweeping at a very slow rate from 20 Hz to 20,000 Hz. We adjusted the sweep rate so that one full sweep took 100 seconds and permitted the sweep to continue, over and over again, for about 15 minutes. Bandwidth of the sweeping filters in the analyzer was adjusted to be narrow enough to differentiate between frequencies one third of an octave apart, yet wide enough so as not to miss responding to musical energy of relatively short duration at specific frequencies. We tuned our FM tuner to a classical music station and let the entire dynamic range and frequency range of the music be stored on the storage oscilloscope for the full fifteen minutes. We assumed that over such a long span of time we would store a good representation of the spectral content of classical music, vintage 1976. The results are shown in the 'scope photo of Fig. 2 and, allowing for the rather random nature of the tests, conformed very closely to the statistical results of Fig. 1 plotted in 1959. So far, no solution to the mystery of the burned out tweeters. Musical energy indeed rolls off at the higher frequencies—at least if one listens to classical music.

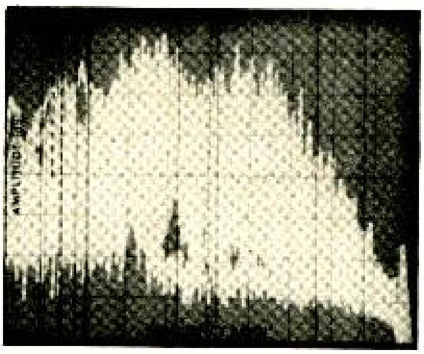


FIG. 2—SPECTRAL DISTRIBUTION of orchestra playing classical music.

Speech frequencies

Perhaps it is the modern disc jockey, with his piercing voice, who is responsible for all those burned out tweeters? Digging back into the textbooks, we came up with a spectral distribution curve of male speech, this one prepared way back in 1940 by Dunn and White and published in the *Journal of The Acoustical Society of America,* Volume 11. Their curve of frequencies and energy levels of the male speaking voice is reproduced in Fig. 3.

Back to our FM set—this time tuned to an all-talk station—and another fifteen minutes of sweeping and storing. Sure enough, the researchers were essentially

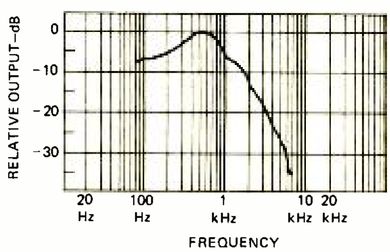


FIG. 3—VOICE OF A MALE falls off rapidly at high frequencies.

FAILING TWEETERS

power handling capacity
the output power rating
often fail. Here's why

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

correct back in 1940. Except for a few sibilant "s" sounds, which managed to cause a couple of spikes above 5 kHz in Fig. 4, speech energy *does* fall off at the

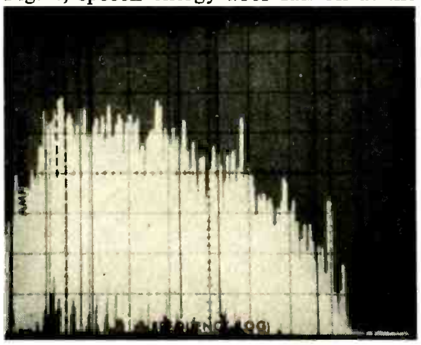


FIG. 4—FREQUENCY DISTRIBUTION of a male disc jockey's voice, averaged over a time period of 15 minutes.

predicted rate and is down about 30 dB well before reaching the 10-kHz mark on the 'scope graticule (vertical divisions are worth 10 dB each in all of these presentations). Obviously, the DJ's are not the culprits.

How about tone controls

Suddenly, we remembered how many audiophiles delight in turning up their bass and treble controls all the way, and decided to re-check earlier results with tone controls set for maximum boost. We played the same classical selection used for the display of Fig. 2 (we had recorded it on a good open-reel tape deck just in case we needed a replay). Again, energy levels at all audio frequencies were stored for the requisite fifteen minutes and are shown in Fig. 5. Comparing results with those obtained in Fig. 2 we had our first

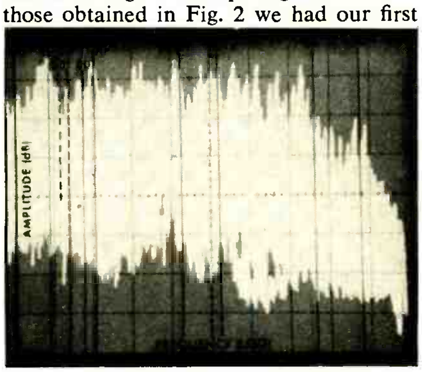


FIG. 5—BOOSTED BASS AND TREBLE controls put more power into the lower and higher ends of the frequency range.

clue as to a possible cause of tweeter failure. Now, energy levels were almost constant all the way up to about 5 kHz. At 10 kHz, energy levels were around 15 dB higher than in the classical music played back with "flat" settings of those tone controls. Not surprising in itself—since the treble control does afford 15 dB of boost—but somewhat startling when presented this way!

Other types of music

Recognizing that these days, most hi-fi systems are not turned on to (nor are most hi-fi listeners turned on by) classical music, we switched to a typical rock-and-roll FM station on the dial and repeated the earlier experiments, with all tone controls set flat. Results shown in Fig. 6 are

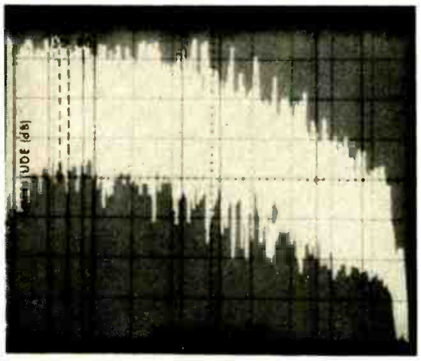


FIG. 6—ROCK MUSIC has higher bass and treble energy than has classical music.

interesting for several reasons, when compared with Fig. 2. For one thing, rock music obviously has more average bass content than does classical music. Notice that the energy from 20 Hz to 1,000 Hz is almost constant.

As for high-frequency energy, while it is significantly greater than in classical

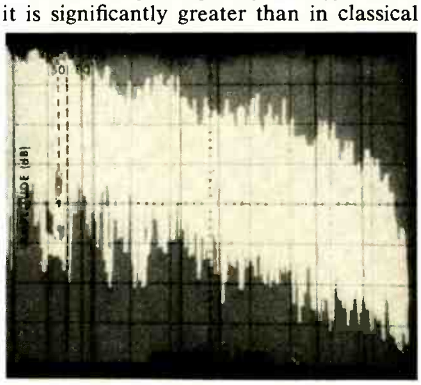


FIG. 7—SAME PIECE OF ROCK MUSIC played with treble and bass controls boosted.

music, it does roll off decidedly at the higher frequencies. Of course, adding bass and treble boost in the extreme does intensify the bass even more, and adds the usual 10 to 15 dB of additional energy at the high end of the audio spectrum, as illustrated in Fig. 7.

Electronic music

As a final experiment in spectrum content of different types of music, we decided to "store" an example of electronic music on the spectrum analyzer. We reasoned that since this newer form of music might have a somewhat different frequency/energy distribution, since it is created by man-and-electronics made tone

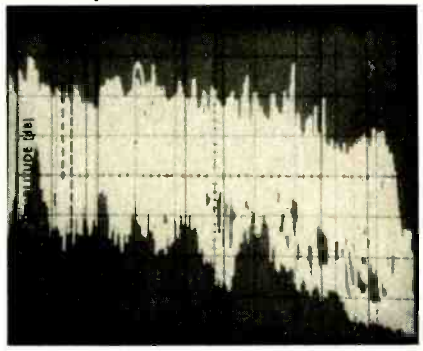


FIG. 8—ELECTRONIC MUSIC LEVELS are almost uniform to beyond 5 kilohertz.

generators, which can be as rich or as poor in harmonic overtones as the composer at the synthesizer desires.

Sure enough, results(shown in Fig. 8), first stored with tone controls set to the flat position, are unlike any "natural" music we had analyzed up to this point. Frequency distribution is almost uniform all the way up to 5 kHz (and therefore

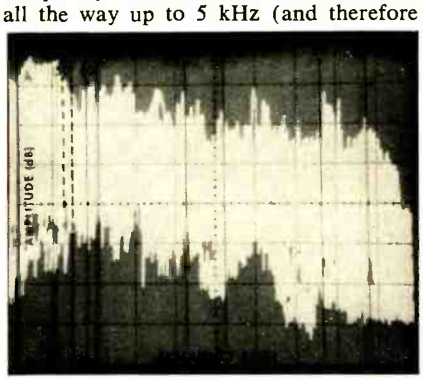


FIG. 9—SAME ELECTRONIC MUSIC as in Fig. 8, played with tone controls full "up."

easily capable of blowing up an unsuspecting tweeter that never ran into this phenomenon before). Repeating the playing with bass and treble controls full up (Fig. 9) we see that energy levels at 10 kHz are just about as great as at 1 kHz. Even super-tweeters might not have a chance to survive under these circumstances.

Under-powering your speakers

Having concluded that some forms of modern music—reproduced with less than ideal settings of tone controls—can actually be harmful to tweeters, we decided to explore yet another mystery. We had heard of many cases in which a tweeter was destroyed by an amplifier whose power ratings were far below the "nominal maximum power rating" of the speaker system. For example, why would an amplifier rated at 50 watts per channel destroy the tweeter in a system that had a power handling capability of 100 watts. Even if we allow for the fact that the tweeter might be rated at, say 20 watts, in line with our earlier five-to-one ratio, surely the energy level of all the types of music we have examined up to this point would never be that great at those higher frequencies.

It occurred to us that perhaps the real cause of failure lay in the fact that the amplifier was *not powerful enough* for the speakers in question. Here's the reasoning. If an amplifier is pushed beyond "clipping," output waveforms take on the shape illustrated in Fig. 10. The output begins to look like a square wave instead

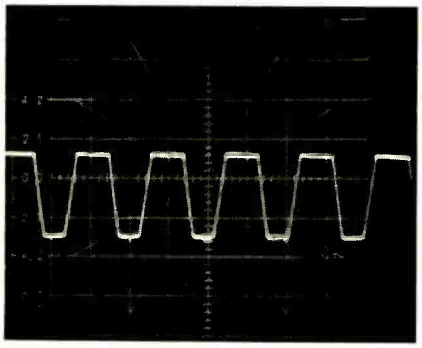


FIG. 10—OVERDRIVEN AMPLIFIER makes a 2 kHz sinewave into this square wave.

of a sine wave. We have previously discussed the usefulness of square waves in testing audio amplifiers (**R-E,** November, 1975), but then we were talking about square waves whose amplitude is such that they do not overdrive the amplifier in test.

As we indicated in the earlier article, a square wave really consists of its fundamental frequency plus an "infinite" number of odd-harmonic components. The same is true of a clipped sine-wave; it generates high-frequency odd-order harmonics. Thus, a 250-Hz square wave, fed to the input of a spectrum analyzer, is seen to contain frequencies at 750 Hz, 1250 Hz, 1750 Hz, etc., etc., etc., as illustrated in Fig. 11. Of course, the higher order harmonics diminish in amplitude in accordance with a well known mathematical series, and if such a square wave were fed to an amplifier and then to a multi-driver speaker system, chances are the higher frequencies would be so far down in amplitude that no damage to the tweeter would result.

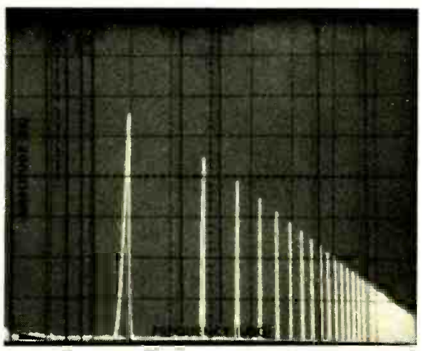


FIG. 11—SPECTRAL ANALYSIS of a 250-Hz square wave shows frequency components every 500 Hz above the fundamental frequency.

But now, consider what happens if the fundamental tone we are trying to amplify is 2000 Hz. If the volume control of your amplifier is turned up high because you want bigger sound, and a pure 2000-Hz tone comes along that is clipped by the limitations of the power amplifier, instead of an output of only 2000 Hz, there will be substantal power output at 6000 Hz, 10,000 Hz, 14,000 Hz, 18,000 Hz and beyond. The spectral content of such a square wave

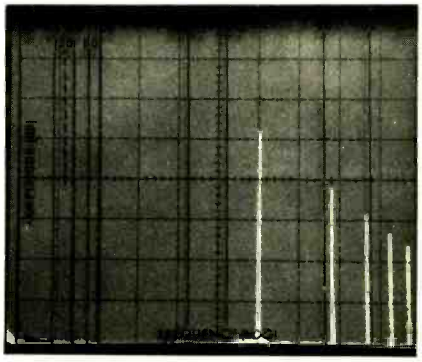


FIG. 12—OVERSIZE 2kHz SIGNAL (a near square wave) produces high-amplitude components at higher harmonic frequencies.

is illustrated in Fig. 12. Note that the level of 6000 Hz (spike to the right of the 2000-Hz fundamental) is almost equal to that of the first odd-order harmonic of the lower frequency square wave of Fig. 11. But it is at a much higher frequency—one that would seriously affect a tweeter. If the amplifier were powerful enough not to have clipped the fundamental 2000-Hz tone, this 6000-Hz component would not have appeared at the output of the amplifier (and at the speaker's terminals) *at all.* Clearly, then, it is just as possible to

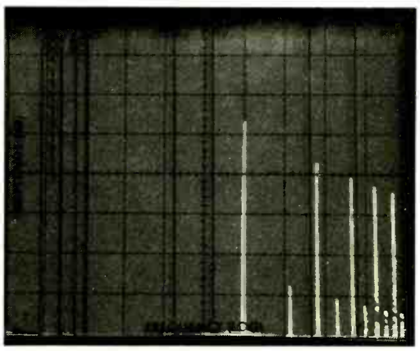


FIG. 13—ADDING TREBLE BOOST to the overdriven signal of Fig. 12 increases higher-order harmonic amplitudes even more.

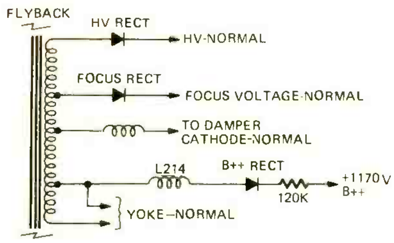
injure a tweeter by using an amplifier that has too little power output (and clips when attempting to reproduce music at adequate loudness levels) as to play some of today's "non-confroming" music over speaker systems that are designed using frequency/energy relationships that no longer apply.

Compound this felony by boosting the treble control while overdriving the amplifier (as we did, to illustrate the point in Fig. 13) and those high frequency spikes grow even taller and more apt to blow up that overburdened tweeter. **R-E**

THIN VERTICAL LINE

All I can get on this Emerson 12P50 portable is a thin vertical line right in the middle of the screen. Tubes all good, DC voltage OK, boost voltage a little high. I subbed the yoke; no help. The horizontal hold makes the line move a little. Any ideas?—M.W., Elmhurst, NY.

Process of elimination. You have B+, boost, and high voltage (or you would not see the line). So, you have lost your *horizontal sweep.* You were



right to substitute the horizontal winding of the deflection yoke. However, the fact that the boost is there, and high, could be saying that the yoke is OK.

There's no smoke, so this isn't a short. Something is *open.* A very good candidate for these symptoms would be an open C60, .1 μF, that is the yoke *return* capacitor. (See diagram).

(Feedback from Reader. That was the one! Thanks!)

HORIZONTAL SYNC HINT

If anyone ever asks about a loss of horizontal sync and intermittent sound in a Zenith 19EC45, tell them to check an open 330-ohm ½-watt resistor, R808, in the emitter circuit of the horizontal sawtooth shaper transistor. I've found this in five sets in this series.

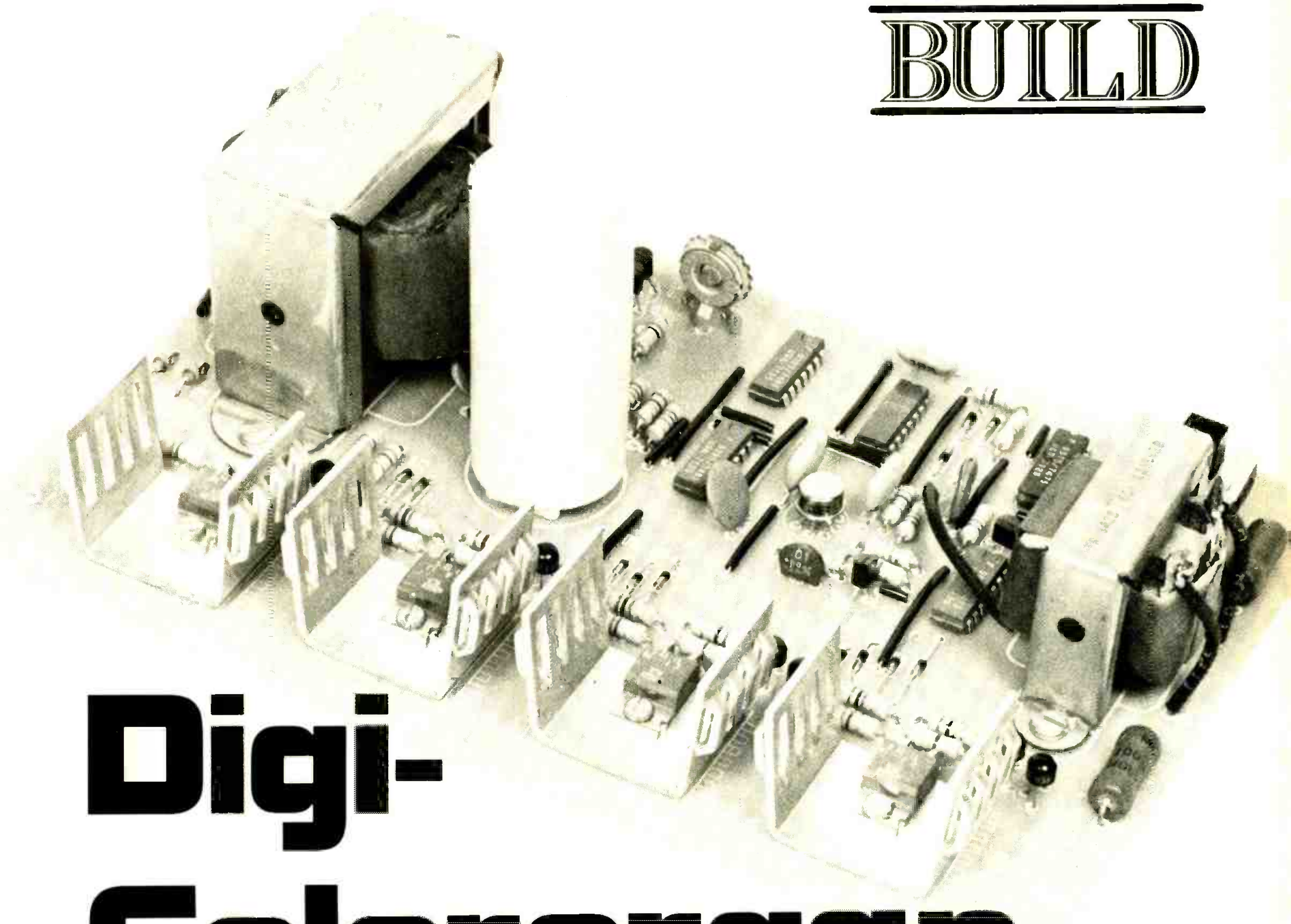
Thanks very much to William Behler, Rockaway, NY.

RASTER TURNS RED

There is an odd intermittent in this G-E 19JA chassis. I've had it in several times for the same thing. It suddenly turns red, goes out of focus and blanks out. I've changed modules, and the horizontal output transistor. I'm wondering if it's the flyback. Any help will be appreciated.—R.W., Schenectady, NY.

From the symptoms and the fact that you have changed modules, etc., I'd suspect something else. This symptom doesn't really sound like a solid-state trouble. More like a tube problem. Since you're somewhat limited on tubes in this chassis, how about the picture tube? A heater-cathode short in the red gun would do this.

If it is, don't change the picture tube. Replace the three-lead heater supply transformer with the four-lead type, and you'll isolate it.



Digi-Colororgan

Build this sensitive, high-speed, digitally-filtered color organ that can control 800 watts in each of its four channels

DAN MEYER

THE DIGICOLOR ORGAN IS A SENSITIVE, HIGH-speed, absolute frequency discriminative digitally-filtered, four-channel color organ. High-speed TTL integrated circuits are the primary elements in the unit. They are interconnected in a circuit configuration that operates as a non-programmable digital computer. By measuring and analyzing the time period between crossings of the audio information, the Digicolor organ is able to differentiate between different frequencies and control up to 800 watts of 117-volt lights connected to each of its four channels. The results of such a unique method of audio analysis are astounding. Not only is the sensitivity high but the unit is not affected by changes in the audio level of the sound system to which it is connected. This means there is no channel mixing at high volume intervals and no loss of display action at low volume intervals. This eliminates one of the most annoying problems that most color organs suffer from today. Another benefit of the digital circuitry is its speed. The unit is so fast that the delay in the electronic circuitry is negligible when compared with the delay in the display lights themselves. These and other features make it unique among the color organ designs known today.

How it works

The Digicolor organ contains an externally controlled free-running oscillator whose frequency is adjustable from 5 to 50 Hz. At the onset of each pulse from the oscillator, the unit waits for the first positive-going zero-crossing of the audio information, then measures the period of time between it and the second positive-going zero crossing. Since the frequency of the cycle of music information analyzed is inversely proportional to the length of this time period, the unit derives a binary representation of the frequency of that particular cycle measured. It then decodes this binary data, determines which one of the four channels the frequency is allocated to and turns on the bank of lights connected to that channel. This bank of lights is electronically locked on until the next cycle of audio information is analyzed. The time delay between the second zero crossing and the turning on of the circuitry controlling the appropriate bank of lights is well under 10 microseconds, which means the delay in the unit is negligible in relation to the delay in the lights themselves. Since this unit's operation is based on zero crossings, the display is not affected by changes in the volume level of the audio being analyzed. The unit's sensitivity is such that it can respond to signal amplitude levels of less than 10 millivolts RMS or 12.5 mW into 8-ohms.

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As you might have already noticed, this unit works by measuring the frequency of audio information as it would any periodic waveform. However, audio information is not a periodic waveform. It is a series of a non-sinusoidal, non-repetitive, highly complex waveforms. In instances where there appears to be a relatively loud dominate note, whether it be from a drum, guitar, horn, or other instrument, the waveform takes on the appearance of the fundamental frequency of the note with the harmonics and other less intense audio information superimposed on it. The unit measures the frequency of the individual cycles of this waveform by measuring the time between two consecutive positive-going zero crossings. Thus if there is a dominate low note in the audio being analyzed, the bank of lights connected to the low-frequency channel will be turned on.

The Digicolor organ is provided with an externally adjustable repetition rate control, which sets the rate at which the unit samples and displays the frequency of the audio being analyzed. This rate may be varied from 5 to 50 times a second but the rate of 25 times a second seems to give the most desired results visually. With fast-paced music and a 25-Hz repetition rate, the lights of the display change at a rate that is hard for the eye to follow. This gives it a real eye-catching appeal. The unit can be connected across speakers handling from less than one to up to 100 watts of audio without modification. This makes it ideal not only for use with home sound systems but for high-power instrument amplifiers used in rock groups.

Circuit operation

Referring to the schematic, Fig. 1, let us assume the function switch S1 is in the operate position and all the flip-flops in the unit have been cleared. This means all Q outputs are at a logic 0 level (0 to 0.4 volts and all $\overline{Q}$ outputs are at a logic 1

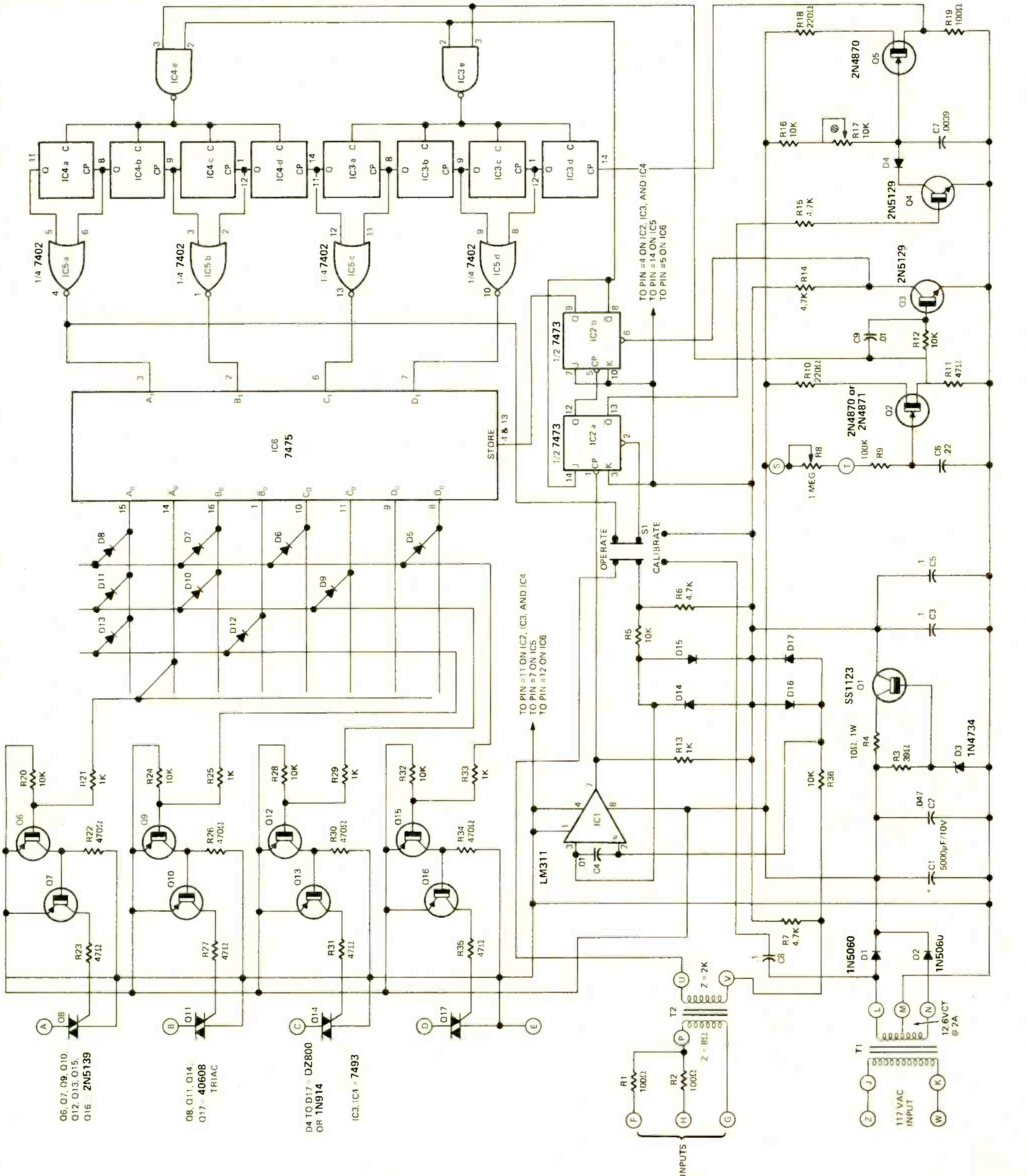


FIG. 1—DIGICOLOR ORGAN uses digital filtering technique to prevent channel bleed-over at high volume levels and dropout at low volume levels.

PARTS LIST

All resistors ½-watt, 10%, unless noted
R1, R2—100 ohms, 2 watts
R3—39 ohms
R4—10 ohms, 1 watt
R5, R12, R16, R20, R24, R28, R32, R36—10,000 ohms
R6, R7, R14, R15—4,700 ohms
R8—1 megohm linear potentiometer
R9—100,000 ohms
R10, R18—220 ohms
R11, R23, R27, R31, R35—47 ohms
R13, R21, R25, R29, R33—1,000 ohms
R17—10,000-ohm trimmer resistor
R19—100 ohms
R22, R26, R30, R34—470 ohms

C1—5,000 μF, 10V DC, electrolytic
C2—.047 μF, Mylar
C3, C5—0.1 μF disc
C4—.01 μF Mylar
C6—0.22 μF Mylar
C7—3,900 pF polystyrene
C8—0.1 μF Mylar
C9—.01 μF, disc
C10—0.56 μF, 600 V DC

D1, D2—1N5060
D3—5.6 V, 1 watt Zener, 1N4734 or equivalent
D4-D17—DZ800 or 1N914 silicon diodes

Q1—SS1123
Q2—2N4870 or 2N4871 unijunction transistor
Q3, Q4—2N5129
Q5—2N4870 unijunction
Q6, Q7, Q9, Q10, Q12, Q13, Q15, Q16—2N5139
Q8, Q11, Q14, Q17—40668 or T2800B Triac

IC1—LM311 voltage comparator
IC2—7473 dual J-K flip-flop
IC3, IC4—7493 4-bit binary counter
IC5—7402 quad NOR gate
IC6—7475 4-bit bistable latch

T1—power transformer, 117 V AC primary 12.6V AC, 2A center-tapped secondary
T2—Audio transformer, 2,000-ohm primary, 8-ohm secondary

S1—dpdt printed circuit board mounted slide switch
S2—spst switch

F1—fuse (see text)

Note: The following are available from Southwest Technical Products Corp., Box 32040, San Antonio, TX 78216: Etched and drilled PC board—$8.50 postpaid.

Complete kit of parts, including the PC board, but less display cabinet—$44.95, plus postage and insurance on 4 lbs.

Display cabinet semi-kit, less bulbs (assembled except for attaching and wiring the light sockets)—$26.50. (Too large to mail, shipped bus or express collect.)

level (2.4 to 5.0 volts). When an audio source is connected to the input side of T2, the secondary voltage is fed to inputs of IC1 through the voltage-limiter consisting of D14 thru D17.

IC1 is a voltage comparator. When the voltage at its (+) input is positive with respect to the voltage at its (−) input, the output is at a logic 1 level, and when the voltage at its (+) input is negative with respect to the voltage at its (−) input, the output is at a logic 0 level. So IC1 squares off the audio waveform and puts it in a form compatible with the input of the flip-flop IC2-a.

At the first positive-going zero crossing of the audio in the T2 secondary between points U and V with Point V as the polarity reference, the output of IC1 changes from a logic 1 to a logic 0 level. As a result of this transistion the outputs of IC2-a change states. The $\overline{Q}$ output goes to a logic 0 level, causing transistor Q4 to turn off. This in turn allows the unijunction transistor oscillator consisting of Q5 and its passive components to turn on. This oscillator starts toggling the string of flip-flops contained in IC3 and IC4. The Q output of each of these flip-flops changes states whenever its CP input is changed from a logic 1 to a logic 0 level.

At the second positive-going zero crossing of the audio information, the output of IC1 again changes from a logic 1 to a logic 0 level. As a result of this transition, the outputs of IC2-a again change states. This time the $\overline{Q}$ output goes back to a logic 1 level, causing transistor Q4 to turn on, which in turn shuts off the unijunction transistor oscillator Q5. The Q output makes a logic 1 to a logic 0 transition, which in turn causes the outputs IC2-b to change states. The $\overline{Q}$ output of IC2-b goes to a logic 0 state which feeds the J input of IC2-a. Changing this input to a logic 0 state prevents the outputs of IC2-a from changing states even though its CP input sees logic 1 to logic 0 transitions.

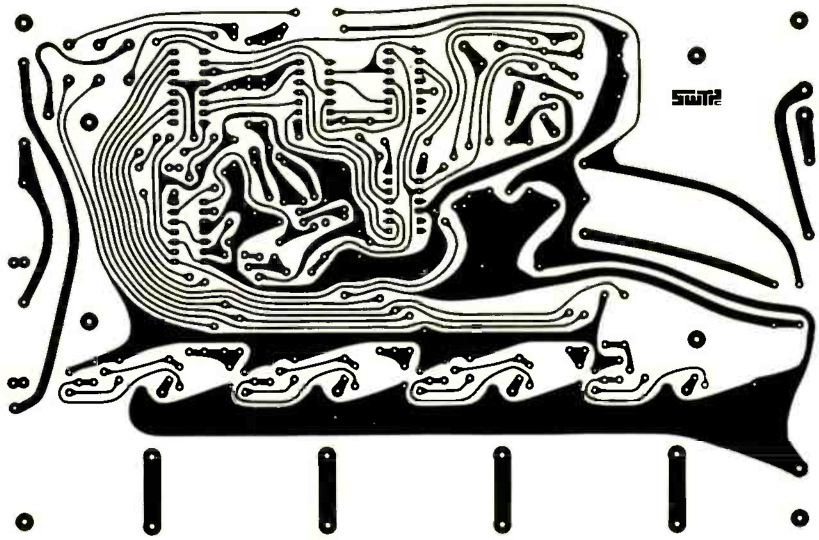


FIG. 2—PRINTED-CIRCUIT board measures 8¼ × 5½ inches (20.96 × 13.97 centimeters).

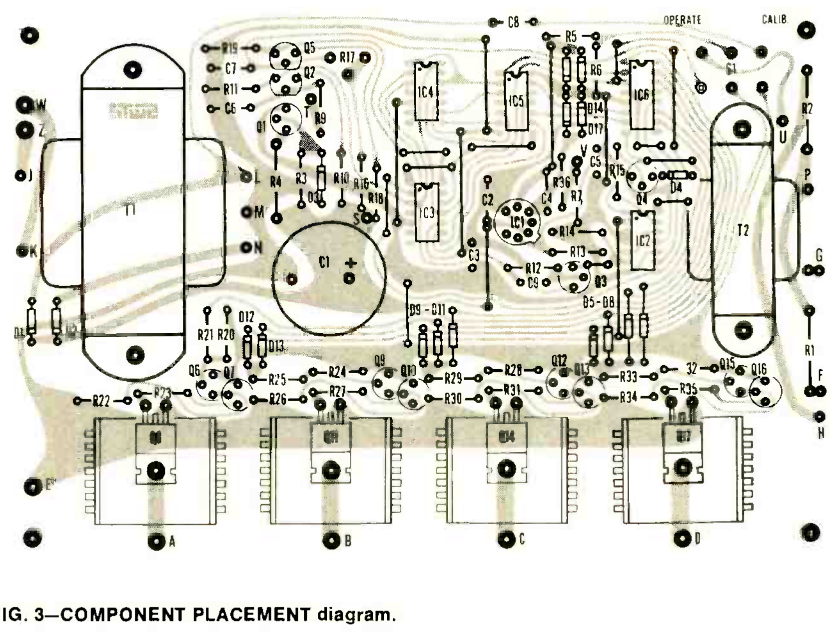


FIG. 3—COMPONENT PLACEMENT diagram.

The Q output of IC2-b goes from a logic 0 to a logic 1 level, which causes the storage integrated circuit IC6 to transfer the data from the input pins, (A_I, B_I, C_I, D_I) to the output pins (A_o, $\overline{A}_o$, B_o, $\overline{B}_o$, C_o, $\overline{C}_o$, D_o, $\overline{D}_o$) of the integrated circuit.

The flip-flops in IC3 and IC4 contain information which is actually a binary representation of the frequency of the cycle of audio information being analyzed. By knowing just how far the oscillator pulses of Q5 propagated through the flip-flops of IC3 and IC4, it can determine the frequency band into which the cycle of audio being analyzed falls. Since we are interested in dividing the bandwidth into four channels rather than the eight divisions provided by the flip-flops, the outputs of each adjacent pair of flip-flops are NOR'ed together by the four gates of IC5 before being fed into IC6.

The data at the output pins of the storage integrated circuit IC6 is decoded by the diode array consisting of D5 through D13. This array assures that only one bank of lights is turned on at a time. For example, if the frequency was such that the oscillator pulse train propagated through the first five flip-flops in IC3 and IC4, then the B_I and consequently the B_o pin of IC6 would be at a logic 0 level. The data on the C_o, $\overline{C}_o$, D_o, and $\overline{D}_o$ pins of IC6 is irrelevant and must be nullified so it does not turn on another bank of lights. The diode array takes care of this nullification by eliminating all but the most significant bits of data. Each of the four outputs of the diode array feeds a triac driver circuit which in turn drives one of the four triacs Q8, Q11, Q14 or Q17. The triacs are the actual AC control elements that switch each of the banks of lights either on or off.

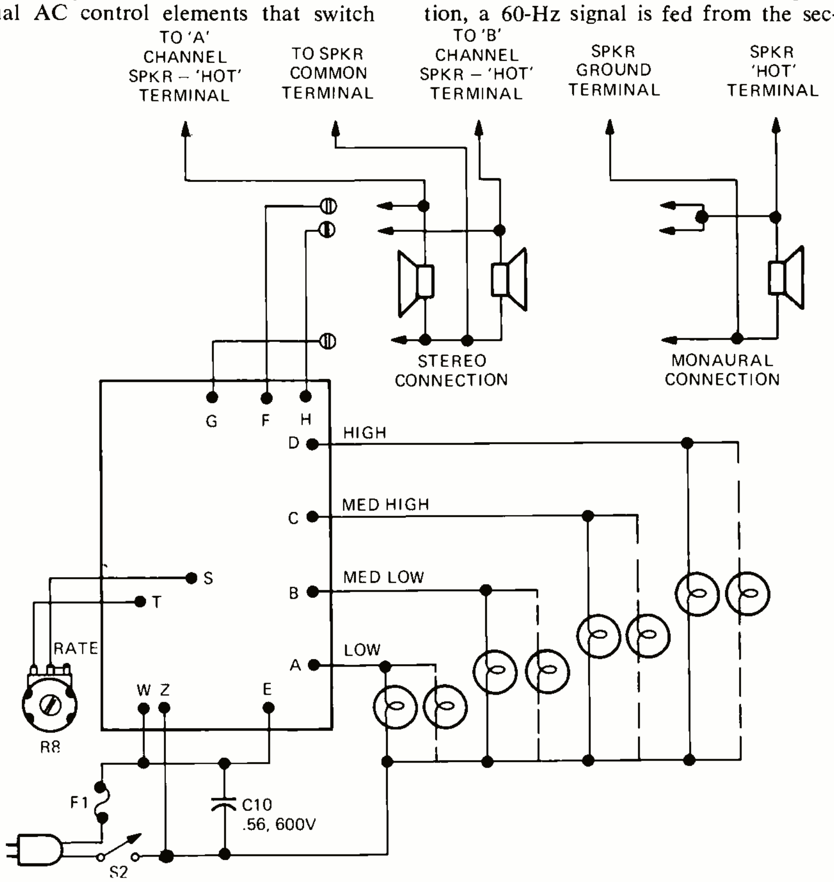
The unit now remains in the previously described state until the externally controlled repetition-rate oscillator consisting of Q2 and its passive components provides a pulse. This pulse is inverted by Q3 and fed to the reset pin of IC2-b where it causes the Q output to go to a logic 0 level. This Q output is in turn connected to the store inputs of IC6, and changing this input from a logic 1 to a logic 0 level causes the outputs of IC6 to hold the data present on its outputs at the time of the logic 1 to logic 0 transition even though the data present on the inputs may change after the transition. So in other words IC6 stores data while its store inputs are in the logic 0 state.

When IC2-b was reset, the $\overline{Q}$ output also changed states, and for the short period of time that there was a logic 1 level developed by Q2 and a simultaneous logic 1 level at the $\overline{Q}$ output of IC2-b, a clear command was given to the flip-flops of IC3 and IC4 through the internal NAND gates of IC3 and IC4. The $\overline{Q}$ output change of IC2-b also causes the J input of IC2-a to be returned to a logic 1 level, thus putting the unit in the same state it was in at the beginning of the discussion with the exception that a different bank of lights may be turned on, depending upon the frequency differences in the audio information being analyzed.

Regulator transistor Q1 provides the 5 volts required by most of the individual circuits in the unit. The OPERATE-CALIBRATE switch S1 provides a means of accurately setting the bandpass of the unit. When the switch is in the CALIBRATE position, a 60-Hz signal is fed from the secondary of the power transformer to the input of the comparator. Resistor R17 is then adjusted until the 60-Hz signal is right on the border line of the low-frequency channel. When the switch is back in the operate position, the audio frequency band is divided into four pairs of octave bandwidths:

CHANNEL A (LOW)	60—240 Hz
CHANNEL B (MED. LOW)	240—960 Hz
CHANNEL C (MED. HIGH)	960—3840 Hz
CHANNEL D (HIGH)	3840—15360 Hz

Since there is a connection from the A_I input of IC6 to the C input of IC2-a, the unit responds to frequencies lower than 60 Hz on the low-frequency channel.



WIRING DIAGRAM – DIGITAL COLOR ORGAN

FIG. 4—DIGICOLOR ORGAN is connected directly to speaker systems. Each channel of the Digicolor organ can control 800 watts.

Construction

A printed-circuit board must be used on this project. Mount all the parts on the circuit board, Fig. 2, using the parts list and the component layout, Fig. 3. The 18 jumper wires are shown as the solid lines between holes on the component layout diagram. The center lead of each of the four triacs Q8, Q11, Q14 and Q17 as well as pin number 5 of IC1 should be cut off. (The center lead of the triac is common to the tab and is not needed.) Be sure to orient all diodes, transistors, integrated circuits and electrolytic capacitors properly before soldering them to the board. Use a low-wattage iron and 60/40 alloy resin-core solder when soldering the connections. A small heat sink is sandwiched between each triac and the circuit board and is held in place with a No. 4-40 x ⅜ in. screw, lockwasher and nut. Transformers T1 and T2 are also mounted on the circuit board, with each held in place by 6-32 x ¼ in. screws and nuts. Transformer T2 must be oriented and connected so the primary leads attach to points U and V and the secondary leads to points P and G.

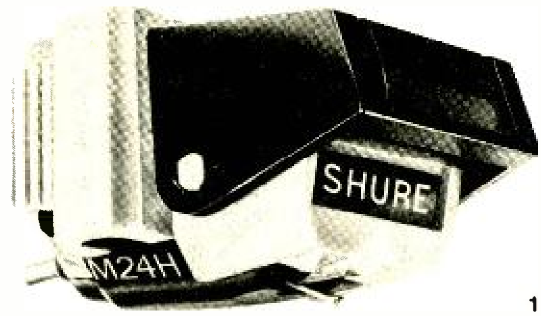
Calibration

With the potentimeter R8 disconnected from between points S and T, temporarily attach and solder a 1-megohm ½-watt resistor between these two points. Solder one lead of a 6-volt 50-mA lamp to the Q7 side of R23 on the bottom of the board and solder the other lead to point E on the circuit board. Attach and solder the line cord wires to points W and Z and tape the foil side of the board between points Z, J, W and K with electrical tape to prevent accidental shock. Set the circuit board top side up on an insulating surface. Set the OPERATE-CALIBRATE switch S1 to the CALIBRATE position and turn trimmer resistor R17 so the tab on the knurl of the control faces toward the integrated circuits. Insert the line cord plug in a wall outlet. The 6-volt 50-mA lamp should light. Slowly advance control R17 toward the Q5 side of the control until the lamp just goes out. It is at this point that the unit is properly calibrated. If the unit calibrates properly, unplug the unit, remove the electrical tape, unsolder and remove the 1-megohm resistor and the 6-volt lamp and flip switch S1 back to the OPERATE *position* while making sure not to jar or change the setting of trimmer resistor R17.

If the 6-volt lamp fails to light or does not go out when advancing R17 something

Continued on page 110

Radio-Electronics Tests Shure Model M24H



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LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

SHURE BROTHERS, INCORPORATED, IS WELL known for their fine line of stereo cartridges, the most outstanding of which is the V15 Type III, itself the descendent in a long line of excellent tracking cartridges that began with the Shure V15 many years ago. During those recent exciting years when it seemed that quadriphonic sound would become the standard method of listening to music at home, the industry was surprised and puzzled by Shure's reluctance to introduce a new cartridge that would be able to track the high-frequency information imbedded in the grooves of the new Quadradisc records. Now, even though interest in 4-channel has abated somewhat, Shure has made its long-awaited entry into the 4-channel market with what it reports is a stereo-quadriphonic cartridge that "does not have its stereo reproduction qualities compromised to accommodate full quadriphonic reproduction capabilities".

The M24H, shown in Fig. 1, physically resembles that company's Model M95ED cartridge which we had an opportunity to experiment with some months ago. The molded screw-retaining cylinders require long screws (supplied) and make mounting the cartridge into a pick-up arm shell quite easy and help to prevent that nightmare of dropping the tiny screws on a patterned floor where they invariably become invisible. The replaceable stylus assembly has an integral pivotable stylus-guard that swings down to protect the stylus itself during assembly or transportation. Staggered terminals are color-coded with the standard colors and a grounding strap connects from the right-channel ground terminal to an internal metal-shield buried beneath the outer plastic housing of the cartridge.

According to Shure, the new cartridge achieves an effective stylus mass of 0.39 milligrams which, they claim, is the lowest available in any discrete quadriphonic cartridge currently marketed. According to the manufacturer, it is this extremely low mass that results in the cartridge's high trackability and low carrier distortion.

A new stylus tip shape developed by Shure has been named "hyperbolic" and they claim it engages more of the groove wall than is possible with either conical or elliptical styli. Based upon illustrative drawings supplied by Shure, we surmise that the new hyperbolic tip is yet another variation on the so-called Shibata-stylus first introduced by Japanese manufacturers for CD-4 record playback applications.

A laminated electromechanical structure is used in the M24H and Shure claims that it reduces signal losses. This is linked to a high-energy magnetic stylus assembly for improved output in the high-frequency range.

Performance measurements

All of our lab tests were conducted with the Shure M24H mounted in the pick-up arm of a new Empire 698 turntable. Downward tracking force was adjusted to the recommended optimum of 1¼ grams, with anti-skating force similarly adjusted. Frequency response tests were conducted using two test records: the CBS STR-130 and JVC TRS-1004. This was necessary because most frequency response test records simply cover the range from 20 Hz to 20 kHz. The JVC test record, on the other hand, supplies a reference frequency of 1 kHz (by which we normalized output so that it was equal to that obtained at the same test frequency using the CBS test record) followed by spot frequencies of 10 kHz, 20 kHz, 30 kHz and 40 kHz. The resulting composite frequency response curve, shown in Fig. 2, consists of swept frequencies covering the audio range and spot measurements at the higher frequencies named that have been combined to form a continuous curve.

Much of the design philosophy behind the M24H becomes clear from an examination of

TABLE I

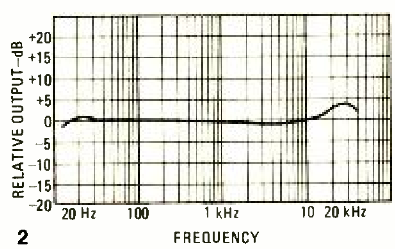
RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Shure Brothers** Model: **M24H**

PHONOGRAPH CARTRIDGE MEASUREMENTS

	R-E Measurements	R-E Evaluation
FREQUENCY RESPONSE (Hz-kHz, ±__dB)	20-50, +4, −2 See Fig. 2	Excellent
STEREO SEPARATION		
Separation, 1 kHz (dB)	24	Good
Separation, 10 kHz (dB)	18	Very Good
Separation, 30 kHz (dB)	16	Very Good
CHANNEL BALANCE, 1 kHz (dB)	1.3	Very Good
TRACKABILITY MEASUREMENTS		
Stylus velocity at 1 kHz (cm/s)	28	Excellent
Stylus velocity at 10 kHz (cm/s)	50	Excellent
COMPONENT MATCHING CHARACTERISTICS		
Output level, 1 kHz, 3.54 cm/s (mV)	3.0	
Optimum load impedance (ohms) (pF)	47K ohm; 100K ohm,* (250 pF, 100 pF*)	
Tracking force range (1 to 1½ grams)	1¼	
Cartridge weight (grams)	6.0	
OVERALL PHONO CARTRIDGE RATING		Excellent

* Values recommended for use with CD-4 records



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MANUFACTURER'S PUBLISHED SPECIFICATIONS:

Frequency Response: 20 Hz to 50,000 Hz (No tolerance given). **Output Voltage:** 3.0 mV per channel at 1 kHz, 5 cm/s peak velocity. **Channel Balance:** Within 2.0 dB. **Channel Separation:** At least 22 dB @ 1kHz. **Tracking Force Range:** 1-1½ grams. **DC Resistance:** 510 ohms. **Inductance:** 160 mH. **Optimum Load** CD-4: 100K ohms in parallel with 100 pF; Stereo or Matrix: 20K ohms to 100K ohms in parallel with 100 to 250 pF capacitance. **Trackability** at 1¼ grams: 400 Hz: 20 cm/s; 1 kHz: 28 cm/s; 10 kHz: 50 cm/s; 30 kHz: 25 cm/s. **Net Weight:** 6 grams. **Mounting Centers:** Standard ½-inch.

this response curve. Since every stereo phono cartridge exhibits a resonance at some high frequency, Shure succeeded in pushing that resonance out beyond audibility, centering it at almost precisely 30 kHz, where it serves the useful purpose of deliverying greater carrier amplitudes. The carrier happens to be centered at precisely that frequency. The result, as we were to confirm in our later listening tests, is extremely flat, peak-free response in the important stereo baseband (which, according to Shure, represents between 60% and 90% of all the sound we hear when playing a CD-4 disc) and increased super-audible frequency output needed by the CD-4 demodulator.

Other vital measurements are listed in Table I. Our trackability tests (that indicate the ability of the stylus to track grooves having high velocities) were performed using Shure's own TTR-103 test record in conjunction with a handy test fixture manufactured by that company as well (their C/PEK-3 Tester). We confirmed good tracking at 28 centimeters-per-second for a 1 kHz tone and 50 centimeters-per-second for a 10 kHz tone recorded at that velocity. While we did not test for other velocities at other frequencies, Shure supplied us with a curve of trackability versus frequency (shown in Fig. 3) that we have every reason to believe is accurate, based upon our other measurements.

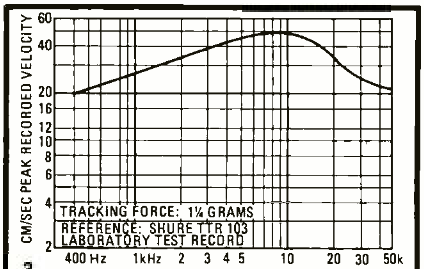

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TABLE II

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Shure Brothers** Model: **M24H**

OVERALL PRODUCT ANALYSIS

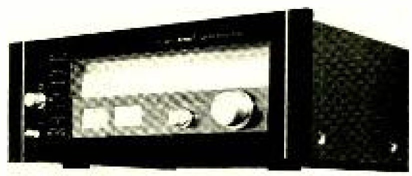
Retail price	**$74.95**
Price category	**Medium**
Price/performance ratio	**Excellent**
Sound quality	**Excellent**
Mechanical Performance	**Very good**

Comments: The audio industry had been wondering why Shure Bros. waited so long to produce a CD-4 compatible cartridge when just about everyone else in the cartridge field had quickly produced one or more models that could track the high frequencies contained in a quadradisc. Well, perhaps Shure Bros. knew what they were doing after all, and will have the last laugh. Design emphasis seems to be applied towards excellent stereo reproduction as well as good recovery of all the complex signals contained in a discrete 4-channel disc. Resonance has been pushed out way beyond audible limits and positioned almost precisely at the 30 kHz CD-4 carrier point which not only makes for very smooth peak-free audio response that may actually take some getting used to but delivers extra carrier amplitude to work easily even with early generation CD-4 demodulators that were not sensitive enough to operate correctly with many of the earlier CD-4 cartridges produced by competing manufacturers. The low downward tracking force (we recovered CD-4 information perfectly at 1 gram force, though measurements were made at the recommended optimum value of 1.25 grams) combined with what Shure calls its "hyperbolic" shaped stylus tip actually results in less stylus *pressure* on groove walls than might be applied with conical or elliptical styli operating at higher downward tracking forces. The expected Shure quality is abundantly present in the M24H, and even though 4-channel is not presently the hottest thing around, this cartridge should not be overlooked as a fine stereo cartridge that will not require replacement if and when 4-channel takes off again.

Summary

In our comments following our overall product analysis (Table II) we mention the fact that listeners may find the musical accuracy of the M24H unnerving at first, especially if they have been conditioned to expect that high-end sizzle that is so characteristic of many stereo cartridges (but not faithful to the original recorded signals). To our taste, we would rather have the smooth accurate response of a cartridge such as the Shure M24H than the artificially peaked high-end that is enjoyed by some. Accordingly, the M24H rates high in our list of cartridges we have known and loved. **R-E**

Sansui Tuner Model TU-9900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MANUFACTURER'S PUBLISHED SPECIFICATIONS

NOTE: Many of the specifications associated with this tuner are presented as two readings; one for the "narrow" bandwidth setting and one for the "wide" bandwidth setting. In the following listings, such specs are separated by a slash mark (/) with wide-band readings listed to the left of the slash, and narrow band readings to the right.

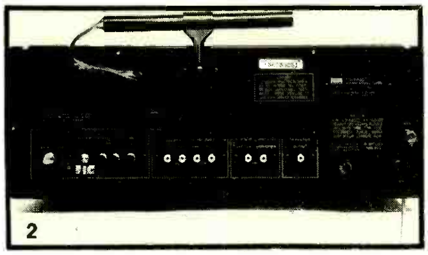
FM SECTION
IHF Sensitivity: 1.5 μV (9.0 dBf). **Signal-to-Noise Ratio:** mono, 80 dB; stereo, 76 dB. **Harmonic Distortion:** 1 kHz: mono, 0.06/0.5%; stereo 1 kHz, 0.08/0.8%; 50 Hz, 0.1/0.8%; 10 kHz, 0.15/1.2%. **Selectivity:** 55/90 dB. **Capture Ratio:** 1.0/3.0 dB. **AM Suppression:** 58 dB. **Image Rejection:** Better than 100 dB. **IF Rejection:** Better than 110 dB. **Spurious Rejection:** Better than 110 dB. **Stereo Separation** 1 kHz: 50/30 dB. **Frequency Response:** 30 to 15,000 Hz, +0.5, –0.8 dB.

AM SECTION:
Sensitivity: 45 dB/m (internal antenna). **Selectivity:** 70 dB. **Image Rejection:** Better than 100 dB/m. **IF Rejection:** Better than 100 dB/m.

GENERAL SPECIFICATIONS:
Output Level: (variable) 0 to 1.0 volts; dolby outputs, 0.4 volts. **Power Requirements:** 120 VAC 50/60 Hz, 23 watts maximum. **Dimensions:** 18⅛" wide × 6$^{5}/_{16}$" high × 12¼" deep (46 W. × 16 H. × 31.1 D. cm). **Net Weight:** 21.2 lbs (9.62 Kg.) Retail Price: $450.00.

DESIGNING STATE-OF-THE-ART TUNERS SEEMS to have become an engineering exercise with many of the world's leading high-fidelity engineering departments. The latest such "high-end" tuner to appear in our laboratories for test and evaluation is Sansui's new *TU-9900*. Perhaps the most outstanding characteristic of this new tuner is its selectable IF bandwidth, about which we shall have more to say in a moment. For the moment, let's examine the interesting looking front-panel of this tuner (Fig. 1). This thick, black, front-panel extends beyond the dimensions of the chassis and its metal wrap on all sides so that the unit could be easily custom mounted in a wood cabinet or other suitable piece of furniture. Contrasting with the black outer section, the highly visible light-colored dial area has a back sloped section on which a linear FM and an AM dial-scale are printed. Calibration marks for FM are at every quarter of a megahertz. A vertical, brown, section of the panel, also located behind the dial glass, houses a pair of meters—signal strength and center-of-channel tuning. The signal-strength meter doubles as a multipath indicator when a button is depressed. This section also contains a stereo indicator light, a three position selector switch (AM, FM-AUTO and MONO) with accompanying indicator lights and a massive tuning knob. One good twist of that tuning knob is enough to send the dial pointer scurrying smoothly across the entire span from 88 to 108 MHz or from 530 to 1600 kHz. To the left of the somewhat assymetrically positioned dial area are seven buttons arranged in a vertical row. In addition to the meter selector just described, six other buttons handle antenna atenuation, bandwidth selection (wide or narrow), a noise cancelling circuit, a built-in calibration tone oscillator (useful for setting up level controls on associated recording equipment, and set to correspond to 10-dB below 100% FM-modulation output) and a low-pass filter switch that effectively cuts out residual subcarrier (19 and 38 kHz) signals without materially affecting audio-frequency response. A rotary output-level control and a toggle power switch complete the front-panel layout.

The rear panel, shown in Fig. 2, has a



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coaxial connector as well as conventional screw terminals for connection of either a 75-ohm or a 300-ohm transmission line. An external AM antenna terminal is also provided. Output terminals are incorporated for variable output as well as for fixed output. The fixed-output terminals (which deliver approximately 0.4 volts for 100% modulation) are labelled DOLBY OUTPUTS, which may be a bit confusing to the user even though they are correctly described in the manual. Specifically, the Dolby outputs do have a passive network that converts the de-emphasis characteristic from 75 microseconds to 25 microseconds (at the expense of some output level) but an outboard Dolby decoder or adaptor would still be necessary if you want to enjoy Dolby broadcasts in properly decoded form. An additional pair of jacks are included for connecting to the horizontal and vertical inputs of any oscilloscope for more precise observation of multipath interference (and for proper orientation of your external FM antenna), as is a single detector output jack intended for future connection to a 4-channel FM adaptor if discrete 4-channel broadcasting should be approved by the FCC at some future date. A convenience AC outlet (unswitched) and a chassis ground terminal are also included on the rear panel of the TU-9900 tuner.

Construction and circuitry

Six major circuit modules and four smaller ones make up the circuitry of the *TU-9900* tuner. Five of these are visible in the photo of Fig. 3. The shielded front-end is located in the right portion of the photo and the shielded FM IF section is also clearly visible, with access holes for alignment also seen in the photo. The front-end of the tuner contains three dual-gate FET's, two of which are used as RF amplifiers. In the wideband position, the IF section uses two 6-pole LC block filters while the narrowband setting adds an additional narrowband ceramic-filter is added. A wideband ratio detector is used ahead of a phase-locked-loop multiplex demodulator. A sharp low-pass filter follows the demodulator. A dual element ceramic-filter plus a double-tuned circuit are used in the completely separate three-gang tuned AM section of the *TU-9900*. The FM antenna attenuator switch inserts a 30-dB pad in the antenna circuit preventing overload from unusually nearby strong signals.

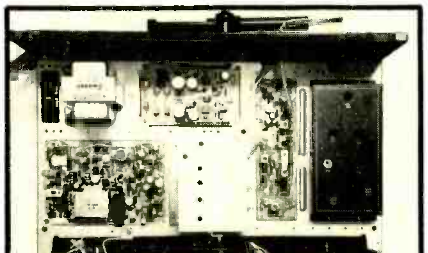
TABLE I

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Sansui** Model: **TU-9900**

FM PERFORMANCE MEASUREMENTS

	R-E Measurement		R-E
SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE	**WIDE**	**NARROW**	**Evaluation**
IHF sensitivity, mono: (μV) (dBf)	1.5 (9.0)	1.7 (10.0)	**Superb**
Sensitivity, stereo (μV) (dBf)	5.0 (19.4)	3.0 (14.9)	**Excellent**
50 dB quieting signal, mono (μV) (dBf)	2.2 (12.2)	2.0 (11.4)	**Excellent**
50 dB quieting signal, stereo (μV) (dBf)	28 (34.3)	22 (32.2)	**Superb**
Maximum S/N ratio, mono (dB)	84	84	**Superb**
Maximum S/N ratio, stereo (dB)	73	73	**Excellent**
Capture ratio (dB)	1.0	3.3	**Excellent**
AM suppression (dB)	60	—	**Very good**
Image rejection (dB)	100 +	—	**Excellent**
IF rejection (dB)	100 +	—	**Excellent**
Spurious rejection (dB)	100 +	—	**Excellent**
Alternate channel selectivity (dB)	57	95	**See Text**
FIDELITY AND DISTORTION MEASUREMENTS			
Frequency response, 50 Hz to 15 kHz (±dB)	+0.3	–0.5	**Very Good**
Harmonic distortion, 1 kHz, mono (%)	0.037	0.20	**Superb**
Harmonic distortion, 1 kHz, stereo (%)	0.037	0.55	**Superb**
Harmonic distortion, 100 Hz, mono (%)	0.075	0.075	**Excellent**
Harmonic distortion, 100 Hz, stereo (%)	0.075	0.095	**Excellent**
Harmonic distortion, 6 kHz, mono (%)	0.075	0.65	**Superb**
Harmonic distortion, 6 kHz, stereo (%)	0.10	0.50	**Superb**
Distortion at 50 dB quieting, mono (%)	1.0	1.3	**Good**
Distortion at 50 dB quieting, stereo (%)	0.3	1.3	**Very good**
STEREO PERFORMANCE MEASUREMENTS			
Stereo threshold (mV) (dBf)	5.0 (19.3)	3.0 (14.9)	**Very Good**
Separation, 1 kHz (dB)	46	42	**Excellent**
Separation, 100 Hz (dB)	43	39	**Excellent**
Separation, 10 kHz (dB)	36	40	**Superb**
MISCELLANEOUS MEASUREMENTS			
Muting threshold (μV) (dBf)	5.0 (19.3)	3.3 (15.8)	**Good**
Dial calibration accuracy (±kHz @ MHz)	–.2 MHz	—	**Fair**
EVALUATION OF CONTROLS, DESIGN, CONSTRUCTION			
Control layout			**Excellent**
Ease of tuning			**Superb**
Accuracy of meters or other tuning aids			**Excellent**
Usefulness of other controls			**Very Good**
Construction and internal layout			**Excellent**
Ease of servicing			**Excellent**
Evaluation of extra features, if any			**Superb**
OVERALL FM PERFORMANCE RATING			**Excellent**



FM measurements

The measurements listed in Table I take on a somewhat different form, since many of the performance results differ depending upon whether the tuner is set to the wideband or narrowband position. In the narrowband position, distortion readings are anything but outstanding, but this is to be expected since narrowing the IF bandwidth restricts the ability of the circuit to linearly pass the complex sideband information that is contained in a received FM signal.

Note that the 100 Hz THD in mono is the same regardless of which bandpass mode is chosen, whereas at higher modulating frequencies (such as at the 6-kHz test frequency), the higher-order sidebands generated by such a modulating frequency are "lopped off" in the narrowband position. This results in distortion readings that are a whole order or magnitude greater than when tested in the wideband position. But oh, those wideband readings! We have never measured distortion that is any lower for any tuner ever tested.

The signal-to-noise reading of 84 dB in mono is an all-time lab record for us as well

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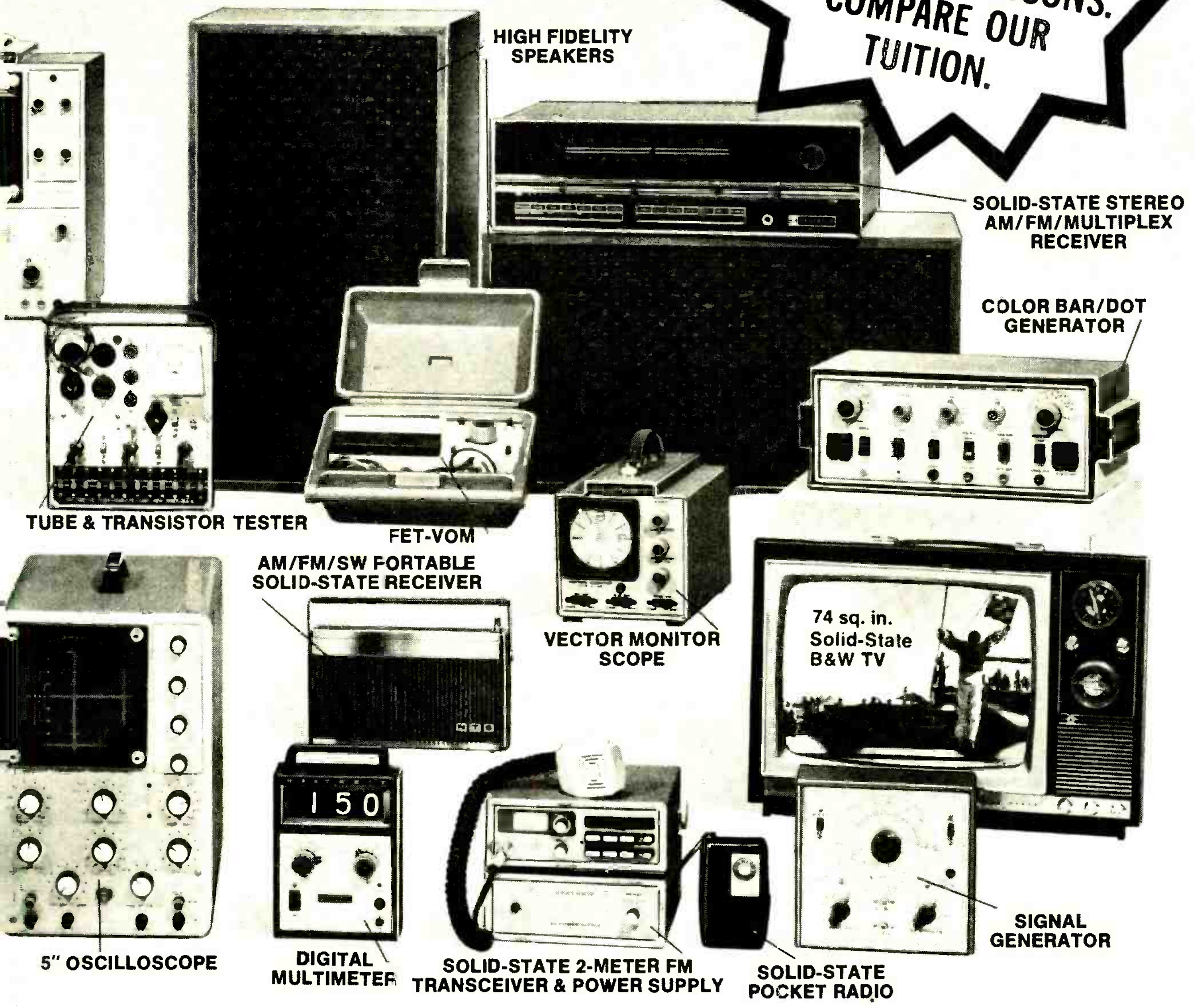

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and the stereo 50-dB quieting point, which in most cases requires around 35 μV (36.3 dBf), is achieved on this remarkable tuner with an input signal of only 28 μV (34.3 dBf) or 22.0 μV (32.2 dBf) in the narrowband position. The penalty one has to pay in using the wideband position is, of course, reduced alternate channel selectivity, which means that if you are in the unhappy position of living in an area that has a very crowded FM band, you may not be able to avail yourself of the incredible performance that this tuner can deliver when set to the wideband mode.

Note that in the wideband mode, selectivity is a mediocre 57 dB; whereas when the narrowband mode is selected, it increases to a superb 95 dB. It's all a matter of tradeoffs, though we believe that Sansui might have made the narrowband mode just a little *less* narrow than they did so that the differences in performance between the two positions would not be quite as great as they are.

Separation, which was supposed to undergo some appreciable degradation when the receiver is operated in the narrow mode, remained surprisingly good (42 dB at mid-band). In the wideband mode, however, we were not able to achieve the mid-band separation of 50 dB as claimed. Stereo threshold was just about where we would like to see it, as was the muting threshold which is not customer adjustable. We were somewhat surprised to find that frequency calibration of the tuner was off by a consistent 200 kHz all the way from one end of the dial to the other. A repositioning of the dial pointer by a small amount would correct this, since the error is consistent from 88 MHz to 108 MHz and did not seem to be a function of misalignment (after all, we did read an incredible 1.5 μV of IHF sensitivity in the wideband mode—the lowest reading possible at 300 ohms and the best we have ever read).

TABLE II

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Sansui** Model: **TU-9900**

OVERALL PRODUCT ANALYSIS

Retail price	**$450.00**
Price category	**Medium/High**
Price/performance ratio	**Superb**
Styling and appearance	**Very good**
Sound quality	**Excellent**
Mechanical performance	**Excellent**

Comments: Any tuner designer is faced with a series of tradeoffs. If IF bandwidth is made too wide, selectivity suffers, though low orders of distortion can be achieved. If too narrow bandwidth is chosen, selectivity can be made as high as desired, but needed sideband energy contained in the modulation pattern of the FM signal is attenuated with resulting distortion in recovered audio. Sansui has solved this problem by providing the best of both worlds. Offering selectable bandwidth (wide and narrow) lets the user who is not plagued by closely spaced stations enjoy FM reception at its very finest, while the user in a crowded signal area has the option of listening to a bit higher distortion in return for being able to separate out those closely packed stations on the dial. The idea is not new (Yamaha and McIntosh have had such variable bandwidth FM circuits on the market for some time) but never has it been executed so as to achieve the incredibly low distortion figures (in the wide position) which we measured for this magnificent tuner. One measurement "record" after another was "broken" as we put this tuner through its paces. For example, the 84 dB S/N ratio measured was thought to be beyond the capability of our test equipment—but that is what we were able to read in the mono mode of the Sansui TU-9900. Most amazing of all is the price of this tuner. At a suggested retail of $450 its performance exceeds that of $600.00, $1200.00 and even more expensive units that have passed through our laboratories. One nagging question remains, however: with tuners such as the Sansui TU-9900 now available at such reasonable cost, what stations are users going to be able to tune to in order to really realize just how good the FM reception from these products can really be? What you will hear when using a Sansui TU-9900 will in every case, be limited by transmission practices and signal quality from your own local FM stations. Sadly, in most cases, that just isn't good enough to show off this tuner to its best advantage. You can, of course, apply lobbying pressure to your favorite stations to clean things up—or you can invest in a Sansui TU-9900 now and hope that station practices will get better someday in the future.

Listening tests

If anything, using the *TU-9900* to listen to local FM fare in our area merely points up once again just how bad some FM signals are. With a tuner such as this, it is really possible to judge station signal quality, for any differences in distortion that are audible are definitely a function of the broadcast signal and not the tuner. We were, of course, careful to reduce multipath interference to an absolute minimum in judging the listenability of this product and used a scope for this purpose in addition to the built-in multipath indicator. Our summary comments and overall product evaluation concerning this elegantly executed stereo tuner will be found in Table II. In addition to its being a top performing tuner for use with the most sophisticated "separate" high-fidelity component system in anyone's home, may we humbly suggest that some of the FM radio stations in our area (and yours) purchase one of these wonders as a station monitor. Perhaps many of them have been blaming their monitoring tuners or receivers for the poor quality they've been hearing. Given the capabilities of the Sansui *TU-9900*, perhaps they will realize that the trouble may lie elsewhere and will do something to bring us the kind of FM reception that this tuner is capable. **R-E**

BATTERY REFERENCE BOOK?

Do you know of a good book dealing with batteries? I need something that covers all types.—M.J.W., Mt. Dora, FL.

The reference nook I use most often is Union Carbide's "Eveready Battery Applications Engineering Data", put out by Union Carbide Corp., Consumer Products Div., 270 Park Ave., New York, NY 10017. This is available in many radio-TV supply houses. I'm sure that there are several others from the larger battery makers.

The March 1976 issue of IEEE Spectrum has a very good article dealing with all types of batteries. You may find this in the library.

VERTICAL SYNC PROBLEM!

You won't believe this! I wrote you in December 1974 about a vertical sync problem with a Magnavox U99. You gave me some ideas (none of which helped) but it was crazy. With the back off, the sync was OK; back on, no sync. Change the tube, integrator, etc., etc.—no help. Finally dawned on me. With the back off I was hooking the antenna to the insulation of the lead-in to the tuner. Now I could make it roll with the back off by hooking to the ends of the line.

Checked all capacitors; good. Changed all capacitors. Nothing. Once in a while the picture would go very snowy. Changed the 2DZ4 and cleared that up. Still had no vertical sync! Finally, in desperation, I changed the 1N82 mixer diode. THAT DID IT! Putting the old one back in, you could see the vertical sync disappear on the scope! New one, fine sync!—Glenn Schaefer, Schaefer TV, Peoria, IL.

NO CATHODE VOLTAGE

After replacing the flyback in this Philco 21L23, nothing works! Used exact replacement transformer and I've changed all of the tubes. No raster, no high-voltage. Boost voltage reads only +87 volts. The damper cathode reads zero, so I know it's not conducting. Have you got any fresh ideas?—R.B. Santa Ana, CA.

Fresh ideas? At my age? Hmm. However, I can see something decidedly wrong here! You read zero on the damper cathode. You *must* have the full DC supply voltage at this point, even though the horizontal sweep section is not operating. Reason: every bit of the current used in this whole section flows *through* the damper tube!

This doesn't seem to be a short circuit, for this would trip the breaker. So, something is open. I have seen this happen before. In one set, the damper cathode ribbon was broken. Since you've tried new tubes (right!) that should be OK. Look for something like a broken connection. **R-E**

MIND POWER: ALPHA

Part IV. Build this biofeedback device that displays the presence of alpha waves on a TV screen. You can use it to learn how to control your alpha waves, and gain from the benefit of the relaxation that comes with it

BIOFEEDBACK IS ONE OF THE IMPORTANT METHODS THAT SCIENCE has unearthed to help us relax. The principle is simple: provide a way for the brain to sense that it is successfully gaining control over sources of stress, and control will become a new, normal function. Thus, just as your brain can learn to read, understand a foreign language, play a chess game, etc., so too can it learn to reduce tension and stress.

During the state of relaxation and tranquility, brainwaves show a dominant *alphawave rhythm.* To detect these alphawaves, an outside instrument is needed. That instrument is Mindpower: Alpha.

Mindpower: Alpha is a unique new biofeedback instrument that serves as a link between your mind and a visible, controllable display on your television set's screen. It aids you to train your mind to come down from a high-tension state of anxiety and stress, to a state of relaxation and stress-relief. This *alpha* state—the subject of intense interest among physicians, meditators, yogis, mind control groups and scientific researchers—has been shown to be beneficial to the body as well as to the mind.

In the preceding three parts of this article, the design, components, and assembly of Mindpower: Alpha have been described in detail. This month's concluding part of the article will describe how to connect Mindpower: Alpha to your television set, the initial set-up procedures and how to use Mindpower: Alpha to gain control over your alphawaves.

Hookup

The composite video output signal from the Mindpower: Alpha video-driver can enter the TV set by either of two ways: *direct connection* to the video amplifier stage of the TV set; or, injection via a modulated RF-oscillator connected between the video output of Mindpower: Alpha and the antenna input terminals of your TV set. The modulated RF-oscillator is the type commonly used and sold to connect a television camera to a TV set for closed-circuit use. Such an oscillator generates a very low-power TV signal on a selected TV-channel that is then tuned-in as a broadcast TV signal would be.

Although not offered for sale by National Mentor Corporation, a modulated RF-oscillator that is compatible with Mindpower: Alpha's video levels is the *Pixie-Verter,* model PXV-2A, available in kit form at $8.50 postpaid from ATV Research, 13th and Broadway, Dakota City, NE 68731. Instructions for assembly and use accompany the *Pixie-Verter.*

Note: The combination of Mindpower: Alpha and any modulated RF-oscillator may be construed to be a *Class-1 Video Device,* within the meaning of Part 15 of FCC Rules and Regulations. The FCC may require certification of such a combination and can impose penalties for willful, malicious or harmful interference. Moreover, it is against FCC regulations to sell such a combination unless properly certified. Users of such combinations are advised to familiarize themselves with the relevant portions of Part 15 so as to ensure compliance with present standards and requirements.

NOTE

Mindpower: Alpha is an intriguing device for entertainment and experimentation in video biofeedback. It is not a therapeutic instrument, neither is it suggested as a cure for individuals suffering from psychological or physiological disorders.

Direct Connection

If you choose, instead, to connect your Mindpower: Alpha directly to your TV set's video amplifier, be sure to take safety into consideration. First, determine what kind of power supply your TV operates from. If it is an AC-DC set, it lacks a power transformer. This means that one side of the power line connects directly to the chassis of the TV set, making it "hot" with respect to ground. **Connection to a set of this type is hazardous and is not recommended.** The danger, here, is that the shield of the video cable may bring the "hot" chassis potential of the TV set out to the otherwise safe, transformer-operated section of the Mindpower: Alpha printed-circuit board. Your TV set should have a power transformer-isolated power supply for complete safety in operation. If it does not, locate one that does or purchase an external isolation transformer and use it to operate your TV set.

Second, be aware that hazardous-level voltages are present inside any TV set. It is possible to receive a severe shock from the circuitry, even with power-off due to storage of potentials in power supply capacitors and the second-anode capacitance of the picture tube. If you are unfamiliar with the locations of hazardous voltages within your set, have a qualified TV service technician make the connection for you.

Third, locate the input to the video amplifier section of your TV set. To do this, you should have the schematic diagram of your TV set. As an aid in locating the correct connection point, Figs. 1 and 2 show typical vacuum tube and transistor-type video amplifier stages used in most TV sets. Yours will probably be a variation of either circuit. The connection point will be the input to the video amplifier where the video detector connects.

While the video output level of Mindpower: Alpha is just right for most TV sets, it may be too high for some. If necessary, you can reduce the video output to a lower level by

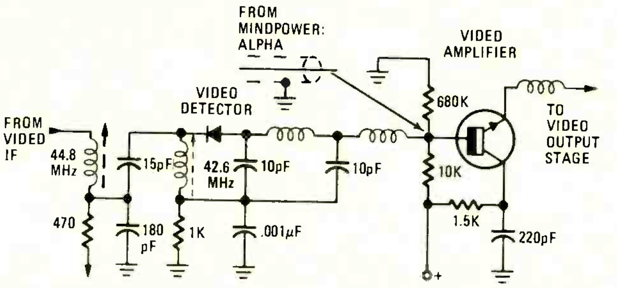


FIG. 1—TYPICAL TRANSISTOR VIDEO AMPLIFIER stage showing the connection point of Mindpower: Alpha.

use of a simple resistive divider. (The resistor values to be used depend upon the circuit values in the video amplifier of your TV set.)

Final check

With the TV set on, plug in Mindpower: Alpha and set its MODE switch to the 1 position. (Turn off the BATTERY switch to prevent stray pickup from the electrode circuit from affecting the display.) At this point, you *may* see the display on the screen, although you probably will have to adjust the horizontal hold control of your TV set slightly to account for the 390-Hz difference between Mindpower: Alpha's horizontal frequency (15.36 kHz) and the 15.75 kHz horizontal frequency of a standard U.S. television broadcast signal. When this simple adjustment has been made, the image should stabilize and the TV screen should now be displaying a stationary white "hollow" rectangle against a dark field. Turn down the TV's brightness control to darken the field. Turn up the contrast control to increase the "whiteness" of the rectangle while improving the "blackness" of the field. Avoid excess contrast that makes the display seem harsh. Find a combination of settings at which the display seems visually comfortable to you.

Next, set the ALPHA switch to the TEST position. Note that the display shrinks to the center of the screen and blinks at the alpha test oscillator's rate. If you'd like to hear this, set the BEEP switch to the ON position.

If you don't obtain the results specified, re-check your connections and be sure that you've properly chosen the video amplifier connection point in your set. If the display won't stay in sync, or tears, you are probably overloading the video amplifier with signal, and a resistive divider will be needed to reduce the signal level. (Alternatively, you may wish to reduce the value of resistor R91 to lower the video signal output of driver Q12.)

Using Mindpower: Alpha

Note: Mindpower: Alpha is intended for use by normal individuals, as a device for entertainment and experimentation in video biofeedback. Persons suffering from epilepsy, or mental or physical disorders of any kind, should use Mindpower: Alpha only under the supervision of a physician. No therapeutic claims are made for this device, nor that each and every individual who uses the device will benefit from such use. National Mentor Corporation assumes no liability whatsoever with respect to the assembly, installation, use or misuse of this device.

To apply the electrodes, hold the headband so that the two frontal electrode-buttons are closest to your right hand; the buttons should be facing toward you. Place the buttons against your forehead (comb back your hair first so that no hair gets trapped between button and skin to cause erratic contact), then wrap the band around your head about as snugly as you can comfortably stand. The prongs of the occipital electrode should comb through the hair at the back of the skull, and you should feel them contact the skin, below. If there is any sensation of discomfort, at first, it will pass within a minute or so as your skin sensors become accustomed to the headband and electrodes.

Turn on the TV and plug in the Mindpower: Alpha power transformer. Now, turn on the EEG front-end by setting the BATTERY and BEEP switches to the ON positions. With electrodes positioned as described above, gradually turn the THRESHOLD control clockwise. If you've barely turned it and hear a raspy, buzzing note from the speaker, plus a display that shrinks to nothing or even vanishes from the screen, you're not seeing alpha but you are seeing stray 60-Hz pickup caused by poor electrode contact. Check that there is no hair interfering between the electrodes and skin. Also, that there is no skin lotion, cream or make-up on the skin where electrodes are contacting. Wash the skin and clean the electrodes, if necessary, and try again.

Assuming, however, that you *don't* have a problem, advance the THRESHOLD control about a third of its rotation and blink your eyes. At some point, you will hear a "beep" and see the display shrink slightly in response to your eye blink. The blink response shows that gain is close to the

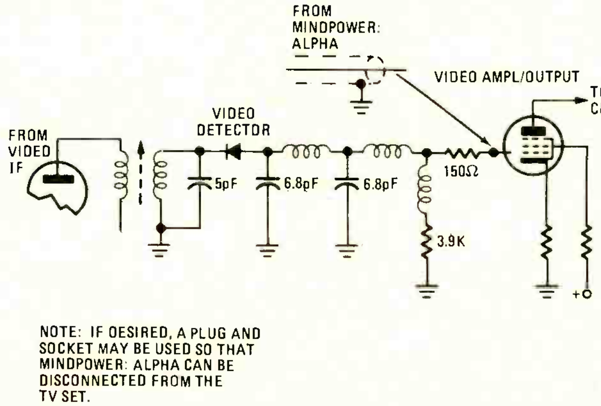


FIG. 2—TYPICAL TUBE-TYPE VIDEO AMPLIFIER STAGE. Mindpower: Alpha is connected between video amplifier and video detector.

correct setting. You are now picking up bioelectric signals from the occipital region of the brain, where visual signals are "projected" on the surface of the brain's cortex. Advance the THRESHOLD control a bit further and you may notice occasional beeps and response of the video image. You are now catching occasional alpha bursts that may be originating in any region of the brain between the right frontal electrode and the left occipital electrode. Advancing the control further, you may start to pick up 60-Hz interference, and you should now back off slightly on the control until the device responds only occasionally to bursts and is otherwise quiet. Note the setting of the THRESHOLD control for future reference.

To give yourself with a reference as to what strong, sustained alpha looks and sounds like, move the ALPHA switch to TEST. You should hear a rhythmic beeping and observe that the display shrinks to screen center and flickers at the beep rate. Slide the ALPHA switch back to NORM and you're ready to begin experimenting.

Progressive stages of training

Despite the temptation you may feel to rush ahead *now* and try controlling the TV display with your brainwaves, you may be in for a disappointment if you do. As in all learning processes, the power to learn increases with each thing we learn. And so, Mindpower: Alpha is designed to help you progress through five learning stages; each strengthening your capacity to handle the next stage.

First, turn off the TV set and the BATTERY switch on Mindpower: Alpha. If possible, darken the room you're in to dimly lit state. Choose a comfortable chair to rest in and place a stool or hassock beneath your legs so that you can relax your leg muscles. Leave the headband electrodes on so that you will remain accustomed to the gentle pressure of the band. Settle back in your chair, trying to make yourself as comfortable as possible. You may want to place a cushion or pillow behind your shoulders and neck so that you don't press the occipital electrode uncomfortably against the head. Loosen or remove any tight articles of clothing that make their presence felt. As much as you can, try to eliminate distracting sensations. Now, commence this simple relaxation exercise.

HEADBAND shown properly positioned on users head.

Think of the word RELAX. It has five letters. Breathe in deeply and think of the letter R. Now, exhale slowly visualizing the letter R in your mind. Repeat the sound of the letter R to yourself three times, silently. Remain quiet and breathe regularly. Now, breathe in deeply and think of the letter E, and exhale slowly visualizing the letter E in your mind. Repeat the sound of the letter E to yourself three times, silently. Remain quiet and breathe regularly. Repeat this procedure for the letters L, A and X.

Your body and your mind should now be relaxed and alert, ready to try the first of the five learning stages.

Stage 1. Set the BATTERY switch to ON and note the beeper's response to your present comfortable state of mind and body. Settle back with your eyes closed and recall the pleasant relaxation sensations of a few minutes earlier. Let your mind drift, daydream if you wish. It doesn't matter about what, so long as you don't focus intently on some detail or problem. (Doing so will immediately shift your mind into beta, causing cessation of alpha.) As you mentally drift you will hear the beeper occasionally, signifying alpha occurrence in bursts. As time passes, the bursts will grow longer and more frequent. (This may happen within the first session, or, it may take several hours, spread over many twenty-minute sessions.) When alpha is occurring, try opening your eyes and note if the beeper's response stops abruptly or diminishes to random bursts. In most cases, opening the eyes will cause cessation of alpha. Close your eyes again and try to regain the alpha state. When it occurs note the mental state and physical sensations you feel when the beeper sounds. With practice you should be able to learn the mental and physical states that bring on the greatest alpha response. When you have achieved this, you're ready for Stage 2.

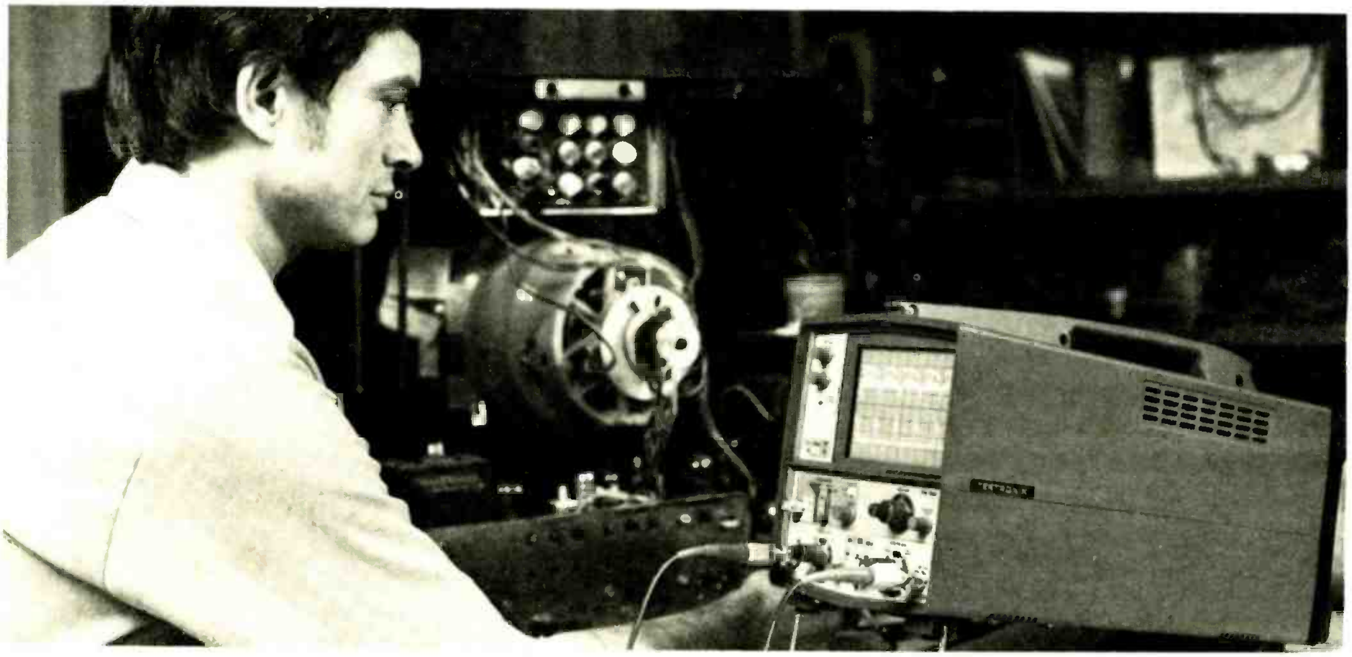
Stage 2. The setup is the same as for Stage 1. With your eyes closed, try to recall the mental and physical sensations that brought on the greatest alpha response in Stage 1. If you have difficulty in achieving alpha, try the R-E-L-A-X method to help you settle down. When alpha is occurring, reinforce yourself by noting your mental and physical state. Settle down again into alpha, and now try opening your eyes. If alpha ceases, try regaining it with your eyes open by recalling the mental and physical states that brought greatest response in Stage 1. (Generally, keep your eyes fixed on a point, while letting your attention drift.) With practice, you should be able to generate alpha with your eyes open, and you should be able to associate your mental and physical states with prolonged alpha generation. The time required to reach this state will vary. But, when you've obtained alpha with your eyes open, you are ready for Stage 3.

Stage 3. The setup is much the same as for Stages 1 and 2, except that the TV set is now on and the Mindpower: Alpha unit's MODE switch is set to 1. Begin with your eyes closed, working with the beeper to get into sustained alpha. Open your eyes and try to regain the eyes-open alpha you learned in Stage 2. Now, commence watching the Mode 1 video display on the TV screen. Slide into alpha again, noting what happens when the display shrinks in reaction to your alpha. If the shrink reaction causes cessation of alpha, try to regain the mental and physical sensations you learned in Stages 1 and 2. This should restore alpha each time it is "blocked" by the display's movement. With time and practice, the "blocking" reaction should be extinguished. Gradually, your alpha should become sustained and you will find the rectangle shrinking to a smaller and smaller size and remaining so for longer periods. When you've reached this point, move on to Stage 4.

Stage 4. You are now ready to make the transition from audio feedback to video feedback. Set the BEEP switch to OFF and use Mode 1 video alone. Using the methods described earlier, get into a relaxed state and now attempt to recall the sensations that produced the greatest alpha response. As you now see the alpha response by the video display, you will realize that what your brain has previously learned through aural sensation has now been carried over into the *visual* sensory pathway. To increase the strength of your alpha, try reducing the THRESHOLD setting slightly so that it will be necessary to generate alpha waves of higher amplitude to secure response. With time and practice, you should see this increase occur. You are then ready to move on to Stage 5.

Stage 5. In this stage, we add the dimension of *movement* to the video display. We live in a world of moving visual-stimulus, and so it is another training step toward relaxing in the real world to learn how to generate alpha when confronted by a dynamic visual sensation. Commencing as before, enter the alpha state. Now, set the MODE switch to 2 and let your eyes follow the periodic expanding display on the TV set screen. Recall the physical and mental states that yield peak alpha and observe how each burst arrests the rectangle's outward expansion. Your goal is simple: overcome the display's motion and hold the rectangle at a fixed size on the screen. Beyond this, you can try to *back it down* to a minimum size at screen center, completely preventing its outward motion. Both of these tasks are difficult because they require sustained high-amplitude alpha. It should be expected that considerable time may be required to master this stage. Once you have done so, however, you will have reached a new plateau of control over the brain-body matrix.

Perhaps the most fascinating results of your experience with Mindpower: Alpha will come from your day-to-day experiences in real-world situations. Your mind and body have now been trained to some extent to relate to one another in a new way. In the presence of a stressful situation, attempt to recall the mental and physical sensations associated with peak alpha. By doing so, you should be able to bring on a state of stress-reduction. The degree of success you experience in doing this will determine whether or not you need additional training in the earlier stages to achieve stronger results. **R-E**



Delayed-Sweep Scopes–how and why

Delayed-sweep oscilloscopes are gaining in popularity. Here's a description of what delayed-sweep does and how to use it

BILL GLAZE*

DELAYED SWEEP, A METHOD OF MAGNIFYING selected portions of an oscilloscope trace, is now available even in some low-cost instruments. It might be just what you need to make faster and better scope measurements. The technique is particularly useful in working with complex waveforms, composite video signals for example.

A delayed sweep makes use of two traces, one or both of which may be displayed. One trace is used to present the larger waveform being studied. The second or delayed trace, running faster than the first, is used to produce a "close-up" of some desired portion of the signal.

Triggering

The trigger circuit in a conventional oscilloscope starts each sweep of the trace at a preset input-signal level. Triggering can normally be adjusted for a particular input signal slope and level, or can be controlled externally.

Conventional triggering produces a flicker-free trace only if the trigger is set off by just one event in each waveform. This can make it difficult to examine portions of a complex waveform in detail, since it may be hard to find a unique signal level close to the point of interest to trigger on.

With delayed sweep, the main ("A") channel of a delayed-sweep scope operates in the conventional trigger mode. The "B" channel can sometimes be operated similarly. But with delayed sweep, the B-channel triggering can also be delayed (set to trigger at a given time after the A-channel triggers. The length of time between the start of the A-channel sweep and the delayed B-channel sweep is called the delay time and is adjusted with the scope's delay control.

Thus, the A-channel sweep can be set on any clear trigger point in the signal, and the delayed sweep can be set to start at a specified time later, even if there is nothing in the signal itself to trigger a second trace.

Trigger holdoff is sometimes mentioned as a more inexpensive substitute for delayed sweep. This feature will do the job in a limited set of cases where the only triggering problem is too many trigger points on a repetitive signal. The holdoff control simply blocks triggering for a settable time after normal retrace. Consequently, this method cannot be used when there is no clear signal close to the point of interest, the signal is not repetitive, or the interval involved cannot be synchronized—is shorter or longer than the holdoff period. For this reason, trigger holdoff, although useful in itself, is rarely an adequate replacement for delayed sweep. It is a good supplement and is often offered as a convenience on delayed sweep scopes.

Operation

Suppose you are interested in viewing the central portion of the trace illustrated in Fig. 1-a. If you set a conventional scope to trigger at the slope and amplitude of the part of the wave you are interested in, it would also be triggered by several other portions of the wave and produce a flickering display. To avoid flickering, the scope must be set to trigger only on a unique peak in the signal. When triggering on the beginning of the waveform, you must use a relatively slow sweep rate to view

* Tektronix, Inc., Beaverton, OR 97077

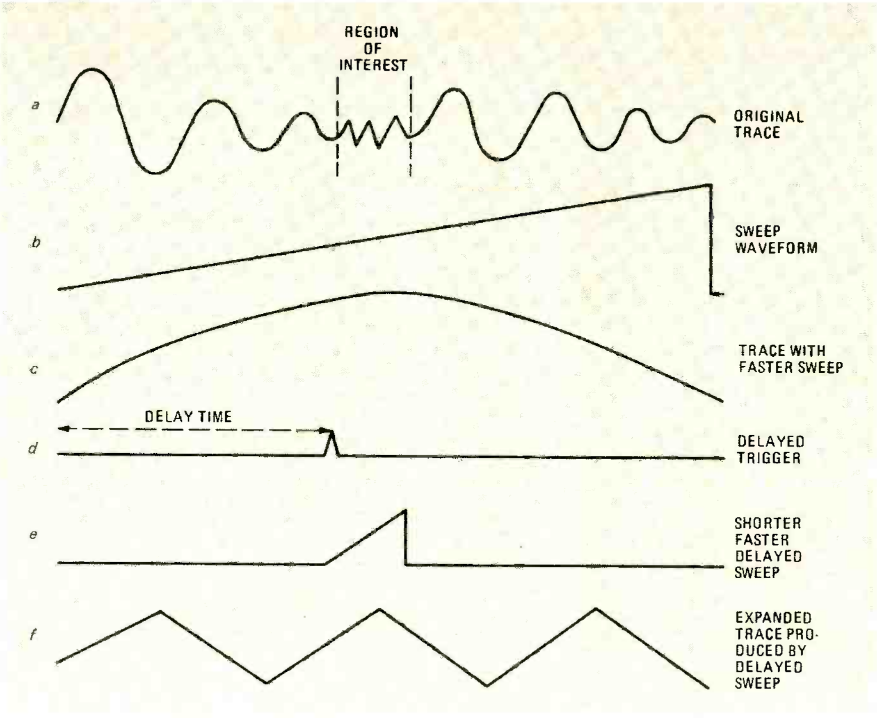


FIG. 1—DELAYED SWEEP WAVEFORM—how it is produced.

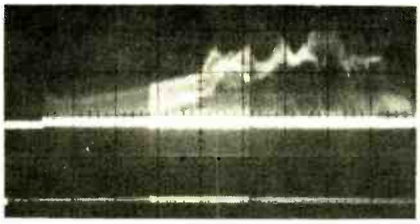


FIG. 2—FRAME OF COMPOSITE VIDEO showing how the intensified region on the delaying trace marks the area to be presented on the delayed trace.

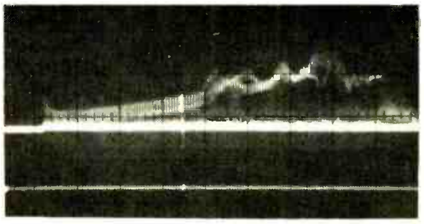


FIG. 3—A SINGLE LINE from a whole frame of composite video can be selected for display with delayed sweep.

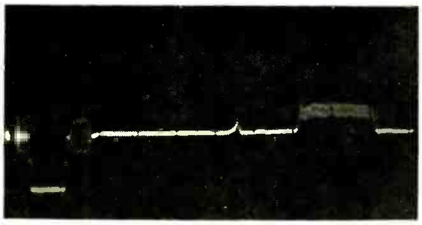


FIG. 4—THE SINGLE VIDEO LINE. (All waveform photos made with the Tektronix T935 oscilloscope.)

the desired portion of the signal. (Figure 1-b shows the sweep waveform that a conventional scope would use.) A slow sweep-rate produces a trace that shows relatively little detail.

If you simply increased the sweep rate. you would only be able to see a small part of the signal in detail (Fig. 1-c) and in many cases you would miss the point of interest.

To view the wave with a delayed-sweep scope, you would first adjust the A-channel of the scope to give the best presentation of the wave you could get with conventional triggering. You would then adjust the delay time so that the B-channel does not trigger until just before the part of the signal you are interested in (Fig. 1-d). The timebase of the delayed sweep is independent of the main channel. By increasing the sweep rate of the B-channel (Fig. 1-e), the desired portion of the signal can be expanded to stretch the width of the screen.

The delayed sweep now shows a small, selected portion of the main trace (Fig. 1-f.)

Some delayed-sweep scopes have "displayed switching" capability, allowing you to choose between viewing the A-channel only, B-channel only, or both at the same time. Many scopes provide for intensifying the part of the main trace duplicated by the delayed trace. This makes it easier to adjust the delay control to show the desired portion of the trace.

Magnification

The delayed trace, set on a faster timebase, effectively magnifies a portion of the main trace. The amount of magnification is equal to the sweep speed of the main trace, in time per division, divided by the sweep speed of the delayed trace expressed in the same units. For example, if the delaying sweep is set at 20 ms/div and the delayed sweep at 2 ms/div, the magnification will be 10×. By speeding up the delayed sweep to 0.2 ms or 200 ms/div, one hundredth of the main trace is displayed at 100× magnification.

At very high magnifications, on the order of 1000×: the delayed trace may be somewhat jittery. Even small variations in the signal, or in the triggering or delay of the main trace, will cause large displacements of the delayed trace. This difficulty can be overcome only by modifying the delayed channel trigger. On some more expensive scopes, instead of triggering automatically a set time after the maintrace triggers, the B-channel is merely enabled or armed after the delay time, and actually triggers on the input signal.

Using another technique, to allow further magnifications, some delayed-sweep scopes have a magnified mode. This allows the center portion of either or both traces to be magnified.

Video signals

The usefulness of the delayed-sweep scope is obvious when working with a composite video signal. The basic signal is displayed as the main trace. The delayed sweep controls can then be set to determine how large a portion of this initial trace will be expanded the full width of the cathode-ray tube for more detailed viewing. If the delayed sweep is set ten times faster than the main sweep, then one tenth of the original waveform will be expanded.

Choosing the portion of the main trace to be magnified is simplified if the scope can be set to intensify it automatically, as shown in Fig. 2. By adjusting the time delay, this brighter segment can be shifted left or right.

A further increase in the delayed sweep speed selects a shorter portion of the main waveform. Figure 3 shows a complete frame of a TV composite signal as the main trace, with one line to be magnified intensified. The chosen portion is so short, relative to the width of the main trace, that it appears as a single bright point. Fig. 4 shows the single TV horizontal line of picture information magnified and displayed as a delayed trace.

If the scope has a delayed-sweep magnifier feature, a portion of the delayed display can be further expanded. This could be used, for example, to expand the horizontal sync pulse (at the far right in the Fig. 4 display). A flicker-free, readable image of this signal showing as much detail would be impossible without delayed-sweep triggering. **R-E**

All about SWR and CB performance

ONE OF THE MOST POPULAR CB ACCESSORIES is the SWR meter, also known as the VSWR meter or VSWR bridge. The reason for the SWR meter's popularity, and the reason you should have one if you don't already own one, is that it quickly and easily indicates whether your antenna system is matched to your transceiver.

The SWR determines how much RF output the transmitter delivers to the line and how much of the energy fed into the line gets to the antenna. If the SWR is poor, very little of your transmitter's RF power will actually leave the rig.

Actually, SWR means *standing wave ratio*, and it is defined as the antenna's impedance divided by the transmission-line impedance, or vice versa. The exact arrangement of numbers isn't important as long as we end up with a whole number. For example, if the transmission line is 50 ohms and the antenna is 25 ohms, the SWR is 50/25 or 2:1. If the transmission line is 50 ohms and the antenna is 100 ohms, the SWR is 100/50, or 2:1. The ideal SWR is 1:1 and occurs when the two impedances are equal.

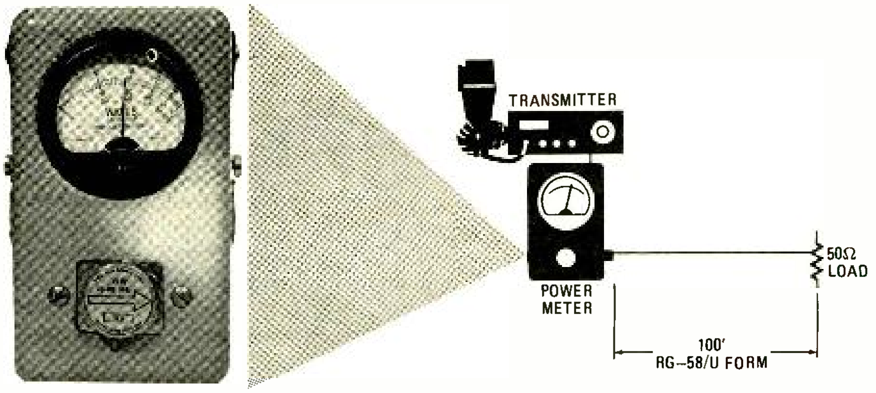
Impedance

Coaxial cable used for transmission lines has what is known as a characteristic impedance. This impedance is determined by the thickness and spacing of the wires and the dielectric that separates the center-conductor and shield.

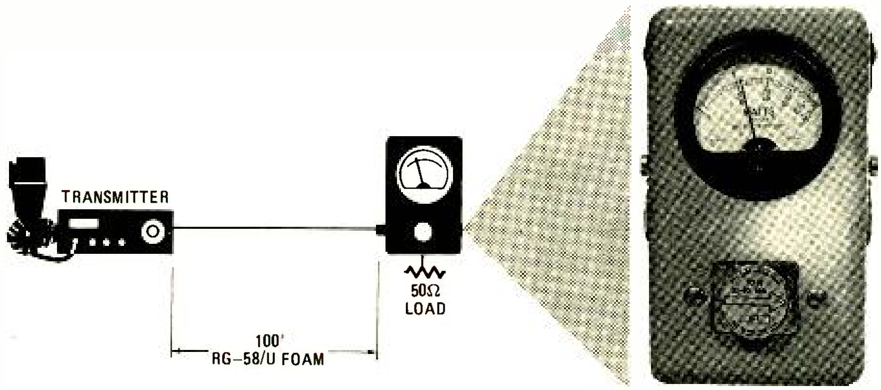
The antenna, at it's resonant frequency, has a *resistive impedance*—which is something other than *radiation resistance* though the two are often confused as meaning the same thing. The resistive impedance of an antenna is anything we design it to be. In the case of *most* CB antennas, the *impedance* is designed or tuned for a nominal 50 ohms. In this case, the antenna's radiation resistance might actually be closer to 10 ohms.

Maximum power is transferred from the transmission line to the antenna when the antenna's resistive (resonant) impedance is equal to the transmission-line impedance. Assuming no other line losses, if a CB transmitter feeds 4-watts RF into the transmission line, 4-watts will flow out the other end and into the antenna. If you could measure the voltage and current at any point along the transmission line you would find equal values all along the line.

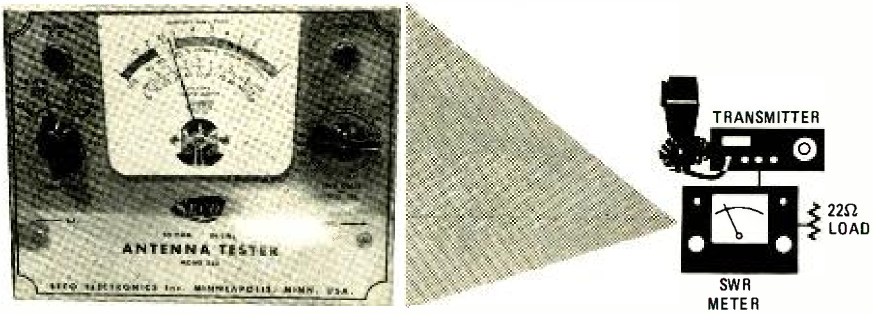
When the antenna is not equal to the line impedance, part of the energy at the line's output does not flow into the antenna; it actually turns around and flows back to the transmitter. The RF that is turned back is termed *reflected power* and it is dissipated as heat in the line and in the transmitter's output circuit. The amount of RF that is reflected is determined by the SWR—the mismatch between the antenna and line. Table 1 shows the effect of antenna/line mismatch for common SWR values. The table assumes the transmitter can deliver 4-watts into the



POWER MEASUREMENT at input to transmission line shows that the reference CB-transmitter used throughout the following tests delivers almost 3.7 watts of RF output.



POWER MEASUREMENT at the end of the 100-foot transmission line shows only 2.2 watts; 1.5 watts is lost as heat in the transmission line—a loss of 2.2 dB.



SWR MEASUREMENT with a 22-ohm load on a 50-ohm SWR meter indicates 2.7:1 instead of the calculated 2.27:1. The difference results from the meter acting as an ordinary transmission line and the meter does not "see" a pure resistance. It is not unusual for different SWR meters to produce slightly different readings.

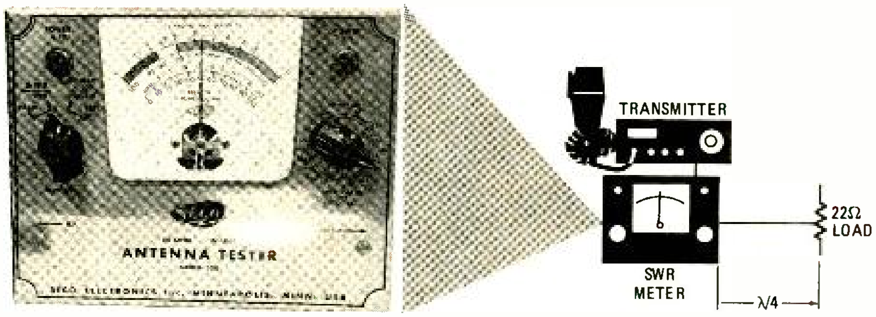
Getting maximum performance from a CB rig means reducing the SWR to a minimum, but this can mean more than simply adjusting the antenna. Other factors, such as the length of the transmission line, play a major role

HERB FRIEDMAN

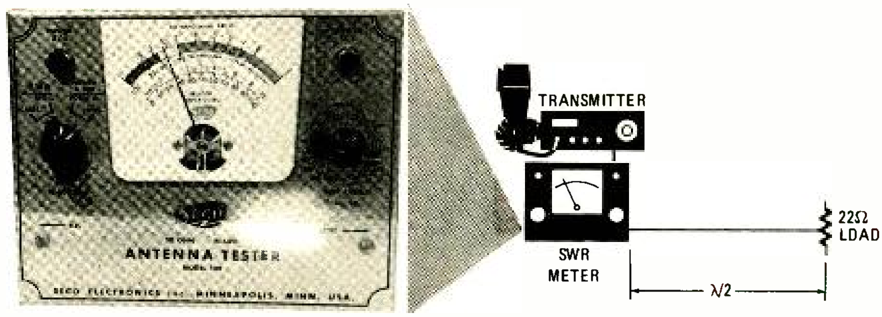
line under any condition, though as we'll show later this is rarely possible with CB gear.

Note that at almost perfect match—SWR of 1.2:1 or lower—most of what goes into the line eventually gets to the antenna. Even with an SWR of 1.5:1, 96% of the power fed into the transmission line gets to the antenna. It is only with an SWR of 2:1 that the power loss starts to be of concern. At 2:1, nearly a ½-watt of RF power is reflected and only 3.52 watts gets to the antenna. But even this is not a great loss if there were no other losses in the antenna system, for the loss represents only 0.55 dB—really an insignificant loss when you consider 1 S-unit is accepted to represent 6 dB.

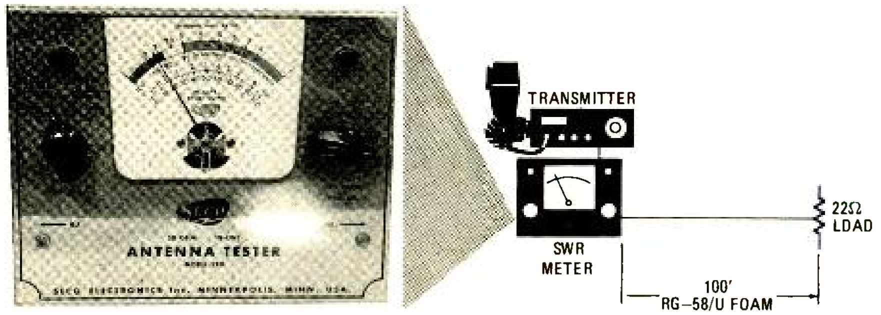
At SWR values from 3:1 upwards, however, the losses become severe and a substantial part of the RF energy fed into the line never makes it into the antenna. When the SWR reaches 8:1, a full 40% of the RF power is reflected back.



¼-WAVELENGTH TRANSMISSION LINE connected between SWR meter and 22-ohm load raises the SWR reading to 4.3:1. The meter "sees" the input to the ¼-wavelength matching section, which is a high impedance when the load is less than the characteristic impedance of the line.



ESSENTIALLY CORRECT SWR READING of 2.4:1 is obtained with a ½-wavelength line connected between the SWR meter and the load. The meter "sees" essentially the load because the ½-wavelength section acts as a load-repeater. The slight error is due to the meter's internal coax.



INCORRECT SWR READING of 1.7:1 is obtained using 100-feet of transmission line. The low reading results from the line-loss that reduces the reflected power.

Measuring SWR

The SWR of an antenna system can be measured in any number of ways. For the hobbyist, the easiest way to determine SWR is by using a *reflectometer.* This instrument measures the forward power (the power flowing from the transmitter to the antenna) in the transmission line and the reflected power (the power flowing from the antenna back to the transmitter). The magnitude of the SWR is the ratio of the forward power to the reflected power. The meter scale of the reflectometer is simply calibrated to read SWR.

A simple low-cost reflectometer can be made from a few common components. A simplified circuit of a low-cost reflectometer is shown in Fig. 1. The RF voltage in the transmission line is induced in the sensing wire and rectified by a diode. The resulting DC voltage is

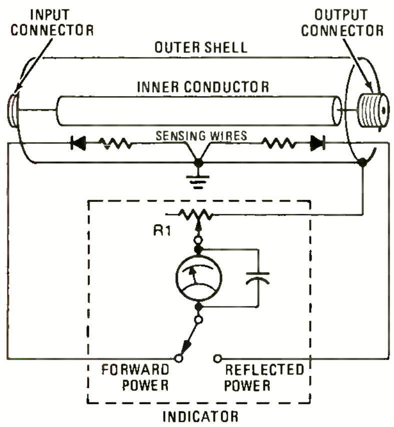


FIG. 1—SIMPLIFIED SWR METER. R1 is adjusted so meter indicates a full-scale reading for the forward power. Suitable calibrations indicate the reflected power in terms of SWR when S1 is switched.

proportional to the RF voltage in the transmission line. Since the impedance of the transmission line is constant, the DC voltage is also proportional to the RF power in the transmission line.

Two sensing wires and diodes are used. One combination senses the forward power and the other senses the reflected power. A switch is used to select between the two.

To use the reflectometer, the switch is first set for a forward power measurement and R1 is adjusted for a full-scale reading on the meter. The switch is then changed to measure the reflected power and the SWR is read directly from the meter scale. In many CB rigs, this circuit is built on a small PC board allowing built-in SWR metering.

Problems

If all a line/antenna mismatch meant was a loss in energy fed to the antenna there wouldn't be too much concern as long as the SWR was below 3:1, and in fact a 3:1 SWR is acceptable in mobile installations with short coax runs. It's the base installations, however, that really get socked by moderate SWR values, for SWR magnifies all other line losses as well as changing the apparent input impedance of the transmission line. Taking one thing at a time let's start with line losses.

All transmission lines have losses, there is no such thing as a lossless transmission line. Ordinary RG-58/U coax cable has a loss of 2-dB to 3-dB per 100-feet at around 27 MHz. For the sake of discussion let's assume you were stuck with a 3-dB loss in a 100-foot run between your transceiver and the antenna. If all you had to contend with was the normal 3-dB line-loss and the SWR (reflected power) loss was 25% (3:1 SWR) of the 4-watts fed into the line, only 1.5 watts would be fed into the antenna. No, don't shake your head. this is a common base situation and if you think a 3:1 SWR is unusual you have another guess coming (which we'll get to later).

Now note that we have allowed only for the normal line and SWR losses. During actual operation, the SWR has a multiplier effect on normal line loss. A 3:1 SWR on a transmission line with a normal 3-dB loss adds 1-dB more to the overall loss in the line. So, of the 4-watts fed into the transmission line under best-case conditions, only 1.2-watts gets into the antenna.

Or is it 1.2-watts? An SWR meter is really a forward/reflected power meter with a control that permits the user to calibrate the forward power to represent full scale. Keeping this in mind, let's look at the 3:1 SWR on the antenna system with 100-feet of coax transmission line. If the SWR meter and transceiver were connected directly at the input to the antenna, the meter would "see" 4-watts forward power and 1 watt (25%) reflected power. But in normal use the SWR meter is at the input to the transmission line—close to the transmitter's output where it "sees" 4-watts fed into the line. The 4-watts travels down the line and the actual 4-dB loss (3-dB line loss plus 1-dB loss due to the SWR) allows only 1.6-watts to come out. The antenna mismatch turns back 25% of the 1.6-watts, or 0.4-watts. The 0.4-watts that is reflected back down the line under the best-case condition will be

TABLE 1—EFFECT OF SWR (line to antenna mismatch) assuming the CB transmitter delivers 4-watts RF output into a lossless transmission line.

SWR	Percent power reflected at antenna	Watts fed into antenna
1:1	0.00	4
1.05:1	0.06	3.997
1.1:1	0.22	3.991
1.2:1	0.82	3.96
1.5:1	4.00	3.84
2:1	12.00	3.52
2.5:1	18.00	3.28
3:1	25.00	3.00
4:1	36.00	2.56
5:1	44.00	2.24
8:1	60.00	1.6

attenuated by the normal line-loss of 3 dB, so only 0.2-watts gets back to the SWR meter at the input to the line. The SWR meter knows nothing of line losses: it simply "sees" 4-watts forward power and 0.2-watts reflected power. As far as the meter is concerned, these values represent an SWR of about 1.6:1. So that's what the meter indicates, an SWR of 1.6:1—which is pretty good in anyone's book until you realize the actual SWR is 3:1.

Again. the foregoing analysis is true if we consider everything being theoretically correct; unfortunately there is another *zinger* waiting for the unsuspecting.

CB transceivers are designed and factory-tuned for a 50-ohm resistive load, the antenna impedance at resonance. When there is a mismatch between the line and the antenna, the input to the line appears resistive only when the length of the line is an *electrical* quarter wavelength. or its multiple. (To keep this short and simple just assume the antenna characteristic is entirely resistive; let's not get involved in non-resonant antennas.) If the length of the line is a quarter wavelength or an *odd multiple*. the line acts as an *impedance inverter* with the input/output impedance hinged at the line's characteristic impedance. Assuming the line is 50 ohms, if the load is less than 50 ohms the input impedance to the line is greater than 50 ohms. If the load is greater than 50 ohms, the input to the line appears as an impedance of less than 50 ohms. For example, if the load is 25 ohms (2:1 SWR) the input impedance of the line is 100 ohms.

At other than one-quarter wavelengths, if the line length is shorter or longer than one-quarter wavelength, or its multiple, the input to the line will have a resistive and reactive component that can be well beyond the range of values that a modern solid-state CB transceiver can load efficiently. Fact is, connecting a 100-ohm load to most CB transceivers with a 4-watt output cability might result in as little as 1-watt output.

A half-wavelength transmission line (or multiple) acts as a *repeater* or *1:1 matching transformer* in that the input to the line repeats exactly what appears at the load end. If there's a 25-ohm load at the end of the line, the input to the line appears as 25 ohms. Most solid-state rigs work better into lower rather than higher impedances, and so will put out more power into 25 ohms than it will into 100 ohms.

Some of the new low-pass filter RF-output circuits will deliver greater RF output into a load of less than 50 ohms. Unfortunately. when the RF output is increased without an increase in modulator power to maintain the same modulation level, the *readability* of the signal at the receiving end is sharply reduced. Also. the power output transistor heat dissipation rises sharply, and the life expectancy of the RF output-transistors might drop to a few months.

No matter how we look at it, an unusually high SWR *usually* prevents the transmitter from delivering its maximum available power, and in most instances the loss in transmitter output generally exceeds the SWR loss. This can be compensated with a *matching device* that makes the input to the transmission line appear as 50 ohms. An SWR meter connected between the transmitter and matcher will indicate 1:1 when the matcher is properly adjusted. and the transmitter will deliver its total available output because it sees a 50 ohm load—the design value. But make no mistake, all the SWR and line-loses that previously existed still exist between the matcher and the antenna. If you had two SWR meters, one in front of the matcher and one after. the one in front would indicate 1:1 and the one after the matcher would indicate the antenna system SWR reading. plus or minus some small change because of the added transmission line between matcher and transmitter. (The transmission line length is the *total* length from the transmitter's output circuit—inside the cabinet—to the antenna.)

If at this point you get the feeling SWR and its effects is some slippery evil

continued on page 114

R-E's Service Clinic

Stacked transistor IF stages

An odd circuit made easy

JACK DARR
SERVICE EDITOR

A LONG TIME AGO THERE APPEARED AN ODD circuit in TV sets. The circuit had two identical tubes connected in a cascade configuration. The DC voltage supply was applied to the plate of the second tube. The cathode of the second tube was connected to the plate of the first tube and the cathode of the first tube went to ground. So, the DC voltage was divided equally between the two tubes. The signals were fed through bypass and coupling capacitors for isolation. A common supply voltage was +300, so +150 volts appeared across each tube. This was called a stacked IF circuit. Other and much less printable names were heard on occasion. For a while, it was quite common in IF stages. (Actually, I don't know why they fed the high voltage to the second tube. They did, though. Could have gone to the first just as well. No matter.)

Now, it's showing up again in quite a few popular TV sets, both color and black-and-white, using transistor IF stages. Figure 1 shows a typical stacked transistor IF as used in RCA's CTC-38 series. Note that the signal path is quite normal. From the input through the tuned transformers and traps to the 1st IF transistor. Then through another tuned circuit, with a coupling capacitor to the 2nd IF transistor. Finally on to the 3rd IF, which is completely isolated from the first two for DC only.

Let's lift the stacked circuit out and see what the difference is. Figure 2 shows it with the DC supply path *only*. All bypass and coupling capacitors have been left out. We start with a +80 volt DC supply. There is a 1 volt drop across the low resistance of the collector coil. The base is clamped by an elaborate voltage divider network from the +80 volts through four resistors to ground. This same network also clamps the base of the 1st IF transistor. A small thermistor is used for stabilization.

Now we get back to the DC path through the two transistors. The path is through the coil, 2nd IF transistor, 1st IF transistor, and then through a comparatively large resistor to ground. The AGC voltage is fed to the emitter of the 1st IF transistor.

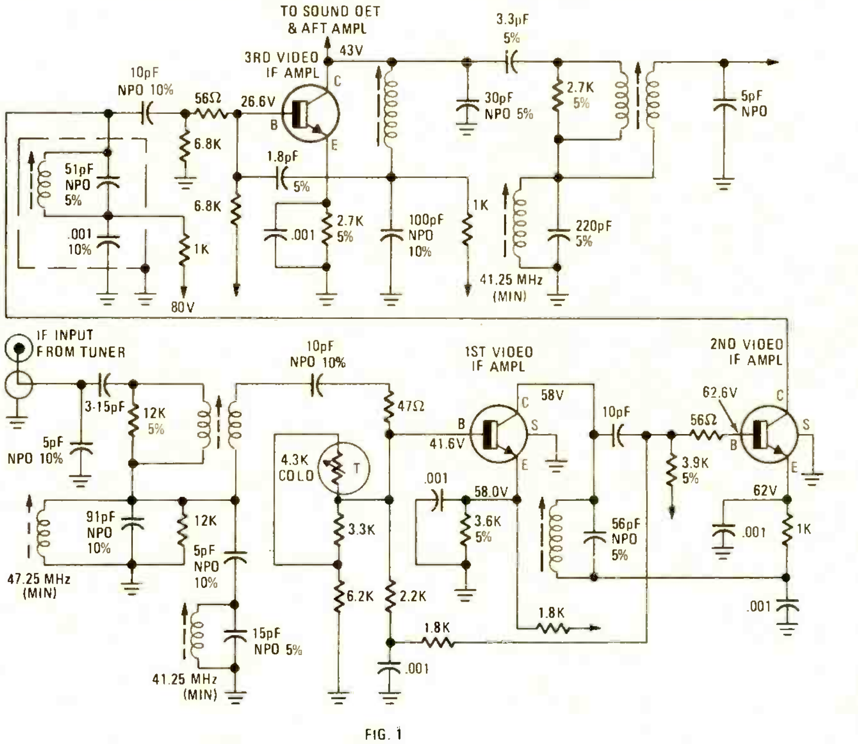


FIG. 1

Troubleshooting

If you find troubles in the IF that has

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such a circuit, the DC voltages can give you a good idea as to what's going on. As usual, this column was inspired by quite a bit of mail from readers who were having problems with it. In one of the latest, the reader found the DC voltage readings as shown in the balloons alongside the normal voltage readings (Fig. 2.) Here, you can see several things. For one very good possibility, Q1 is very likely shorted. Note the same voltage on all three terminals of Q1.

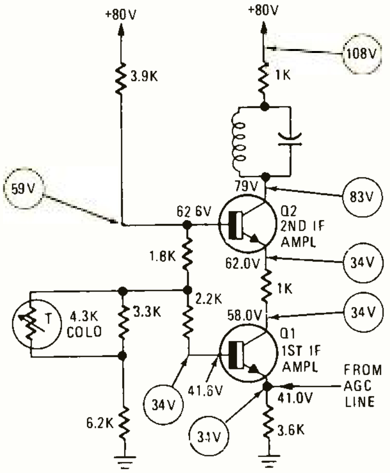


FIG. 2

This, of course, is upsetting the 2nd IF stage. The transistor has a normal base-emitter voltage of only +0.6 volt—+62.6–62.0 = +0.6 V. This is a very important point! The DC voltages on any of these transistors are *always* read from the transistor's own emitter, never from ground. The fault checks out as a base-emitter voltage of +25 volts for Q2. This should turn this transistor on and make it conduct very heavily. Yet, its collector voltage as well as the supply voltage are both very high. So, a very likely possibility here would be that Q2 is open, and Q1 shorted.

To make sure of this, you will probably have to take out at least one of these transistors. The short in Q1 could be confirmed with an ohmmeter, of course. After the transistors have been taken out, it would be a good idea to make a careful check of every resistor in this circuit. They're all critical, most of them are 5% tolerance types.

For replacement transistors, it would be a good idea to use the exact duplicate types. Note that the voltage on the 1st IF transistor is determined by the *conduction* of the 2nd IF transistor. So, if you got a little too quick in grabbing up a replacement transistor, you might get one with a lot higher or lower beta than the original. This will show up as a good sized difference in the DC voltage distribution. Since the bases of both transistors have their own separate clamp network, these voltages will probably stay in the ballpark. If the collector and emitter voltages are off, you should try different transistors until you find a set that will get you back to the original DC voltages.

Another reader wrote in about this problem. After some correspondence, he finally said that he had to use the original RCA replacement types, and this cleared up the problem. In this chassis, both of these are the same type, RCA No. 124757. No general-purpose replacements are listed. Even the RCA SK Guide doesn't show them, nor do any of the rest. So, this is evidently the exception that proves the rule. The rule being what I have said on many occasions in the past, that transistors aren't all that critical! I *have* substituted general-purpose transistors in conventional common-emitter IF circuits without affecting the response curve, etc. In this kind of circuit, substitution of transistors with a different beta could definitely lead to an upset of the DC voltages and a drastic change in the response of the circuit. (Up till now, I had not thought of running an actual test of this, but you can bet I will on the next CTC-38 I get my hands on!)

The typical symptom will be a complete loss of picture and sound. The AGC will probably have no effect at all.

Remember that the 2nd IF is separated from the first two. You may get a signal through by injecting it into the base of the 3rd IF. If this happens, then the problem is definitely in the 1st and 2nd IF stages. The DC voltage readings will confirm this.

While this looks like a very complex circuit, it really isn't. Take DC voltage readings in both DC paths, the collector-emitter path and the base path. The polarity and the amount of change from normal will give you a good idea as to what has happened. **R-E**

reader questions

ZENER SUBSTITUTE

I'm rebuilding a solid-state scope. Thanks to your previous help, it's now functional! One problem left; I need a replacement for a Zener diode, 1N1817R, in the power supply. I can't locate this. Can you help again?—E.L., Niagara Falls, NY.

I can try! This particular number isn't too popular, but I did find a listing of it in the Sylvania *ECG Replacement Guide*. They show three of them, up to 1N1817C. They have quite a few types; this is a 15-volt Zener. The one listed is a 10-watt stud-mount type, ECG 5191. If this is too big, they have a 5-watt axial lead type, ECG-5130. Choose the one that seems to match the original.

RESISTOR FAILURE

Resistor R314, in the pulse-gate circuit of this Sylvania D-14-3, burns out. However, the set will work for almost a year before it does. This is the third time it's happened. What component is breaking down to cause this?—W.L., Jenison, MI.

If this set *works* for that long a time, I doubt if any other part is breaking down. This is shown in the parts list as a ½-watt resistor. I believe I'd replace it with at least a 1-watt type, or maybe 2-watt. Should stand up a little better. Resistors in circuits with fairly high pulse-voltages do strange things.

There's no mention of this in any of the Production Change Bulletins.

HIGH-VOLTAGE PROBLEMS

I've got all kinds of problems in the high-voltage circuit of this Sylvania D-12! The cathode current of the 6LR6 is too high, the high-voltage is too low, and so on. If I pull the 6BK4 tube, the high-voltage drops to 20 kV, the grid of the 6LR6 goes to −60 volts and the current drops to 170 mA. What goes on here?—A.P., Lexington, KY.

Something around the 6BK4 high-voltage regulator, I think. There is a "Regulator Limiter" diode in the 6BK4 cathode. Actually, the 6LR6 should have been cut off when you pulled the 6BK4 tube! Check this diode and the circuit.

I see a factory service note on the troubleshooting schematic for this one. It says check R454, which is the grid resistor of the 6BK4. If this opens *under load*, the high-voltage will go to about 20 kV and other problems show up.

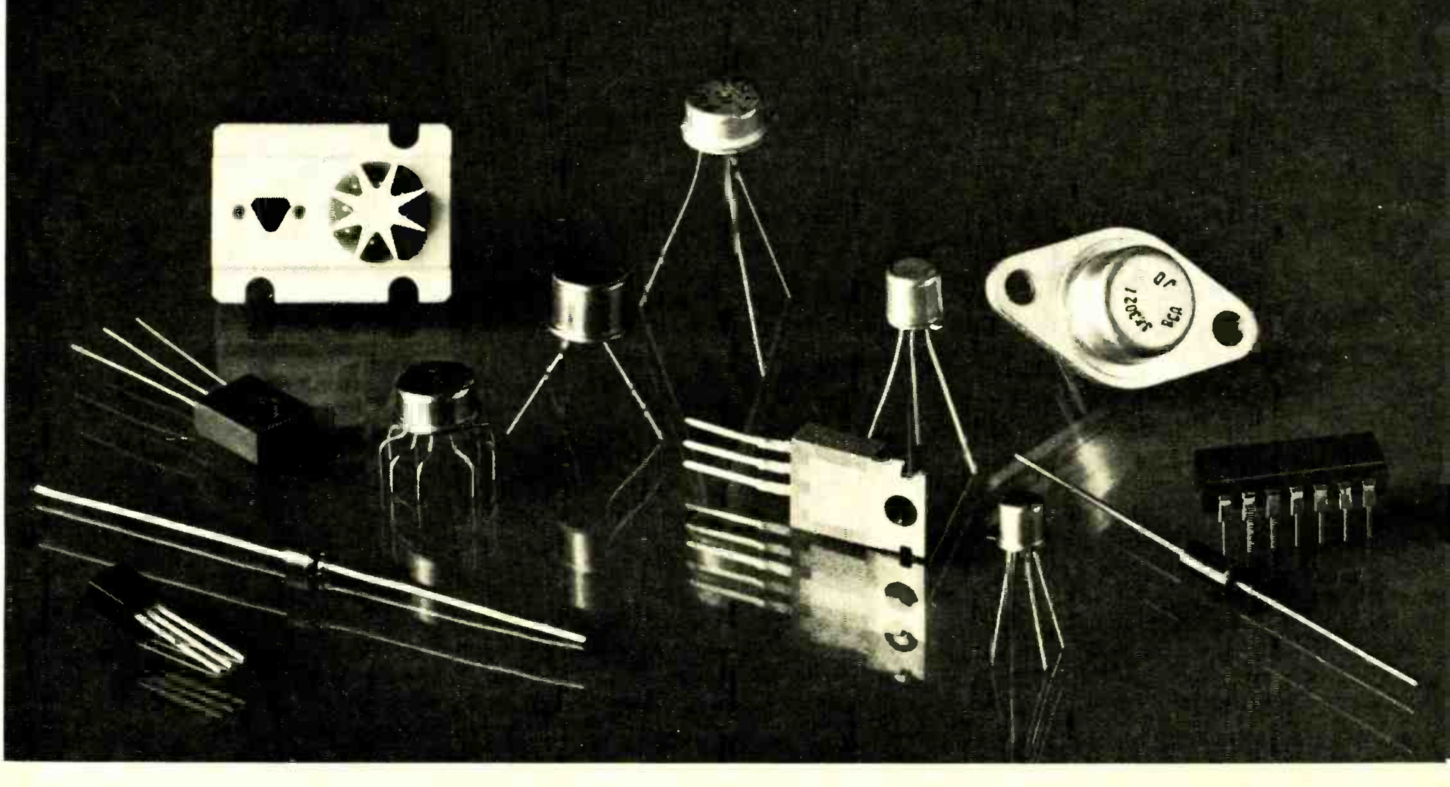
SHORTED PINCUSHION

If the pincushion transformer in Sylvania D-19 chassis shorts, check to see if it is a part number 50-33900-3. If so, replace it with a part number 50-39244-1. This is an improved type.

JUMPS OUT OF CONVERGENCE

I've had several calls on this Zenith 14CC15. It jumps out of convergence. I can get it back, but it won't stay. Since it affects all three guns, I don't know exactly where to look.—J.T., Orlando, FL.

This isn't an everyday thing, but I have seen it happen. One good possibility is a "thermal" diode-clamp unit on the convergence board. Try heating and cooling this to see if this will make it show up. This is one of the few things



that might affect all three guns at once.

HORIZONTAL INSTABILITY

I have intermittent horizontal instability and pulling in this Zenith 14M21. I checked and replaced all of the tubes and checked the capacitors. What now?—D.D., Norfolk, VA.

After the checks you have made the most likely thing would be an intermittent horizontal AFC diode unit. If one of the diodes is leaking or intermittently opening, this can do it. These diodes must be perfectly balanced. If this doesn't help, check that VDR from the +125-volt source to the grid (pin-7) of the 4HS8 AGC tube. If this is "thermal", it can upset the AGC and several other things at the same time.

SUBSTITUTE PICTURE TUBE

Help! We have a Sears 563-51350300 black-and-white TV in our shop. We need a new picture tube; the original is broken. This is a "500SB4". No one has a replacement. Can you tell me anything about this?—G.B., Jamaica, NY.

A "500SB4" tube would be a 19-inch type. This is "19V" in the new code. The first digits of the original type-number indicate the diagonal measurement in millimeters. So, any of the 19V tubes might work. From the schematic, this seems to have an 8HR base. There are several tubes using this. Check up and see if a 19AYP4 won't be a pretty good match!

SSB ADAPTER WON'T WORK

I've built an SSB adapter from plans in the (BLEEP!) magazine. They say to adjust it for a zero-beat on an AM radio with 455 kHz IF, and then feed it into a CB radio. I can get a loud zero-beat on the AM radio, but nothing at all on the CB. What's wrong?—R.K., Middleburg Heights, OH.

Normally, I don't comment on plans from other magazines. This *could* be fairly simple, though. One of two possible things. You may have been zero-beating with the station carrier on the AM radio, and not the IF. See if you get the zero-beat on only *one* station. You should hear it on each one.

Two, the CB radio you're using may have a different intermediate frequency. Check this on the schematic.

BLACK MATRIX TUBE

Can I use a black matrix picture-tube to replace the 25GP22 in my old TV set?—W.D., Ojai, CA.

Yes. Just order the same or an equivalent picture-tube with a black matrix screen. There are three types (at least) that will interchange with the 25GP22. These are: 23VANP22, 23VATP22 and C25BAP22. The "23" is the new designation for picture tubes that used to be called "25". I think you'll see quite an improvement!

BAD PICTURE-TUBE

I've checked everything in the high-voltage section of this set and I can't get any high-voltage. Finally, I pulled the socket off the picture-tube and the high-voltage came back. I checked it on a Tele-Matic test jig, and it makes a good picture. The picture tube is a rebuilt and I've had problems with it. Do you think the picture tube is bad?—M.B., Chicago, IL.

Yes!

WEIRD RASTER DISTORTION

I've never seen a symptom like this before. The raster on this Admiral G13 shows a couple of horizontal bars and with a pull-in with three colors in it at each side. I found a leaky filter capacitor and changed it. No help at all.—Any ideas?—C.K., Churchville, MD.

One fairly good one. Check the thermal switch on the degaussing coil. This has a habit of sticking, leaking, and so on. If it stuck and left the degaussing coil in-circuit, this could create magnetic fields with just such characteristics. The current through this coil is 120-hz pulses, but it is supposed to be switched completely out of the TV receiver circuits during normal operation. **R-E**

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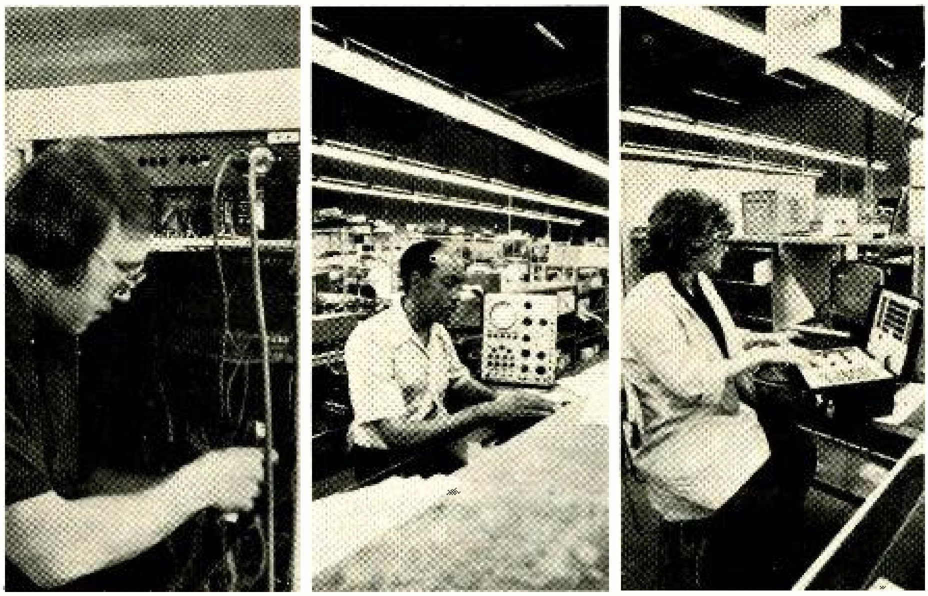

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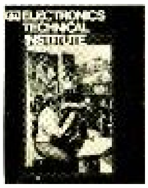

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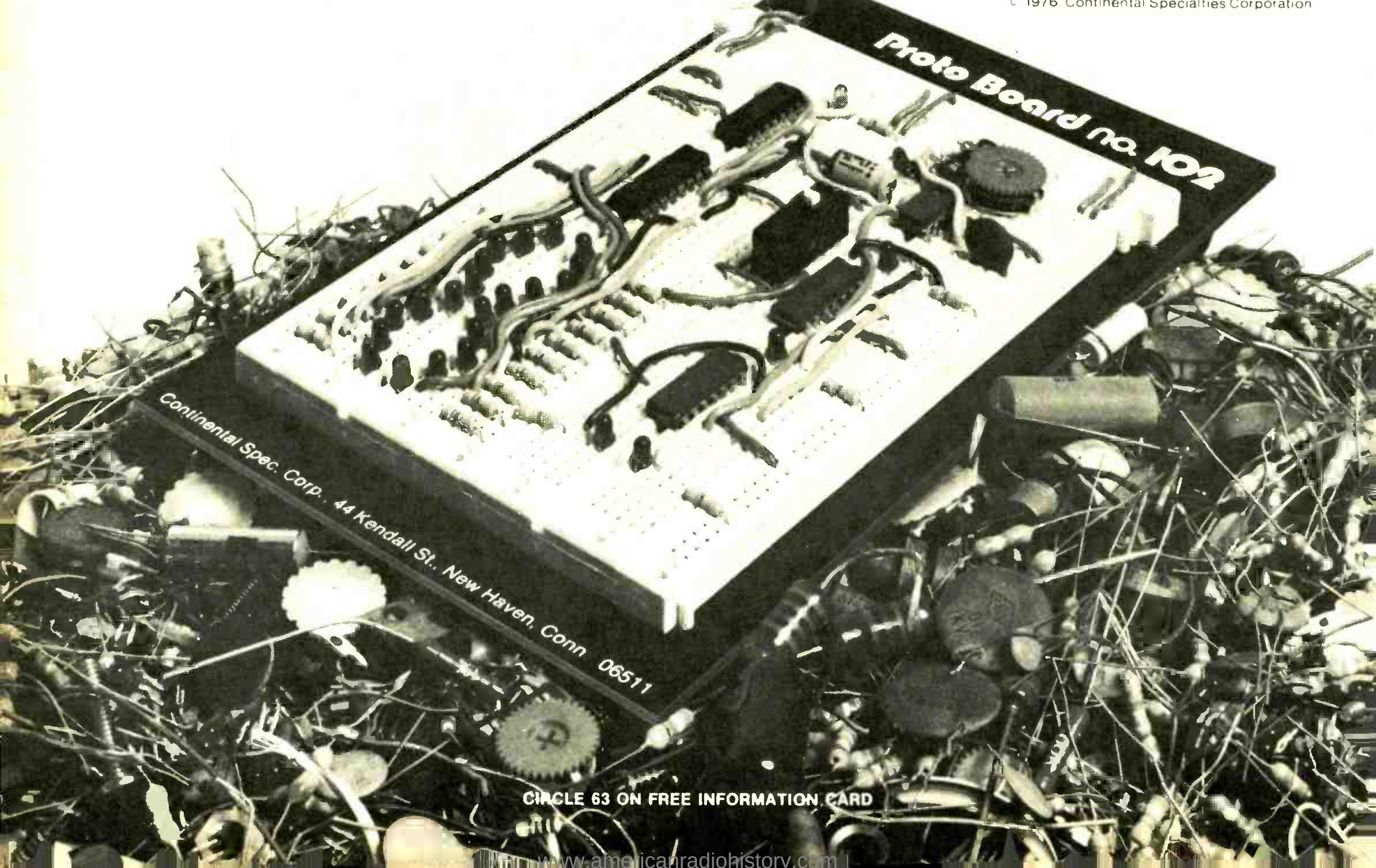


CIRCLE 63 ON FREE INFORMATION CARD

Step-by-step TV Troubleshooters Guide

You might call it an amplified-burst reference oscillator, but its not an oscillator. Actually, the 3.58 MHz burst is gated out, amplified and used as the chroma reference. Here's how to troubleshoot it

JACK DARR
SERVICE EDITOR

SEVERAL COLOR OSCILLATOR CIRCUITS ARE used in color TV sets. We discussed the crystal-controlled type with a phase detector and reactance stage in 1974. Another type is used in several makes, but is probably most familiar in such chassis as G-E's CB, KC, KD and KE. It might be called an "amplified-burst" reference oscillator, since that's actually just what it does. The actual burst from the color signal is gated out, amplified, and becomes the 3.58-MHz reference oscillator signal. Let's go through this type of circuit and see how it works:

Figure 1 shows a typical circuit. This one is from G-E's CB chassis. For the first step, the burst is gated out of the complete color signal and amplified. Note that the cathode of the burst-gate tube goes back to ground *through* the secondary of the bandpass transformer. This is the source of the color signal and burst for the gate stage. The burst-gate stage actually has some amplification; so, the burst comes out at a greater amplitude.

This is fed into a transformer as a series of bursts of 3.58-MHz signal. The transformer primary is tuned to this frequency. In its secondary, the crystal is connected in series as a "filter". (A crystal can be considered as a very sharply-tuned filter, with a tremendously high Q and very narrow bandpass. That's what they're doing with it here.) Since both transformer and crystal are tuned to 3.58 MHz, the burst shocks them into ringing. Ringing causes the circuit to sustain oscillations for a much longer time. Another tuned circuit is used in the grid of the subcarrier amplifier for the same purpose. The combined action of all these resonant circuits keeps the 3.58-MHz signal going until the next burst arrives and boosts it up again.

Don't call the subcarrier amplifier the "3.58-MHz *oscillator*", it isn't. It is an amplifier designed to raise the amplitude of the reference 3.58-MHz signal to the necessary level and also to limit it, if needed. Limit but never *clip*. If it clips it flattens the tops of the waves and introduces all kinds of harmonics that we don't need. Figure 2-a shows the burst on the back porch of the horizontal sync, the sharp gating pulse is shown in Fig. 2-b, the gated-out burst in Fig. 2-c, the ringing output of the crystal transformer in Fig. 2-d and the subcarrier amplifier output in Fig. 2-e. In the waveform of Fig. 2-d, you can see the slow decaying of the amplitude of the burst. By the time this gets through the other tuned circuit and the amplifier, it is smoothed off and looks like Fig. 2-e.

In Fig. 1, there is a 5–60 pF, variable capacitor connected in the plate circuit of the subcarrier amplifier. Figure 3 shows a later version used in KC and KD chassis. The tint is controlled by a varactor diode connected in the grid circuit. The actual TINT control is a variable resistor that is part of a voltage divider network fed from the +270-volt line. Figure 4 shows the same stage as used in the KE chassis. A transistor buffer amplifier has been added between the crystal-tuning coil and the grid of the subcarrier amplifier. This provides better isolation during the scan period to prevent any undesired 3.58-MHz signal from feeding through the capacitance of the burst-gate tube.

Let's look at another novel circuit used in some of the early runs of the KC and KD chassis. This is shown in Fig. 5. Note the little neon lamp in the grid circuit of the burst-gate tube. A positive-going pulse from the flyback, about 150 volts P-P, is applied to it. The 1500-μH choke and .0018-μF capacitor form a resonant circuit that is tuned to about 90 kHz. It's damped by the 270-ohm resistor. Once again, the "decaying pulse" reaction is used. This time, only the first half-cycle of the pulse is high enough to make the neon lamp ionize and conduct. This pulse is shaped into a squarewave by the other parts in the grid circuit.

This stage neatly "punches-out" only the color burst and passes it along after amplifying it to the input of the crystal-filter transformer (Fig. 3). The series-resonant circuit in the burst-gate grid, 100-μH choke and 18-pF capacitor, resonates at 3.58 MHz. This acts as a trap to prevent any other 3.58-

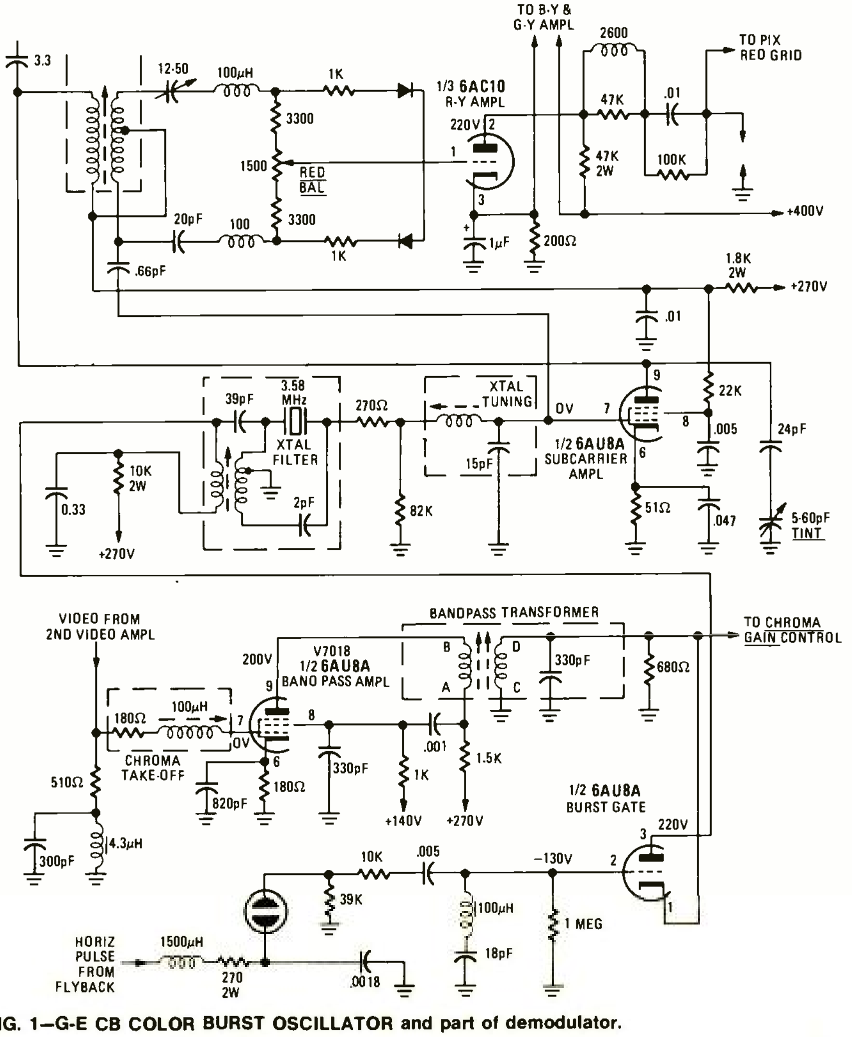


FIG. 1—G-E CB COLOR BURST OSCILLATOR and part of demodulator.

MHz signals from getting into the circuit while the gate tube is cut off during the scan period.

The crystal transformer

The 3.58-MHz crystal and the transformer build up the amplitude of the burst signal. The transformer primary is tuned to 3.58 MHz. The burst is coupled to the secondary and because of the reaction of a resonant circuit, it is amplified. It is then fed *through* the crystal causing it to ring, which sustains oscillation for a longer period. These are all very high-Q circuits that maintains the amplitude of the signal. The crystal-tuning coil is also resonant at 3.58 MHz, which keeps the amplitude up still longer. So, in the end, we come out with a sustained oscillator signal phase-locked with the burst (which is natural considering that it *is* the burst!) and at the amplitude needed to drive the demodulators.

Troubles

That's how it works when it works. Now let's look at this circuit and some of its reactions when it isn't working right.

For one, the horizontal oscillator frequency is critical. If there is a problem in the horizontal AFC, which lets the oscillator run just a little off frequency without losing horizontal hold, you can see problems in the color. This is due to the precisely-timed gating needed to punch out the color burst. Just a little too much phase difference can weaken the burst and cause a color problem. Be sure that the horizontal hold is set "right in the middle".

In the chassis using the neon lamp in the burst-gate circuit, the lamp is very important. I used to say "the burst goes through the neon lamp" but, of course, it doesn't. The *gating pulse* does, which has the same effect. If this lamp goes bad, you can have intermittent color, no color, weak color, wrong color, or "the color won't come on until it's been on for several minutes". If you lose the burst, of course, you've got problems. Check this little lamp; you can usually see it light. With the set off, see if the bulb is blackened or broken. The glass should be clear. If it's bad, replace it. The G-E part number is ET41X6, which is a NE83/5AH or NE-2H. You can often replace this from the top of the chassis. Clip the leads of the old one and tack the new one to them. Don't leave the leads too long.

If the lamp looks OK but you still have problems (lamp not glowing), check to make sure that the gate pulse from the flyback is present. This too can be checked with the scope from the top of the chassis. A bad ground on the pulse winding of the flyback can cause all the symptoms given above, from the same cause.

Tubes should be checked by replacement, and for goodness sake use the same type. You can really build in a whole brand new set of mysterious symptoms if you use a substitute with different characteristics. Check DC voltages, too.

If the complaint is "wrong colors", check parts that could upset the phase relationship. Check the tint control circuitry and the alignment of the crystal transformer and filter coils. As a last resort, try a new crystal.

WARNING: The crystals used in this circuit are not the same as those used in the other type of crystal oscillator circuit. If the set has been worked on before, check the crystal to be sure that someone hasn't used the wrong replacement. This crystal acts as a filter with a tremendously high Q, so it is critical.

In the sets with a varactor tint-control, if you have no tint-control action or incorrect colors, or both, check the DC voltage on the varactor, the resistors in the voltage divider, or try a new varactor diode. The DC voltage on the cathode of this diode will run about +7.5 volts properly centered. G-E gives this on one schematic as varying between +68 volts with the tint control full counterclockwise, and +3.1 volts full clockwise. Be sure that this DC voltage does vary as the tint control is turned. One problem that has been found is a bad ground on the tint control itself. If it is open, the tint control voltage will go completely out of range.

Alignment

The *results* of color alignment in this circuit are the same as in the others, but the methods are different. You can't use the "ground the grid of the burst amplifier and adjust the oscillator" technique. This circuit will not free-wheel, since the amplified burst *is* the oscillator signal. To align, feed in a known color signal from a color-bar generator or an off-the-air program. Connect a VTVM or FETVM to the test point. This will be one of the demodulator diodes. Any of the diodes can be used, but G-E recommends the lower diode of the red demodulator. If the 3.58-MHz signal is present, you'll see a small DC voltage here. Since this is on the cathode, it will be positive. You can use the other diode but the voltage will be negative since you'll be on the anode. Tune for maximum DC voltage, positive or negative.

Align the crystal transformer primary and the crystal tuning coil for a peak. Ballpark values of this voltage will be about 10 volts or more. (For the next step in a complete alignment you'll tune up the demodulator transformers using the same test point. This is

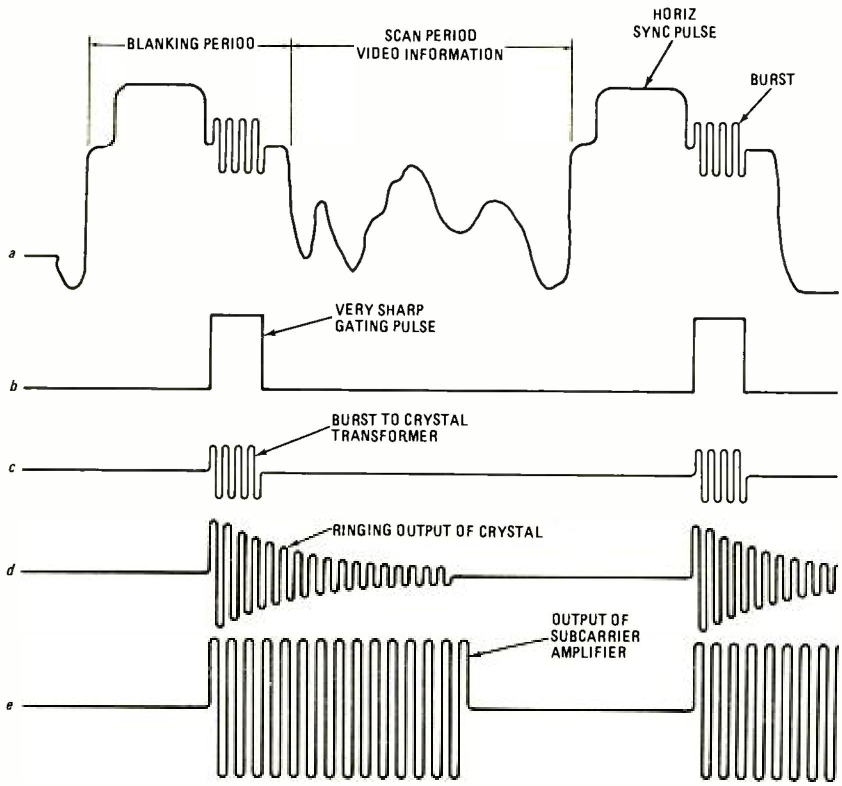


FIG. 2—WAVEFORMS in each step of the circuit. The scan period with burst is shown in a. The sharp gating pulse is shown in b. Burst to Y701 and Y702 is shown in c. Ringing output is shown in d. Subcarrier amplifier output is shown in e.

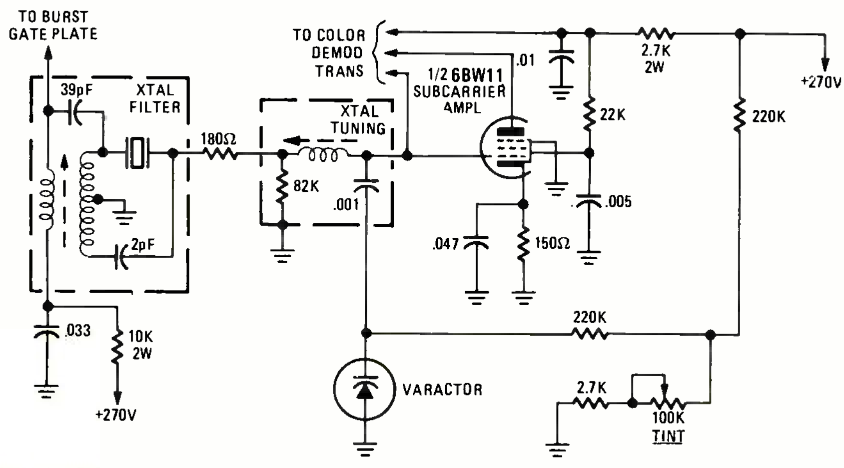


FIG. 3—BURST-GATE AMPLIFIER and crystal filter in the G-E KD color chassis.

for demodulator alignment rather than reference oscillator setup.) Follow the set-maker's alignment procedures carefully. In practically all of these, you'll find the test points printed on the PC board, which makes things very nice!

Step-by-step testing

This circuit is ideal for step-by-step test methods since it's basically a series circuit. You can walk troubles out with very little difficulty. The first step, as usual, is to make sure that everything else is all right! This means that the set must be able to make a good clean picture, with no sync, AGC, or other problems. The horizontal hold control must be centered and the horizontal sync stable. (Fix all of these and you may not *have* color problems any more!)

Trouble in the reference oscillator will cause weak color, wrong color or no-color problems. It will not cause "one-color" problems such as "green screen" etc; these will be in the demodulators, diff-amps or picture tube. You must have a good clean normal amplitude video signal at the video detector output.

Now, we can go. The first step in this is to verify the identification of the problem. With a color-bar signal input, you can scope the output of the bandpass amplifier and make sure that the characteristic. comb pattern is

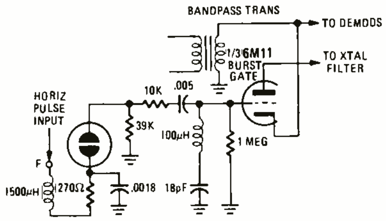


FIG. 5—EARLY KC AND KD CHASSIS used a neon tube before the crystal filter.

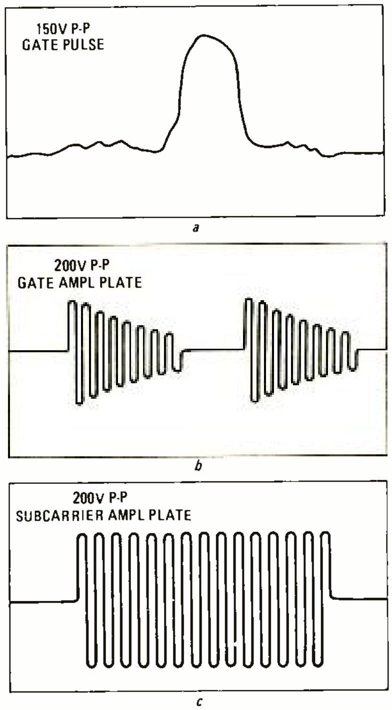


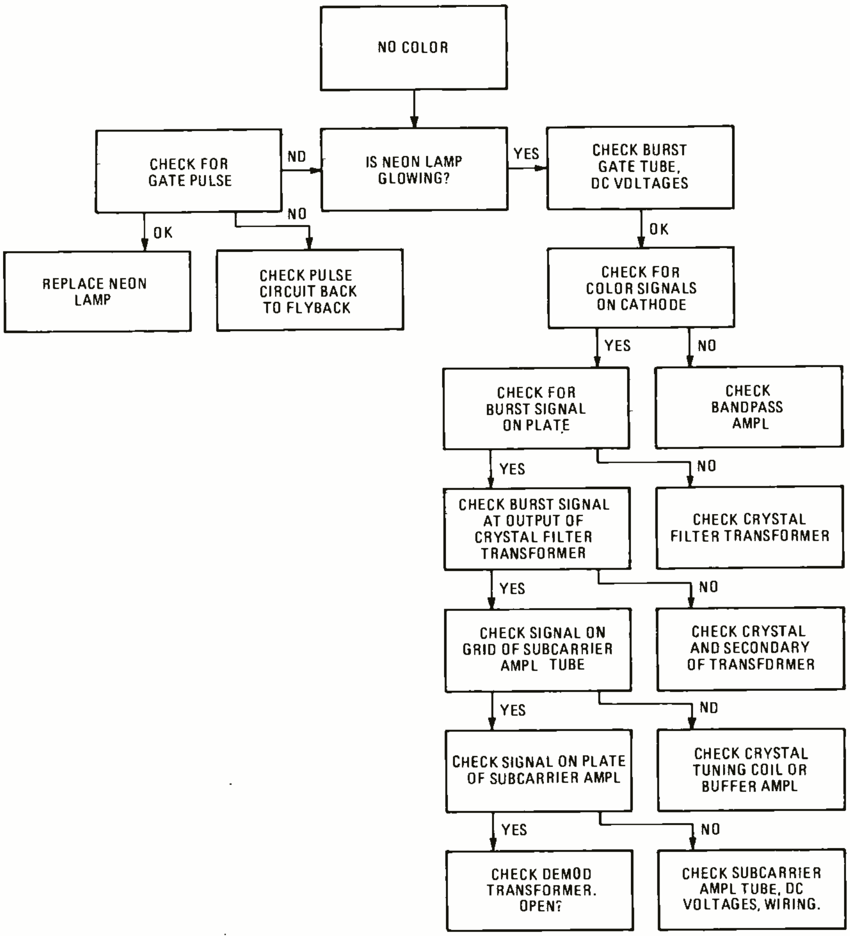
FIG. 6—SOME TYPICAL WAVEFORMS and voltages, on CB, KC and KD chassis.

present at the correct amplitude. The next step would be to scope the demodulator input to make sure that the reference oscillator signal is or isn't present there. If it isn't, we know that the trouble is definitely in the reference oscillator circuitry.

Start back at the burst-gate stage. Scope the input to be sure that the gating pulse is there. Next, check for the gated-out burst signal on the plate of the burst-gate stage. Fig. 6 shows the waveforms you should find in one G-E chassis. Figure 6-a is the gating pulse, Fig. 6-b is the gated burst, and Fig. 6-c output of the subcarrier amplifier. Peak-to-peak amplitudes are as shown. If the gate pulse is OK but there is no burst output, check for the presence of the color signal (the comb) on the cathode of the burst-gate tube.

continued on page 114

TROUBLESHOOTING CHART. Amplified-burst oscillators.



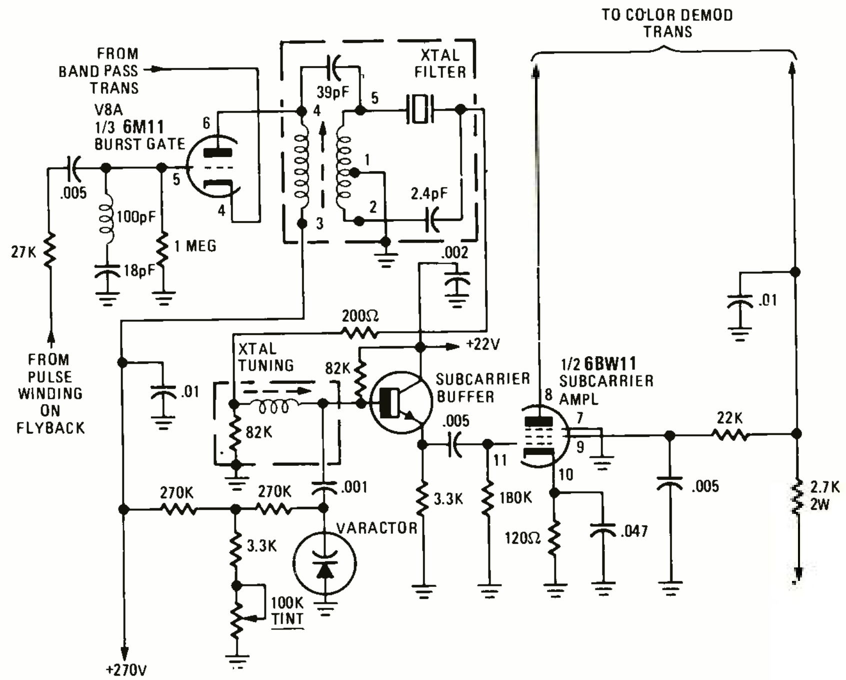


FIG. 4—KE VERSION uses a buffer stage.

new products

More information on new products is available from the manufacturers of items identified by a Reader Service number. Use the Free Information Card following page 116.

OPEN-REEL STEREO DECK, *model SG-630,* has three-speed operation and exclusive Omega drive system for stabilized tape speed. New electronic tape tension regulation with "motionless sensors" keeps tension constant regardless of the mode of operation and is completely uninfluenced by spool diameter at any time, even when going from one mode of operation to another. Switching directly from fast wind to rewind is easily accomplished, even simultaneously, without tape spill.

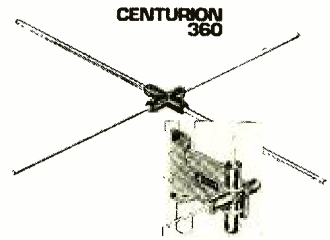
The Omega drive system eliminates the pinch roller, drive couplings, springs and function wheels—parts that traditionally wear out. The logic-controlled tape transport machine features a four-motor drive system with two newly developed DC hub motors and a collectorless electronically regulated motor for the capstan drive and a servo motor to form the Omega loop.

All the operating controls are arranged on the front panel and the tape transport mechanism is controlled by means of illuminated function indicators. Actual tape speed may be verified with a built-in stroboscope disc that works in conjunction with a speed control. A fast peak-reading meter with relatively long return permits simultaneous and precise control of both stereo channels.

The *SG-630* has a built-in "Dia-Pilot" for recording signal impulses and automatic slide projector control for either single projector or multi-media show. Also featured is a switchable peak-level meter, separate stereo headphone power storage with its own volume control, separate bass and treble tone controls, A/B monitoring, and remote control facilities. Specifications include: signal-to-noise ratio, better than 67 dB; wow-and-flutter, 0.02%. Suggested retail price is $1,100.00—**Uher of America,** 621 S. Hindry Avenue, Inglewood, CA 90301.

CIRCLE 86 ON FREE INFORMATION CARD

CB BASE-STATION ANTENNA, *Centurion 360,* is a cross-polarized antenna that has 18-foot 3-inch elements, a sealed extra length Cycolac center-insulator and generates up to 15.4 dB gain. Antenna has omni-directional response and a power handling capability of 1000-watts AM or 2000-watts SSB. Elements are constructed of anodized aircraft aluminum and the wind rating is 90 miles per hour.



The antenna will mount vertically from a window sill or frame, or vertically and horizontally from a master tripod. Weighs 5-pounds 10-ounces and sells for less than $90.00.—**Airequipt, Inc.** 1301 Brummel Ave., Elk Grove, IL 60007.

CIRCLE 87 ON FREE INFORMATION CARD

DIGITAL MULTIMETER, *model 283,* has high intensity 3½-digit LED display, 0.41-inch high that can be easily read in brightly lit rooms at a distance of at least six feet. It measures DC volts, AC volts, DC current, AC current and resistance. A special low voltage circuit permits measuring resistance of transistor-shunted resistors.

Model 283 has 100% overrange capability on four ranges, so that one can read to 199.9 on a scale that is normally set for 100.0 maximum. Out-of-range is indicated by a flashing digit and three zeros. All readings have an automatically positioned decimal point.

There are 4 DC voltage ranges, with ±0.5% accuracy on the 1.000, 10.00 and 100.0 ranges and ±1.0% on the 1000-volt range. Polarity change is automatic. Four AC voltage ranges have ±1.0% accuracy on 1.000 and 10.00-volt ranges and 1.5% accuracy on the 1000-volt range. There are four AC current and four DC current ranges with the similar accuracies. The six resistance ranges (100 ohms, 1K, 10K, 100K, 1000K and 10 megohms) have ±1% accuracy, except top range which is ±2%. Input impedance is 10 megohms on all voltage ranges. Overload protection is provided, up to 1000 volts on the ohms, 1500 volts on the voltage ranges, and 3 amperes on current shunts.

An optional battery pack provides 8 hours of operation on an overnight charging. Batteries also charge when the *model 283* is used on 110 VAC powerline.

The multimeter weighs only 3 pounds and measures 9 × 7 × 3.6 inches. With battery pack weight is 6 pounds.—**B&K Precision, Dynascan Corporation,** 6460 W. Cortland, Chicago, IL 60635.

CIRCLE 88 ON FREE INFORMATION CARD

DIGITAL CB-TESTER, *model 388*, is a combination SWR, power, % modulation and frequency meter.

The SWR and % modulation functions allow continuous monitoring as output power is adjusted or fluctuates without troublesome recalibration steps, thus saving valuable service time. The *model 388* may be switched between any of the functions without recalibration while maintaining rated accuracy. A front-panel mounted BNC-connector enables frequency measurement from 1 Hz to 80 MHz with full 7-digit counter capability and resolution to 10 Hz. An AM output jack on the front panel permits scope display of modulation

The *model 388* with standard timebase has a frequency accuracy of 10 parts-per-million. The available *model 388X* with a Temperature Compensated Crystal Oscillator (TXCO) timebase has a frequency accuracy of 1 part-per-million and aging of less than 1 part-per-million per year. The *model 388X* requires less frequency recalibration reducing service-bench downtime.

Both units are rack mountable using the new Hickok rack mount kits designed to mount the complete Hickok line of test instruments in standard 19-inch racks. Minor internal modification allows 12 VDC operation of the *model 388* or *388X*.

Prices are: $349.00 for the *model 388* and $475.00 for the *model 388X*.—**Hickok Electrical Instrument Co.,** Marketing Services, 10514 Dupont Avenue, Cleveland, OH 44108.

CIRCLE 89 ON FREE INFORMATION CARD

TURNTABLE, *model 1000*, is a belt driven unit that incorporates two motors. A smooth running 24-pole 300-RPM synchronous motor is used to drive the turntable only. A second motor controls the cue and change cycle. Operation is unique; the turntable stops when cued or in cycle. This facilitates reading the record label and provides more precise cueing control. A printed-circuit board controls the cue and cycle operation. Electronic touch-buttons initiate all actions and LED's illuminate to indicate the operations that are taking place.

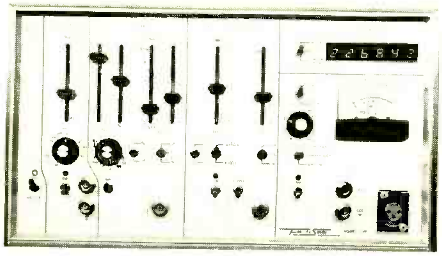
The turntable has machined strobe markings on the perimeter. The strobe light has a built-in speed control and acts as a pilot light to show that the electronic circuit is operational. Other features include: electronic speed control using frequency to control speed through a Wien bridge oscillator, a new low-mass cartridge skeletal head-shell, removable plug-in record support post, a tonearm system with a new CD-4 position in its anti-skating control and computer-designed isomer shock mounts. Price:

$279.95.—**British Industries Co.,** Westbury, NY, 11590.

CIRCLE 90 ON FREE INFORMATION CARD

CASSETTE DECK, *model 350*, is a compact deck that can be used just about anywhere. The unit is powered by 12 volts DC, but an AC power pack (included with the unit) permits its use indoors with household AC power. Other features include: three low-noise low-impedance microphone inputs with individual input level controls, 8-ohm stereo headphone output, Dolby noise reduction, tape selection, and a single 35-dB range peak-reading level meter that indicates the higher of the two channels at any given instant. An automatic shut-off function not only shuts off power to the deck, but also completely disengages the transport at the end of the tape or if the power to the unit is interrupted. Specifications include: frequency response, 40 to 15,000-Hz ±3 dB; signal-to-noise ratio, better than 58 dB; total harmonic distortion, less than 2%; channel separation, better than 35 dB; crosstalk, better than 60 dB; wow-and-flutter, less than 0.08% (WRMS).

Heavy-duty carrying case is available as an



MODEL 100 AUDIO RESPONSE PLOTTING SYSTEM and general purpose sweep/tone burst/pulse generator consists of two sine /square/triangle function generators, pulse generator, frequency counter and peak amplitude measurement sections. It is primarily intended to generate a frequency response plot on an X-Y recorder or scope.

Time base generator offers symmetrical or independent control of the positive and negative sides of the ramp providing a duty cycle of .7% to 99.3%. Frequency range is .0035Hz to 100kHz. Amplitude is 15Vpp into 500 ohms with ±5VDC offset. The time base output drives the X axis of an X-Y recorder.

Audio sweep generator provides manual frequency adjustment or log/linear sweep of 20Hz to 20kHz. Blanking mode produces zero reference line on X-Y recorder or tone burst. Amplitude is 15 Vpp into 500 ohms or 10 Vpp into an 8 ohm speaker.

Pulse generator frequency range is .0035Hz to 525kHz. Pulse wideth is adjusted independent of frequency from 4 seconds to 40 nanoseconds. Outputs are complimentary TTL.

Peak amplitude measurement section measures internal or external signals from mike to power amp level. Amplitude output drives Y axis of X-Y recorder.

Frequency counter is 6 digit, line triggered, and reads either internal or external. Sensitivity is 50 mv peak at 20kHz.

Dimensions: 8 x 14 x 3. Warranty: 1 year. $525, stock to 30 days.

FIDELITY SOUND

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CIRCLE 9 ON FREE INFORMATION CARD

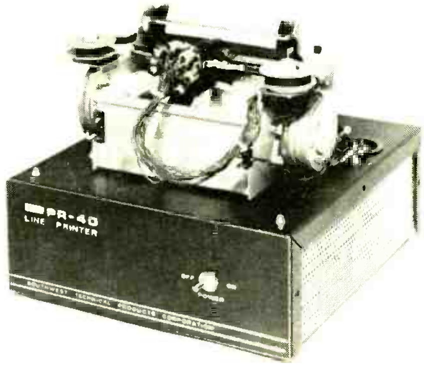
optional accessory. A rechargeable lead-acid 12-volt battery is built into the carrying case so that the *350* in its case will be a self-powered unit. The carrying case also contains a circuit that converts the *350's* AC power pack into a recharging unit. A 12-hour charge permits five to six hours of continuous recording.

Measuring $7^1/_3 \times 3^1/_2 \times 9^1/_2$ inches (without carrying case) and weighing 7 pounds, the unit sells for $350.00. The optional carrying case sells for $100.00—**Nakamichi Research (U.S.A.), Inc.,** 220 Westbury Avenue, Carle Place, NY 11514.

CIRCLE 91 ON FREE INFORMATION CARD

ALPHANUMERIC PRINTER KIT, *model PR-40,* is a 5 × 7 dot matrix impact printer. It prints the 64-character upper-case ASCII set with 40 characters-per-line at a print rate of 75 lines-per-minute on standard $3\text{-}^7/_8$-inch wide rolls of adding machine paper. One complete line is printed at a time from an internal 40-character line buffer memory. Printing takes place either on the receipt of a carriage return or automatically whenever the line buffer memory is filled.

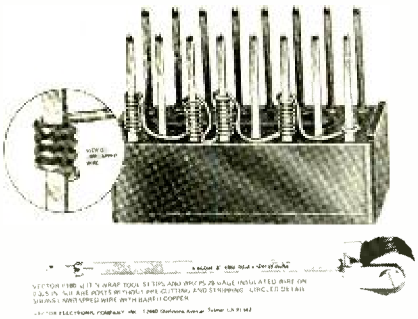
The printer is available in kit form only and includes the assembled print mechanism, chassis, circuit boards, components, 120/240-VAC, 50/60-Hz power supply, assembly instructions, one ribbon and one roll of paper. It sells for $250.00 postpaid in the US and delivery is 30



days.—**Southwest Technical Products Corp.,** 219 W. Rhapsody, San Antonio, TX 78216.

CIRCLE 92 ON FREE INFORMATION CARD

WIRE-WRAP TOOL, *Slit-N-Wrap,* intended for manual and hand-held electric motor tools. Makes possible a reduction in wiring time of about 80% over conventional manual wrapping. Wire is drawn off the spool at the top of the tool, led through a tube past a slitting-edge adjacent to the wrap-post. A narrow slit is made in the thin, but tough, insulation in the region that overlays the square corners of the post so the bare copper makes a good wire-wrap joint. The wire slits cleanly where required, but is not cut when pulled out in going from post to post. Unlike other strip and wrap tools which will strip and wrap only one end of a wire, this tool will quickly connect both ends. Available in two models: The hand-rotated *P180* is $24.50 and comes with instructions, the forming tool and



two 100-foot spools of 28-gauge wire. The *P160-4T*, a cordless, battery-operated version that sells for $69.00, is also available.—**Vector Electronic Company,** 12460 Gladstone Ave., Sylmar, CA 91342.

CIRCLE 93 ON FREE INFORMATION CARD

FM BOOSTER operates through the existing FM car radio and antenna and gives better than 15-

dB gain on weak stations. Slightly larger than a pack of cigarettes, the compact FM booster is installed under any car or trunk dashboard, and amplifies weak signals and mutes background noise of hard-to-get stations. The unit is vinyl finished in a black steel case with chrome trim.—**Solitron Devices, Inc.,** 256 Oak Tree Road, Tappan, NY 10983.

CIRCLE 94 ON FREE INFORMATION CARD

CB TRUNK-LID MOUNT, *model TLM,* clamps to the vehicle with stainless steel hollow-head screws that provide a positive ground and will

not rust or freeze in place. A special no-mar molded gasket is provided to protect the car finish. Finished in high-polish chrome, the mount comes complete with 17 feet of RG-58A/U coax and plug. The *model TLM* is available with hardware to accommodate all standard antenna mounts including Motorola, Larsen, ASP, G-E, RCA, etc. It is also available complete with antenna and even without either antenna or mounting hardware.—**Larsen Electronics, Inc.**, P.O. Box 1686, Vancouver, WA 98663.

CIRCLE 95 ON FREE INFORMATION CARD

AM CB MOBILE, *model Sabre,* has sloped front-panel and dimmer switch for controlling light intensity. SWR/RF/S meter and LED channel readout for night time use. Other controls include a volume, tone, SWR, Delta tune and

squelch selector plus PA/CB switches. It incorporates a fully variable noise-limiter and a switchable noise-blanker. It measures 9.34 × 6.92 × 2.34 inches.—**Browning Laboratories Inc.**, Laconia, NH 03246.

CIRCLE 96 ON FREE INFORMATION CARD

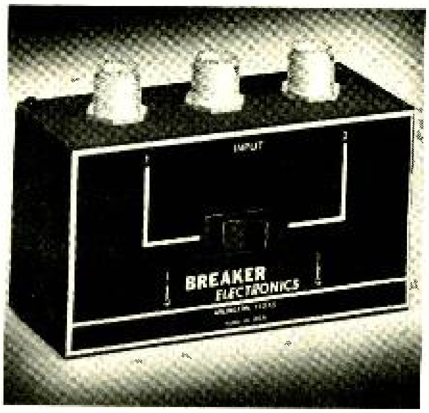
RECORD CLEANER, *Mark II Dust Bug,* keeps records clean by removing dirt and dust that can settle on the surface of the record while in use. When the red pad of the *Dust Bug* is slightly dappened with an anti-static fluid, the pad collects dust and dirt is swept out the grooves by the *Dust Bug's* nylon brush. The *Dust Bug* also applies the proper degree of humidity to neutralize and prevent the generation of static electricity that attracts dust into the grooves.

The *Dust Bug* is furnished with a choice of two support mountings for simple attachment to the surface of any manual turntable or automatic turntable used in single play. Both the suction cup and PVC mounting are supplied. The PVC mounting base is provided for those turntables surfaces to which the suction cup will not adhere or where a more permanent mounting is

desired.—**Elpa Marketing Industries, Inc.,** Watts Record Care Products, Thorens Bldg., New Hyde Park, NY 11040.

CIRCLE 97 ON FREE INFORMATION CARD

CB COAX SWITCH, *model 13-200,* permits changeover from single to duals, or other CB antenna arrangements by a simple flick of the switch. It has a single SO-239 transceiver input



connector and is switchable to either of the two SO-239 antenna cable connectors. The switch eliminates tedious changes in transmission-line connections and concern about proper impedance matching when it is desirable to use a different antenna. Measuring $4^3/_4 \times 2^1/_2 \times 2$ inches, the unit is housed in a black metal case. List price is $7.95.—**Breaker Corp.,** Marketing Dept., 1101 Great Southwest Parkway, Arlington, TX 76011.

CIRCLE 98 ON FREE INFORMATION CARD

CB CONVERTER, *Roadmate model CBC-1,* converts ordinary car radio into CB receiver. After mounting the unit under the dashboard, plug the car's broadcast antenna into the unit, the unit's antenna connector into the car radio,

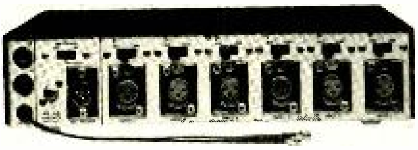
hook it up to your 12-volt car battery and the car radio tuning dial becomes the tuner that lets you select any of the 23 CB channels. *CBC-1* features pushbutton on/off control and an LED

CIRCLE 20 ON FREE INFORMATION CARD

to indicate that the unit is on and operating. A flick of the switch and the car radio will receive ordinary broadcast stations. Priced at $29.95, the unit comes complete with installation and operating instructions.—**EICO Electronic Instrument Co., Inc.**, 283 Malta Street, Brooklyn, NY 11207.

CIRCLE 99 ON FREE INFORMATION CARD

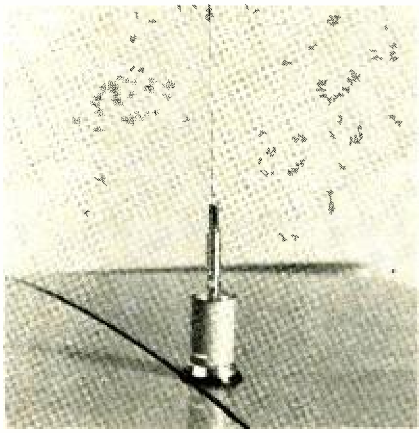
MICROPHONE MIXER, *model M677,* adds six additional low-impedance balanced microphone inputs to a sound system. Specifications include: frequency response, ±2 dB from 30 Hz to 20,000 Hz; equivalent input noise, −128 dBv, 300 to 20,000 Hz noise bandwidth at full gain; equivalent input hum-and-noise, −125 dBv, 30 to 20,000 Hz noise bandwidth at full gain; distortion less than 1% THD at 1,000 Hz; low-cut filters, −6 dB at 1,000 Hz typical.



The new *M677* mixer can be powered from the nominal 28—30-volt DC output of the attached master mixer or from a Shure *A67B* battery power supply. Measures $11^{3}/_{8} \times 7 \times 2^{1}/_{2}$ inches, weighs 3-$^{3}/_{4}$ pounds and sells for $181.20—**Shure Bros., Inc.**, 222 Hartrey Avenue, Evanston, IL 60204.

CIRCLE 100 ON FREE INFORMATION CARD

MOBILE CB ANTENNA, *model M-510,* can be permanently mounted on a trunk lid with no holes by using the handy grip trunk-lid mount. It



also converts easily for roof-top mounting. $36.75.—**The Antenna Specialist Company,** 12435 Euclid Avenue, Cleveland, OH 44106.

CIRCLE 101 ON FREE INFORMATION CARD

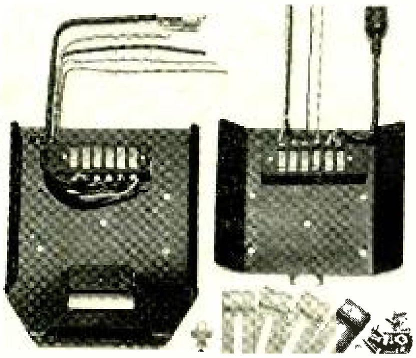
CB LOCK-MOUNT, *model 301C,* features heavy-gauge steel construction with key lock for protection. Contact wiring is provided for transceiver, remote CB speaker and public address. Coaxial antenna leads come complete with PL-259 connector and threaded antenna connector post.

Removal of transceiver from car, truck or van is simple operation. Lock mount is all black

CIRCLE 79 ON FREE INFORMATION CARD

CIRCLE 45 ON FREE INFORMATION CARD

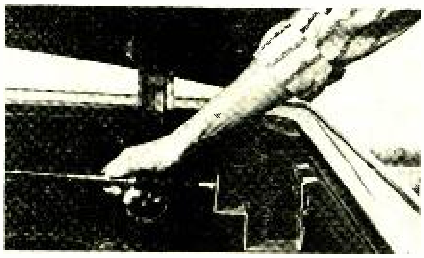
color providing minimum attention to CB unit.—



Electronics Industries, Inc., 333 Taft Drive, So. Holland, IL 60473.

CIRCLE 102 ON FREE INFORMATION CARD

CB ANTENNA, *Tuk-A-Way,* installs easily on the trunk lip of most cars, and provides complete antenna concealment inside the trunk when not in use. It accepts antennas designed for either roof or trunk mounting. Built of 12-gauge cold-



rolled steel coated with zinc chromate. The hinge is of stainless steel and is spot-welded to the clamp to provide a positive ground contact. $15.95, with a one-year limited warranty.—**Deep South Marketing Corp.,** 2828 Telephone Road, Houston, TX 77023. **R-E**

CIRCLE 109 ON FREE INFORMATION CARD

Computers show motorists the way around traffic jams

Traffic-control computer systems, used for years in many cities, are now being tried on intercity highways. An experimental system in the Rhine-Main area in Germany, where the highways handle traffic between several large cities, shows considerable promise. The system is designed to spot areas of extra-heavy traffic—potential traffic jams—and direct vehicles to alternate "relief" routes to avoid such a situation.

Special detectors imbedded in the road collect information on the number of vehicles passing, their speed and whether they are passenger cars or trucks. (It is important to distinguish between cars and trucks wherever there is a possibility that the traffic may be diverted to routes with uphill gradients.)

The information collected on the various roads is reported to the traffic control center, where a Siemens 16030 traffic control computer evaluates the data, displays the information on a video display unit and reroutes traffic to other roads wherever the load is extremely heavy or is moving rapidly toward such a situation so that the situation can be avoided.

The rerouting is done with a series of roadside signs. These are set up in sets of three—two advance and one main sign—to give motorists ample warning of the turnoff. The three signs of a set are not changed simultaneously, but consecutively, at a rate depending on the average speed of traffic. Otherwise a sign change might cause a motorist to receive one routing recommendation at the first sign he sees and a contrary one at the next sign.

During the experimental period, the control computer has not been allowed full control over actual traffic. The rerouting decisions are first displayed, then scanned by a human traffic expert before the variable relief-route signs are acti-

AN ALTERNATE ROUTE is recommended to Dortmund-bound motorists, and the sign also tells them the distance to the turnoff point.

vated. The system will become fully automatic as soon as enough knowledge has been gained to bring the computer programming to a point that will assure near-perfect traffic control. No projection is made as to how long that may take. **R-E**

new lit

More information on new lit is available from the manufacturers of items identified by a Reader Service number. Use the Free Information Card following page 116.

OSCILLOSCOPES. 12 pages of pictures, facts and specifications on the six oscilloscopes that make up this manufacturer's T900 series. All units in this series have an 8 x 10 centimeter display area and 2 units are storage scope models.—**Tektronics Inc.,** P.O. Box 500, Beaverton, OR 97077

CIRCLE 103 ON FREE INFORMATION CARD

SERVICE TECHNICIAN AND INDUSTRIAL CATALOG. 336 pages loaded with all kinds of devices for the service technician. Everything in the GC, Telco, Walsco, Calectro, Electrocraft, and Audiotex lines. In addition, a complete section of CB-equipment. This is one catalog that every service technician should have.—**GC Electronics,** Rockford, IL 61101

CIRCLE 104 ON FREE INFORMATION CARD

ELECTRONIC TEST ACCESSORIES. 76 pages of plugs, patch cords, cable assemblies, test socket adapters, space molded accessories, test leads, connecting leads, and IC test clips. Special charts covering a cross index of type numbers includes description of various wire and cable types.—**Pomona Electronics,** 1500 East Ninth St., P.O. Box 2767, Pomona, CA 91766

CIRCLE 105 ON FREE INFORMATION CARD

TEST INSTRUMENTS of many different varieties are described and illustrated in this 40-page booklet. There's everything from CB radio test instruments, to curve tracers, to FET multimeters, to oscilloscopes, plus signal and marker generators, tube testers and vectorscopes. A valuable guide to this manufacturer's line of test equipment and accessories.—**B&K Precision Instruments,** 6460 W. Cortland, Chicago, IL 60635

CIRCLE 106 ON FREE INFORMATION CARD

REPLACEMENT TUNER GUIDE and parts catalog. Extensive listing of all major makes and models of tuners and replacement parts. Includes photo enlargements of tuners for quick detection of a tuner problem and easy location of the correct replacement part. The new catalog is **available for $2.00** and has 134 pages.—**PTS Electronics, Inc.,** 5233 S. Hwy. 37, Bloomington, IN 47401

CIRCUIT DESIGN LINE. A 24-page illustrated catalog that shows a complete line of Solderless Breadboards and Breadboard IC Testers in a number of varieties along with many useful accessories.—**E & L Instruments, Inc.,** 61 First St., Derby, CT 06418

CIRCLE 107 ON FREE INFORMATION CARD

TAPE & PHONO DRIVE & BELTS CATALOG, *catalog WA-00CG-0290.* A complete guide to exact replacement of drives and belts for cassette, cartridge, recorder/player, and phonographs. The *Walsco Tape & Phono Exact Replacement Drives ? Belts Catalog* illustrates and describes the entire line of exact replacement units, as well as containing a cross-reference guide to more than 200 manufacturers. The line includes fabric belts, square belts, "O rings," drive wheels, pressure rollers, turret drives, and switches.—**G.C. Electronics,** Division of Hydrometals, Inc., 400 South Wyman Street, Rockford, IL 61101.

CIRCLE 110 ON FREE INFORMATION CARD

OVERSPEED ALARMS

continued from page 47

complete, the system can be removed from the vehicle and returned to the workshop for the fitting of R9 and C3.

The next step is to consult the graph of Fig. 8 to find the frequency or frequencies that correspond to the desired "alarm" RPM setting or settings. If these frequencies are referred to as f_{trig}, the value (or values) of R9 can be calculated on the basis of:

$$R9 = \left(\frac{150{,}000{,}000}{f_{trig}}\right) - R7, \text{ when}$$

C3 = .01 µF and R7 is the calculated or measured value of resistance when C2 = .01 µF.

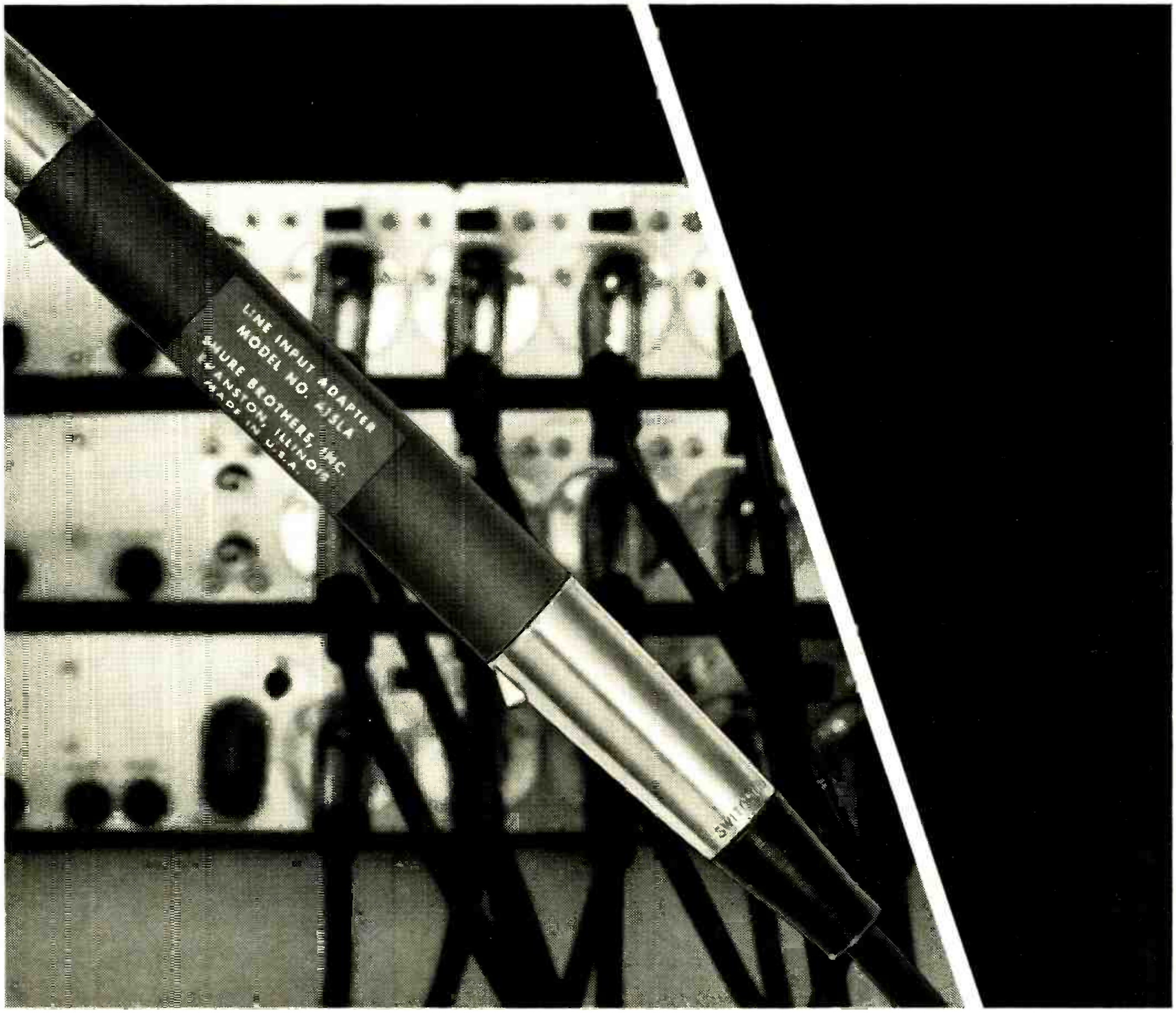
Thus, in our example, which needs a 470 K value of R7 to give an 8,000 RPM value at 267 Hz, R9 needs a value of about 176 K to sound the alarm at 7,000 RPM, 280 K to sound it at 6,000 RPM, or 650 K to sound it at 4,000 RPM. If desired, these values can in practice be reduced by a factor of ten and the value of C3 increased to 0.1 µF.

Once the values of R9 and C3 have been calculated, C3 can be wired permanently into place in the circuit, and R9 can be made up from a fixed and a variable resistor and wired temporarily into place. The R9 value or values can then be finally adjusted in the same way as R7.

The actual method is to connect the unit to a 12-volt supply, feed a suitable trigger signal of the calculated frequency, f_{trig}, across the R2-R3 combination, and then adjust R9 so the alarm just triggers at that precise frequency: If necessary, modify the value of the fixed part of R9 so that triggering can be obtained at the specified frequency.

Once the setting (or settings) of R9 is complete, the resistor can be permanently wired into place in the circuit. Calibration of the tachometer and the alarm system is then virtually complete, and the unit can be wired into the vehicle on a permanent basis.

The unit should then be given at last check to ensure that its calibration is correct, and any necessary final adjustments made. It is then ready for use. If desired, the actual 1-mA moving-coil tachometer can be finally discarded at this stage, and replaced by a short circuit. **R-E**



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MULTIPLE PIX

All I can get on this Philco 21HT15 is three or more pictures, overlapping! Everything else seems to be normal. I checked AFC diodes, capacitors and tube. Waveforms all funny. The horizontal hold works normally. What do you think this is?—G.L., Bronx, NY.

I think your horizontal oscillator is running off frequency. In fact, I will go so far as to say that it definitely is! It *is* running, or you wouldn't have a picture at all. If you checked the capacitors across the coil as you said, this leaves only one real good possibility. This is the horizontal hold coil itself. Check resistance of the windings and above all, make sure that the adjustable core hasn't been turned away too far in or out! Kill the AFC and adjust this for a *single* floating picture.

(Feedback: This did it! The coil checked OK but when I turned the core it was binding! I thought that I had reached the end of rotation but I hadn't! Thanks!)

CAPACITOR BURNING

This RCA CTC-44 came in with the circuit breaker tripping. I found the cause to be C3 (Sams number; C403 RCA), a .072 μF 600-volt type. I replaced it with a .075-μF. In about 15 minutes the same thing happened and the new capacitor burnt up. Tried another one and it got very hot in just a few minutes! Checked waveforms; all looked fairly good. Then my scope went out! Shorted power transformer. Any ideas?—C.G., Staten Island, NY.

There are days when it doesn't pay to get out of bed, aren't there? I've had 'em. Anyhow, I think I know what this is. *Don't* use a standard bypass capacitor in places like this. They will not carry the high RF current that is necessary. Use an exact duplicate replacement which will be a high-current type, very likely with polycarbonate insulation. This is getting to be pretty common, so watch out for similar circuits in other sets. (Triad and Thordarson have power transformers.) **R-E**

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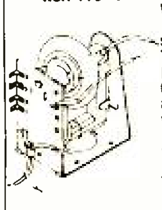

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CIRCLE 36 ON FREE INFORMATION CARD

DIGICOLORORGAN

continued from page 68

is wrong. Using point M as a reference, the voltage at point S should be about 9 and at the Q1 side of C3 should be about 5. These voltages indicate proper power supply operation. In any case, unplug the unit and check all component placement, component orientation and solder joints.

The light display built for the prototype uses a hexagonal lensed translucent plastic panel that is used to cover fluorescent lights. The plastic panel is mounted on the front of a black vinyl covered 23½ x 13¼ x 14-inch particle board box. The low-wattage lights connected to the color organ are several inches behind the plastic panel on the inside of the box, and the color organ circuit board itself is attached to one of the sides on the inside of the box. A small rectangular hole is also provided on the side of the box so a panel holding power switch S2 and potentiometer R8 can be mounted. When viewed from the front, each of the lights that are turned on behind the panel have the appearance of a six-petal flower whose size and brightness are dependent upon the light wattage and the light's distance from the plastic sheet.

Although this type of display was used on the prototype, almost any type of display or light configuration can be used as long as it uses 117-volt lights and not more than 800 watts per channel.

The unit should be wired as shown in the wiring diagram, Fig. 4. Although high-wattage spot or flood lights may be used, it is recommended that parallel combinations of smaller lights (40 watts or less) be used instead, since the smaller lights have a faster response time. Fuse F1 and switch S2 must be capable of handling the total amount of current drawn by the lights. Since the lights require much more than their rated power for a short period of time after turn-on it is best to use a slow-blow fuse. Its rated current should be about 1 ampere for every 100 watts of bulbs connected to the unit. If the total combination is greater than 1,000 watts, use a heavy line cord. All the wiring interconnecting the lights and points W, Z, E, A, B, C and D must use at least No. 18 gauge wire and go to a heavier gauge if more than 500 watts of bulbs are connected to the unit.

After the organ has been wired as shown in Fig. 4, all points on the circuit board—excluding the secondary side of transformer T2—are either directly or indirectly connected to one side of the line cord. So be sure not to attempt repairs or measurements on the unit while it is plugged in.

Connect the input terminals of the color organ to the speaker terminals of your existing sound system as shown in the wiring diagram. Turn both your sound system and color organ on and set the repetition rate control R8 to give the most desired visual effect.

The unit can detect low-level noise generated by your amplifier, so the display may be active while there is no sound from the speakers. When the normally audible sound level coming from the speakers is present, the low-level noise is superimposed on this high-level signal and will not affect the unit's operation.

If the organ is driven from sound sources delivering more than 100 watts, increase the value of R1 and R2 to 500-ohm, 5-watt resistors. **R-E**

40-CHANNEL CB

continued from page 6

may not be very much new 40-channel CB equipment available before March 1977. And even then, shortages and scarcity of equipment for sale should be commonplace.

Although a reduction in the age requirement for an operator was proposed, 16 instead of the current 18-years, it was not approved. The minimum age for a license is still 18. However, under the present rules, all persons under the age of 18 residing in the same household may operate under a license held by a parent.

The proposal to combine Class-C and Class-D operating privileges under one license was not adopted. The subject is still under review but no change will be made now.

The Citizens Radio Service name will not be changed. The FCC believes that the proposed names are more descriptive of the character of the service. However, since such changes would obsolete millions of application forms, license documents and other printed material, the change of name will not be implemented now, but will be made at a more opportune future date.

Perhaps most important of all is the FCC statement that the channel expansion to 40-channels is only an interim measure. The problem of long distance "skip" propogation at 27-MHz caused by sunspot activity is minimal at this time. In the next several years the solar cycle is expected to peak and much long-distance interference is expected. As a result, the FCC Office of Plans and Policy and the Personal Use Radio Advisory Committee (PURAC) is studying the area of personal radio. Both groups will consider an alternate spectrum in the 220- and 900-MHz range that favor radio wave propagation over short line-of-sight distances and is unaffected by the solar cycles. This could mean a change at some future date to a completely different set of frequencies and all existing CB gear for 27-MHz operation would be obsolete. It would also mean that the new gear would be much more costly, because of the frequencies involved. **R-E**

"Swan Lake" broadcast-telecast is largest in stereo history

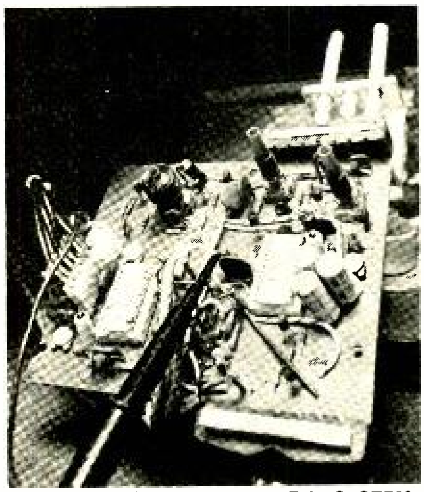
The *Live from Lincoln Center* broadcast-telecast of the American Ballet Theatre's "Swan Lake" last June 30 was the largest live stereo network transmission in the history of broadcasting. The broadcast covered a potential audience of 107 million—more than half the nation's television viewing audience.

The television portion of the program was transmitted over PBS TV stations, and the stereo network signals of the sound portion were distributed by land line, microwave and satellite. Viewers were urged to tune their TV sets to the local PBS TV station and their FM radios to the local station carrying the Lincoln Center stereo broadcast—placing a speaker on either side of the TV set, if practicable.

The *Live from Lincoln Center* broadcast was produced by Lincoln Center in collaboration with WNET/Channel 13. The ballet featured Natalia Makarova as the Swan Queen and Ivan Nagy as Prince Siegfried. **R-E**

Paper on quadriphonic FM receives Chicago IEEE honors

A paper entitled *A Quadriphonic FM Broadcasting System Incorporating Pilot-Control Compression and Pre-Emphasis* was selected as the outstanding paper presented at the 1975 Fall Conference of the Chicago Section of the IEEE and the Consumer Electronics Group (CEG). Authors were Pieter Focken and Carl G. Eilers, Zenith research scientists.



DISCRETE FOUR-CHANNEL FM SYSTEM, shown undergoing tests in the Zenith engineering studio, is part of the company's quadriphonic broadcasting system proposed for adoption by the Federal Communications Commission.

The system reported on is the one now being proposed by Zenith Radio Corp. for adoption by the FCC as the standard for quadriphonic broadcasting. **R-E**

FCC and discount phone service

An FCC draft order now under consideration would, if put into effect, strike down the phone company's prohibition against resale and sharing of private-line services. This would permit greater access by small users to Bell's Telpak service, through which users get "bundles" of 60 or 240 lines at low rates.

The draft proposal asserts that the resale and sharing proposal would eliminate waste that occurs because the bulk rate structure often encourages customers to buy much more capacity than they can use.

The FCC pointed out that there are already significant exceptions to the phone company's rule against sharing or reselling private-line service. Western Union, for example, leases several types of facilities for resale to others. Aeronautical Radio, Inc., a not-for-profit organization owned by the nation's domestic airlines, is treated as a "single customer" allowing a number of companies access to the service.

The FCC draft order states: "What our decision does is simply to require that AT&T treat all its customers alike unless valid reasons exist to the contrary." **R-E** *continued from page 44*

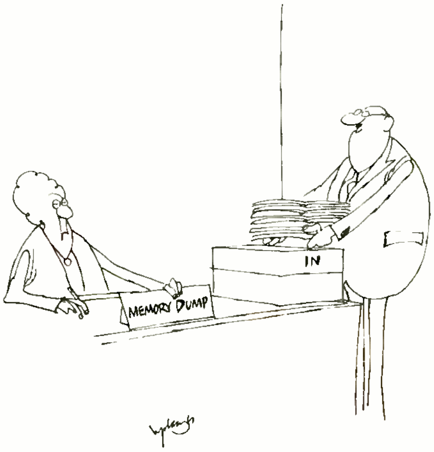
the desired channel.

On Channel 19, the 23.490- and 14.970-MHz oscillator signals are summed in the synthesizer mixer to produce a 38.460-MHz output. When transmitting, this signal beats with the signal from the 11.275-MHz oscillator to provide the desired 27.185-MHz Channel-19 output frequency.

When the transceiver is in the receive mode, the synthesizer output and the incoming signal beat in the first mixer to develop the 11.275-MHz first IF (38.460 − 27.185 = 11.275). This signal is heterodyned against the output of the 11.730-MHz crystal oscillator to develop the 455-kHz second IF. Fixed capacitors can be switched in and out of the crystal circuit to provide +1 kHz and −1 kHz delta tuning.

If you want to be sure that you understand this variation on the frequency synthesizer, try a few examples on your own. Just remember that the transmitter frequency equals the *sum* of the crystal frequencies selected by S1-a and S1-b *minus* 11.275 MHz. The first local oscillator in the receiver equals the *sum* of the two selected crystal frequencies and is 11.275 MHz *above* the channel frequency.

There are a few other variations in the heterodyne-type frequency synthesizer but you won't find them difficult to understand if you master the three schemes covered here. Frequency synthesizers are almost as easy to troubleshoot as circuits using individual crystals in the receiver and transmitter circuits for each channel. As an exercise, see if you can prepare a chart that will indicate which crystal circuits are defective if: you can transmit but cannot receive on any one channel or on any group of channels; receive but cannot transmit on one or more channels; or you can receive but cannot transmit on any channels. While this is keeping you busy—and, I hope, entertained, I'll be pouring over PLL circuits that I hope to include in an early issue. **R-E**



"ELCASET"
(continued from page 50)

lengths; 30 minutes and 45 minutes per-side, respectively) are just becoming available. Obviously, audiophiles are not going to rush right out to their nearest tape dealers to purchase them by the dozens unless there are machines to go with them. At the recent Consumer Electronic Show held in Chicago, we saw two such machines that were ready for the marketplace, both produced by Sony (one of the Elcaset's sponsors). The model EL-5 shown in Fig. 8 is expected to sell for around $630.00,

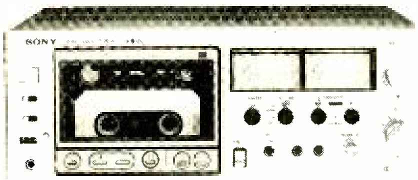


FIG. 8—SONY MODEL EL-5 STEREO DECK uses the new Elcaset.

while the model EL-7 (shown in Fig. 9) will have a nationally advertised value of around $900.00. Neither of these machines takes full advantage of all the automatic possibilities inherent in the Elcaset's construction, but both machines were able to produce recordings that, upon first hearing, certainly sounded excellent in terms of fidelity and signal-to-noise ratios.

At that same trade show, we saw prototypes of Elcaset decks developed by the other two sponsoring companies, Technics by Panasonic and Teac, both of which went far beyond the features available in Sony's first production models. They also will probably be far beyond the price of the EL-5 and EL-7 as well, though no prices or delivery

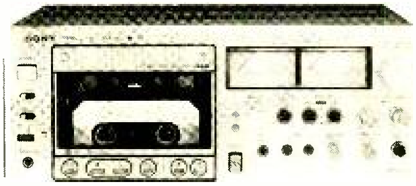


FIG. 9—SONY MODEL EL-7 ELCASET STEREO DECK.

dates were quoted by representatives of either company.

Besides the three previously mentioned companies, two other manufacturers, Aiwa and JVC have also agreed to adopt the Elcaset system standards. These companies, and perhaps others, will no doubt announce products and place them on the market in the near future.

There will no doubt be Elcaset machines available in the future that will sell for less than the first available units already seen. But if scaled down versions do appear, the question naturally arises as to whether these less expensive Elcaset machines (that will probably not take advantage of the increased control flexibility and detection systems built into the basic Elcaset) will really offer any advantages over similarly priced well-performing standard cassette decks.

There is also the question: Where will they fit in? The enthusiastic promoters of the Elcaset feel certain that the Elcaset will bring new recordists into the marketplace: people who wanted something better than the best cassette decks offer, for one reason or another, but did not want to get involved with the added complexity of open-reel tape recording. Claims of "equal performance" to open-reel machines can be contradicted to some degree. While the Elcaset will permit editing more easily than does a standard cassette, precision editing will not be as easy as it is with open-reel machines, which means that the very serious, semi-professional recordist may shy away from the new format, if only for that reason. Then too, if 3¾-IPS tape travel provides better performance than is possible with 1⅞-IPS speeds (and there is no doubt about that), then it can be argued that open-reel machines still have the upper edge in absolute fidelity at their 7½ and even 15 IPS speeds. On the other hand, no one would have predicted that the standard performance that it now does, and in like manner, the Elcaset and its hardware are bound to undergo refinements and further improvements as this new tape format begins to gain acceptance and the public begins to make its needs known.

Obviously, it is too early to come to any definite conclusions regarding the future of the new Elcaset. We have yet to test our first one (but you can be sure that we will, and will report the results in these pages as soon as we can get our hands on a sample machine).

In the meanwhile, you might find it worthwhile to compare the characteristics of cassettes, Elcasets and open reel using the information supplied by one of its sponsors and tabulated in Table I. Bear in mind, though, that this information, while completely true, may not take *all* factors into consideration since, as we stated, it is compiled by a very interested party. **R-E**

CB AND SWR

continued from page 84

you can't quite get a grasp on, you're right.

When you think you've got one effect beat another takes its place. For example, most of you are familiar with the "trick" of reducing the SWR reading by "trimming" the transmission line. The only thing you are actually trimming is your antenna's radiation pattern.

A mismatch causes current to flow on the transmission line shield and the line actually becomes part of the antenna (parallel currents). The line radiates and modifies the antenna's radiation pattern. When you trim the line you are actually trimming the radiating antenna system, and who knows what's happening to your signal. As far as the SWR meter is concerned, everything after the meter's output terminals is antenna, not transmission line. If trimming the transmission line reduces the SWR reading, you know for certain you've got problems that are being caused by the antenna.

And antenna problems is all the SWR meter really shows the CB'er: that's why it's so important. Unless the SWR is 2:1 or less for a station fed with less than 100-feet of RG-8/U, or less than 1.5:1 for 100-feet or more of RG-8/U or RG-58A/U, you know for certain much of your transmitter's output isn't getting into the antenna. The best antenna in the world won't help if you don't put RF into it.

In fact, the ideal Citizen-band installation should consist of at *least* a transceiver, an antenna and an standing-wave ratio meter. **R-E**

STEP-BY-STEP

continued from page 97

If you lose the 3.58-MHz signal at any point in this series, stop and check out the place where it's disappearing. The standard causes will be found—open coupling capacitors, bad resistors, open PC board conductors, open coils, bad solder-joints and so on.

If the signal output of the oscillator is too low, it can cause a weak-color symptom. Check back to make sure that the input signal and others are up to normal amplitude. If they are, start looking for things like a weak subcarrier amplifier tube, low DC voltages on this tube, low screen-grid voltage, defective cathode resistor or open cathode bypass capacitor.

If all colors are off and can't be brought back by realignment, check the varactor diode, its DC voltages, and substitute a new crystal. One quick check here is to turn the tint control and see if it does *anything*. If it does not, check the small coaxial cable connecting the tint control to the chassis; loose ground, short or open in the coax.

If everything seems normal in this circuit and the tint control does have some effect, it might be a good idea to run a quick check on the demodulator *balance* adjustments. These may have been turned to the wrong setting by someone who didn't know what was going on. In this type of demodulator, it's fairly easy. Just read the DC voltage on each of the test-points, which means the grids of the three color-difference amplifier tubes. This should be zero with a color-bar signal input. If any of them are off, readjust the DC balance control to zero. This should be the last step in the color alignment.

All in all, this isn't a hard circuit to service if you know how it works and what the *normal* reactions and tests are. Just go through it one logical step at a time and you will find the defective part very quickly. Remember the one we mentioned a while back: if that neon tube isn't glowing, fix that first or you're not going to get *anywhere*! **R-E**

PICTURE PULLS IN

This Zenith 20CC50Z is getting to me! The vertical size and linearity controls have very little effect and the picture is stretched a little but only in the lower half! Also, the corners of the raster pull in at the bottom of the screen. This is worse with low brightness. Wow!—E.M., Kew Gardens, NY.

Check the 30-μF electrolytic capacitor connected in the screen grid circuit of the 6JB5 vertical output tube. This is *not* the screen-grid bypass capacitor; that is the 10-μF connected directly to the screen terminal with its negative going to the cathode. There is a 22K resistor between the 30-μF and the screen. This is actually a waveshaping capacitor that works in the pincushion-correction circuitry! If it's open, you can get a fake keystone raster.

Don't overlook the little 100-μF electrolytic in the 6JB5 *cathode* circuit, either. This can cause some real oddball problems.

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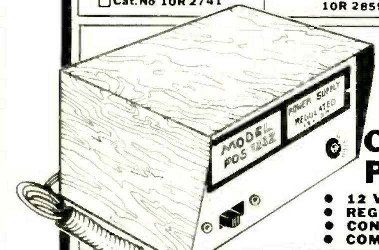

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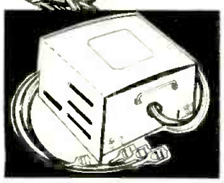

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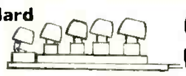

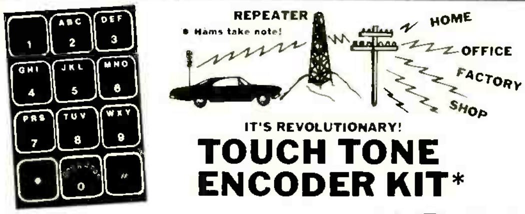

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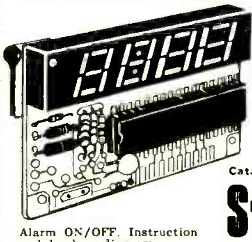

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☐ SN7409	.52	.53
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☐ SN74154	1.53	1.54
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SPECIAL OF THE MONTH

TRANSISTORS

2N3906 MOT 12/1.00 100/7.00

SWITCHING DIODES

1N4148
Switching Diodes
20/1.00 100/4.00

DIODES

1N4007
12/1.00 100/6.50

1 Watt 5% Zeners
1N4728 to 1N4757 series
5/1.00 100/15.00
State Voltage — 3.3V to 51V

SWITCHES

DPDT Slide 5/1.00 25/4.00
V3-101-D8 10A 125V Micro 2/1.75
311SM56 10A 125V Micro 2/1.50

ASSORTMENT

10 different switches 1.00

SMOKE DETECTOR KIT $29.95

C MOS

34001	FSC	1.00
4000		4/1.00
4001		4/1.00
4002		4/1.00
4006		1.50
4007		4/1.00
4008		1.00
4009		2/1.25
4010		2/1.25
4011		3/1.00
4012		3/1.00
4013		2/1.00
4014		1.25
4015		1.50
4016		2/1.25
4017		1.25
4018		1.25
4019		2/1.25
4020		1.25
4021		1.50
4022		1.25
4023		3/1.00
4024		1.00
4025		3/1.00
4027		2/1.25
4028		1.25
4029		1.35
4030		2/1.25
4032		2/1.00
4033		2.00
4035		1.85
4040		2.45
4041		1.25
4042		1.25
4043		1.25
4044		1.25
4049		2/1.35
4050		2/1.35
4051		1.50
4052		1.50
4053		1.50
4060		3.00
4066		1.25
4069		3/1.00
4070		1.35
4071		2/1.00
4077		1.00
4081		2/1.50
4511		1.75
4512		1.75
4518		1.50
4520		1.65
4528		1.50

CrownTec L.E.D. watches

6-Function, 1-Button Solid State. Hours, Minutes, Seconds, Day of Week, Month & Day. The Crowntec L.E.D. watch contains the finest custom designed quartz crystal to assure accuracy of 3 min. per year. Guaranteed 1 yr. from date of purchase (battery excepted).

From 29.95 up

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Men's Rhodium with Leather Band $29.95
Ladies $39.95

Other styles available in gold tone as well as Rhodium finish.

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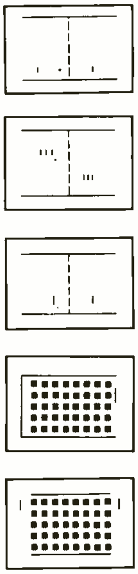
Package Codes
H-TO5 K-TO3 M-8 PinMin N-14 PinDip T-TO220

304H	Neg Reg	1.00	566H	V Cont OSC	1.50
305H	V Reg	1.00	566N(8)	V Cont OSC	1.50
306H	V Comp	2.25	567N(8)	Tone Decoder	1.50
307H	OpAmp	3/1.00	702H		1.00
307N(8)	OpAmp	3/1.00	703H	RF/IF Amp	2/1.00
308H	OpAmp	1.00	709H(14)	OpAmp	3/1.00
308N(8)	OpAmp	1.00	710H	V Comp	2/1.25
309H		1.10	710N(14)	V Comp	2/1.25
309K	5V Reg	1.25	711H	Dual Comp	2/1.00
310H	V Fol	1.15	711N(14)	Dual Comp	2/1.00
310N(8)	V Fol	1.15	723H	V Reg	2/1.00
311H	V Comp	1.00	723N(14)	V Reg	2/1.10
311N(14)	V Comp	1.00	725H	Instr OpAmp	2.00
318H	HiPerOpAmp	2.00	733H	Dif Vid Amp	1.00
318N(8)	HiPerOpAmp	1.50	733N(14)	Dif Vid Amp	1.00
320T-5V	Neg Reg	1.75	739N(14)	Dual Aud PreAmp	1.00
320T-6V	Neg Reg	1.75	740H	FET OpAmp	7.00
320T-8V	Neg Reg	1.75	741H	OpAmp	3/1.00
320T-12V	Neg Reg	1.75	741H(8)	OpAmp	3/1.00
320T-15V	Neg Reg	1.75	741N(14)	OpAmp	3/1.00
320T-18V	Neg Reg	1.75	747H	Dual OpAmp	2/1.50
323K-5V	Reg	6.00	747N(14)	Dual OpAmp	2/1.50
339N(14)	LoV Quad Comp	1.80	748H	OpAmp	3/1.25
340K-5	Pos Reg	1.95	748N(14)	OpAmp	3/1.25
340T-5V	Pos Reg	1.75	749N(14)	OpAmp	1.50
340T-8V	Pos Reg	1.75	760N(14)	Dif Vol Comp	4.25
340T-12V	Pos Reg	1.75	1303N(14)	Dl Ster PreAmp	1.00
340T-15V	Pos Reg	1.75	1414N(14)	Dual Dif Comp	1.75
340T-18V	Pos Reg	1.75	1458N(8)	Dual OpAmp	2/1.00
370H	AGC/SgAmp	1.15	1488N(14)	Quad MDTL Dr	2.00
370N(14)	AGC/SgAmp	1.15	1489N(14)	Quad MDTL Dr	2.00
373N(14)	AM/FM IF Det	3.25	1496N(14)	Mod-DeMod	1.00
380N(8)	Audio Amp	1.00	2900N(14)	Quad Amp	1.00
380N(14)	Audio Amp	1.25	3065N(14)	TV Snd Sys	2/1.50
381N(14)	Dual PreAmp	1.50	3900N(14)	Quad Amp	2/1.25
531H	OpAmp	3.00	3905N(14)	Prec Timer	2/1.25
550N(14)	Prec V Reg	1.00	3909N(14)		1.25
555N(8)	Timer	2/1.00	4136N(14)	Quad 741	1.75
556N(14)	Dual Timer	1.35	4558N(14)	Dual 741	2/1.00
565N(14)	Ph Lock Loop	2.00			

VIDEO GAME KIT
5IVE Games To Play

A CHALLENGE TO BUILD,
A CHALLENGE TO PLAY.



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1. Basic Tennis games in three variations.
2. Plus 2 variations of Wipe Out the squares. A fascinating game for 1 or 2 players. Not available in most games sold.
3. All 5 games in one kit.
4. Curve Button for added excitement.
5. On screen scoring between plays.
6. Sound.
7. Basic TTL circuitry except for VK-6 proms.
8. Requires 5V DC+ at ½A.

VK-1	PC Board Only Includes parts list & wiring Diagram requires VK-6	25.00
VK-2	PC Board with parts Includes PC Board, 78 IC's (those necessary are pre-programed) resistors & capacitors to stuff the board.	125.00
VK-3	Hardware Kit Controls, switches, wire Does not include Housing.	17.50
VK-4	RF Module Kit To convert video signal to TV receiver signal. Eliminates internal "wire in" on TV set.	22.50
VK-4-A	Antenna-Game Switch Allows outside antenna to remain connected while game is in use.	9.50
VK-5	Power Supply Kit For VK-1 or VK-2 PC Board ONLY.	12.50
VK-6	PROM Set 3 Programmed DM8574N with 2 DM8130N for VK-1 (If you have plenty of TTL).	50.00

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18	4/1.25	—	—
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28	—	3/1.12	2/1.50

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22 Pin dual Read Out .156 2.25
50 Pin dual Read Out .125 5.00

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TIL312	0.3 ChHt	1.00
MAN4	0.187 ChHt	2/1.00
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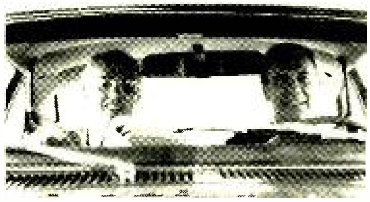

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JAPANESE TRANSISTORS

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2SA316	.75	2SB235	1.75	2SC460	.70	2SC828	.75	2SC1756	1.25
2SA473	.75	2SB303	.65	2SC478	.80	2SC829	.75		
2SA483	1.95	2SB324	1.00	2SC491	2.50	2SC830	1.60	2SD30	.95
2SA489	.80	2SB337	2.10	2SC497	1.60	2SC839	.85	2SD45	2.00
2SA490	.70	2SB367	1.60	2SC515	.80	2SC945	.65	2SD65	.75
2SA505	.70	2SB370	.65	2SC535	.75	2SC1010	.80	2SD68	.90
2SA564	.50	2SB405	.85	2SC536	.65	2SC1012	.80	2SD72	1.00
2SA628	.65	2SB407	1.65	2SC537	.70	2SC1051	2.50	2SD88	1.50
2SA643	.85	2SB415	.85	2SC563	2.50	2SC1061	1.65	2SD151	2.25
2SA647	2.75	2SB461	1.25	2SC605	1.00	2SC1079	3.75	2SD170	2.00
2SA673	.85	2SB463	1.65	2SC620	.80	2SC1096	1.20	2SD180	2.75
2SA679	3.75	2SB471	1.75	2SC627	1.75	2SC1098	1.15	2SD201	1.95
2SA682	.85	2SB474	1.50	2SC642	3.50	2SC1115	2.75	2SD218	4.75
2SA699	1.30	2SB476	1.25	2SC643	3.75	2SC1166	.70	2SD300	2.50
2SA699A	1.75	2SB481	2.10	2SC644	.70	2SC1170	4.00	2SD313	1.10
2SA705	.55	2SB492	1.25	2SC681	2.50	2SC1172B	4.25	2SD315	.75
2SA815	.85	2SB495	.95	2SC684	2.10	2SC1209	.55	2SD318	.95
2SA816	.85	2SB507	.90	2SC687	2.50	2SC1213	.75	2SD341	.95
		2SB511	.70	2SC696	2.35	2SC1226	1.25	2SD350	3.25
2SB22	.65			2SC712	.70	2SC1243	1.50	2SD352	.80
2SB54	.70	2SC206	1.00	2SC713	.70	2SC1293	.85	2SD380	5.70
2SB56	.70	2SC240	1.10	2SC732	.70	2SC1308	4.75	2SD389	.90
2SB77	.70	2SC261	.65	2SC733	.70	2SC1347	.80	2SD-390	.75
2SB128	2.25	2SC291	.65	2SC739	.70	2SC1383	.75	2SD437	5.50
2SB135	.95	2SC320	2.00	2SC715	1.75	2SC1409	1.25		
2SB152	4.50	2SC352	.75	2SC762	1.90	2SC1410	1.25	MPS-U31	4.00
2SB173	.55	2SC353	.75	2SC783	1.00	2SC1447	1.25	MPS8000	1.25
2SB175	.55	2SC371	.70	2SC784	.70	2SC1448	1.25		
2SB178	1.00	2SC372	.70	2SC785	1.00	2SC1507	1.25		
2SB186	.60	2SC394	.70	2SC793	2.50	2SC1509	1.25		

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1N270	.10	2N960	.55	2N2219A	.30	2N2913	.75	2N3740	1.00	2N4401	.20
1N914	.10	2N962	.40	2N2221	.25	2N2914	1.20	2N3771	1.75	2N4402	.20
		2N967	.50	2N2221A	.30	2N2916A	3.65	2N3772	1.90	2N4403	.20
2N173	1.75	2N1136	1.35	2N2222	.25	2N3019	.50	2N3773	3.00	2N4409	.20
2N178	.90	2N1142	2.25	2N2222A	.30	2N3053	.30	2N3819	.32	2N4410	.25
2N327A	1.15	2N1302	.25	2N2270	.40	2N3054	.70	2N3823	.70	2N4416	.75
2N334	1.20	2N1305	.30	2N2322	1.00	2N3055	.75	2N3856	.20	2N4441	.85
2N336	.90	2N1377	.75	2N2323	1.00	2N3227	1.00	2N3866	.85	2N4442	.90
2N338A	1.05	2N1420	.20	2N2324	1.35	2N3247	3.40	2N3903	.20	2N4443	1.20
2N398B	.90	2N1483	.95	2N2325	2.00	2N3250	.50	2N3904	.20	2N4852	.55
2N404	.30	2N1540	.90	2N2326	2.85	2N3375	6.50	2N3905	.20	2N5061	.30
2N443	1.75	2N1543	2.70	2N2327	3.80	2N3393	.20	2N3906	.25	2N5064	.50
2N456	1.10	2N1544	.80	2N2328	4.20	2N3394	.17	2N3925	3.75	2N5130	.20
2N501A	3.00	2N1549	1.25	2N2329	4.75	2N3414	.17	2N3954	3.50	2N5133	.15
2N508A	.45	2N1551	2.50	2N2368	.25	2N3415	.18	2N3954A	3.75	2N5138	.15
2N555	.45	2N1552	3.25	2N2369	.25	2N3416	.19	2N3955	2.45	2N5198	3.75
2N652A	.85	2N1554	1.25	2N2484	.32	2N3417	.20	2N3957	1.25	2N5294	.50
2N677C	6.00	2N1557	1.15	2N2712	.18	2N3442	1.85	2N3958	1.20	2N5296	.50
2N706	.25	2N1560	2.80	2N2894	.40	2N3553	1.50	2N4037	.60	2N5306	.20
2N706B	.40	2N1605	.35	2N2903	3.30	2N3563	.20	2N4093	.85	2N5354	.20
2N711	.50	2N1613	.30	2N2904	.25	2N3565	.20	2N4124	.20	2N5369	.20
2N711B	.60	2N1711	.30	2N2904A	.30	2N3638	.20	2N4126	.20	2N5400	.40
2N718	.25	2N1907	4.10	2N2905	.25	2N3642	.20	2N4141	.20	2N5401	.50
2N718A	.30	2N2060	1.85	2N2905A	.30	2N3643	.15	2N4142	.20	2N5457	.35
2N720A	.50	2N2102	.40	2N2906	.25	2N3645	.15	2N4143	.20	2N5458	.30
2N918	.35	2N2218	.25	2N2906A	.30	2N3646	.14	2N4220A	.45	C103y	.25
2N930	.25	2N2218A	.30	2N2907	.25	2N3730	1.50	2N4234	.95	C103d	.40
2N956	.30	2N2219	.25	2N2907A	.30	2N3731	2.75	2N4400	.20	C106b1	.50
										C106di	.75

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2N2647	.60	2N4891	.50
2N6027	.55	2N4892	.50
2N6028	.70	2N4893	.50
D5E37	.25	2N4894	.50
2N2160	.65	MU10	.40
2N4870	.50		

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7438	.16	4002	.20
7454	.09	4009	.39
74151	.59	74C00	.14
74153	.65	74C73	.69
74154	.98		
74192	.79		

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8038 FUNCTION GENERATOR
Voltage controlled oscillator — sine, square, triangular output. 16 pin DIP with data **$3.95**

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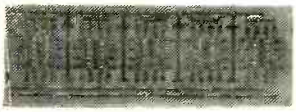
1024 bit fully decoded static RAM
DTL/TTL compatible — 16 pin DIP 1.69



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5738	1.95

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7401	.16	7453	.17	74154	1.20
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7403	.15	7460		74156	.97
7404	.16	7464	.35	74157	.99
7405	.19	7465	.35	74158	1.79
7406	.20	7470	.30	74160	1.23
7407	.28	7472	.30	74161	.97
7408	.18	7473	.35	74162	1.39
7409	.19	7474	.28	74163	1.09
7410	.16	7475	.49	74164	.99
7411	.25	7476	.30	74165	.99
7413	.43	7483	.68	74166	1.25
7414	.65	7485	.88	74170	2.10
7416	.35	7486	.40	74173	1.49
7417	.35	7489	2.25	74174	1.23
7420	.16	7490	.43	74175	.97
7422	.30	7491	.75	74176	.89
7423	.29	7492	.48	74171	.84
7425	.27	7493	.48	74180	.90
7426	.26	7494	.78	74181	2.45
7427	.29	7495	.79	74182	.79
7430	.20	7496	.79	74184	1.90
7432	.23	74100	.98	74185	2.20
7437	.25	74105	.44	74187	5.75
7438	.25	74107	.37	74190	1.15
7440	.15	74121	.38	74191	1.25
7441	.89	74122	.38	74192	.95
7442	.59	74123	.65	74193	.85
7443	.73	74125	.54	74194	1.25
7444	.73	74126	.58	74195	.74
7445	.73	74132	.89	74916	1.25
7446	.81	74141	1.04	74197	.73
7447	.79	74145	1.04	74198	1.73
7448	.79	74150	.97	74199	1.69
7450	.17	74151	.79	74200	5.45

LOW POWER

74L00	.29	74L51	.29	74L90	1.40
74L02	.29	74L55	.29	74L91	1.20
74L03	.23	74L71	.29	74L93	1.50
74L04	.29	74L72	.45	74L95	1.50
74L06	.29	74L73	.56	74L98	2.25
74L10	.29	74L74	.56	74L164	2.25
74L20	.29	74L78	.75	74L165	2.30
74L30	.29	74L85	1.09		
74L42	1.39	74L86	.65		

LOW POWER SCHOTTKY

74LS00	.36	74LS32	.38	74LS95	2.09
74LS02	.36	74LS40	.45	74LS107	.59
74LS04	.36	74LS42	1.40	74LS164	2.20
74LS08	.38	74LS74	.59	74LS193	2.20
74LS10	.36	74LS90	1.30	74LS197	2.20
74LS20	.36	74LS93	1.30		

HIGH SPEED

74H00	.25	74H22	.25	74H61	.25
74H01	.25	74H30	.25	74H62	.25
74H04	.25	74H40	.25	74H74	.39
74H08	.25	74H50	.25	74H101	.58
74H10	.25	74H52	.25	74H102	.58
74H11	.25	74H53	.25	74H103	.60
74H20	.25	74H55	.25	74H106	.72
74H21	.25	74H60	.25	74H108	.72

SCHOTTKY

74S00	.38	74S08	.52	74S22	.38
74S02	.45	74S10	.38	74S32	.52
74S03	.38	74S20	.38	74S74	.38
74S04	.45				

8000 (NATIONAL)

8091	.61	8220	1.49	8811	.65
8092	.61	8230	2.19	8812	1.02
8095	1.25	8288	1.49	8822	2.19
8121	.80	8520	1.16	8830	2.19
8123	1.43	8552	2.19	8831	2.19
8200	2.33	8563	.62	8836	.29
8214	1.49	8810	.70	8880	1.19

8000 (SIGNETICS)

8263	5.79	8267	2.59

9000

9002	.40	9309	.79	9601	.61
9301	1.03	9312	.79	9602	.79

DVM CHIP 4½ DIGIT
MM5330 — P channel device provides all logic for 4½ digit volt meter. 36 pin DIP with data **$9.95**

POCKET CALCULATOR KIT
5 function plus constant — addressable memory with individual recall — 8 digit display plus overflow — battery saver — uses standard or rechargeable batteries — all necessary parts in ready to assemble form — instructions included

Calc. Kit. Kit only	$ 9.95
Batteries (alkaline, disp.)	2.00
Adapter	3.95

Data included with order on request.
Add $.30 ea. if item is priced below $1.00

IC SOCKETS
Solder Tail · low profile

8 pin	$ .17	24 pin	.42
14 pin	.20	28 pin	.59
16 pin	.22	40 pin	.69
18 pin	.29		

WIRE WRAP · gold plate
14 pin .49

CMOS

4000A	.26	4018A	1.39	4066A	.89
4001A	.25	4020A	1.72	4068A	.44
4002A	.25	4021A	1.18	4069A	.44
4006A	1.35	4022A	.94	4071A	.26
4007A	.26	4023A	.25	4072A	.35
4008A	1.52	4024A	.89	4073A	.39
4009A	.57	4025A	.25	4075A	.39
4010A	.54	4027A	.59	4078A	.39
4011A	.29	4028A	.98	4082A	.35
4012A	.25	4030A	.44	4518A	1.56
4013A	.45	4035A	1.27	4528A	1.56
4014A	1.27	4040A	1.39	4585A	2.10
4015A	1.27	4042A	1.47		
4016A	.48	4049A	.59		
4017A	1.01	4050A	.59		
74C00	.19	74C74	1.04	74C162	2.49
74C02	.26	74C76	1.34	74C163	2.66
74C04	.44	74C107	1.13	74C164	2.66
74C08	.68	74C151	2.62	74C173	2.22
74C10	.35	74C154	3.15	74C195	2.26
74C20	.35	74C157	1.76	80C95	1.15
74C42	1.61	74C160	2.48	80C97	.96
74C73	1.04	74C161	2.49		

SPECIAL DEVICES

372	AF-IF Strip Detector DIP	2.93
546	AM Radio Receiver Subsystem DIP	.75
1310	FM Stereo Demodulator DIP	2.90
1496	Balanced Modulator-Demodulator	.99
1800	Stereo multiplexer DIP	2.48
ULN2208	FM Gain Block 34db (typ) mDIP	1.18
ULN2209	FM Gain Block 48db (typ) mDIP	1.35
2513	Character Generator 64x8x5 DIP-24	10.20
3046	Transistor Array DIP-14	.73

THESE DISCOUNTS APPLY TO TOTAL OF ORDER — SPECIALS INCLUDED

10% OFF ON ORDERS OVER $25
15% OFF ON ORDERS OVER $100

LARGE QUANTITY PRICING AVAILABLE ON REQUEST
PLEASE SPECIFY ITEM AND QUANTITY

MEMORIES

1101	256 bit RAM MOS 16 pin	1.39
1103	1024 bit RAM MOS dynamic 18 pin	1.95
1702A	2048 bit PROM static electrically programmable UV erasable 24 pin	10.95
2102	1024 bit RAM static 16 pin	1.95
5203	2048 bit PROM static electrically programmable UV erasable 24 pin	10.95
5260	1024 bit RAM MOS dynamic 16 pin	1.95
5261	1024 bit RAM MOS dynamic 16 pin	1.95
7489	64 bit ROM TTL 16 pin	2.25
82S23	256 PROM-SCHOTTKY 16 pin	3.69
F93410	256 bit RAM bi-polar 16 pin	1.95
74187	1024 bit ROM TTL 16 pin	5.75
74200	256 bit RAM tri-state 16 pin	5.45

CLOCK CHIPS

MM5311	6 digit multiplexed BCD, 7 seg, 12-24 Hr, 50-60 He — 28 pin	4.45
MM5312	4 digit multiplexed BCD, 7 seg, lpps. 12-24 Hr. 50-60 Hz — 24 pin	3.95
MM5314	6 digit multiplexed 12-24 Hr, 50-60 Hz 24 pin	4.45
MM5316	4 digit, 12-24 Hr, 50-60 Hz, alarm 40 pin	4.95
537AA	4-6 digit, 12 hour, 60 Hz snooze alarm brightness control capability, alarm tone output — 24 pin	4.95
CT7001	6 digit, 12-24 Hr, 50-60 Hz, alarm, timer and date circuits — 28 pin	5.95

CALCULATOR CHIPS

CT5002	12 digit, 4 function fixed decimal battery operation — 40 pin	1.95
CT5005	12 digit, 4 function plus memory, fixed decimal — 20 pin	2.49
MM5725	8 digit, 4 function, floating decimal 18 pin	1.98
MM5736	6 digit, 4 function, 9V battery operation — 18 pin	2.95
MM5738	8 digit, 5 function plus memory and constant floating decimal, 9V battery operation — 24 pin	3.95
MM5739	9 digit, 4 function, 9V battery operation — 22 pin	3.95

TANTALUM CAPACITORS
Solid dipped +20%

.1 mfd	35V	$ .25	10 mfd	16V	$ .40
.33 mfd	35V	.25	10 mfd	25V	.45
1 mfd	35V	.25	15 mfd	10V	.40
2.2 mfd	20V	.25	15 mfd	20V	.45
2.2 mfd	35V	.30	22 mfd	16V	.45
3.3 mfd	35V	.30	33 mfd	10V	.40
4.7 mfd	16V	.30	47 mfd	6V	.40
6.8 mfd	6V	.30	56 mfd	6V	.45
6.8 mfd	50V	.40	150 mfd	15V	.50

CLOCK KIT
6 Digits (NS71L)
MM5314 Clock Circuit
2 PC Boards Clock & Display
All Transistors, Resistors
Capacitors & 3 switches with Schematic & Instructions **$14.95**

4 Digits (NS74)
MM5312 Clock Circuit
1 PC Board
All necessary transistors, resistors, capacitors, diodes & switches.
With schematic & instructions **$10.95**

DISPLAYS

MAN1	$1.95
MAN2	3.95
MAN3A	.19
MAN5	2.25
MAN6	2.49
MAN7	1.49
MAN8	2.25
MAN66	2.25
DL10A	2.19
FND500	1.89
NS71L	1.39

DISCRETE LED'S

ME4	$ .29
MV50	.12
NSL100	.12
NSL101	.12
NSL102	.15
MV5020	
RED	.15
GREEN	.15
AMBER	.15
CLEAR	.15

MULTIPLE DISPLAYS

NSN33	3 digit .12" red LED	1.79
HP5082-7405	5 digit .11 red LED	3.49
HP5082-7414	4 digit .11 red LED	3.25
SP-425-09	9 digit .25 gas disch.	1.79

OPTO ISOLATORS

MCD2	Opto isolator diode	1.09
MCT2	Opto isolator transistor	.70

LINEAR CIRCUITS

300	Pos V Reg (super 723) TO-5	$ .71
301	Hi Perf Op Amp mDIP TO-5	.29
302	Volt follower TO-5	.53
304	Neg V Reg TO-5	.80
305	Pos V Reg TO-5	.71
307	Op AMP (super 741) mDIP TO-5	.26
308	Micro Pwr Op Amp mDIP TO-5	.89
309K	5V 1A regulator TO-3	1.35
310	V Follower Op Amp mDIP	1.07
311	Hi perf V Comp mDIP TO-5	.95
319	Hi Speed Dual Comp DIP	1.13
320T	Neg Reg 5, 12, TO-220	1.39
320K	Neg Reg 5.2, 12 TO-3	1.39
322	Precision Timer DIP	1.70
324	Quad Op Amp DIP	1.52
339	Quad Comparator DIP	1.58
340K	Pos V reg (5V, 6V, 8V, 12V, 15V, 18V, 24V) TO-3	1.69
340T	Pos V reg (5V, 6V, 8V, 12V, 15V, 18V, 24V) TO-220	1.49
370	AGC/Squelch AMPL DIP	1.20
372	AF-IF Strip detector DIP	2.93
373	AM/FM/SSB Strip TO-5	2.42
376	Pos V Reg mDIP	.68
380	2w Audio Amp DIP	1.30
380-8	.6w Audio Amp mDIP	1.25
381	Lo Noise Dual preamp DIP	1.75
382	Lo Noise Dual preamp DIP	1.75
531	High Slew rate Op Amp	2.95
540	Power driver TO-5	2.95
550	Prec V Reg DIP	1.02
555	Timer mDIP	.45
556A	Dual 555 Timer DIP	1.19
560	Phase Locked Loop DIP	3.39
562	Phase Locked Loop DIP	3.39
565	Phase Locked Loop DIP TO-5	1.18
566	Function Gen mDIP TO-5	1.95
567	Tone Decoder mDIP	1.95
709	Operational AMP TO-5 or DIP	.26
710	Hi Speed Volt Comp DIP	.35
711	Dual Difference Compar DIP	.26
723	V Reg DIP	.62
733	Diff. video AMPL TO-5	1.02
739	Dual Hi Perf Op Amp DIP	1.07
741	Comp Op Amp mDIP TO-5	.32
747	741 Dual Op Amp DIP or TO-5	.71
748	Freq Adj 741 mDIP	.35
1304	FM Mulpx Stereo Demod DIP	1.07
1307	FM Mulpx Stereo Demod DIP	.74
1456	Op Amp mDIP	1.83
1458	Dual Comp Op Amp mDIP	.62
1800	Stereo multiplexer DIP	2.48
3900	Quad Amplifier DIP	.49
7524	Dual core memory sense Amp	.71
7525	Dual core memory sense Amp	.90
8038	Voltage contr. osc. DIP	4.16
8864	9 DIG Led Cath Drvr DIP	2.25
75150	Dual Line Driver DIP	1.75
75451	Dual Perepheral Driver mDIP	.35
75452	Dual Peripheral Driver mDIP	.35
75453	(351) Dual Periph Driver mDIP	.35
75491	Quad Seq Driver for LED DIP	.71
75492	Hex Digit driver DIP	.80

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Satisfaction guaranteed. Shipment will be made postage prepaid within 3 days from receipt of order. Payment may be made with personal check, charge card (include number and exp. date), or money order. Phone Orders — BofA and M/C card or C.O.D.

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CIRCLE 13 ON FREE INFORMATION CARD

CIRCLE 42 ON FREE INFORMATION CARD

CRYSTALS

THESE FREQUENCIES ONLY

Part #	Frequency	Case/Style	Price
CY1A	1.000 MHz	HC33/U	$5.95
CY2A	2.000 MHz	HC33/U	$5.95
CY3A	4.000 MHz	HC18/U	$4.95
CY7A	5.000 MHz	HC18/U	$4.95
CY12A	10.000 MHz	HC18/U	$4.95
CY14A	14.31818 MHz	HC18U	$4.95
CY19A	18.000 MHz	HC18/U	$4.95
CY22A	20.000 MHz	HC18/U	$4.95
CY30B	32.000 MHz	HC18/U	$4.95

CLOCK CHIPS — CALCULATOR CHIPS

MM5309	6 Digit, BCD Outputs, Reset PIN	$5.95
MM5311	6 Digit, BCD Outputs, 12 or 24 Hour	4.95
MM5312	4 Digit, BCD Outputs, 1 PPS Output	4.95
MM5314	6 Digit, 12 or 24 Hour, 50 or 60 Hz	4.95
MM5316	4 Digit, Alarm, 1PPS Output	6.95
MM5318	Video Clock Chip, For Use With MM5841	9.95
CT7001	6 Digit, Calander, Alarm, 12 or 24 Hour	6.95

CALCULATOR CHIPS

MM5725	6 Digit, Four Function, Less Decimal	$2.95
MM5738	8 Digit, 5 Function + = × ÷ %	2.95
MM5739	8 Digit, 4 Function, Floating Decimal	2.95
CT5030	12 Digit, 4 Function and %	7.95

MISC. MOS

MM5320	TV Camera Sync. Generator	$19.95
MM5330	4½ Digit DVM Chip	9.95
MM5369	60 Hz Timebase Circuit From 3.58 MHz	3.95
MM5841	Video Generator for MM5318	18.00
MC1408-L7	7 Bit Digital to Analog Converter	9.95
MK5007	4 Decade Counter with Latches	10.95
LD110/LD111	3½ Digit DVM Chip Set	25.00
95H90	100 MHz ÷ 10 Counter For Prescalers	13.95

THE NEW RCA CA3140
MOST USEFUL OP AMP SINCE THE 741
CA3140 vs. 741 at a glance

	CA3140T,S	CA741CT,S
Input Resistance R_I (MΩ)	1,500,000	2
Input Current I_I (pA)	10	80,000
Slew Rate, SR (closed loop) (V/μs)	9	0.5
Gain-Bandwidth Product, f_T (MHz)	4.5	1.0

$1.25

DIP SWITCH

These switches feature seven SPST slide switches in a molded dip. They are ideally suited for microprocessor applications. **$1.95**

VECTOR WIRING PENCIL

SPECIAL SPECIAL

Vector Wiring Pencil P173 consists of a hand held featherweight (under one ounce) tool which is used to guide and wrap insulated wire, fed off a self-contained replaceable bobbin, onto component leads or terminals installed on pre-punched "P" Pattern Vectorbord® Connections between the wrapped wire and component leads, pads or terminals are made by soldering. Complete with 250 FT of red wire. **$7.95**

REPLACEMENT WIRE — BOBBINS FOR WIRING PENCIL

W36-3-A-Pkg. 3	250 ft	36 AWG GREEN	$1.95
W36-3-B-Pkg. 3	250 ft	36 AWG RED	$1.95
W36-3-C-Pkg. 3	250 ft	36 AWG CLEAR	$1.95
W36-3-D-Pkg. 3	250 ft	36 AWG BLUE	$1.95

1/16 VECTOR BOARD

0.1" Hole Spacing, P-Pattern

	Part No.	L	W	Price 1	Price 2-Up
PHENOLIC	64P44 062XXXP	4.50	6.50	1.72	1.54
	169P44 062XXXP	4.50	17.00	3.69	3.32
EPOXY GLASS	64P44 062	4.50	6.50	2.07	1.86
	84P44 062	4.50	8.50	2.56	2.31
	169P44 062	4.50	17.00	5.04	4.53
	169P84 062	8.50	17.00	9.23	8.26
EPOXY GLASS COPPER CLAD	169P44 062C1	4.50	17.00	6.80	6.12

VECTOR TERMINALS

Series	Part No. Finish: Gold	Part No. Finish: Tinned	Post Size	25 pcs Gold	25 pcs Tin	50 pcs Gold	50 pcs Tin
T44	T44-1	T44	.025 sq	1.50 lot	1.00 lot	2.75 lot	1.75 lot
T46	T46-1	T46	.028 sq	1.75 lot	1.25 lot	3.00 lot	2.25 lot
T49	T49A	T49	.025 sq	1.75 lot	1.25 lot	3.10 lot	2.25 lot
T42-1	PKG 100		Terminals	$3.50 C	$13.00M		

NIBBLING TOOL

Nibbling Tool $6.95
Replacement Punch $3.75 Each

DIAGONAL CUTTER

½" Semi-Flush Cut Fine Diagonal

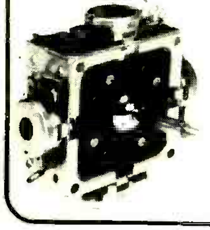
Light Blue Handle A97MS $8.50 ea.

64 KEY KEYBOARD

This keyboard features 64 unencoded SPST keys unattached to any kind of P.C.B. A very solid molded plastic 13" x 4" base suits most applications. **$19.95**

HD0165 16 LINE TO FOUR BIT PARALLEL KEYBOARD ENCODER $7.95

JOYSTICK



These joysticks feature four 100K potentiometers, that vary resistance proportional to the angle of the stick. Sturdy metal construction with plastics components only at the movable joint. Perfect for electronic games and instrumentation.

$9.95 ea.

MICROPROCESSOR COMPONENTS

8080 SUPPORT DEVICES

8080A $34.95 — **8080 $24.95**

8212	8 BIT INPUT/OUTPUT PORT FOR 8080	$5.95
8216	NON INTERRUPT BI-DIRECTIONAL BUS DRIVER	7.95
8224	CLOCK GENERATOR AND DRIVER FOR 8080	12.95
8228	SYSTEM CONTROLLER AND BUS DRIVER FOR 8080	12.95

CPU'S			RAM'S			
8008	8 BIT CPU	$19.95	1101	256 x 1	Static	$2.25
8080	Super 8008	24.95	1103	102 x 1	Dynamic	2.95
8080A	Super 8008	34.95	2101	256 x 1	Static	6.95
SR'S			2102	1024 x 1	Static	1.95
2504	1024 Dynamic	$9.00	2107	4096 x 1	Dynamic	9.95
2518	Hex 32 BIT	7.00	2111	256 x 4	Static	7.95
2519	Hex 40 BIT	4.00	7010	1024 x 1	MNOS	29.95
2524	512 Dynamic	2.95	7489	16 x 4	Static	2.49
2525	1024 Dynamic	6.00	8101	256 x 4	Static	7.95
2527	Dual 256 BIT	3.95	8111	256 x 4	Static	7.95
2529	Dual 512 BIT	4.00	8599	16 x 4	Static	3.49
2532	Quad 80 BIT	3.95	91L02	1024 x 1	Static	2.49
2533	1024 Static	7.95	74200	256 x 1	Static	6.95
3341	Fifo	6.95	93410	256 x 1	Static	2.95
74LS670	16 x 4 Reg	3.95	MM5262	2K x 1	Dynamic	.99
UART'S			PROMS			
AY-5-1013	30K Baud	$5.95	1702A	2048	Famos	$15.95
ROM'S			5203	2048	Famos	14.95
2513	Char. Gen.	$11.00	82S23	32 x 8	Open C	5.00
2516	Char. Gen.	13.00	82S123	32 x 8	Tristate	5.00
74S387	1024-Bit Programmable	1.95	74S287	1024	Static	7.95
			3601	256 x 4	Fast	5.00

BIPOLAR PROM SPECIAL

6300-1 (70 NS) 256 x 4 OPEN COLLECTOR BIPOLAR PROM (EQUIVALENT TO 82S126)	$2.95
6301-1 (70 NS) 256 x 4 TRI STATE BIPOLAR PROM (EQUIVALENT TO 82S129)	$2.95

Special Requested Items

RC4194	Dual Track V Reg	$5.95	N8T97	$2.00	MK5007	$10.95	MC4044	$4.50
RC4195	±15V Track Reg	3.25	4024P	2.25	8263	5.95	LM3909	1.25
F9368	Decoder	3.95	DM8130	3.25	8267	2.75	MM5320	19.95
LD110/111	DVM Chip Set	25.00	CD4520	$2.50	8288	1.15	4072AE	.45
CA3130	Super CMOS Op Amp	1.39	MC14016	.56	8826	3.00	7422	1.50
MC1408L7	D/A	9.95	2525	6.00	8880	.80	7497	4.00
F3341	FIFO	6.95	2527	3.95	4511AE	2.50	74186	5.00
MM5841	Character Gen.	18.00	CD4518	2.50	XR4136	2.00	74279	.90
AY5-9100	Push Button Dialer	17.50	MM5309	5.95	4566AE	3.00	82S90	4.00
CDP1802	CPU Microprocessor	39.95	DM8131	4.00	ICM 7205	29.95	MCT-2E	2.95

Continental Specialties

PROTO POWER!

POWER FOR THE PROFESSIONAL

$75 Proto Board 203

Breadboard Prototyping with 5 Volt 1 AMP Regulated Power Supply Included!

Made in USA. Patents Pending.

A total ready to use power breadboard Prototest device with a built-in regulated short proof power supply. Just plug-in and start building! 2 extra floating 5 way binding posts for external signals. Self-contained with power switch indicator lamp and power fuse. 24 14 pin DIP capacity. Attractive two tone quality case. All metal construction. 9¾" L x 6¾" W x 2¾" H. 5 lbs. Order today!

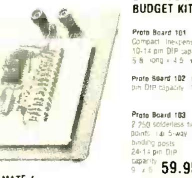
For the economy-minded experimenter . . .

NEW

Proto Board 100

$17.95

Here's a low cost, big 10 IC capacity breadboard kit with all the quality of QT Sockets and the best of the Proto Board series ... complete down to the last nut, bolt and screw. Includes 2 QT-35S Sockets, 1 QT-35B Bus Strip, 2 5-way binding posts, 4 rubber feet, screws, nuts, bolts and easy assembly instructions.



THE MINI-BREADBOARD BUDGET KIT

Proto Board 101 Compact, inexpensive 10-14 pin DIP capacity, 5.8" long x 4.5" wide **29.95**

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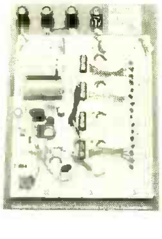

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COMPLETE KIT

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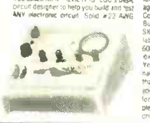
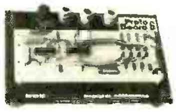
CIRCUIT DESIGNER
You asked for it: HERE IT IS. CSC's basic circuit designer to help you build and test ANY electronic circuit. Solid #22 AWG wire interconnects any discreet component without solder. Resistors, Transistors, Linear Digital ICs in TO 5 DIP packages (from 8-40 pins). And more. Components fit directly into Sockets and Bus strips instantly and easily. Plus DESIGN MATE ONE's (DM-1) variable regulated power supply gives 5-15VDC up to 600ma (9 watts). Now that's design flexibility for you.
You can even monitor the DM-1's internal power supply or external circuits thanks to the built-in 0-15V voltmeter. If you're into electronics, DM-1 is a must for your laboratory. It comes to you completely wired, tested and ready to use for only $54.95





PROTO BOARD 6
The PB 6 lets the user test and build circuits without soldering or patch cords ... all interconnections between components are made with common #22 AWG hook up wire. This quality breadboarding unit includes 630 component tie points at less than 2½ cents each. It measures 6" long by 4" wide. Designed specially to Breadboard Microprocessor Circuits. $15.95

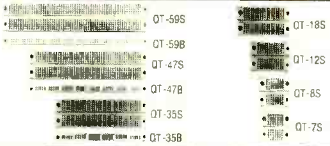
Now trace signals or troubleshoot fast. Inject signals or wire unused circuits into existing boards. Scope probes, test leads lock onto Dynagrip insel. Plastic construction — no springs or pivots. Thousands of operations. Narrow throat for high density PC boards.

PC-14	14 pin Proto-Clip	$3.90 ea
PC-16	16 pin Proto-Clip	$3.90
PC-24	24 pin Proto-Clip	$6.90

SPECIAL!

LOGIC MONITOR

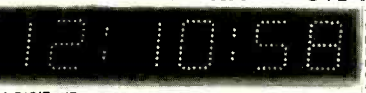
Simultaneously displays static and dynamic logic states of DTL, TTL, HTL or CMOS DIP ICs. Pocket size $84.95



QT Proto Strips

QT type	#holes	price
QT-59S	590	12.50
QT-59B	bus strip	2.50
QT-47S	470	10.00
QT-47B	bus strip	2.25
QT-35S	350	8.50
QT-35B	bus strip	2.00
QT-18S	180	4.75
QT-12S	120	3.75
QT-8S	80	3.25
QT-7S	70	3.00

DIGITAL CLOCK KIT — 3½ INCH DIGITS



This clock features big 3½" high digits for viewing in offices, auditoriums, etc. Each digit is formed by 31 bright 0.2" LED's. The clock operates from 117 VAC, has either 12 or 24 hr. operation. The 6 digit version is 27" x 3½" x 1½" and the 4 digit is 18" x 3½" x 1½". Kits come complete with all components, case and transformer.

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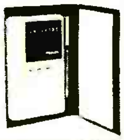
$8.95

FEATURES:
- 8 Digit Display
- 5 Functions consists of addition, subtraction, multiplication, division, percentage, with constant on all functions, with full floating decimal point
- Power source is 1 piece 9V DC Battery 00GP jack for AC adapter
- Black superfine grained finish plastic cabinet

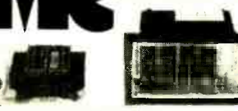
5 FUNCTION ELECTRONIC CALCULATOR WITH WALLET-NOTEBOOK AND POCKET CHECKBOOK RADOFIN MODEL 1710



$19.95

FEATURES
- 8 Digit Display
- 5 Functions consists of addition, subtraction, multiplication, division, percentage, with constant on all functions, with full floating decimal point
- Power source is 6 AAA cells 9 V DC
- Wallet is 2 tone texon, cabinet is black plastic

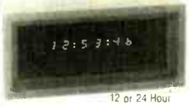
IMC 3½ DIGIT DVM KIT



This 0-2 VDC .05 per cent digital voltmeter features the Motorola 3½ digit DVM chip set. It has a .4" LED display and operates from a single +5V power supply. The unit is provided complete with an injection molded black plastic case complete with Bezel. An optional power supply is available which fits into the same case as the 0-2V DVM allowing 117 VAC operation.

A. 0-2V DVM with Case	$44.95
B. 5V Power Supply	$14.95

JE700 CLOCK



12 or 24 Hour

115 VAC

The JE700 is a low cost digital clock, but is a very high quality unit. The unit features a simulated walnut case with dimensions of 6" x 2½" x 1". It utilizes a MAN72 high brighiness readout, and the MM5314 clock chip. **$17.95**

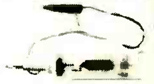
Liquid Crystal Temperature Display
Six Digit Light Emitting Diode Display
DL 33 Display

This clock makes an attractive addition to any desk. It has an extruded, black anodized aluminum case. It displays hours, minutes, and seconds with .11 inch displays, and comes complete with a liquid crystal thermometer. It operates off 115 VAC at 50 or 60 Hz. **$24.95**

This large digit clock (.6" hours & minutes, .3" seconds) features the MM5314 clock chip. It operates from 117 VAC, and will operate in either a 12 or 24 hour mode. The clock is complete with a walnut grain case, and has fast set, slow set, and hold time set features.

KIT - ALL COMPONENTS & CASE $34.95
WIRED & ASSEMBLED $39.95

JE803 PROBE



The Logic Probe is a unit which is for the most part indespensible in trouble shooting logic families TTL, DTL, RTL, CMOS. It derives the power it needs to operate directly off of the circuit under test, drawing a scant 10 mA max. It uses a MAN3 readout to indicate any of the following states by these symbols (HI) - 1 (LOW) - 0 (PULSE) - P. The Probe can detect high frequency pulses to 45 MHz. It can't be used at MOS levels or circuit damage will result.

$9.95 Per Kit
printed circuit board

T²L 5V 1A Supply

This is a standard TTL power supply using the well known LM309K regulator IC to provide a solid 1 AMP of current at 5 volts. We try to make things easy for you by providing everything you need in one package, including the hardware for only. **$9.95 Per Kit**

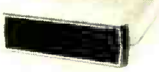
exelar

This watch is manufactured by National Semiconductor. It provides 5 functions: hours, minutes, seconds, date, A.M. indicator dot. Accuracy is assured to 5 seconds per month by precision quartz crystal. If something should go wrong with the watch, repair is assured within 48 hours after it is received. Complete with steel black leather band.

ES4-YS
3 MICRON GOLD PLATE BEZEL
$29.95

DIGITAL ALARM CLOCK — Novus

This 4 digit Novus Alarm Clock is a very reliable and smartly styled unit. It provides such features as an alarm settable to any minute of the day, a 7 minutes snooze alarm, a power failure indicator, and even an A.M., P.M. indicator.



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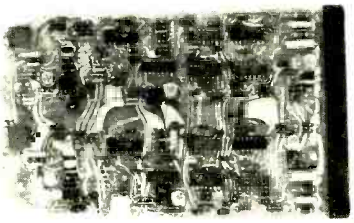

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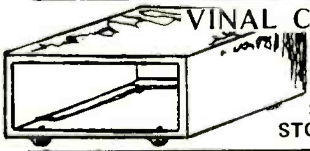

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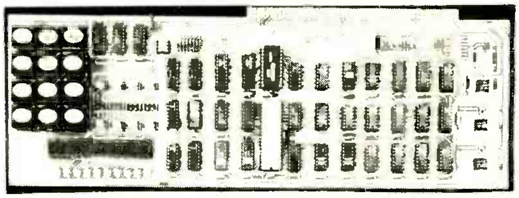
8080 microprocessor board $139.95



This board is 5" x 15" --- the same size as an Altair 8800 or IMSAI front panel. Add it to your machine, and you upgrade **both** the front panel and CPU board. Or build your own computer system around it, using Altair/IMSAI compatible peripherals.

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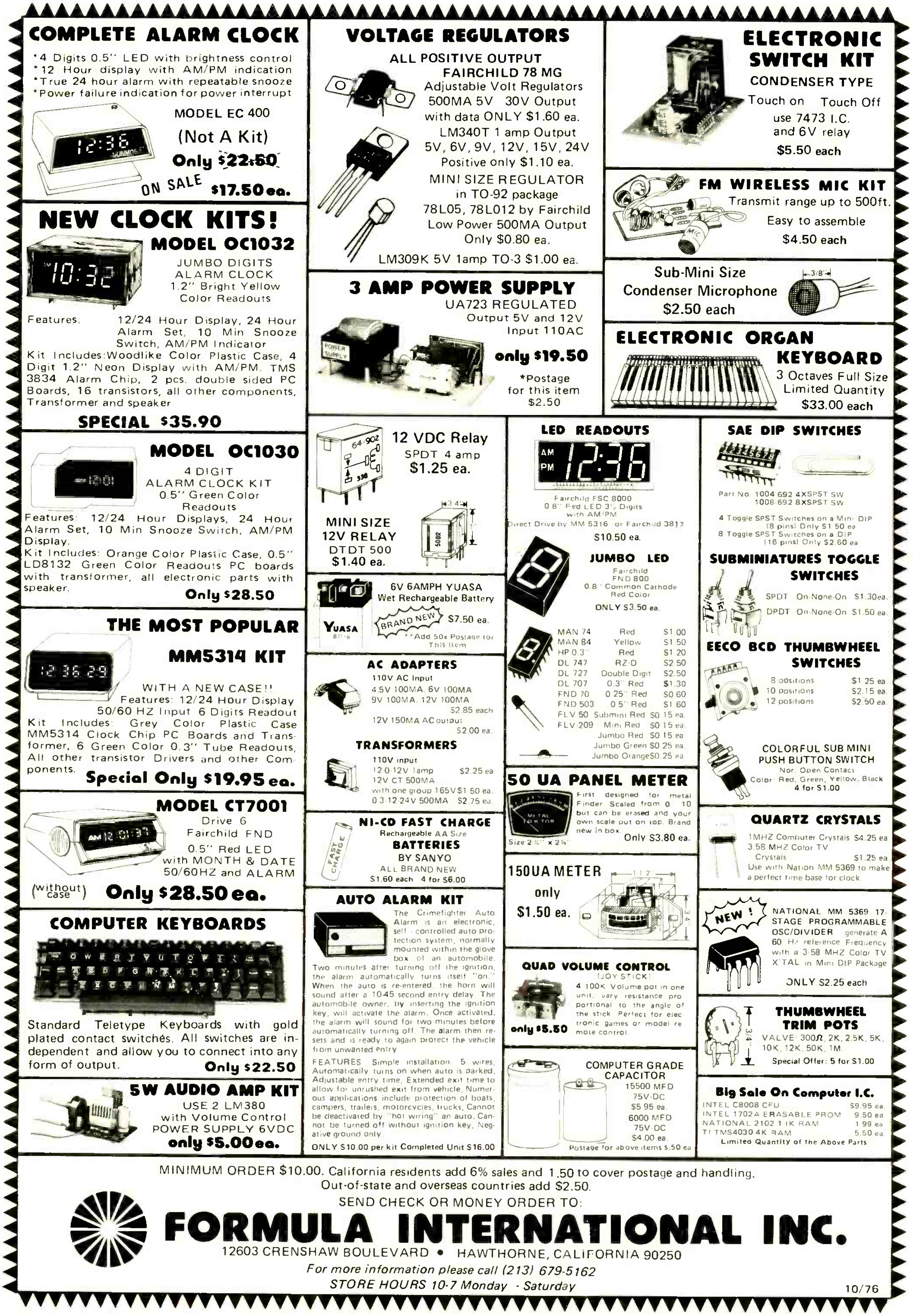

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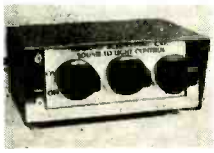

New 3-Channel Color Organ adds to music listening pleasure, lets you modulate 3 independent strings of colored lamps with intensity of your music to create an audio "light show." They flash, vary in brightness related to music's rhythm, pitch, volume—pulsating lighting performance to music! Fully assembled & priced half that of others, the Edmund Sound To Light Control is a terrific value. Plug in, turn on!

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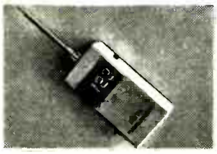

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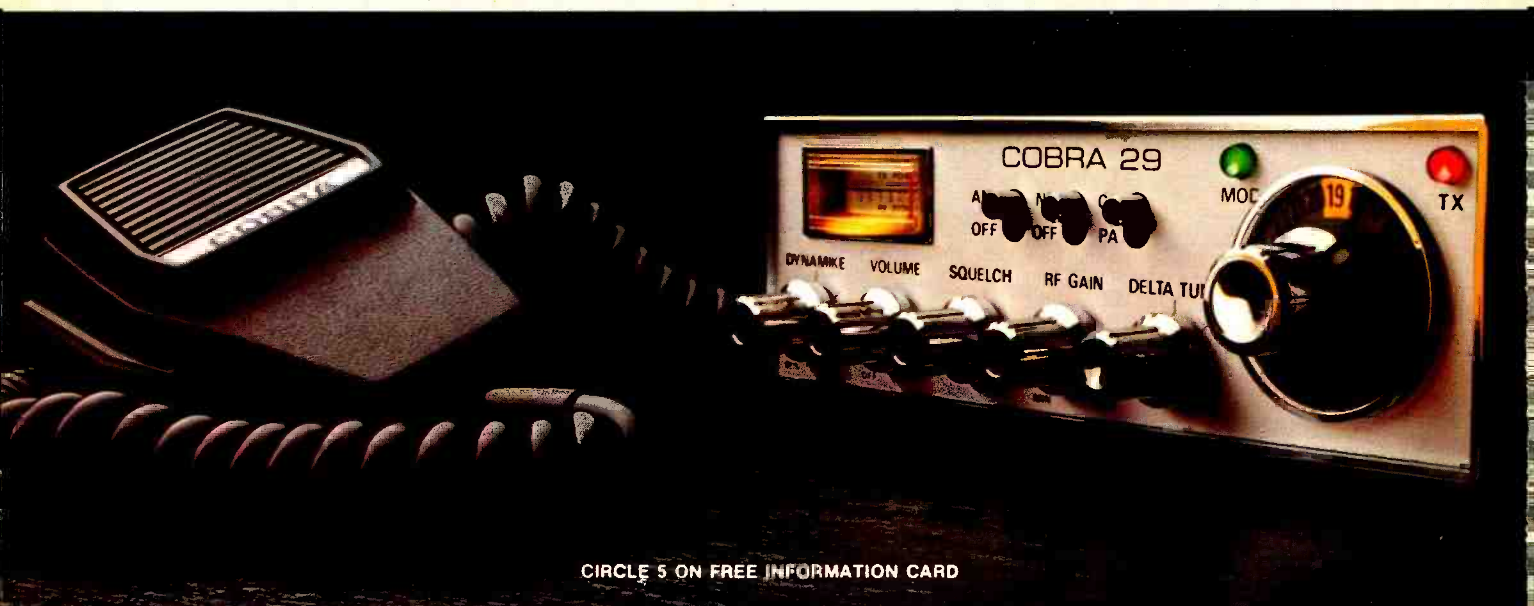
6460 W. Cortland St., Chicago, Illinois 60635

IF YOUR FIRST CB ISN'T A COBRA YOUR SECOND ONE WILL BE.



CIRCLE 5 ON FREE INFORMATION CARD