

# Radio-<sup>IND</sup>Electronics

\$1.25 ■ AUG. 1979

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

## ADAPTIVE NOISE FILTER

Hi-fi add-on you build

## SATELLITE TV RECEPTION

A new DX craze

Build your own

## AC POLARITY CHECKER

Don't get zapped!

## TV ADD-ON GADGETS

Do they really work?

## WIRING SYSTEMS

Easy ways to build projects

Build this 4½-digit

## PRECISION DMM

with true RMS and temperature



**PLUS:**

- ★ New FM Tuner Circuits
- ★ 2 R.E.A.L. Lab Test Reports
- ★ Hobby Corner ★ Equipment Reports ★ Service Clinic

RETAILER: SEE PAGE 102 FOR  
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*Creative Computing January, 1979*

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*Interface Age April, 1979*

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# BECKMAN

CIRCLE 51 ON FREE INFORMATION CARD



# Radio-Electronics®

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS  
Electronics publishers since 1908

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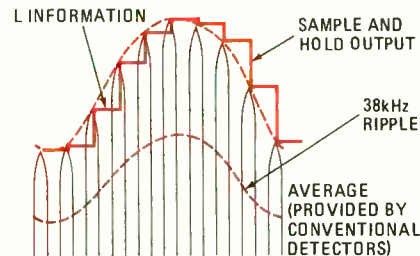
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## ON THE COVER

Precision 4½-digit DMM has lab-grade performance and features, including true-RMS and temperature measurement. Basic DC accuracy is better than .05%. Internal rechargeable nickel-cadmium battery pack provides portability. Sounds interesting? Construction details start on page 37.



**SATELLITE RECEIVING ANTENNA** being mounted on posts in authors' backyard. To find out what's being broadcast and the frequencies, turn to page 47.



**SAMPLE-AND-HOLD STEREO DECODING** circuit is just one of the new circuits manufacturers are using for increased FM tuner performance. To find out what the circuits look like and how they work, turn to page 57.

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# looking ahead

**9-hour VCR?** Things have changed in just 30 days' time. Last month, the Beta group announced that they had finally overtaken the VHS group in recording time per cassette, by means of a third (slower) speed and a cassette containing more tape. This combination provides five hours, as compared with four hours for the longest recording per cassette with the VHS system.

The VHS camp lost no time in adding a third speed of its own, which it calls "super long play" or SLP. Like Beta's new speed, this is one-third slower than the previous slowest tape movement in this format. Thus, VHS recorders push recording duration to six hours on the same cassette that will record for two hours on the original speed and four hours on the LP speed. But one technique employed by the Beta group is yet to be tried by VHS—longer and thinner tape. This is currently under development, however, and could expand the recording time to nine hours per cassette.

The first super-long-play VHS recorder will be a Matsushita-built programmable machine to be offered by RCA, but the third speed is expected to be added eventually to all VHS brands. Among other new VCR's is a Betamax by Sony, and a similar unit from Zenith, that offer stop motion, visible rewind and visible fast-forward (the latter function valuable for speeding through commercials without missing any of the program), all controlled from a wired remote control panel.

**TV for the deaf:** A government-sponsored "closed-captioning" project is designed to make television more meaningful for America's 14 million hearing-impaired citizens. The system approved by the FCC uses one line of the vertical blanking interval, doesn't affect the picture seen by those viewing in the normal way, but superimposes a caption on the screen of those using special decoders. The Public Broadcasting System will supply 10 hours of programming weekly, ABC and NBC will supply five hours each to a new nonprofit National Captioning Institute that will encode the broadcast material for captions. The captioning decoders, using a Texas Instruments IC, initially will be manufactured by Sanyo Manufacturing Co. in Forrest City, AK. Decoders will be sold by Sears Roebuck next year at \$225 to \$250 and 19-inch color sets with built-in decoding capability will retail at about \$500. The National Captioning Institute will be supported by captioning fees paid by the networks and an eight-dollar royalty on each decoder or decoder-equipped TV set. CBS has declined to join the other networks in using the captioning system because it believes captioning should be but one of the features of a more all-inclusive teletext system. The other networks agree that teletext systems can accomplish more and conserve vertical-interval space, but say it could be many years before such services are available, while captioning can start early next year. They also argue that teletext decoders will be far more expensive than simple captioning attachments.

**Farewell to dots:** The phosphor dots and delta guns that were important parts of the first practical color TV tube, as

introduced by RCA 25 years ago, will fade into history before the end of this year. Tube makers are now phasing out the last of these tubes in favor of slot-mask tubes with in-line electron guns. In the latter, instead of phosphor dots there are strips of colored phosphors. Europe and Japan have already switched over, and in the U.S. the change is almost complete. Manufacture of delta-gun tubes will be confined to the replacement market.

Slot-mask in-line-gun tubes simplify the TV set manufacturing process and are more reliable because they eliminate most convergence adjustments. Until recently, their use was principally confined to small-screen tubes because of resolution problems involved in their use in larger tubes. But new electron gun designs have increased the resolution to the point where it is claimed to be better than that of delta-gun tubes. The new tubes in 19- and 25-inch sizes generally employ 100-degree deflection, which also helps increase resolution and makes the set about two inches slimmer from front to back. Most manufacturers are expected to change over their entire large-screen lines to 100-degree deflection.

**Computers & games:** Consumer logic and data-storage devices keep getting more sophisticated. Although computers as such have failed to catch on with the general non-sophisticated public, there's no doubt they will when somebody finds the correct formula. Mighty Texas Instruments is betting that it has that formula, although it hasn't yet announced what it is—only that it will have a home computer TV attachment for under \$500 with color graphics and a 16-bit MPU.

Semi-computers and video games *have* caught on, though, and their sophistication grows every day. Portable storage and retrieval devices—such as the language translators by Craig and Lexicon—are being snapped up almost as fast as they can be made. Now Texas Instruments has come up with its own version, a *talking* language translator which gets the accent right every time. It has combined a translator with a voice synthesizer. You merely punch in the word in English, and the translation comes out the loudspeaker while the proper spelling is displayed. The handheld unit accommodates modules containing 1,000-words, of which half the words can be pronounced by the unit, all of them displayed. English and Spanish modules (150 each) are scheduled for marketing in September, along with the under-\$500 translator, with French, German, Japanese and Chinese modules due later.

A video game that is programmed by cable TV is the new "Playcable" by Mattel and Jerrold, which will be tested by four CATV systems. Two-way cable systems aren't required. For \$50, an "emulator" cartridge is inserted into the standard Mattel video game, the user selecting the program he wishes from a catalog of 20 to 40 games stored in the cable system's head-end computer—for a monthly fee. After the initial games are tried, computer programs are expected to become available.

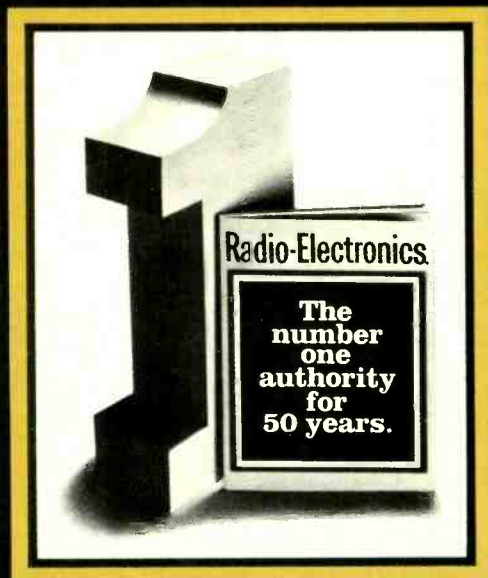
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CONTRIBUTING EDITOR



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Anniversary Issue**



From "Radio-Craft" in 1929 to Radio-Electronics today, and tomorrow, from the vacuum tube to the chip, from "wireless radio" to interplanetary communication—it's fifty years of history, experiments, and excitement from the pages of America's greatest newsstand electronics magazine, all in the most spectacular issue ever of any electronics magazine—October, 1979 Radio-Electronics.

Don't miss a word of this colorful, extra-special retrospective issue, bursting with all the excitement of all those years—or of our experts' fascinating projections and predictions for "The Next Fifty Years" of our lives.

It's October Radio-Electronics. On your newsstand September 18 ... but not for long. Don't miss it.

# editorial

## What's Special About Radio-Electronics?

I was asked that question recently by a prospective reader. It's a simple question; a good one and it requires much more than just a simple response.

The answer starts off simply enough—**Everything!**

But that's only the start. Let's look at the issue you are now reading. There are six major articles. They range from a full-blown detailed story on how you can build your own 4½-digit precision DMM, to a newsbreaking article on tuning in television satellites to a how-to story on wiring systems to use when building projects. There are also a variety of features including an article on new FM tuner circuits, two R.E.A.L. Sound reports and numerous columns, equipment reports and product previews.

All of the material in this issue was carefully selected with your specific interests in mind. There is a variety of material because you have a variety of interests. Sure, some will like one article more than another and all of you may find some particular story that doesn't appeal to you at all. But what has been done is to put together a package of information deliberately designed to keep you up to date on what is happening in our industry.

When the computer came along, Radio-Electronics presented the first article to ever tell readers how to build one for themselves. When the Videodisc was announced, Radio-Electronics presented a group of three articles to show how the player works. When flat-screen or 3-D color TV comes along we'll tell you about that too.

In this issue, our story on Satellite TV Reception is a first. The satellites have been there for quite some time. Now you will discover just what is being broadcast, how it is being broadcast; and in the next few months, how you can tune in on these broadcasts—direct from space to your home.

That's the kind of magic that makes Radio-Electronics special. That's how we have kept Radio-Electronics special and young and growing. That's why in October 1979 we will celebrate 50 years of publication; 50 years of new events and happenings; 50 years of excitement in a never-dull field. That's why we are special and that's why we will continue to be special.

We don't promise to make all of our readers happy all of the time. We do promise to deliver the best and most authoritative electronics magazine you can purchase.

  
**LARRY STECKLER**  
Editor

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# letters

## 3 UNIQUE PROJECTS

The "3 Unique Projects" article (April 1979 issue, page 48) has been a godsend.

We built two of the One-Station Intercoms and installed them in Sales and Engineering; communications between the two are now on an order of magnitude better than before! The next two we build will go to Production and Quality.

Our Engineering Director has been complaining that he doesn't get "hands-on" duties since his promotion, so we gave him the Solar-Powered Night Light to debug: A glitch you failed to notice is the unit's behavior in semidarkness—when the lamp light reflects from our receptionist's jewelry onto the solar cells, which in turn increases drive to the lamp, etc. This feedback ultimately results in broadband oscillations centered just below  $10^{15}$  Hz. Our Engineering Director solved the problem by replacing the lamp with one of National's Dark-Emitting Arsenide Diodes (DEAD's).

Finally, the Single-Shot Logic Indicator

with Memory ended our long search for a readout device for Signetics' 25120 Write-Only Memory (WOM). Due to the WOM's unique architecture (all inputs are wired-don't-care), we've had trouble remembering if we had loaded a given IC with the program, and if so, with *which* program. The Logic Indicator worked so well in this application, it's no exaggeration so say it left us with stars in our eyes.

DOUG PRUNER  
Genisco Technology  
Compton, CA

I have been a subscriber to **Radio-Electronics** since 1956. I received my April issue and, with trepidation derived from past experience, examined the index, and was immediately drawn to the construction articles on pages 48 and 49.

I think the authors of these articles should be admonished on two counts:

1. They failed to emphasize the main outstanding feature of the One Station In-

tercom—its portability over all other systems.

2. The Solar-Powered Night Light would be a great boon on polar expeditions. With suitable modifications to maintain orientation, it should operate at full brilliance for six months at zero degrees, north or south latitude. The cells should be oriented to the noon sun and the light 180 degrees away, illuminating the midnight area.

I will not construct the Logic Indicator as searching for logic in this day and age is an exercise in futility.

JOHN MOON  
Brossard, Canada

The Solar-Powered Night Light in the April 1979 article contains a philosophical error, which I figured out as soon as I built it. Those charlatans, Weinstein and Gartman, don't *really* care about energy conservation. That's why the lamp runs wastefully all the time even when it is not needed.

*continued on page 14*

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## LETTERS

continued from page 12

So I added an ON-OFF switch in series with the circuit (at the risk of increasing circuit complexity and operating-procedure confusion). I refrained from the temptation to use a momentary-on pushbutton switch as that would increase the number of on-off surges and lead to short bulb life. This disadvantage would offset the automatic-off mode's advantages.

The ON-OFF switch is also essential in case of extreme positive feedback from the lamp output back to the cells, which could happen if you carried the night light into a well-mirrored bathroom, for example. Turning the switch promptly OFF can prevent the

familiar motorboating condition or the dread runaway situation.

By the way, I was able to increase the usefulness of the night light by simply connecting about 10,000 miles of twisted pair in the circuit. Just put the solar cells either east or west of the lamp location.

ROBERT A. PEASE  
Transtronics  
San Francisco, CA

## VIDEODISC SYSTEMS

Regarding the article that appeared in the April 1979 issue on the competing Magnavox and RCA videodisc systems, there are several points that should be made. No matter how biased my statements may sound, I am *not* professionally connected with any companies involved in

promoting either system, although I do own and enjoy a Magnavox optical videodisc player and an assortment of the programs.

The author makes the point that several Japanese manufacturers (Panasonic and JVC) have already joined RCA in promoting the capacitive format. This has not yet occurred; and the JVC Visc system has so many obvious advantages over RCA's approach that if there is to be any standardization between these three companies, it may well be that RCA will join them.

Also, while the article states that these companies are at least talking with RCA about standardization, no mention is made of the fact that there is presently a partnership between MCA and Pioneer Electronics (under the name of Universal-Pioneer) to market optical videodisc players, and that General Motors has already placed an order for a *minimum* of 7000 players from the new company.

Although the article points out that due to the laser scanning of the MCA discs there is no deterioration from repeated playing, it does not tell us that with the RCA capacitive design, the discs wear out after about 200 plays and that the stylus that tracks RCA's grooves must be replaced after (approximately) 300 hours of use.

The paragraph that states that MCA is supplying the discs for the optical system reads as if MCA is the only source of feature movies. It is true that MCA is the only manufacturer of the discs; however, the initial program catalog includes feature films licensed to MCA from other studios, including Paramount, Disney and Warner Brothers.

ALFRED W. MYERS  
White Plains, NY

## EXPERIMENTERS' GROUP

I am a longtime reader and subscriber to your magazine, and it goes without saying that I like it very much. The articles give a very rounded insight into many aspects of electronics.

Being an experimenter by nature, I have felt there was a need for an organization to bring amateur scientists together. Now that need has been filled—the Amateur Scientists Research Organization has been formed. Interested persons can find out more by writing to ASRO, P. O. Box 4, McMechen, WV 26040. The latest newsletter and bulletin will be sent free with no obligation.

RICHARD S. MEYER  
McMechen, WV

## ON-SCREEN DIGITAL CLOCK

This is in reply to J. G. Ash's letter in the March 1979 issue regarding construction of the on-screen digital clock (July 1977 issue).

It appears to me that if S1 is held down longer than the C9-R13 time constant, the clock will be permanently on. This is because when S1 is initially closed, a ground is applied not only to pins 4 and 5 of IC2-b, but also to the negative side of C8. This will cause C8 to charge more or less instantly to pin 3's level, which is now going low. After C9 charges (from 4 to 6 seconds), current ceases to flow through R13, causing pins 1 and 2 to go low and pin 3 to go high. At this point, if S1 is still depressed,

continued on page 16



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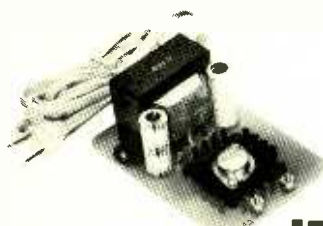
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## LETTERS

continued from page 14

C8 will charge instantly to this new level and will stay there even if S1 is released. We now have a stable state and the clock will stay on indefinitely.

My solution was to place an SPST toggle switch in parallel with C9. Closing the switch and activating S1 will cause the clock to stay on indefinitely (for setting purposes). After the clock is set, open the switch and the display will turn off after 4 to 6 seconds. I call this switch "Display Hold" on my clock.

D. A. TABBUTT  
Las Vegas, NV

### BURGLAR ALARM FLAW

Several years ago I built and installed a burglar alarm from an article in **Radio-Electronics** ("Anti-Theft Devices," R.M. Marston, November, December 1976). The circuit was ingenious and worked well—so well that I later built several for friends. But recently I discovered a basic and serious flaw in this design that applies to any other circuits using CMOS gates as sensitive switches.

The circuit takes advantage of the very high input impedance of CMOS gates, in order to use the series loop of normally closed switches with very low standby current. The switches are in series with a 22-megohm resistor. If all switches are closed, the input to the gate is pulled high; if any switch opens, the 22-megohm resistor pulls

the input low, triggering the alarm.

The system I installed in my apartment uses conventional magnetic reed switches with exposed screw terminals. The apartment was painted recently by a sloppy housepainter using water-based latex paint. Several days afterward, quite by accident I discovered the alarm would not trigger if a particular door was opened.

A careful investigation revealed some paint had been slopped over the screw terminals of the reed switch. While the top surface of the paint was dry and measured infinite resistance, the underside of the peeled-off chip was evidently still damp and showed a series resistance of only 300K across the 1-inch span between terminals.

Since this 300K resistance was shunting the open switch, the alarm system interpreted it as a closed door. I don't know how long it would take for the paint to dry enough to increase its resistance to the 30 megohms or so that would be required to allow the circuit to function normally.

But this suggests a more serious problem. Any moisture across the screw terminals would shunt the open switch to the point where the circuit would not trigger! Readers who have installed alarms using this circuit should be warned to do one of two things:

1. Decrease the value of the pulldown resistor from 22 megohms to no more than 50K. Unfortunately, this will increase standby current to about 250  $\mu$ A, but it will prevent dampness and condensation from defeating the system. OR . . .

2. Paint, spray or otherwise completely insulate the terminals on all sensor switches with a non-water-based paint or lacquer to prevent them from being shunted by moisture.

ROBERT R. LEVINE  
New York, NY

### CB REPAIR INFO WANTED

Your Jack Darr service format is one of the finest columns in any electronics magazine. I have been using the column for years in my TV servicing and have found many service troubles, thanks to Mr. Darr.

Now I have branched off into CB repair, and the same type of service format would be very useful. You definitely don't have enough information (in some months, none at all) or articles regarding CB's. I would think there would be more readers interested in CB's than in microprocessors, etc. Please stick more with the items the consumer on the street is likely to have.

CHET WHEELER  
Bethlehem, PA

### FUTURE DEVICES

Your April 1979 editorial was a well-produced mini-history lesson that many have probably taken for granted. Concerning the last paragraph about future products, I would probably not be able to fill the bill on dreaming; however, since you did ask:

I have been visualizing the day when our energy problems could be reduced to perhaps 10% of what they are now. To help this

continued on page 22

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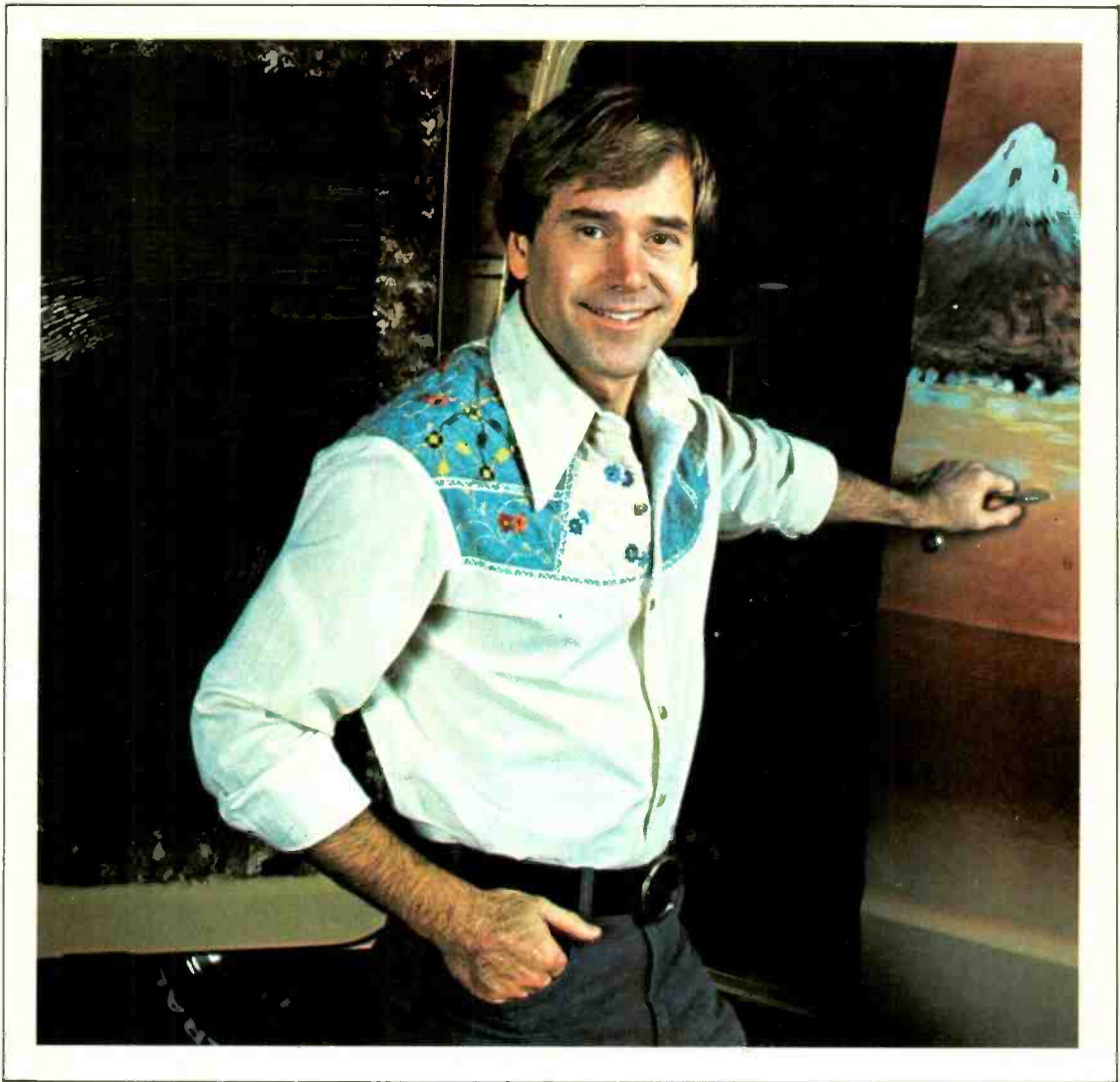


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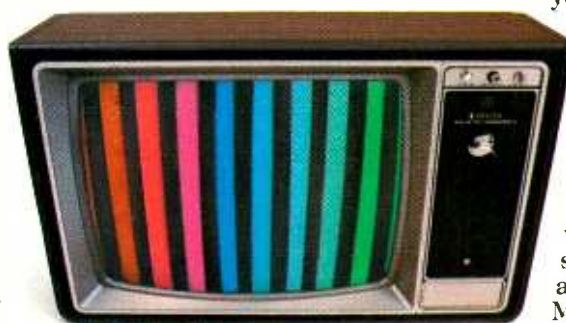


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## LETTERS

continued from page 16

become fact, a better system of transportation would be the chief ingredient—how about a transport system that operates over the phone lines. Sounds a little like "Star Trek," doesn't it? California to New York in two minutes? Remember, you said—dream!! If I get busy this week, maybe I'll have it in operation by, say, 2190. [The article on page 6 ("New & Timely") concerning the light-powered phone gave me the idea.]

And we just loved the Solar-Powered Night Light. As I see it, this should be the first practical perpetual motion machine.

Now, how about an LED on a giant scale

to be used for illumination? What a savings in power consumption for street lights, home lighting, etc. And then, how about a fiber-optic cable system to reduce power even more for street lights by putting one LED cluster in a 10-block sector and cabling to the immediately surrounding blocks?

DAVID HARTMAN  
Portsmouth, VA

### WIRE-WRAP TECHNIQUES

Thank you for an excellent presentation of my article "PC/Wire-Wrap—New Construction Technique" (*Radio-Electronics*, February, 1979).

However, while all basic principles of combined wire-wrap and PC board design of tri-level techniques have been included

in the article, your drawing of the 2102 PC board on page 54 (Fig. 1) does not make clear the breakpoints of the *data-in* and *data-out* pins. The top side of the PC board design shows clearly the breakpoints for 1K (18 IC's) enable lines, but the drawing will still have to show the breakpoints for each data input/output pin. A drawing of the bottom side of the PC board for the 2102 memory IC would have made this important detail clear.

Each 2102 IC must have an isolated wire-wrap foil pad. These pads are made by cutting the final etched PC line, just as the enable lines were separated. The final data lines are then connected for each input or output data bit by wire-wrap process. The data-bit 1 input requires eight wire-wrap connections, and the data-bit 1 output also requires eight wire-wrap connections.

Also the drawing of the edge connections in Fig. 1 for the wire-wrap circuits is misleading. The correct edge-connection pattern would have the following connecting points: 10 address lines, 1 positive line, 1 ground line, 8 enable lines for an 8K board by 1K increments, 8 Data Input Lines and 8 Data Output lines. The correct edge-connector pattern, then, is 36 individual connections for the wire-wrap points.

I hope this omission can be corrected since Fig. 1 only lacks the data line breakpoints of the bottom side of the PC board and the correct 36-line edge connections. Readers who use the drawing as shown will not have all the data that is needed to make this tri-level technique work; corrected drawings will help them beat the "wire-wrap jungle."

JAMES E. TEMPLE

### ELECTRONIC EQUATION

Mr. Ecklin's letter ("Letters," *Radio-Electronics*, April, 1979) about the "electronic equation" appears to correctly challenge the now-sacred law for the conservation of energy. Today's permanent magnets last for decades and off-the-shelf magnets easily lift 25 times their weight in iron, while most lodestones could not lift their own weight.

We now have tiny IC's for 16-bit computers with many thousands of active circuits on them that draw a total current in milliamperes. Even with this high efficiency, IBM is researching superconducting devices for even higher efficiency and speed. It is hard to guess how little power would be required to stop a magnetic field with a superconductor as Mr. Ecklin has suggested. It is also difficult to imagine a direct correlation between a 25-lb. magnet that could cause antigravity to over 600 lbs. of iron, and turning a superconductor on and off below the magnet's pole faces.

Maybe a magnet can store an unending supply of potential energy if we can divert or stop its magnetic field at will. So far we know of no way to stop or divert a gravitational field to create perpetual motion devices. One paragraph in a letter to *Radio-Electronics* may solve our energy crisis in spite of a well-proven law of science.

(By the way, Mr. Ecklin has informed me that the Doppler equation as shown in his letter was wrong; the last equal sign should have been a minus sign—i.e.,  $d = wf - c$ .)

DALE BERG  
Annapolis, MD

R-E

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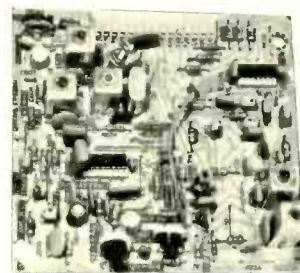
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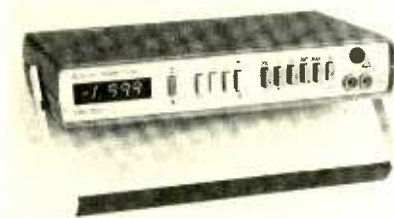
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# equipment reports

## Sinclair Radionics Model DM350 DMM



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THE NAME OF SINCLAIR RADIONICS HAS BEEN familiar in England for quite a while. Now it's appearing in the U.S. The company is Sinclair Radionics, Inc., 66 Mt. Prospect Avenue, Clifton, NJ 07015.

The unit I tested was the *model DM350* bench digital multimeter (shown). This unit is one of a pair; the *model DM350* has a 3.5-digit display and the *model DM450* has a 4.5-digit display. Otherwise, the meters are identical, except for the greater resolution of the 4.5-digit model.

The meters measure AC or DC voltages from 200 mV up to 1200 volts DC or 750 volts AC in six ranges; AC or DC currents from 2.0  $\mu$ A to 10A. A separate input jack is included that can handle up to 20A for up to 10 seconds. Resistance can be measured from 200 ohms to 30 megohms on six ranges. Overrange is indicated by the display being blanked, except for the left-hand digit that displays a "1."

Some unusual switching is used. When you read "6 ranges" and then notice there are only five voltage pushbuttons on the range selector, you start wondering. Then you read the instructions, and the mystery clears up. A special 2000-mV range can be used that has a tremendously high input impedance—greater than 1000 megohms. To set up this range you press both the volts and milliampere buttons simultaneously, and then you release all the range pushbuttons. The display is in millivolts divided by 10.

On DC and AC current ranges, you do the same thing: the lowest range pushbutton is 200  $\mu$ A. A 2- $\mu$ A scale is produced by pressing the V and the mA pushbuttons in plus the 200- $\mu$ A pushbutton. For a 20- $\mu$ A scale, press the 20V pushbutton.

Autozeroing is used on all ranges. On the lowest resistance range, shorting the test leads displays the lead resistance—typically 0.3 ohm. For precise readings, subtract this value. Accuracy on the DC voltage ranges is 0.1% on the three lowest ranges and 0.25% on the higher ranges; for AC voltages, 0.25% on the low range and 0.4% on the higher ranges; and for AC or DC currents, accuracy is typically 0.2%. Ohmmeter accuracy is 0.2% on all ranges.

The *model DM350* provides overload protection up to 1200 volts DC on all ranges, and to 750 volts AC on the AC ranges. The ohmmeter withstands up to 400 volts peak AC.

Current ranges are protected by a 2A fuse (located in the back panel) except for the 10-amp range, which is not fuse protected.

The *model DM350* is housed in a small flat plastic case that measures 10 inches wide but is only 1.5-inches high. Despite the compactness of the DMM, the panel is easily accessible, and the pushbuttons are large enough and spaced far enough apart so that they are easy to hit. The displays are 7-segment LED's that are bright enough to read at any practical distance. The test leads (which are included) plug into three jacks at the far right of the panel, out of the way. A bail-type carrying handle doubles as a bench rest to hold the panel at the best viewing angle.

Power is provided by four built-in dry "C" batteries or from an AC adapter. The batteries are located under a sliding cover on the back of the unit. A selector switch on the back allows you to choose either disposable or rechargeable batteries. When the switch is in the disposable position, the internal batteries are disconnected when the AC adapter is plugged in. If rechargeable batteries are used, just set the switch to the rechargeable position, and the battery charge is maintained while the unit is plugged in. A low-battery condition is indicated by the whole display flashing; this means the batteries are down to 4.4 volts. However, accurate measurements can still be made for a few minutes before errors occur.

These DMM's are manufactured in England, and the workmanship looks good. Incidentally, if you misplace the manual, a label on the bottom of the case gives complete information on all ranges and functions. This is a very handy little instrument, at a reasonable price—\$139.

## PTS Model 8001 Component Analyzer



CIRCLE 102 ON FREE INFORMATION CARD

PTS ELECTRONICS, INC., (BOX 272, BLOOMINGTON, IN 47401) has added test equipment to its TV tuner repair and module rebuilding ser-

vices. There are several units. One of these is the *model 8001* Component Analyzer. It's a compact instrument that is easy to run. All you need is a scope (of any kind) and connect the *model 8001* to its vertical and external horizontal inputs and off you go. Calibration and setup are fast. Adjust the scope's vertical gain plus the horizontal calibration control on the analyzer and there you are.

The *model 8001* can be used for tests on all solid-state components, such as transistors, diodes, etc. On a good diode or transistor junction, the analyzer shows a sharp right-angle pattern. A rounding of the angle shows there is leakage. A straight vertical line indicates shorted parts; open circuits show up as a horizontal line. Here's a quick check before starting: short the test leads together, a vertical line shows. If the circuit's open, then a horizontal line appears.

The *model 8001* can be used for in-circuit transistor testing. The patterns will differ from the out-of-circuit patterns, but the characteristic sharp angle will be there. The patterns are distinctive enough to indicate whether the component is bad or good. Several manufacturers have adopted this testing method, and their service manuals show the typical patterns that are found in various stages.

A good resistor shows a straight diagonal line. The angle varies with the value of resistance. A good capacitor will show an oval or a round pattern. Large capacitors have very low impedance. The *model 8001* has a LOW-MED-HIGH range switch to check any size. Many low-frequency inductors, such as power transformers, vertical-output transformers, chokes, etc., can be checked for shorts. If the winding is good, the analyzer will show a definite ellipse or even a circle if the inductance is high enough. If the component has shorted turns, a straight vertical line appears, and you cannot get a loop at any range-switch setting. Check the analyzer on a few good parts and you'll discover what to look for.

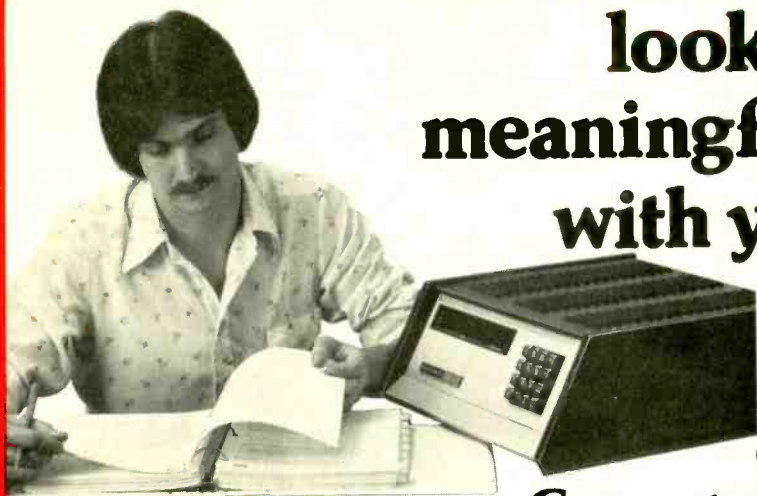
This instrument is useful for making A-B comparisons between identical circuits. In a stereo amplifier with one bad channel (a common fault), the same stage and junctions can be cross-checked between the working channel and the bad one. Here again, check some working circuits and observe what the patterns look like.

The front panel of the *model 8001* contains all the controls. The scope is connected to the horizontal and vertical jacks, and the test leads (provided) go to two universal binding posts. These binding posts are colored red and black, but the *model 8001* has no polarity. Hook up the leads one way, the angle goes up and to the right; reverse the leads, the angle goes down and to the left; but the sharp angle remains. The scope's vertical-gain control sets the length of the vertical line; the horizontal calibration control on the *8001* front panel adjusts

*continued on page 26*



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## EQUIPMENT REPORTS

continued from page 24

the length of the horizontal line. The pattern will get smaller as you switch from HI to LOW on the RANGE switch. If the pattern becomes too small, just reset the horizontal calibration and vertical gain controls. The size makes no difference.

This is a simple but handy instrument that can be very accurate when used properly. It doesn't take long to set up, and it is priced at \$54.95. **R-E**

## Apple Disk II Floppy Disc System



CIRCLE 103 ON FREE INFORMATION CARD

OWNERS OF THE APPLE II COMPUTER (Apple Computer, Inc., 10260 Bandley Drive, Cupertino, CA 95014) now have an alternate to their cassette tape system for saving programs and data. The Disk II system allows fast, reliable storage on standard 5¼-inch minifloppy dis-

kettes. Up to 14 disc drives can be connected to the Apple II for access to nearly 1.6M bytes of data. The DOS (Disc Operating System) is activated via a PROM-based bootstrap loader and master diskette supplied by Apple. The DOS adds the following commands: OPEN, CLOSE, READ, WRITE, SAVE, LOAD, EXEC, RUN, APPEND, RENAME, POSITION, VERIFY, CHAIN, LOCK, UNLOCK, DELETE, MON, NOMON, MAXFILES, CATALOG, INIT, BSAVE, BLOAD, BRUN, FP, and INT.

The Disk II consists of a controller card that plugs into one slot of the Apple II motherboard, a modified Shugart SA-400 disc drive, a system software diskette, a blank diskette and instructions. The packaging of the drive is excellent; the color-coordinated steel cabinet fits nicely on top of the computer. One controller card handles two drives; so up to a maximum of seven controllers can be used. Each drive is then referred to by its number, D, and by its controller's slot number, S (e.g., D1 and S6). Once a drive has been accessed, these values default to that drive until they are explicitly changed. Included on the software diskette is a game program, ANIMALS that demonstrates very nicely how the disc can be used to store data.

Using the Disk II is a breeze. Programs save and load by name, and about 10 times faster than by cassette. Thus, to store a program on the disc, you simply type SAVE <file name>, where <file name> is any name you select for the program. The DOS automatically keeps a directory of all files; these files can be seen by using the CATALOG command. The CATALOG command also shows the nature of the file (BASIC, Applesoft, machine code, or text),

whether the file is protected, and also gives you some indication of the file length. Using the LOCK command protects files from accidental change or deletion.

The command list gives a fairly good indication of the power of the disc system. Particularly noteworthy are the EXEC, FP and INT commands. The EXEC command is similar to a RUN command except that the indicated file may contain entries not normally allowed in a BASIC program; for example, the HIMEM command used to run many programs (i.e., the Apple Startrek game). Normally, such a program must be loaded into the computer and a HIMEM command issued to set memory pointers correctly before it is run. Using the EXEC command allows such a program to be run from the disc just like any other program.

Another good feature of the disc is that the floating-point BASIC (Applesoft) is always handy and can be loaded within 8 seconds. For convenience, the commands FP and INT are used to switch between BASIC's. When a program is loaded from the disc, the computer checks which BASIC it was written in, and then loads Applesoft (or selects the Applesoft firmware card when installed) if necessary. Incidentally, this Applesoft is actually Applesoft II, an improvement over the original version. The DOS also allows a program to begin executing immediately after booting for a turnkey type of operation.

The DOS however has two flaws; its inability to CHAIN Applesoft programs, and the lack of any password security for files. While this last feature is of little value to most home-computer hobbyists, it is very important in

continued on page 33



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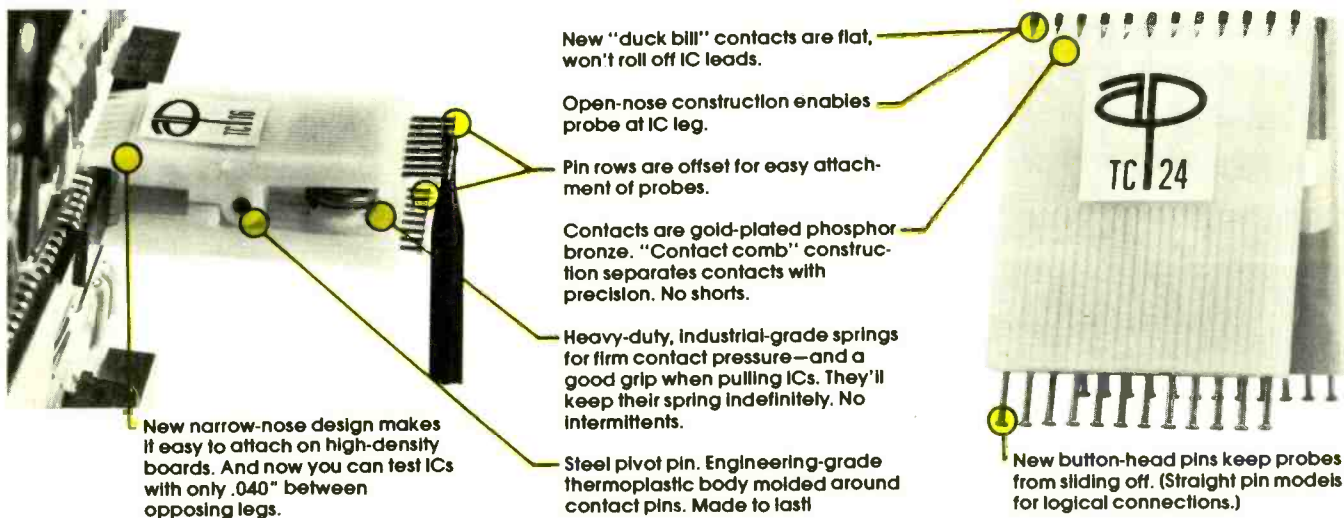
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## EQUIPMENT REPORTS

continued from page 26

multiuser systems such as schools or businesses (where many Apple II's are currently found). Without such file security, a programmer could inadvertently (or even purposely!) change or destroy another programmer's files. Since the DOS resides in RAM, undoubtedly Apple and other computer companies will supply improved versions in the near future.

Overall, the *Disk II* performed very well. I have transferred all my programs from tape to disc, which quickly filled up more than six diskettes (over 600K bytes), and the disc has operated flawlessly. Indeed, the *Disk II* appears to be up to the high standards that the company has shown in the Apple II computer.

The *Disk II* costs \$595, including the controller card. Additional drives (without controller) cost \$495. It should be noted that due to high demand, delivery may be quite slow for a while. **R-E**

## Realistic Model DX-300 Receiver



CIRCLE 104 ON FREE INFORMATION CARD

AFTER A PROLONGED PROMOTION PERIOD, Realistic (Radio Shack) has now made available its newest entry into the hobby listening market: the *model DX-300* general-coverage receiver.

This receiver is continuously tunable from 10 kHz through 30 MHz and features a large, bright digital-frequency display, a frequency synthesizer and triple conversion. Specifications include: a shortwave sensitivity better than 1 mV; an image ratio 70-80 dB down; AM/LSB/USB/CW detection modes; a selectivity of  $\pm 3$  kHz ( $-6$  dB) and ( $\pm 70$  dB); and less than 1-kHz drift after a one-hour warmup period.

The receiver's appearance is exceptionally attractive with a military black finish, aluminum knobs and colorfully illuminated dials.

Since we are aware that packaging is an important part of salesmanship, we were eager to test the receiver to see whether its looks were deceiving. Our first reaction was one of disappointment. The drift rate on the sample receiver we tested was very rapid; it was virtually unusable in the single-sideband or continuous-wave modes until after a lengthy warmup period (the specifications warn the user of this).

Proper adjustment for each frequency range (it tunes in 1-MHz increments) is cumbersome: After the frequency range to be tuned is selected, the megahertz dial ring must be tuned for best signal, and then the preselector must be tuned.

Although the importance of proper adjustment of the megahertz tuning knob is not emphasized in the manual, the setting of this knob is *crucial* to acceptable performance.

continued on page 34

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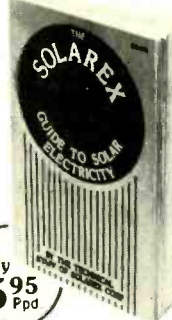
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## EQUIPMENT REPORTS

continued from page 33

Intermediate frequency feedthrough (i.e., the same interfering station is heard in the background, regardless of the setting of the tuning dial) is frequently present; this interference can be reduced by carefully adjusting the megahertz tuning knob and peaking the preselector. An external tuner or preselector would be very helpful here. "Birdies" (spurious signals generated by the synthesizer circuit) are present but no more troublesome than those found on similar receivers employing frequency synthesis.

Our particular sample receiver had a bad AC hum that could have resulted from shipping damage; also, the antenna screw-terminal was nonfunctional, as though it were disconnected internally. A subsequent inspection confirmed that a cold-soldered antenna-coupling capacitor was dangling loose in its solder pad.

Sensitivity was good above 150 kHz or so; below 150 kHz, the sensitivity became progressively worse. The receiver was virtually useless below approximately 70 kHz, even when using an external antenna tuner for optimum signal coupling. The VLF range was very unstable and full of oscillations.

Although the receiver can provide signal-copying capability without a tuner in the low-frequency range down to about 200 kHz, an external antenna-matching circuit is strongly recommended.

The IF selectivity is not adjustable, and some adjacent interference from the crowded frequency spectrum should be expected.

Make sure to read the instruction manual thoroughly while acquainting yourself with the receiver, or you may become very discouraged; with some practice, optimum tuning and adjustments will become automatic.

A company spokesman told us that the receiver is intended for general-purpose use; it is *not* a communications receiver. Now the receiver looks much better to us.

The reception on the AM band is excellent; the audio is crisp and a three-position tune control is provided for customizing the sound. The internal speaker works well without producing acoustic feedback at high volume. The ANL (Automatic Noise Limiter) circuit is highly effective; in a particularly noisy environment, the hash noise was virtually eliminated without degrading the desired audio signal.

The tuning has a particularly good feel; a spinner dial coupled with silicone damping gives a professional touch to the tuning mechanism. A three-way power supply allows 120 VAC, 12 VDC, or battery operation (self-contained; the batteries are optional).

For the international broadcast enthusiast, the *model DX-300* is excellent. When you dial up the proper frequency, you know that you are right on target (within 1 kHz). Single-sideband stations will be offset by several kHz (the manual indicates 3 kHz, but our sample receiver was off by 5 kHz).

The built-in code-practice oscillator could be considered a handy device by an aspiring ham, or just a gimmicky toy by a more serious listener; it depends upon your point of view!

The manual provides several helpful charts, including Morse Code, common radio terms

overheard on the air, and the "Q-signals" that are used to expedite communications over the air. The manual also contains a list of public safety "10-code" signals.

All in all, the receiver is a satisfactory addition to the casual hobby radio market. It is recommended for AM broadcast and short-wave listeners who would like to be able to occasionally copy continuous-wave and single-sideband signals.

We are certain that enterprising experimenters will devise improvements and modifications to increase the receiver's performance. The Realistic *model DX-300* costs \$379.95 and is available from Radio Shack, 1400 One Tandy Center, Fort Worth, TX 76102. (As of this writing, Radio Shack has informed us that several improvements have been made in the *model DX-300*, particularly in frequency stability. We advise our readers therefore to make sure they purchase the most recent model.—

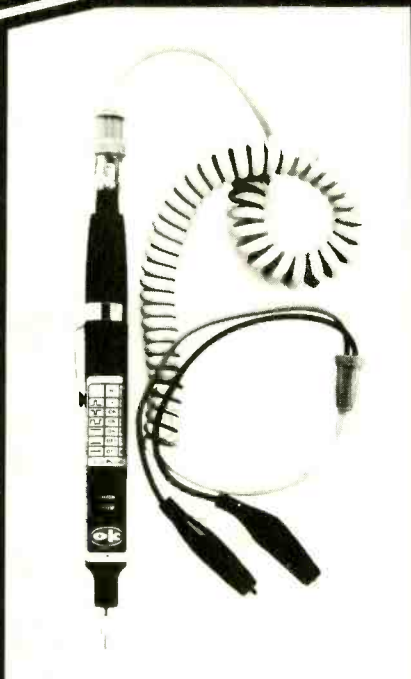
Editor)

R-E



There's something wrong with this digital readout—it's nothing but a bunch of numbers.

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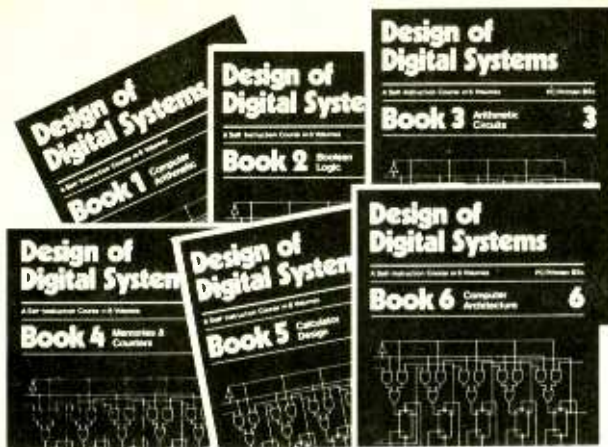
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Book 4: Flip-flops; shift registers; asynchronous counters; ring, Johnson and exclusive-OR feedback counter; random access memories (RAMs); read-only memories (ROMs).

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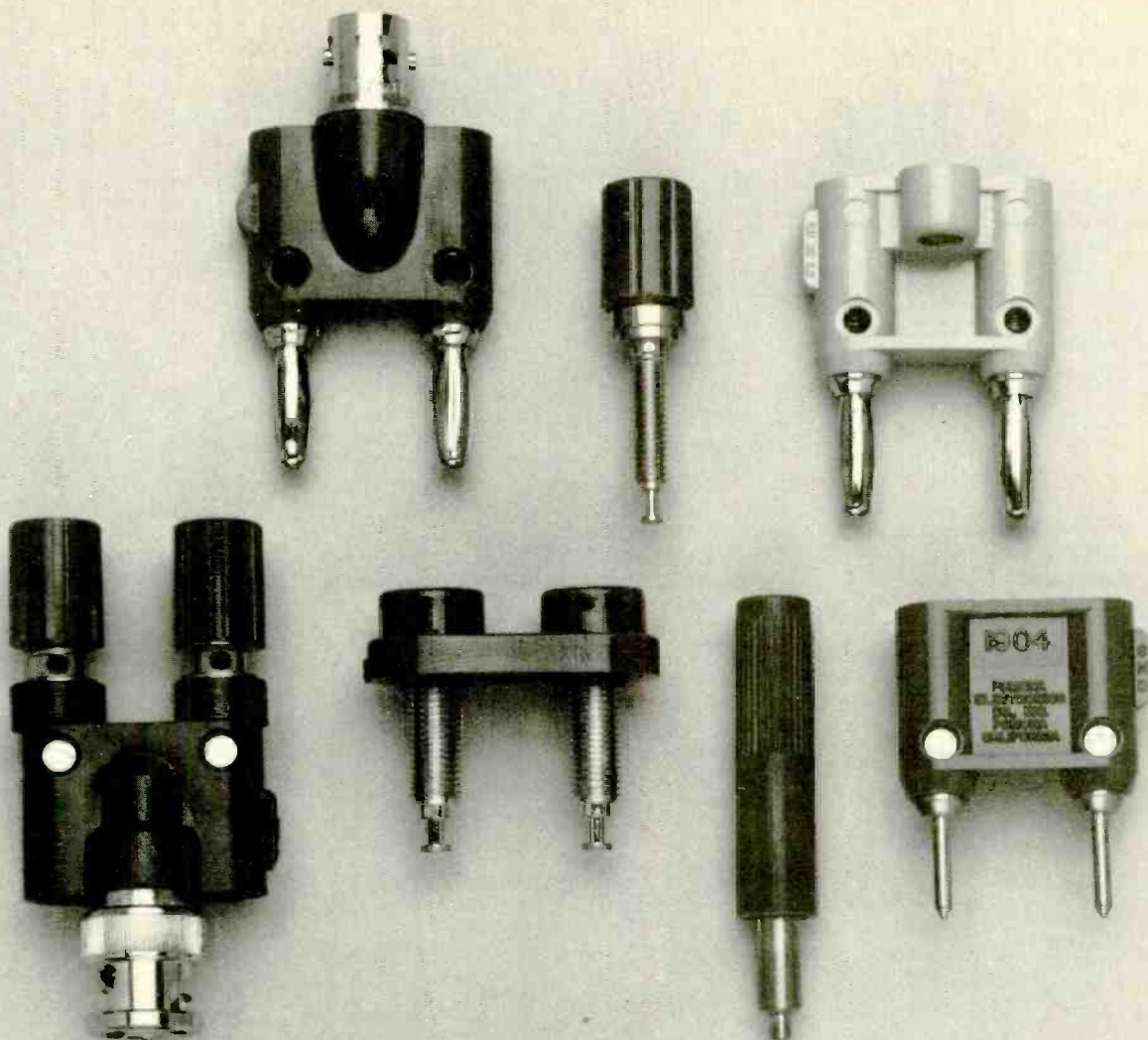
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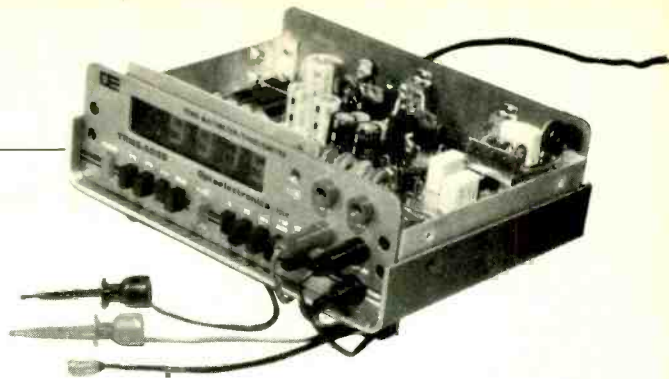
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## BILL OWEN\*

THE TRMS-5000 IS A FULL-FUNCTION, state-of-the-art 4<sup>1</sup>/<sub>2</sub>-digit multimeter with many extra features that usually cost hundreds of dollars as options and accessories. In addition to the industry standard AC/DC amperes, AC/DC volts and resistance ranges, a precision temperature probe gives a switch selectable Celsius and Fahrenheit readout to .01°. A true-RMS-to-DC converter is used for accurate AC voltage and current measurements of complex waveforms from near DC to over 250 kHz. A 10-amp AC/DC current range is available through a separate protected input jack.

Lab bench multimeter features include jumbo 1/2-inch LED digits, uncluttered pushbutton controls and a rugged, yet attractive, aluminum case. Portability is maintained, however, by the convenient size and the optional rechargeable NiCad batteries. A precision band-gap Zener voltage reference and temperature tracking input attenuator network give better than .05% DC accuracy.

The heart of the multimeter is a new analog-to-digital converter IC set from Texas Instruments. The TL500C and TL502C 4<sup>1</sup>/<sub>2</sub>-digit converter features auto zero and true differential high-impedance inputs with autopolarity and overrange indication. A complete list of specifications appears in Table 1.

## Theory of operation

The heart of this digital multimeter is the analog-to-digital converter (ADC).

\*Product Engineer, Optoelectronics, Inc., Fort Lauderdale, Florida

TABLE 1—TRMS-5000 DMM / THERMOMETER SPECIFICATIONS

DC VOLTAGE				
Range		Max. Reading	Accuracy 18°–28°C, 1 Year	
2V		1.9999V	.04% ± 1d*	
20V		19.999V	.04% ± 2d	
200V		199.99V	.04 ± 2d	
1000V		1000.0V	.04 ± 2d	
Maximum Input Voltage: 1040V				
AC VOLTAGE				
		Accuracy 18°–28°C, 1 Year		
Range	Max. Reading	45 Hz–10 kHz	10 kHz–40 kHz	40 kHz–250 kHz
2V	1.9999V	.35% + 15d	.35% + 15d	3DB
20V	19.999V	.35% + 15d	1% + 15d	3DB
200V	199.99V	.35% + 15d	1% + 15d	3DB
1000V	1000.0V	.35% + 15d	2% + 15d	3DB
Crest Factor: 3				
Maximum Input Voltage: 1040V				
RESISTANCE				
		Accuracy 18°–28°C, 1 Year		
Range	Maximum Reading	High Ohms	Low Ohms	
2K ohm	1.9999K ohm	± .05% + 1d	± .10% + 15d	
20K ohm	19.999K ohm	± .05% + 1d	± .10% + 15d	
200K ohm	199.99K ohm	± .05% + 1d	± .10% + 15d	
2 megohm	1.9999 megohm	± .1% + 1d	± .15% + 15d	
20 megohm	19.999 megohm	± .3% + 2d	± .3% + 15d	
Maximum Voltage Output: High 1.5V Low .5V				
Maximum Input Voltage: 150V RMS				
Settling Time: 2 seconds to ± 1 digit of final reading except 10 seconds on megohm range.				

Specifications continued on page 39

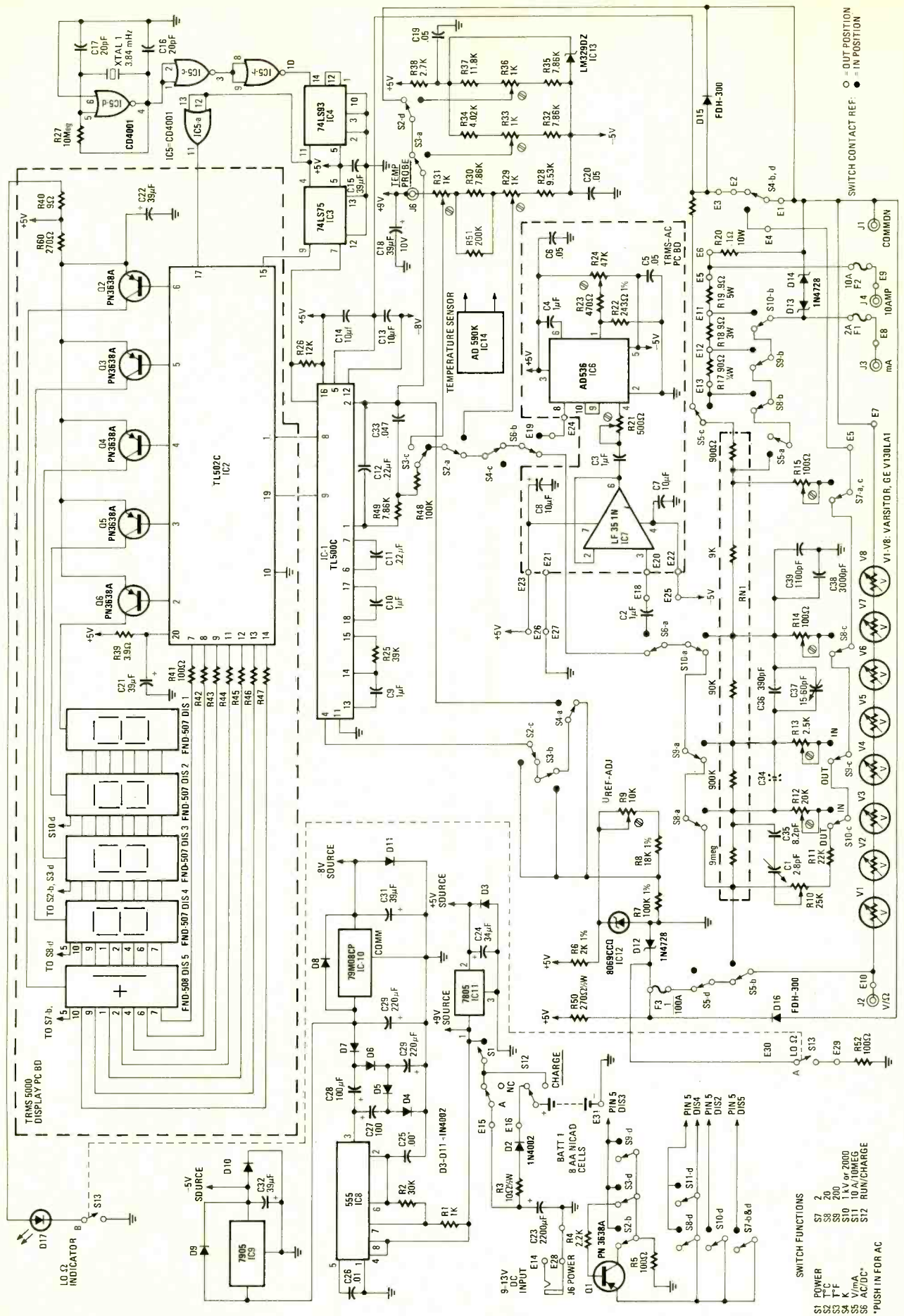


FIG. 1—SCHEMATIC DIAGRAM of the TRMS-5000 digital multimeter. One unusual feature is that on AC, it displays the true RMS value of any waveform, regardless of its complexity.



The ADC converts DC voltages between -2 and +2 volts applied to its input terminals into a digital count from -20,000 to +20,000. A display of 10,000 results from a one-volt input to the ADC.

The ADC employs the dual-slope method of conversion. The TL500C performs the analog processing while the companion TL502C digital processor provides the logic control signals for the TL500C as well as the counter and LED display drivers.

The entire conversion cycle timing is tied to the clock frequency generated by an external oscillator consisting of XTAL1, IC3, IC4 and IC5 (see Fig. 1). The 3.84-MHz crystal is divided down to 240 kHz by IC4. The resultant 240 kHz is a multiple of 60 Hz and is used to reject power-line-frequency interference. IC3 protects against false comparator triggering due to clock-frequency interference on the comparator input.

The precision voltage reference used is an Intersil 8069CCQ 1.2-volt band-gap Zener. Resistors R7, R8 and R9 form an adjustable divider to obtain 1.0000 volt for the reference input. Resistor R6 limits current through the reference to 2 mA.

#### Voltage measuring circuits

Because the ADC input is limited to +2 volts DC, additional signal-conditioning circuitry must be used for the extended multimeter functions and ranges. A voltage divider is used to extend the input voltage range up to  $\pm 1000.0$  volts while on any one range the ADC will see less than  $\pm 2$  volts.

The voltage divider consists of nine resistors connected in series across the multimeter's input terminals. Five are in the precision decade divider network RN1; the others are R17-R20. The total divider resistance is 10 megohms with each resistor having one-tenth the value of the resistor in series above it. When a voltage is applied to the multimeter's input terminals a current flows through the divider, producing a voltage across each resistor that is proportional to its resistance. Thus if 100 volts is applied across the divider, then 10 volts will be measured between the first and second resistors and 1 volt between the second and third and so on. Figure 2 shows the voltage divider with range switches to select the appropriate ratio; 1X for the 2-volt range, 10X for the 20-volt range and so on. A separate pole on each range switch is used to activate the appropriate decimal point in the LED display.

The multimeter's accuracy is dependent upon the ratio stability of the divider resistors. The first five decade resistors are contained in a thick-film network (RN1) in which the resistors track together to maintain their ratios over wide temperature variations. The bottom four discrete resistors plus the 900-ohm sec-

tion of RN1 are used as shunts in the current-measuring ranges.

For AC measurements, a converter circuit generates a DC voltage equal to the RMS (Root Mean Square) value of the applied AC voltage. Two poles of AC switch S6 are used to insert the converter in series with the ADC inputs. Most multimeter converter circuits simply compute the average rectified value of the input signal and are calibrated to display the equivalent sinewave RMS value. For other types of waveforms (square, triangle, pulse, complex, etc.) this type of conversion is inaccurate. The TRMS-5000 uses a true RMS converter that computes the RMS value of any complex waveform. This is a much more useful measurement because it is based upon the equivalent effective DC heating value of the AC voltage. The integrated circuit that performs this conversion is the Analog Devices AD536JH which actually solves the equation:

$$V_{rms} = \text{Avg.} \left[ \frac{V_{IN}^2}{V_{rms}} \right]$$

The AD536JH (IC6) measures AC signals from 10 Hz to over 100 kHz. This wide frequency range (many multimeters have only a few kilohertz of bandwidth) greatly enhances the usefulness of the

multimeter in making AC measurements at not only power line frequencies but throughout the audio frequency spectrum and beyond.

#### Current measurements

Both alternating and direct current measurements are made by placing a known resistor in the current path and measuring the voltage drop across it. The bottom five divider resistors shown in Fig. 2 are used for current measurements. A separate current input is used with the current-range switches. Because there is almost no current flowing into the ADC's analog inputs (input resistance is  $10^9$  ohms) the voltage across the current shunt resistors is seen through the 10 megohms in series with the inputs. The 10-AMP current range has a direct input, so that a 10-ampere current will not have to be switched. The power ratings of the current shunt resistors range from 3.6 milliwatts for the 900-ohm section to 10 watts for the 0.1-ohm resistor.

#### Resistance measurements

The TL500C ADC actually has two sets of analog inputs if the reference voltage and common inputs are considered. The ADC compares the unknown voltage at the input terminals to the known voltage at the reference input when making a

DC AND TRMS AC CURRENT				
		Accuracy 18°-28°C, 1 Year		
Range	Max. Reading	DC	45 Hz-10 kHz	10 kHz-40 kHz
2 mA	1.9999 mA	.6% + 2d	1% + 2d	1.5% + 2d
20 mA	19.999 mA	.6% + 2d	1% + 2d	1.5% + 2d
200 mA	199.99 mA	.6% + 2d	1% + 2d	1.5% + 2d
2000 mA	1999.9 mA	.6% + 2d	1% + 2d	1.5% + 2d
10 Amp	10.000A	.6% + 2d	1% + 2d	1.5% + 2d
Maximum Burden Voltage: 2V Crest Factor: 3				
TEMPERATURE				
	Celsius	Fahrenheit		
Range:	- 50.00° to + 150.00°	- 67.00° to + 199.99°		
Resolution:	.01°	.01°		
Accuracy:	± .5°	± .9°		
Voltage Standoff: Sensor tip to voltmeter common ± 200 volts				
GENERAL				
Display: Five 0.5" Red LED Digits Conversion Period: .1664 Sec Power Supply: Wall Plug Transformer-input 105-125 VAC; output 9 DVC @ 300 mA Dimensions: 3¼"H X 7¼"W X 6¾"D Weight: Approximately 2 pounds Input Impedance: 10 megohm shunted by less than 80 pF				
BATTERY OPTION				
Type: 8, AA NiCAD cells in holders, mounting inside the multimeter cabinet. Charge/operate switch mounts on rear of multimeter cabinet. Operation: 2 hours from full charge Charge Period: 12 hours				

\* ±% of reading + digits

measurement. This voltage ratio measuring ability of the converter is used in making resistance measurements. As shown in Fig. 3, a known reference resistor (one of the precision attenuator resistors) is placed in series with the unknown resistor at the input terminals. A precise 3.3 volts from Zener diode D12 is placed across the reference and unknown resistors and a current flows through them. The voltage drop across the known resistor is applied to the voltage reference and common inputs of the ADC while the voltage drop across the unknown resistor is applied to the analog + and - inputs. The meter's output then becomes the ratio between the reference resistor and the unknown resistor. For different ranges the reference resistor is changed from 1K up to 10 megohms.

### Temperature

The TRMS-5000 can measure temperature using an external sensor probe that plugs into a front panel jack (J6). The sensor is an Analog Devices AD590K temperature-dependent current source that generates 1  $\mu$ A-per-degree-Kelvin. The Kelvin temperature scale starts at absolute zero and has Celsius-sized degrees such that  $0^\circ\text{K} = -273.2^\circ\text{C}$ . The temperature sensor's current output is converted to a voltage, using scaling resistors R28, R29, R30 and R31. The output voltage (referenced to the -5-volt supply) from R29 is equal to 10 mV-per-degree-Kelvin while the output voltage from R31 is equal to 10 mV-per-degree Rankine (the Rankine temperature scale starts at absolute zero and has Fahrenheit-sized degrees). To generate Celsius and Fahrenheit output voltages, the Kelvin output must be offset by 2.732 volts and the Rankine output offset by 4.595

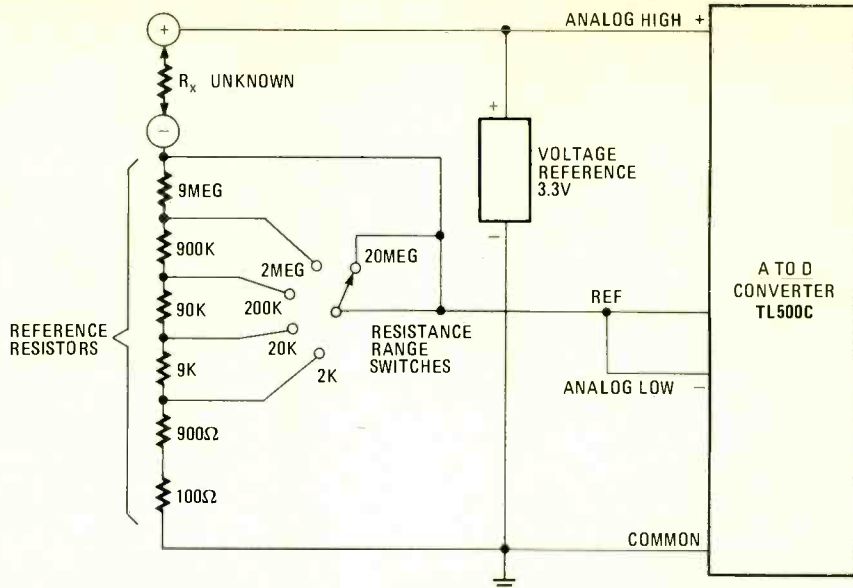


FIG. 3—WHEN MEASURING RESISTANCE, the unknown is in series with a selected known resistor across a precise reference voltage. The A/D converter determines the unknown value.

volts. IC13 is a 6.9-volt integrated circuit Zener reference. Its output is divided by R35, R36 and R37 to generate the Celsius offset and by R32, R33 and R34 to generate the Fahrenheit offset voltage.

When either the  $^\circ\text{C}$  or  $^\circ\text{F}$  switch is depressed, the ADC's analog inputs are switched to the correct temperature and reference voltage as shown in Fig. 4. A temperature range of  $-50.00^\circ\text{C}$  ( $-60.00^\circ\text{F}$ ) to  $199.99^\circ\text{C}$  or  $^\circ\text{F}$  is obtained with the  $4\frac{1}{2}$ -digit ADC. The sensor can be calibrated to within  $\pm 0.2^\circ\text{C}$  from  $0^\circ$  to  $100^\circ$  using trimmers R29 and R31. Because the AD590K sensor is a current source, it requires only a two-conductor cable and can be located over hundreds of feet away from the multimeter because it is not affected by voltage or noise pickup.

The multimeter (see complete schematic in Fig. 1) uses a 9-volt DC plug transformer/power supply to keep the 60-Hz line frequency outside of the instrument case. The circuit operates from three regulated power supplies, one positive and two negative. A 7805 voltage regulator (IC11) supplies +5 volts to the circuit, and because it supplies over 200 mA of current it is heat sunk to the cabinet's rear panel. A 555 timer (IC8) generates a 20-kHz squarewave that is AC-coupled and diode-clamped by a voltage doubler circuit to produce approximately -11 volts. A 79MO8CP regulator supplies -8 volts to the TL500C analog processor (IC1) and a 7905 regulator supplies -5 volts to the AD536 RMS-to-DC converter and the temperature circuit. An optional 10-volt NiCad battery pack consisting of eight size-AA cells is charged through R3 and automatically switched in on the absence of line power by D2. Diode D1 prevents battery discharge through the plug transformer.

The multimeter readout consists of four Fairchild FND507  $\frac{1}{2}$ -inch common-anode red 7-segment LED digits with one FND508  $\pm 1$  digit. The LED digits are multiplexed by the TL502C that directly drives the segments through current limiters R41 through R47 and drives the digits through external digit drive transistors Q2 through Q6.

### Overvoltage protection

A series string of eight metal-oxide varistors across the input divider will provide a short circuit path if 1040 volts or more is applied. Each varistor maintains a very high impedance until 130 volts is applied across it causing it to conduct. The varistors will pass 10 amps and fail as a short circuit if continuous overvoltage is applied.

Both the 2-amp (mA) and 10-AMP current inputs are fused and the 2-amp input

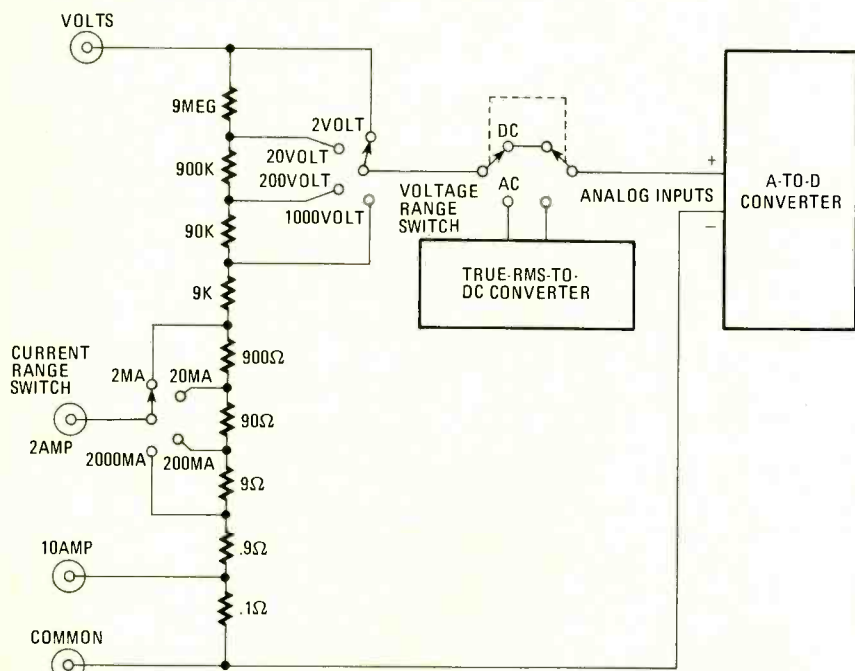


FIG. 2—VOLTAGE DIVIDER AND CURRENT SHUNTS. Resistor string is proportioned so maximum voltage applied to the A/D converter is 2 volts on any voltage or current range.



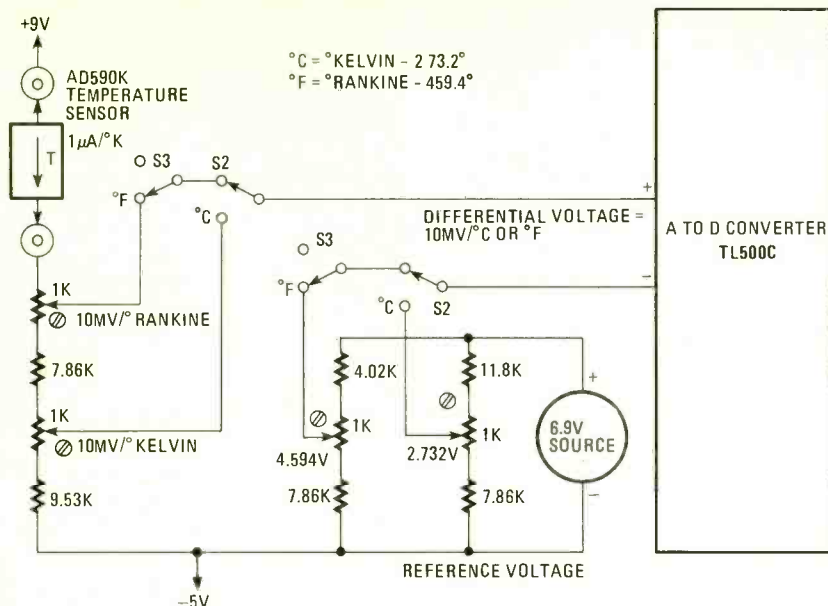


FIG. 4—BASIC DIAGRAM of circuit used for temperature measurement. The temperature sensor is a current source; passing 1  $\mu$ A-per-degree Kelvin. Readout is in  $^{\circ}$ C and  $^{\circ}$ F.

is diode clamped as well to blow the fuse if an overvoltage is applied to the low-current range shunts.

The ohmmeter circuit is fused for  $\frac{1}{100}$  ampere. Low-leakage diodes (D15, D16) steer currents around the reference resistor if a voltage is applied to the input terminals while measuring resistance.

### Making it work

The design of the multimeter's printed circuit board takes into account several factors that would otherwise seriously degrade performance. Ground paths are kept separate to prevent ground loops that cause offset errors that the ADC's autozero circuit cannot remove. Ground planes are used (where possible) to keep resistance in the ground returns as low as possible. The layout avoids putting supply or ground paths close enough to the high-impedance inputs or to the 10-megohm divider to allow leakage currents to cause offset errors. All insulation materials have extremely high resistance to prevent leakage paths. Digital and analog signal paths are kept apart and not parallel to each other on the PC board. The ADC's comparator output causes a problem if there is a path from it to any of the analog lines.

The multimeter's high-impedance input is susceptible to noise pickup, especially 60 hertz, which is almost universally present in our environment. The AC converter circuit's wide bandwidth makes it susceptible not only to 60-hertz pickup but to audio as well as RF frequencies. The TRMS-5000's heavy-gauge aluminum case provides shielding against noise pickup. There is also a filter on the analog inputs to the ADC, consisting of R48, R49, C12, and C33, that rejects 60-Hz voltages.

### Assembly

The TRMS-5000 multimeter is built

on three PC boards. The main board and the TRMS-to-DC converter board are double-sided. The foil patterns for the main board are in Figs. 5 and 6 and the parts layout is in Fig. 7. The two foil patterns for the TRMS board are in Figs. 8 and 9 and the parts are positioned as in Fig. 10. The four 7-segment displays and the polarity and overflow display are on a separate board. The foil pattern in Fig. 11 and the assembly diagram in Fig. 12 show how the readout goes together.

Begin assembly by soldering the components on the display, TRMS-AC and main printed circuit boards. Use the component placement drawings and the parts list to aid assembly. It is helpful to install jumper wires, diodes and resistors before the larger capacitors, trimmers, etc. The TRMS-AC PC board is double-sided but *not plated through, so component leads must be soldered to the foil on both sides wherever the foil comes right up to the lead*. The three PC boards are mated before the switches are installed. Assemble the front panel, rear panel and side

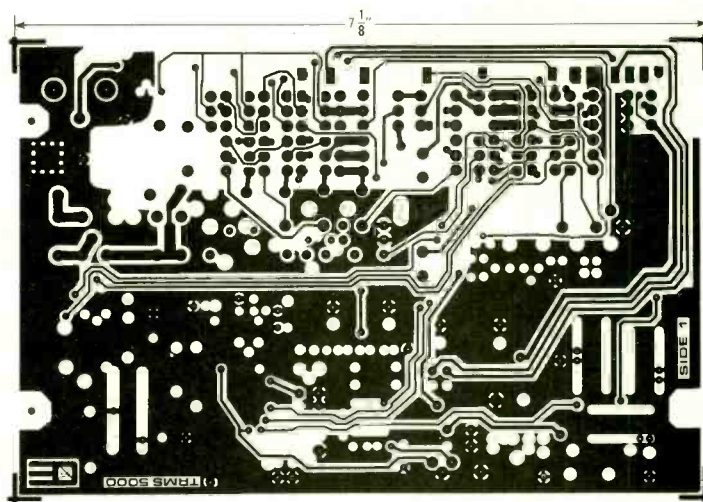


FIG. 5—FOIL PATTERN for Side 1, the top surface of the main board. Pattern is approximately one-half size. Enlarge to  $7\frac{1}{8}$  inches across.

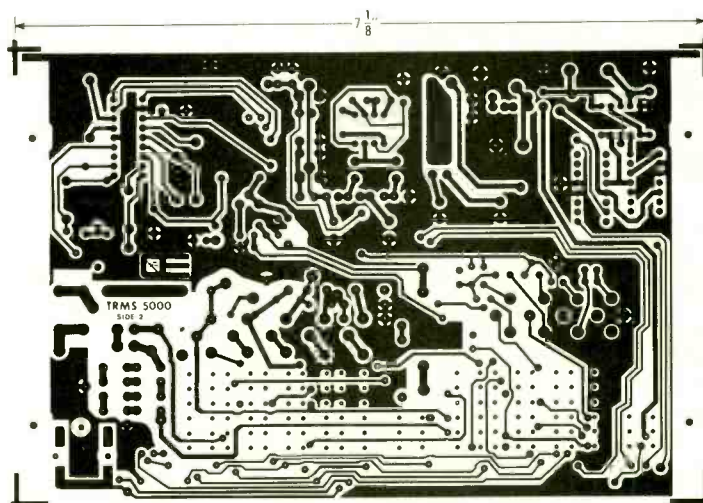


FIG. 6—PATTERN for the under side of the main PC board shown half-size. The pushbutton range and function switches are on this side.

## PARTS LIST

### Resistors, 1/4 watt, 5% unless noted

R1—1000 ohms  
 R2—30,000 ohms  
 R3—10 ohms  
 R4—2200 ohms  
 R5, R41—R47—100 ohms  
 R6—2000 ohms, 1%  
 R7, R48—100,000 ohms, 1%  
 R8—18,000 ohms, 1%  
 R9—10,000 ohms, 10-turn trimmer  
 R10—25,000 ohms, trimmer  
 R11—22,000 ohms  
 R12—20,000 ohms, trimmer  
 R13—2500 ohms, trimmer  
 R14, R15—100 ohms, trimmer  
 R16—100 ohms, 1%  
 R17—90 ohms, 1%, factory calibrated  
 R18—9 ohms, 1%, 3 watts, factory calibrated  
 R19—0.9 ohm, 1%, 5 watts, factory calibrated  
 R20—0.1 ohm, 1%, 10 watts, factory calibrated  
 R21—500 ohms, trimmer  
 R22—243 ohms, 1%  
 R23—470 ohms  
 R24—47,000 ohms, trimmer  
 R25—39,000 ohms, 1%  
 R26—12,000 ohms  
 R27—10 megohms  
 R28—9530 ohms, 1%  
 R29, R31, R33, R36—1000 ohms, trimmer  
 R30, R32, R35—7860 ohms, 1%  
 R34—4020 ohms, 1%  
 R37—11,800 ohms, 1%  
 R38—2700 ohms, 1%  
 R39—3.9 ohms  
 R40—9 ohms, 3 watts, 1%  
 R49—10,000 ohms  
 R50—270 ohms, 1/2 watt  
 RN-1—Temperature tracking precision resistor attenuator (Caddock 1776-231 7849)

### Capacitors

C1—2–8 pF, trimmer

C2, C3, C9, C10—1  $\mu$ F, Mylar  
 C4—4.7  $\mu$ F, tantalum  
 C5, C6, C19, C20, C26—.01  $\mu$ F, disc ceramic  
 C7, C8, C13, C14—10  $\mu$ F, 10 volts, tantalum  
 C11, C12—0.22  $\mu$ F, Mylar  
 C15, C18, C21, C22, C24, C31, C32—39  $\mu$ F, 10 volts, tantalum  
 C16, C17—20 pF, disc ceramic  
 C23—2200  $\mu$ F, 25 volts, electrolytic  
 C25—.001  $\mu$ F disc ceramic  
 C27, C28—100  $\mu$ F, 25 volts, electrolytic  
 C29, C30—220  $\mu$ F, 25 volts, electrolytic  
 C33—.047  $\mu$ F, polypropylene  
 C34—470 pF, disc ceramic  
 C35—8.2 pF  
 C36—390 pF  
 C37—15–60 pF, trimmer  
 C38—3000 pF  
 C39—1100 pF

### Semiconductors

Q1—Q6—PN3638A (National) or MPS 3638 (Motorola)  
 D1, D2—3-amp, 100 PIV diode  
 D3—D11—1N4002  
 D12—D14—1N4728, 3.3-volt Zener diode  
 D15, D16—FDH-300 low-leakage diode (Fairchild only)  
 D17—miniature red LED  
 V1—V8—V130LA1 varistor (GE)  
 DIS1—DIS4—FND570, 7-segment LED  
 DIS5—FND508, +1 LED display  
 IC1—TL500C analog processor (TI)  
 IC2—TL502C digital controller (TI)  
 IC3—74LS75 D-type flip-flop  
 IC4—74LS93 counter  
 IC5—CD4001—quad 2-input NAND gate  
 IC6—AD536JH—RMS-to-DC converter (Analog Devices)  
 IC7—LF351N bi-FET op-amp  
 IC8—555 timer  
 IC9—7905—5-volt regulator  
 IC10—79M08CP—8-volt regulator (National)

IC11—7805 5-volt regulator  
 IC12—ICL8069CCQ 1.22-volt reference  
 IC13—LM329DZ 6.9-volt reference (National only)  
 IC14—AD590KH temperature sensor (Analog Devices)

### Miscellaneous

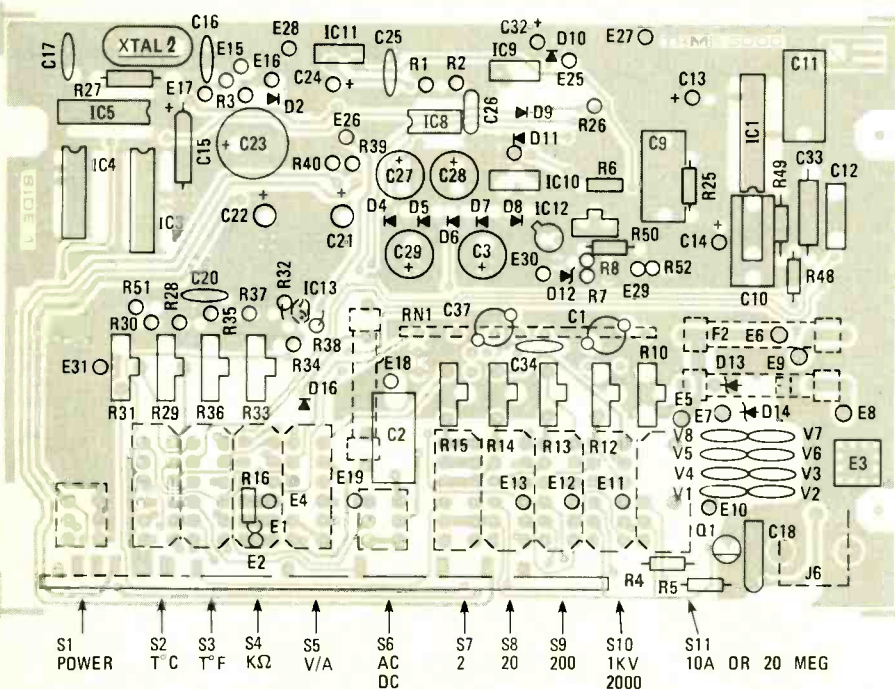
S1, S6—2PDT pushbutton switch  
 S2—S5—4PDT pushbutton switch, interlocked  
 S7—S11—5PDT pushbutton switch, interlocked  
 S12, S13—D PDT miniature slide switch  
 J1—banana jack, black  
 J2—J4—banana jack, red  
 J5—pin-type DC power receptacle  
 J6—PC mount right-angle phono jack  
 XTAL1—3.84 MHz crystal  
 F1—2 ampere fuse  
 F2—10 ampere fuse  
 F3—1/100 ampere fuse  
 Thermometer test cable, power transformer—9 VDC, 300 mA plug type with hollow-pin plug. IC sockets: 2 8-pin, 2 16-pin, 1 18-pin, 1 20-pin, 1 14-pin. PC boards, cabinet and assorted hardware.

**Note: The following are available from Optoelectronics, 5821 N.E. 14th Ave., Ft. Lauderdale, FL 33334.**

**Factory-assembled multimeter with 1-year guarantee (TRMS-5000) \$279.95; complete kit (TRMS-5000K) \$199.00.**

**Set of three PC boards—all boards are glass epoxy, solder-plated with screened printed component layout—\$28.50. Set of all switches (13) \$20.00. TL500C and TL502C IC's \$16.95.**

**Include 5% for shipping, handling and insurance (to a maximum of \$10) with all orders. Florida residents add 4% sales tax.**



**FIG. 7—WHERE PARTS ARE PLACED on the main PC board. Most are on Side 1—the top side. Parts on the underside are outlined in dashed lines.**

rails, and then bolt the main PC board to the side rails. Align the foil fingers on the display board to the pads on the main PC board, and after checking alignment solder them together. The TRMS-AC PC board installs in the same way over the S6 switch area. Install the switches and then use No. 14 or No. 16 hookup wire to make the following connections:

From	To
J1	E1
J2	E10
J3	E8
J4	E9
E2	E3
E4	E5

Connect the following resistors between the points indicated below:

R20—0.1 ohm 10W—E1, E6  
 R19—0.9 ohm 5W—E11, E6  
 R18—9 ohm 3W—E12, E11  
 R17—90 ohm 1/4"W—E13, E12

Use hookup wire to connect the center pin of the power input jack to E10 and the bracket to E11.

Before applying power to the multimeter, check all parts for correct placement.  
*continued on page 79*



# Adaptive Noise Filter



**TIM SKORMOND AND  
GENE GARRISON**

*Simple to construct and operate, this dynamic variable-cutoff low-pass filter removes the snap crackle, and pop from your favorite records and tapes.*

MANY POPULAR NOISE-REDUCTION SYSTEMS are complementary in nature; i.e., the signal is processed by some compression technique prior to being recorded and then decoded by the equivalent expansion technique during playback. This leaves a large quantity of older recorded material, both disc and tape, unable to benefit from the noise-reduction circuits built into many hi-fi systems. Since many of us have treasured recordings that fall into this category, the need exists for a single-ended, add-on Adaptive Noise Filter that will permit us to enjoy these recordings at the same quality level we expect from encoded material.

A great deal of the noise in tape and FM sources is located in the frequency band from about 1 kHz to 7 kHz. This frequency band is also the area in which the human ears are most sensitive. Fortunately, when musical signals are also present in this same frequency band, at a few dB higher level, they effectively mask the noise. This makes it possible to use a variable-frequency low-pass filter in the audio channel to reduce the noise without audibly affecting the dynamics of the desired signal. If no signal is present, between musical passages for instance, a low-pass filter with a cutoff frequency of 800 Hz will substantially reduce the level of the audible noise. When music of sufficient amplitude is present at frequencies above 800 Hz, the filter opens to pass the music, and since the noise and music occupy the same spectral area, the noise is masked and the music faithfully reproduced.

## About the circuit

A block diagram of a suitable circuit is shown in Fig. 1. The circuit consists of

three major sections: a signal path, a control path and an LED bar-graph display.

The signal path is straightforward, consisting of two (one per channel) current-controlled low-pass filters with 6-dB-per-octave slopes. The two filters are designed to roll off at a corner frequency of 800 Hz with no input and at a corner frequency of 30 kHz when fully driven by the common control voltage.

Figure 2 gives a detailed look at the actual current-controlled filter circuits. Most existing variable filter designs use one or more field-effect transistors as voltage-controlled resistors in an active or passive filter configuration. This can lead to two troublesome problems. One is the need for some means of offsetting the difference in pinch-off voltages between individual FET's. A trimmer from each gate to a fixed bias voltage must be adjusted to calibrate each device. The second problem is the modulation of the drain-to-source resistance with moderately large input signals. This modulation quite often results in excessive distortion

at the filter output and, in some cases, will require another trimmer from each gate to minimize the effect.

Both of these pitfalls are successfully avoided in this circuit by using a new operational transconductance amplifier (OTA) as the controlled device. National Semiconductor has recently introduced the LM13600, a dual OTA with Darlington buffers and input linearizing diodes in a single 16-pin DIP package. The linearizing diodes compensate for the logarithmic characteristics of the input stage of the OTA, enabling it to pass relatively large signals with low distortion. (OTA circuits in the past have required very small input signals to obtain respectable distortion levels.)

The transconductance of the OTA's is set by the amplifier bias current (supplied to pins 1 and 16 in the case of the LM13600). The signal path of Fig. 2 uses this variable transconductance (conductance being the inverse of resistance) to implement a current-controlled filter (CCF).

The filter cutoff frequency is initially set at 800 Hz by the current through

**TABLE 1—SPECIFICATIONS (typical)**

<b>Attack time</b> (to within 10% of final value):	1 ms
<b>Decay time</b> (to within 10%)	50 ms
<b>Minimum bandwidth:</b>	800 Hz
<b>Maximum bandwidth:</b>	30 kHz
<b>THD</b> (1 kHz, 1 V <sub>RMS</sub> , max. sensitivity):	0.11%
<b>S/N ratio</b> re: 1 V <sub>RMS</sub> :	
800 Hz, BW, 20 Hz to 20 kHz:	—88 dBV
CCIR/ARM weighted:	—98 dBV
30 kHz, BW, 20 Hz to 20 kHz:	—85 dBV
CCIR/ARM weighted:	—87 dBV
<b>Effective noise reduction</b> (CCIR/ARM weighted cassette tape noise):	14 dB

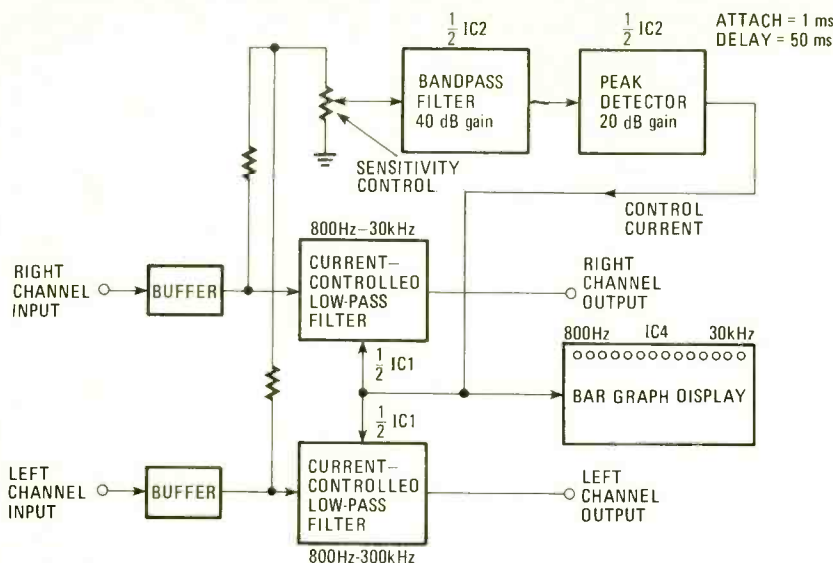


FIG. 1—BLOCK DIAGRAM of the adaptive noise filter. Audio signals are summed into the bandpass filter and then rectified to develop a control current that varies with noise in the signals.

R15. Additional current supplied through R16 by the control path circuitry

increases this —3-dB frequency to as high as 30 kHz, this bandwidth being

directly proportional to the applied current. Figure 3 shows the filter bandwidth vs. the amplitude of an 8-kHz input signal.

The control path consists of two basic stages: a bandpass filter with 40-dB gain and a specially configured peak detector with 20-dB gain. The LM387 operational amplifier was chosen because of its high-gain capability at 20 kHz and its high slew rate (required at the output of the peak detector).

The left and right input signals are summed together by resistors R17 and R18. Capacitor C7 provides a rolloff above 16 kHz, while a rolloff below 1.6 kHz is provided by C8. This low-level input signal is then amplified by the first half of IC2, whose gain is attenuated below 4.8 kHz by C10 with R20. R22, C11, C12, L1 and C13 couple the signal into the peak detector and provide additional frequency shaping, L1 being tuned to provide a filter notch at 19 kHz for use with FM stereo sources. Figure 4 shows the response of the control path.

## R-E TESTS IT

LEN FELDMAN

THE NR-2 NOISE FILTER WAS EVALUATED IN our laboratory, both for its measured characteristics and its performance as a single-ended noise reduction filter. Its principle of operation depends upon signals passing through variable-bandpass filters whose cutoff frequencies are made to vary between 800 Hz and 30 kHz, depending upon a control current derived from the original audio signal. While this is certainly not an original concept, the execution of the design is excellent. Attack time (confirmed as approximately 1 millisecond) and decay times (around 50 milliseconds) are ideally chosen so that, in use, the action of the filter is almost inaudible—except of course for the great audible improvement in noise. The NR-2 can be used to reduce noise in program sources such as records, weak FM signals and, most significantly, playback of cassette tapes that have not had the benefit of a two-sided noise reduction system such as Dolby or dbx encoding and decoding.

Figure 1 illustrates how different levels of swept signals (from 20 Hz to 20 kHz) affect overall response of the device. We see that when the device "senses" low-level signals

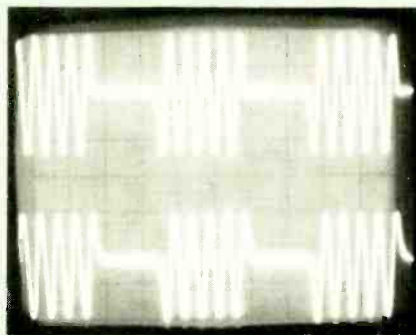


FIG. 2

(equivalent to noise) bandwidth is restricted. On the other hand, when high-amplitude signals, corresponding to musical sig-

nal content, are fed through the device, bandwidth is fully restored so that overall frequency response is virtually flat to 20 kHz.

Figure 2 illustrates the attack and decay times of the device. A tone burst, consisting of several cycles at 1 kHz, was fed through the filter. Upper trace is the input signal, while lower trace is the output signal. Note that the first cycle of each burst, whether negative going or positive going, is accurately reproduced at the output, while the last cycle in each burst is somewhat retarded in the output trace, indicating the slower but desired decay time of the device.

Table 1 summarizes our measured findings as compared with the author's claimed specifications.

TABLE 1

SPECIFICATIONS	DESIGNERS' CLAIM	MEASUREMENTS
Attack Time (ms)	1.0	0.8
Decay Time (ms)	50.0	40.0
Minimum Bandwidth (Hz)	800	800
Maximum Bandwidth (kHz)	30	30
THD (1V, Max. Sensitivity) (%)		
1 kHz	0.11	0.12
20 Hz	N/A	0.3
20 kHz	N/A	0.11
S/N (re: 1V)		
800 Hz B.W.	88 dB (98 Wt'd)*	90 dB (95 Wt'd)
30 kHz B.W.	85 dB (87 Wt'd)*	85 dB (90 Wt'd)
Effective Noise Reduction (tested with cassette tape)	14 dB (Wt'd)*	12 dB (Wt'd)*

\* Small differences in weighted results arise from the fact that the author used CCIR/ARM weighting whereas we used IHF "A" weighting, but, as can be seen, unweighted results are as good or better than claimed.



FIG. 1



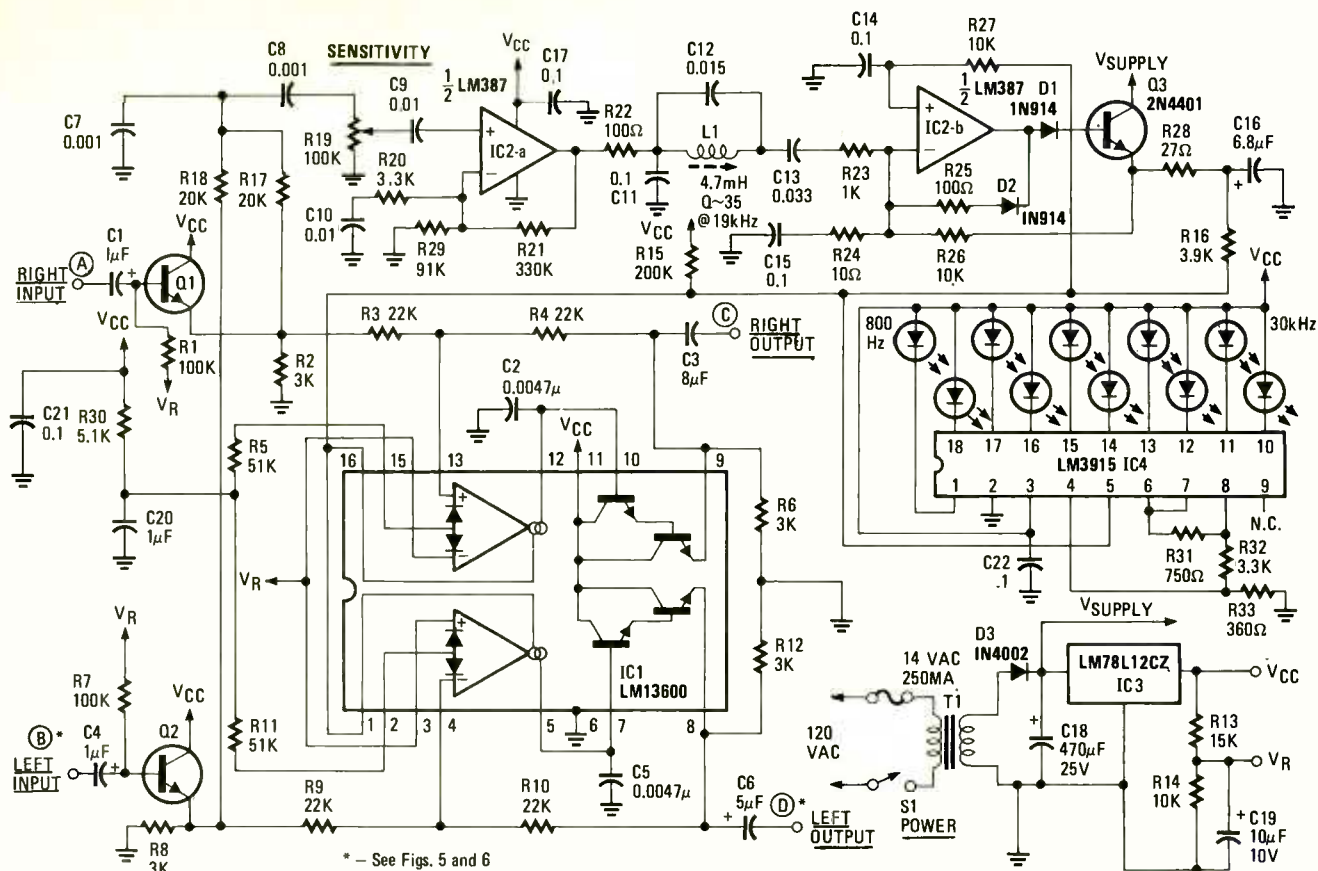


FIG. 2—SCHEMATIC DIAGRAM of the current-controlled variable-bandwidth low-pass filter circuits. Bandwidth is controlled by a current developed from the input signal.

The peak detector amplifies the AC output from the frequency-selective control amplifier and converts it into a DC voltage at the emitter of Q3. Resistor R28 sets the system attack time or charging rate into the peak-detector storage capacitor, C16. Capacitor C16 is discharged at a much slower rate (decay

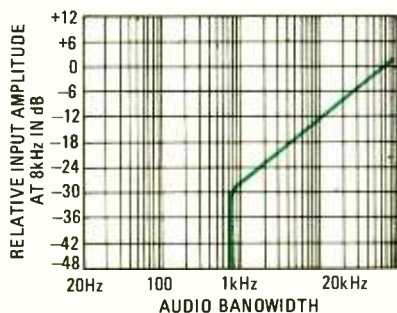


FIG. 3—FILTER BANDWIDTH and how it varies with the input of an 8-kHz signal.

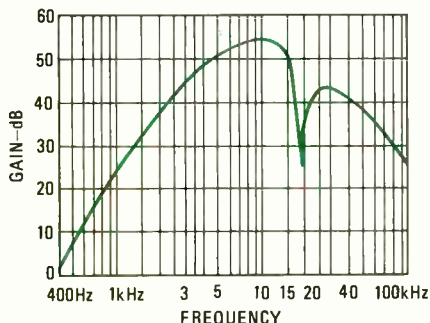


FIG. 4—RESPONSE of the final control path sensitivity vs. input frequency.

time) by the current drains of the two CCF's through resistor R16. Resistor R27 sets the initial no-signal DC level at the peak-detector output.

The attack and decay times and response characteristics were chosen with great care as they determine the subjective effects of the filter. An attack time of 1 ms was selected because it is fast enough to accommodate the response time of the human ear and yet slow enough to be relatively insensitive to "clicks" and "pops" on the record surface. The decay time was set at 50 ms so the filter could close quickly after the passing of high-frequency musical information and thus pass a minimum of noise. A shorter decay time would cut into the natural reverberation time of some program sources, making them sound "sterile" or flat.

The third section of the Adaptive Noise Filter is the bandwidth bar-graph display. A bar graph was used instead of a meter because of the millisecond response time of the control signal. The National LM3915 bar-graph display driver was chosen as it requires only a few external parts and contains all the necessary circuitry for a 10-point logarithmic bar-graph display. The common control voltage at the top of R16 has upper and lower limits of 9.3 VDC and 1.1 VDC, respectively. Therefore, the upper and lower limits of the LM3915 are set accordingly at pins 4 and 6 (internal logarithmic resis-

tor string between these two pins sets the DC levels at which each of the internal comparators drives its associated LED). The left-hand LED corresponds to an 800-Hz bandwidth and the right-hand LED corresponds to a 30-kHz cutoff. The LED's between these two extremes represent steps of approximately 1.5 times the frequency display by the preceding step.

A logarithmic display was selected because it was most indicative of the audible

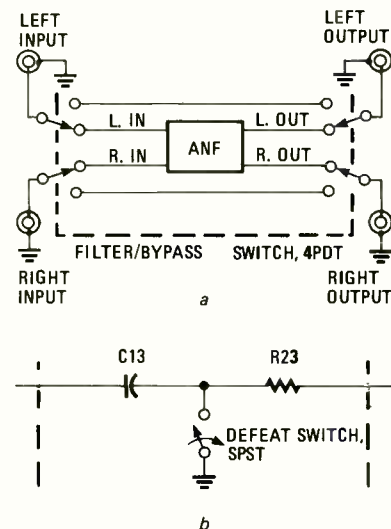


FIG. 5—CONTROL SWITCHING illustrating how the adaptive noise filter can be switched in and out of play-only circuit.

## PARTS LIST

All resistors 5%, 1/4 watt unless otherwise noted

R1, R7—100,000 ohms  
R2, R6, R8, R12—3000 ohms  
R3, R4, R9, R10—22,000 ohms  
R5, R11—51,000 ohms  
R13—15,000 ohms  
R14, R26, R27—10,000 ohms  
R15—200,000 ohms  
R16—3900 ohms  
R17, R18—20,000 ohms  
R19—100,000 ohms, miniature pot, audio taper (Clarostat 389 N 100K-Z)  
R20, R32—3300 ohms  
R21—330,000 ohms  
R22, R25—100 ohms  
R23—1000 ohms  
R24—10 ohms  
R28—27 ohms  
R29—91,000 ohms  
R30—5100 ohms  
R31—750 ohms  
R32—360 ohms

### Capacitors

C1, C4, C20—1  $\mu$ F, 16 volts electrolytic, radial leads  
C2, C5—.0047  $\mu$ F, 50 volts, Mylar, 10%  
C3, C6—5  $\mu$ F, 10 volts, electrolytic, radial leads  
C7, C8—.001  $\mu$ F, 50 volts, ceramic disc  
C9, C10—.01  $\mu$ F, 50 volts, ceramic disc  
C11, C14, C15, C17, C21, C22—0.1  $\mu$ F, 50 volts, Mylar  
C12—.015  $\mu$ F, 50 volts, Mylar, 5%  
C13—.033  $\mu$ F, 50 volts, Mylar  
C16—6.8  $\mu$ F, 25 volts, tantalum, 10%, radial leads  
C18—470  $\mu$ F, 25 volts, electrolytic, radial leads  
C19—10  $\mu$ F, 10 volts, electrolytic, radial leads

### Semiconductors

D1, D2—1N914  
D3—1N4002  
Q1, Q2, A3—2N4401  
IC1—LM13600 dual operational transconductance amplifier (National)  
IC2—LM387N dual low-noise preamplifier (National)  
IC3—LM78L12CZ (National)  
IC4—LM3915N logarithmic bar-graph display driver (National)  
LED1—LED10—NSL57124 rectangular LED for bar graph (National)

### Miscellaneous

S1—miniature SPST toggle switch  
S2, S3—miniature 4PDT toggle switch  
T1—power transformer, 14 VAC, 250 mA (Triad F-112X)  
L1—adjustable inductor, 4.7 mH, Q = 35 at 19 kHz (TOKO CLN20 740 HM)  
J1—J8—panel-mount RCA-type phono  
F1—1/4-amp slow-blow fuse  
Fuse holder, line cord, PC boards, control knobs, hardware

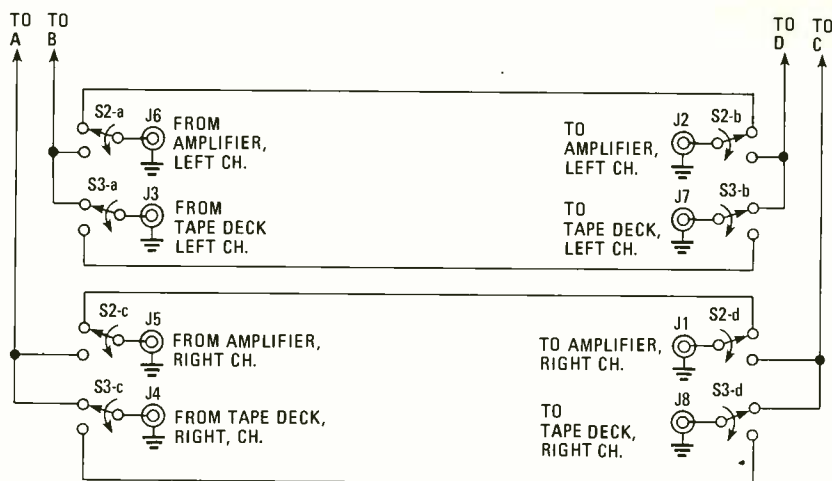
The following parts are available from Advanced Audio Systems, PO Box 24, Los Altos, CA 94022:

DX-244 (NR-2) complete kit including case—\$69.95

DX-245 (NR-2) main and display PC boards—\$19.95

DX-247 (NR-2) component kit; includes D1, D2, D3, IC1, IC2, IC3, IC4, Q1, Q2, Q3 and L1—\$27.50

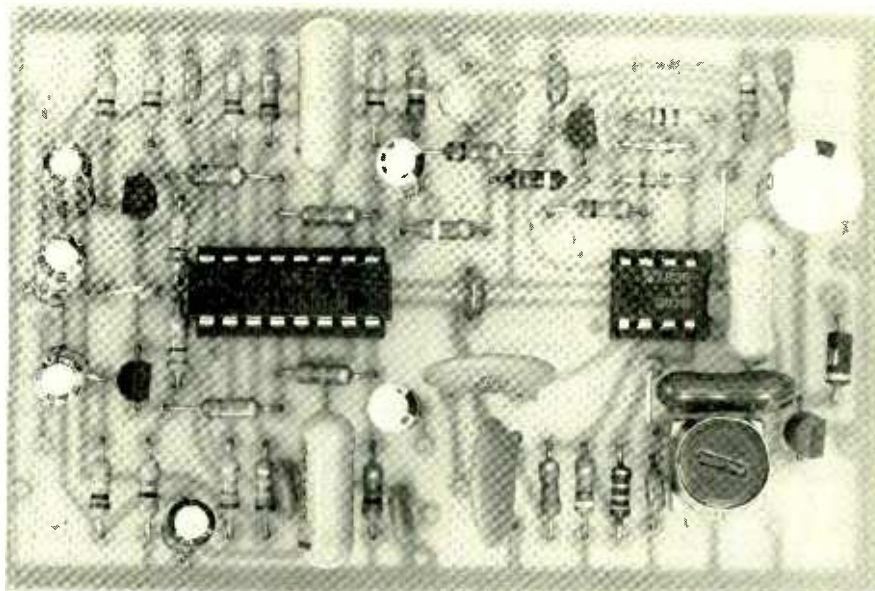
California residents add state and local taxes, as applicable.



SWITCH S2: PRE-TAPE/BYPASS  
SHOWN IN BYPASS POSITION

SWITCH S3: POST-TAPE/BYPASS  
SHOWN IN POST-TAPE POSITION

FIG. 6—IDEAL SWITCHING ARRANGEMENT is simple and flexible. User must be careful not to place both switches in non-bypass positions simultaneously.



TOP VIEW OF THE PC BOARD shows the locations of most of the components. Parts not shown include the bar-graph display and power supply.

action of the filter. It should be noted that the LED bar graph does not indicate signal level, but rather the instantaneous bandwidth of the two filters and, as such, should not be used as a signal-level indicator.

If the Adaptive Noise Filter is used for only one source, such as for tape playback, then a BYPASS switch will be the only switching needed in addition to the power switch. Figure 5-a shows a suitable arrangement. Alternatively, the filter may be defeated by switching the junction of C13 and R23 (Fig. 2) to ground, as shown in Fig. 5-b, thereby forcing the filter to a constant 30-kHz bandwidth. This approach has the advantage of requiring only a single-pole switch as opposed to the four-pole switch and associated wiring required for the straight-wire bypassing.

A more flexible system, as used in the

prototype model, can be obtained by providing for insertion of the filter either before or after the tape deck (record or playback). The rather unusual switching scheme shown in Fig. 6 was selected for its relative simplicity. A setup having a PRE TAPE/POST TAPE and a FILTER/BYPASS switch would require one four-pole and one eight-pole switch. The scheme of Fig. 6 only requires two four-pole switches, but the user should be careful not to place both switches in the non-bypass positions simultaneously.

Printed-circuit construction techniques are used in the assembly of the prototype adaptive noise filter. Foil patterns for the printed-circuit boards used for the filter and associated display board will be published next month along with complete construction details and calibration and operating instructions.

*continued next month*



## Home Reception *via* SATELLITE



*An introduction to domestic satellite communications; with details on how those illusive TV signals are pulled from space*

**ROBERT B. COOPER, JR.**

YOU MAY BE TOO YOUNG TO HAVE BEEN A PART OF THE EXCITING 1946-1952 "dawn of television era." I was a youngster in upstate New York who spent his high school years souping up 630-type chassis, building cascade and cascode signal boosters with 6BQ7's and trying out every antenna I could lay my design hands on—from stacked 10-element Yagi arrays to 12 wave-length rhombic antennas.

Television happened for me at an infectious age. A paper route helped me maintain a library of that era's **Radio-Electronics** and a host of other valuable trade magazines that were documenting the fast changing world of television technology. Summer odd jobs and caddying at the golf course enabled me to buy a minimum tubing, wire, electronics parts and bargain-basement-priced 630 chassis. In later years I would sometimes wish that I had been born "only five or ten years sooner" so that I would have been old enough by 1950 to have really been in a position to participate fully in the television revolution. "But alas" I would say to myself "that's it for the television revolution. Now that it's established nothing will come along to change it 'that much' so I'll just have to find my niche someplace else."

And so it was until 1975 when I discovered a whole new television revolution just getting underway—satellite TV transmission and reception. And I have been tracking it, playing an active part in it and enjoying it ever since.

### Forget everything you know

If you are in the television business to make a living, you probably think you know all there is to know (or need to know) about reception techniques and equipment. You've tracked down ghosts and explained away weather-caused co-channel interference. You've doped out MATV systems and traced bad components. You've been stuck with an inventory full of "brand name" parts that overnight went off the market, and you own every Sams *Photofact* that they ever printed. Forget it all!

First, let me tell you a bit about the TV reception in my present home, some 20 miles outside of Oklahoma City. We have the usual three major networks as well as PBS (Public Broadcasting System). And like a good majority of the United States, that is all we have (or *had* until the fall of 1977).

In August 1977 I placed some 1 × 2 stakes in our sidelawn and backhoed enough clay to let me refill the holes with a few pieces of properly formed steel and around 4 yards of concrete. Then, in September 1977, I brought in a crew of friends and this funny-looking, 3000-lb., all-steel saucer-shaped apparatus, and in about eight hours we had the saucer mounted on a set of steel posts. (See Fig. 1.) The saucer pointed more or less south of us and up into the sky.

The same evening I sat down with a special receiver and watched the evening news live from Vancouver, British Columbia; a baseball game from Atlanta, GA; and a movie via some-





FIG. 1—SATELLITE RECEIVING ANTENNA as it is being installed on steel mounting posts.

thing called HBO (Home Box Office).

My home is located just 18 airline miles from our local network and PBS stations, and I had always been able to receive the best-looking TV pictures this side of a network monitor, up until that fabled September 1977 evening. Until you have had a high-quality color monitor plugged directly into the video output of a satellite TV receiver and observed 54-dB signal-to-noise-ratio video produced by people who really care about how good it looks when it leaves their studio, you simply have not seen how good NTSC color reception can really be!

Let me digress a bit and explain what satellite television is all about, how it works and why it works the way it does.

#### How it began

The first man-made satellite was Russia's SPUTNIK (1) in the fall of 1957. It shook a lot of people up as you may recall. The idea of a ton or so of steel and electronics going around and around the world and crossing our country beeping in Morse code and doing who knows what else spurred the U.S. into the space race. We responded by launching a U.S. Airforce satellite named SCORE in December 1958, and to one-up the Russians, we added a prerecorded message from the President of the United States who welcomed in the American space age and the Christmas season.

TABLE 1—INTELSAT GEOSTATIONARY satellites operating in the 3.7- to 4.2-GHz downlink frequency band are clustered in three separate areas.

Longitude (west)	Name	Year Launched	Service Status
1°	I-IV-F7	1973	Secondary
4°	I-IV-F2	1971	Reserve
19.5°	I-IVA-F4	1977	Reserve
24.5°	I-IVA-F1	1975	Primary
29.5°	I-IVA-F2	1976	Reserve
34.5°	I-IV-F3	1971	Secondary
181°	I-IV-F4	1972	Reserve
186°	I-IV-F8	1974	Primary
297°	I-IVA-F3	1978	Primary
298.6°	I-IV-F1	1975	Primary
300°	I-IV-F5	1972	Reserve
300°	I-IV-F6	1978	Reserve

SPUTNIK, SCORE and all the satellites that followed them through 1963 had one common fault. They were launched into a "low orbit" and (with reference to a point on earth) they were always moving. To receive messages from or transmit messages to these "low orbit birds" required that the stations working with the satellite know rather precisely its orbit path and the timing of that path, and then be prepared to track the satellite as it came over one horizon, moved in an arc through the sky and finally disappeared beyond the opposite horizon.

In 1963 space technology and rocket power progressed, and SYNCOM, designed and built by the Hughes Aircraft Corporation, was launched—the world's first geostationary (or geosynchronous) satellite. (A geostationary satellite has an orbit directly above the equator and an orbital velocity that matches the rotational velocity of the earth. (See Fig. 2.) In this way, the satellite appears to remain stationary in the sky with respect to a point on the earth.) SYNCOM was an experiment. It provided the capacity to relay either a *single* TV channel or 50 separate telephone conversations; from its orbit above the Equator between Africa

and South America, it interconnected North America and Europe with their first real-time (live) television transmissions. By 1965 the geostationary satellite looked like a winner, and 19 countries joined to form something called Intelsat, a consortium of nations that would fund the launching of a series of satellites.

#### The Intelsat world

With nearly 14 years to grow, the Intelsat system is relatively mature. Today, more than 100 nations belong to the system, which consists of 12 separate satellites located in three distinct "groups." Commercial Intelsat installations cost in the megabuck region, but amateur builders of backyard terminals have successfully tapped into the Intelsat circuit, using surplus-salvaged parabolic antennas as small as 8 feet in diameter and with investments well under \$500, as we'll discuss in some detail.

As mature as Intelsat is today, it is in a constant state of evolution. The present satellite series is generally of the so-called Number IV (or "4") class, indicating there have been three previous series. Table 1 lists where they are located; a sharp eye will spot the three "clusters" in operation: One is over the Equator in the Pacific Ocean; another over the Indian Ocean north of the Seychelles Islands; and a third between the tip of Africa and the tip of South America. Each location has as a minimum a "primary" and a "reserve" satellite, but heavy Atlantic and Indian Ocean traffic has resulted in additional satellites in these areas. In 1971 the Intelsat consortium agreed that identical-frequency satellites should be spaced over the equator in 4- to 5-degree increments. In this fashion the large parabolic ground-receiving antennas could intercept the desired satellite's signals without interference from adjacent-position satellites, even though both would be operating on the same frequency simultaneously. The present series IV satellites will begin to be replaced with a new, advanced family of satellites during 1979, the Intelsat V series. We'll look at these later on.

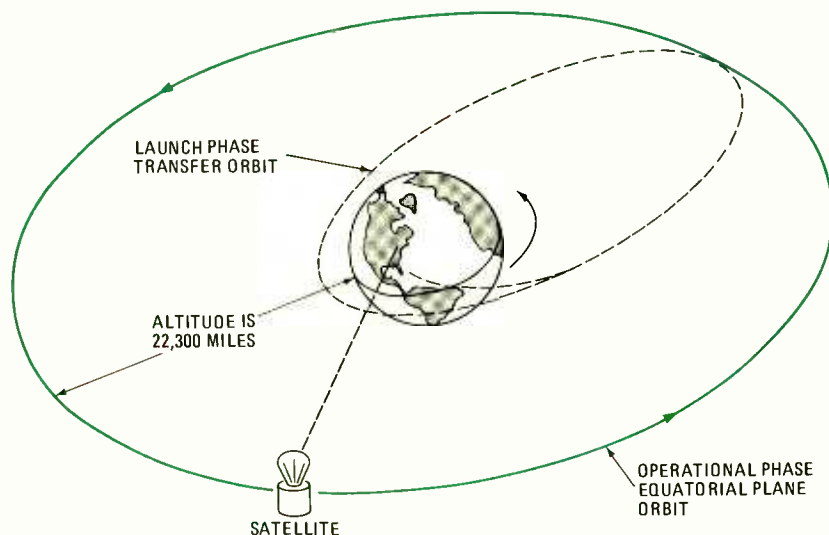


FIG. 2—GEOSYNCHRONOUS ORBIT is achieved by launching satellite into a highly elliptical orbit that is followed by a transfer to an equatorial plane orbit. Satellite's position over equator is typically maintained to  $\pm 0.1$  degree.



# GADGETS— EALLY WORK?

feedline for coupling had no effect. Interference bars were again apparent on several TV channels, with or without the CB filter attached. The trap circuitry is a series L-C filter, designed to short-circuit much of the 27-MHz CB signal, but it has no effect at TV frequencies. The schematic is shown in Fig. 3. Similar to the filter described above, it would be effective only in preventing front-end overload by a powerful 27-MHz CB signal. In fact, if an interference filter were designed to attenuate interfering signals on TV channels, it would also diminish the TV signals since they occupy the same frequencies.

## Ghost eliminator

Phantom borders that accompany the TV picture as a smear or additional outline alongside the primary image are due to phase delay—two identical picture signals arriving slightly apart in time. As a result, the sweep lines that draw the picture on your screen trace two sets of images; one is usually weaker because ghosts are caused by a reflection of the signal from nearby objects, arriving at the antenna both weaker and at a later time than the direct signal from the broadcasting station.

The ghost eliminator shown in Fig. 4 was installed and adjusted as directed; the ghosts were unaffected. Suspecting that the unit was labeled backwards, I reversed the leads, but the ghosts remained.

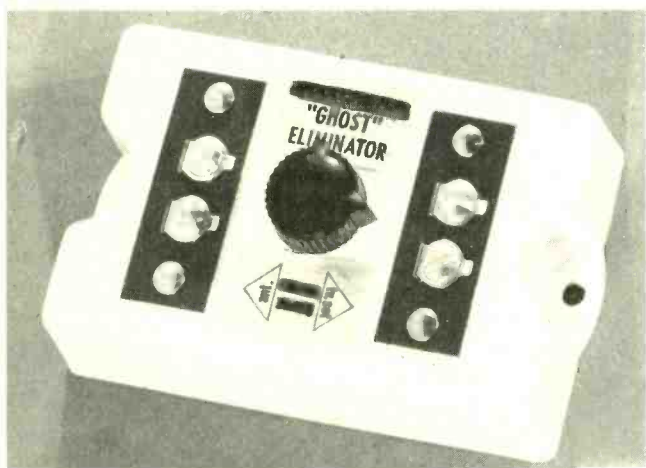


FIG. 4—GHOST ELIMINATOR is inserted in antenna lead-in and adjusted for best picture.

The ghost eliminator is an L-pad (see Fig. 5) consisting of carbon resistances that remain essentially noninductive throughout the VHF range; UHF performance is unpredictable. Because the device is a variable attenuator, it makes signals weaker; and weaker signals are more vulnerable to electrical



FIG. 5—GHOST ELIMINATOR is actually an L-pad attenuator as shown in a. Equivalent circuit when adjusted for minimum signal is shown in b. When adjusted for maximum signal, equivalent circuit is shown in c.

interference. Although it is stated on the eliminator's blister pack that the unit remains at a constant 300 ohms, it does not; the resistance of the device I tested varied from 300 to 7000 ohms at the TV terminals.

While it is dangerous to make generalizations, no inexpensive add-ons can take the place of a good antenna system; an outside antenna is always better than an inside antenna; interference is best eliminated at its source.

This article is not meant to be a blanket indictment of all TV accessories. High-quality picture-enhancing devices such as antenna preamplifiers, cavity wavetraps, etc., are available but at a substantially higher cost. However, the bottom line is: Use a good antenna and transmission line, and additional gadgets will rarely be necessary.

## TV/FM splitters

A splitter is a coupling device that permits you to hookup two sets to one antenna. Since most TV antennas are rather broadband in nature, they work quite well on the FM broadcast band as well as on TV channels; so why not use this feature for your benefit? Since most stereo receivers have a 300-ohm (two screws) antenna input, it is a simple matter to run a length of TV twin-lead from the receiver to the TV antenna splitter and enjoy greater quieting, stronger distant reception, and less flutter and fade. Of course, the FM reception is enhanced in the same direction as the TV antenna is pointed. The TV reception will be virtually unaffected, since splitter loss is minimal. Acceptable units are mass-produced for most retail outlets and large chain discount houses. They are all fairly identical (see Fig. 6) so shop for price; the average price for a typical two-set coupler is from \$3.50-\$4.00. (Be aware that some of the better TV antennas are designed to trap out FM signals—thus eliminating them as a source of interference.—*Editor*)

## Privacy earphone attachments

Although not all TV sets come with earphone jacks, many imported portable sets do. Make sure that the plug size is compatible with the jack on your set (most measure  $\frac{1}{8}$  inch, and adapters are available). If there's no earphone jack on your set, it is a relatively straightforward procedure to cut off the speaker



FIG. 6—TYPICAL TV/FM SIGNAL SPLITTER manufactured by the Finney Company.

lead inside the TV set and attach the adapter; before undertaking this minor surgery make sure instructions are included with the adapter. (Modern TV sets frequently do not have power transformers and, therefore, have a "hot" chassis. The audio output stages are similarly transformerless and the speaker leads can present a potentially dangerous shock hazard.—*Editor*)

Such units are sold for convenience, not hi-fi quality. They are available from the same sources as TV/FM splitters.

### Antenna boosters

These little preamplifiers make a weak signal stronger, and strong signals stronger. They improve a snowy picture. Outdoor antenna-mounted preamplifiers are recommended over indoor antenna boosters, since you want a stronger signal to come down the antenna transmission line and don't want to amplify the



FIG. 7—TYPICAL ANTENNA BOOSTER that is mounted on the antenna mast itself. Made by Channel Master.

interference picked up by the lead-in itself. A typical booster is shown in Fig. 7.

If you are plagued with weak-signal reception, a booster will probably help. Make sure that you purchase one that is weather-proof, with all-channel capability (if you watch UHF transmissions), and that you cover the terminals with a good lacquer or silicone rubber caulk to retard corrosion after you have installed and tested the booster. Unit prices vary from \$30 to \$70.

### Line-noise filters

Noise from motors, fluorescent lights and dimmers, and other sources of AC line interference constantly arrive at the TV line plug as voltage spikes. These interfering electrical pulses may not get filtered out by the TV set's power-supply circuitry and, as a result, show up as a tearing of the picture, or may be even heard through the speaker.

Inexpensive (\$1.50–\$6.00) filters usually consist of a plug and receptacle housing containing a capacitor or two. The TV line plug is inserted into the receptacle, and the unit is plugged into the wall. The line-noise filters are almost always either totally ineffective or inadequate because most electrical interference arrives through the antenna. An external ground should always

be present (and rarely is); more sophisticated (and more expensive) units containing inductor coils are more likely to provide some relief from power-line noise.

### Color purifiers

Color TV pictures are very sensitive to magnetic fields. Iron picture-tube envelopes, nearby steel hardware, etc., all may cause potential color distortion. If a TV set has been recently moved, transported for repair, exposed to strong electric motor fields, exposed to a nearby lightning strike or a host of other unexpected sources of magnetic energy, its components may have become magnetized and could degrade the purity of color distribution on the face of the picture tube. Color purifiers (also called *degaussers*) are simply multiturn loops of wire which, when plugged into the AC power line, produce a strong, fluctuating magnetic field capable of neutralizing the vestigial magnetism on the chassis parts.

At a cost of \$5 or \$6, this device is not a bad investment if it is properly designed and can deliver a strong enough demagnetizing field. Only a test of the unit will confirm this.

### Wall-plate terminals

Many houses are built with TV lead wire "stubbed in"—i.e., twin-lead is left dangling through a hole in the wall for connection. Alternately, a more cosmetic plastic cover plate is connected to the lead-in and affixed to the wall to cover the hole. Connections are then made to the TV set by a short length of twin-lead that is either attached to screw terminals or plugged into the wall plate.

The wall-plate terminals offer very little loss to the TV signals, and are relatively inexpensive. They are worthwhile if you want to give a finished look to the TV installation. Some wall plates contain internal splitters for FM reception as well.

### Wall-through tubes

There are many ways to bring a transmission line into a house from an external antenna: through a louvered vent, a hole under the eaves, or via a hole in the wall. But along with the hole comes another problem: How do you keep bugs, rain, or even temperate air from penetrating the house? The wall-through tube provides a seal. (See Fig. 8.) Consisting of a plastic tube with



FIG. 8—THROUGH-WALL TUBES serve a dual purpose—they protect the lead-in at the point of entry into the house, while covering the hole in the wall. Available from several sources.

finished and adjustable ends, the unit is used to line the hole drilled for the lead-in. Of course, a larger hole must be drilled than would be required for the wire alone, but the device provides isolation and insulation from both the wall and the outside. At a cost of \$2, it is a worthwhile investment.

### Lightning arresters

Solid-state TV sets are far more vulnerable to failure from high-voltage spikes than the old tube sets. Even a nearby lightning stroke can induce enough voltage in a TV antenna line to destroy tuner components. A lightning arrester probably won't protect your set from a direct hit, but it should guard it from nearby lightning during an electrical storm.

A variety of arresters are available for \$3–\$5. Make sure to follow directions to insure both TV protection and efficient signal transfer. A well-grounded antenna mast is mandatory in any TV installation! If your reception seems to be a little weaker than usual, check the lightning arrester, perhaps even replace after a stormy season.





# AC OUTLET CHECKER

*Is the ground grounded or ungrounded?  
Your life can depend on the answer!*

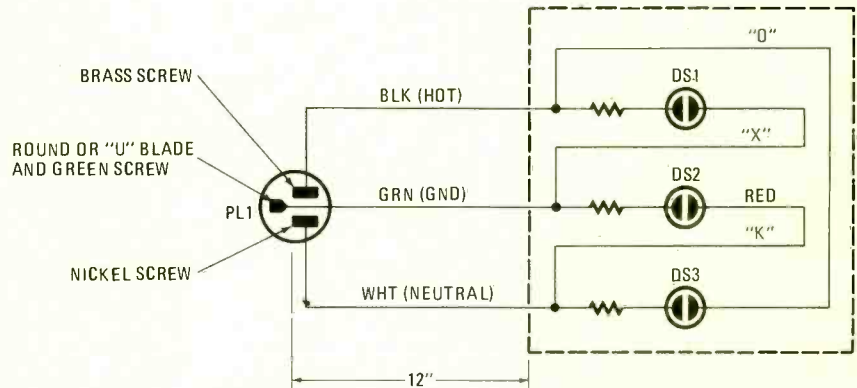
**WILLIAM D. KRAENGEL, JR.**

DO YOU KNOW IF YOUR 3-WIRE AC OUTLETS are functioning properly? If you accept the premise that the purpose of a 3-wire system is to provide an additional margin of safety (with a grounding conductor to which frames, cabinets, housings, etc., are separately grounded), it is necessary to be able to verify that the system is indeed working as designed; i.e., that the ground is really grounded.

How can this be done easily? You can use the Outlet Polarity Checker described in this article. With a little additional sleight-of-hand, the unit can be used to check 2-wire systems to determine if they can be used safely with a 2-to-3-wire adapter. (I don't like them—as shall be seen later, these can lead to a false sense of security!) And it can also be used to check an appliance that has a 3-blade plug.

The checker consists of three neon lights (see Fig. 1) wired so that they light in different combinations according to circuit conditions. Since only one combination of lights (the ones labeled "O" and "K") indicate a correctly wired outlet, the other combinations indicate various faults. Table 1 lists these possible light combinations and their causes. In most cases, but not always, any trouble will be due to an incorrectly wired outlet. However, the entire branch circuit can be incorrectly wired, especially if it has been installed by nonqualified personnel.

When 3-wire systems are working properly, they do provide an extra margin of safety. But what happens when a homeowner wants to use a new 3-wire appliance with an existing 2-wire system? He sometimes buys an adapter or uses the one that is conveniently furnished with many new 3-wire appliances. He hooks the adapter up according (sometimes) to



**FIGURE 1—OUTLET POLARITY CHECKER.** A simple and sure way of knowing if the outlet that you are about to plug into is functioning properly.

**TABLE 1—SIGNAL LIGHT COMBINATIONS**

LIGHTS ○ OFF    ● ON			CIRCUIT CONDITIONS
O	K	X	
○	○	○	OFF - FUSE OR CIRCUIT BREAKER OPEN
●	●	○	OK (SAFE!)
●	○	○	NEUTRAL OPEN - DANGER!
○	●	○	GROUND OPEN - DANGER!
○	○	●	HOT TERMINAL OPEN AND HOT ON NEUTRAL TERMINAL - DANGER!
●	○	●	HOT AND GROUND REVERSED - DANGER!
○	●	●	HOT AND NEUTRAL REVERSED - DANGER!
●	●	●	(NOT POSSIBLE)

## PARTS LIST

DS1, DS3—Amber neon lamp assembly (Lafayette No. 99A62259 or equal)  
DS2—Red neon lamp assembly (Lafayette 99A62267 or equal)  
P1—3-wire polarized plug and cord  
Misc.—Bakelite case (Lafayette No. 99E80780 or equal); grommet to fit cord.

the instructions (if any). He now blithely assumes that he has successfully converted his old 2-wire system into a safe, grounded 3-wire system—but has he? Unless he has actually grounded the green lead of the adapter, he hasn't! Just fastening the green lead under an outlet-plate mounting screw grounds the appli-

*continued on page 78*

# Wiring Syst For Proj

*A comparison look at four different ways you can wire your projects. Selecting the right one for your next construction project will make the task easier and more pleasurable.*

**EARL "DOC" SAVAGE, K4SDS**  
HOBBY EDITOR

NOT SO LONG AGO THERE WAS ONLY ONE WAY TO WIRE AN ELECTRONIC project; and too many people believe there is *still* only one way.

Today there are *four* major wiring systems from which to choose. If you are not familiar with these systems and their advantages and disadvantages, you are likely to spend too much time constructing and correspondingly less time designing and using your projects.

To avoid wasting time, a knowledge of available wiring systems is a *must*. Although it is equally important to be able to use all systems, first you must be able to choose which one is best for a given project. So let's examine and compare the four major wiring systems.

## CSH wiring

This wiring system has been in use for many years. It is conventional or traditional wiring, but many call it CSH (Cut/Strip/Hook). The name itself shows how slow and tedious it is.

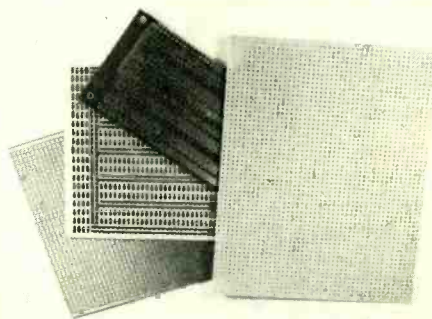
We'll review the CSH wiring system, briefly, but, first, since every project must be built *on* something let's see what's available.

Figure 1 shows several types of perforated boards that are used with the CSH system. A plain perforated board is often chosen. Three types of universal PC boards are also shown. Depending upon the nature of the project circuit, a universal PC board can ease the wiring task.

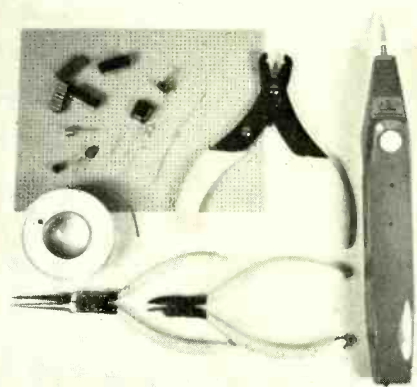
The cut/strip/hook wiring method started when components projects were large. Even so, it is still used on modern small board-mounted projects. Figure 2 shows the tools and materials used in this system. It's the cutting, stripping and hooking that takes so much time; and the hooks must then be clamped to the joints. The final step is soldering, and, a very small iron tip is essential. Note that components can be wired directly or sockets can be used.

The overwhelming disadvantage of this wiring system is the great amount of time and effort it requires. This fact will become more apparent as we look into the following systems.

However, the other side of the coin is that there is no limit to the size wire you can use. When constructing high-current and/or high-voltage circuits, this can be an advantage. The CSH wiring method is generally used in constructing power supplies and high power amplifier stages. Of course, it is standard in tube circuits.



**FIG. 1—PERFORATED BOARDS** are used with the cut/strip/hook and wire-wrap wiring methods. Also shown is a universal-type printed-circuit board.



**FIG. 2—TOOLS AND MATERIALS** required for the cut/strip/hook wiring method.

## Pencil wiring system

Figure 3 shows the tools and materials used in the *pencil* (or *pen*) wiring system. This type of wiring is very much like drawing with a regular pencil. The pencil contains a roll of special wire at one end that passes down the shaft and is dispensed through a small metal point.

The wire is wrapped three or four times around a component lead or socket tail, then fed to the next component and so forth, daisy-chain fashion. At the end of the chain, you cut the wire by



A series of four 1/2-inch videotapes describing various aspects of satellite television communications are available from *Satellite Television Technology*, P.O. Box G, Arcadia, OK 73007:

Tape HTS-1, "How The Home Terminal works"

Tape HTS-2, "Private Terminals Today"

Tape HTS-3, "TV Terminal Technical Topics"

Tape HTS-4, "How The Bird Flies"

Tapes are 1/2-inch and run from 70 to 110 minutes and are in full color. Specify either VHS or Beta format when ordering and enclose payment with order. Price is \$50, each in Beta format; \$55, each in VHS format.

Also available is a "Satellite Study Package," including a 52-page booklet explaining private terminals, a 22 by 35 four-color wall chart showing all satellites in operation and how the receive terminal is designed and installed, and a copy of a recent issue of *CATV* (the worldwide monthly publication dealing with satellite terminal systems) is available for \$13 postpaid (\$16 outside the U.S.).

The first national seminar conference dealing with practical technology for building and operating your own private television receive satellite terminal will be held August 14, 15 and 16 in Oklahoma City.

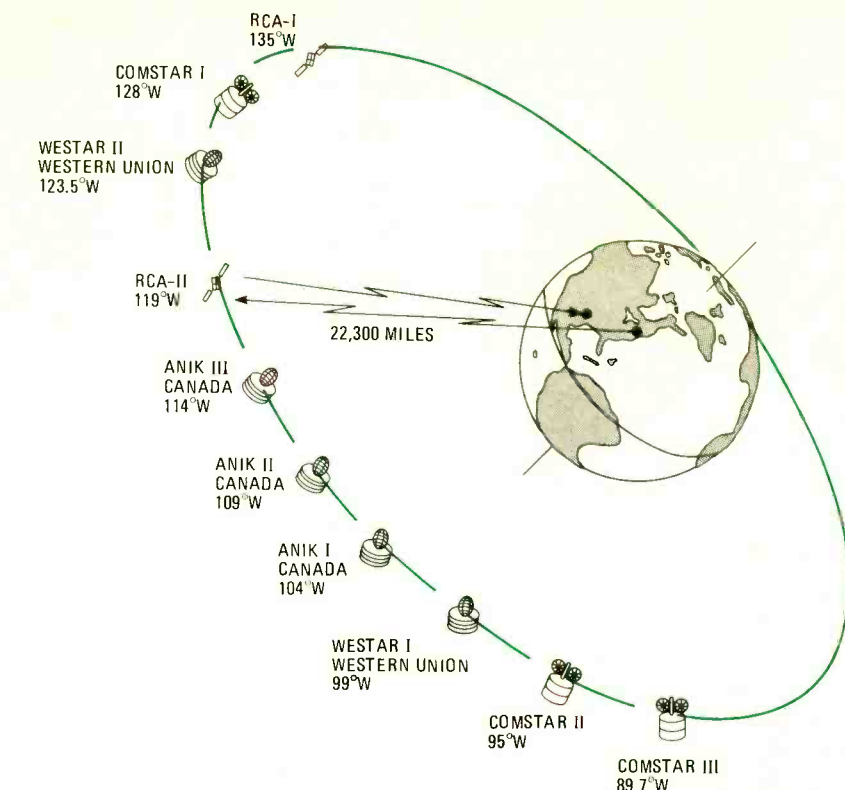
This conference will feature worldwide experts in the field of private (low cost) satellite terminals demonstrating their equipment design and construction techniques. Numerous operating terminals from 6 to 20 feet in size will be on hand and several firms marketing equipment in this field will be on hand to explain their marketing approaches to home terminal installations. Firms interested in acting as area marketing, servicing and installation affiliates of the national suppliers in this field will have the opportunity to learn about the various products being offered in this field.

Among the systems to be demonstrated will be ten foot terminal systems operating without any LNA devices (utilizing new technology in the receiver area), various approaches to low cost privately built receivers and antenna sub-systems, and a series of sessions on the projected growth and activity in this fast moving area.

Attendance is by advance registration only; for full information contact *Satellite Television Technology*, P.O. Box G, Arcadia, OK 73007 (405) 396-2574

## Domestic satellites

As needed as the Intelsat-type satellites are, they cannot serve all the communications needs of all countries. Some nations, such as the U.S., Canada and Russia, have unique internal needs that in sheer



**FIG. 3—DOMESTIC SATELLITE "parking" spots. Ten domestic satellites are currently active—3 Canadian and 7 U. S. A. A third WESTAR satellite should have been launched by the time you read this and a third SATCOM is due for launch between October and December of this year.**

message volume (or circuits required), far outstrip Intelsat's services. For example, in the Atlantic Intelsat cluster five separate satellites have a total flat-out capacity of 100 separate "channels" or transponders. A single transponder can provide (typically) up to 900 voice or message circuits, or one TV channel circuit. Obviously, not all these circuits are used full time, so satellite communications planners take advantage of what are called "peak load times." They attempt to have enough circuits available to handle peak or maximum traffic-time loads. In the long haul, the average number of circuits in use would be somewhat less than 50% of the total capacity available.

Some smaller nations, such as Nigeria, Sudan, Uganda, etc., lease one or more transponder/channels full time from Intelsat to provide ground-to-satellite-to-ground communications for circuits wholly within their own countries (except for the satellite link). Other countries such as Spain, lease full-time circuits to maintain ground-to-satellite-to-ground communications with distant outposts of their nation, for example, television, telephone and data circuits with the Canary Islands.

In 1970-1971 individual countries with projected satellite circuit needs for exceeding Intelsat's capability persuaded other Intelsat nations to allow some portions of the equatorial orbit belt to be reserved for non-Intelsat geostationary satellites, or for domestic satellites. In the interim so-called Domestic Satellite Sys-

tems have been activated for Indonesia, Canada, Russia and the U.S. although actually the Russian system was first made operational back in 1965.

In North America the orbit parking region from 70 degrees west longitude (a point due south of New England) to around 135 degrees west (roughly due south of the Alaskan peninsula) is reserved for North American domestic satellites. (See Fig. 3.) Canada was the first to launch a domestic satellite into this region (ANIK I in 1972); and in seven years, 10 other Canadian or U.S. domestic satellites have joined ANIK I. An additional pair of U.S. domestic satellites will join the crowd before 1979 is over. There are 13 satellites in all, and all are parked between 70 degrees west and 135 degrees west.

On a transponder or channel-capacity basis, the North American satellites have the full-load capability to provide as many as 228 separate TV channels, or more than 200,000 telephone voice channels simultaneously—more than twice that available on the Intelsat system. With all that capacity available, you might suspect there is some extremely interesting, perhaps even downright enticing, "television" up there.

Indeed there is. There's a lot of good watching—more than 40 channels worth—to be had from those U.S. And Canadian domestic birds. Next month, we'll take you channel-by-channel, bird-by-bird as we scan programming available to TV viewers in other locations throughout North America.

R-E

# TV ADD-ONS DO THEY R

*As we strive for improved TV reception, we are offered innumerable gadgets that promise us a near-perfect picture. Not all work as well as the sellers claim that they do.*

ROBERT B. GROVE

WE ARE ALL TEMPTED—AT ONE TIME OR ANOTHER—BY THE quick-and-easy-remedy syndrome: Gas-tank additives, pill-popping medication, flea collars, spray deodorants. Even the family TV set is besieged with handy accessories that promise fantastic results for a minimum investment in time and money.

The TV gadget syndrome began soon after World War II, when small-screen black and white TV was just catching on, and families, friends and neighbors clustered for hours around the magic box, squinting at teeny-tiny pictures.

A few enterprising souls decided to capitalize on the small screen problem by selling attachable magnifiers: A clear, convex cell of mineral oil was braced in front of the tiny screen; if the viewer sat directly in front of the screen, he could view an enlarged (albeit blurry) picture. The hapless souls who had to view the magnified image from an angle were plagued by incredible distortion. The magnifiers finally went the way of the dinosaurs!

Another item that appeared was the color-filter adapter, an incredible hoax consisting of alternating horizontal bands of colored plastic film stuck to the face of the picture tube. True, your black and white TV set could then show color . . . if you didn't mind seeing Ed Sullivan with red eyes, green nose, blue lips and a yellow chin!

Accessory gadgets are still in popular demand, but do they really work? I decided to find out. A trip to my local electronic store provided several devices intended to improve TV picture quality. Interestingly enough, *none* carried a guarantee of any kind!

The devices were tested on two separate TV sets in two different locations, and the results were disturbing. Here's what I found:

## TV interference filters

These devices are advertised as being effective against neon signs, fluorescent lights, auto ignition noise, airplanes, appliances, amateur radio transmitters, medical and X-ray equipment, electric razors, and oil burners. I purchased the filter shown in Fig. 1 and tested it using a CB transceiver; the filter did not reduce the interference on either set. Further experiments using an RF signal generator radiating local interference on TV channels also resulted in no improvement with the filter attached. The filter was then tested for its effectiveness in

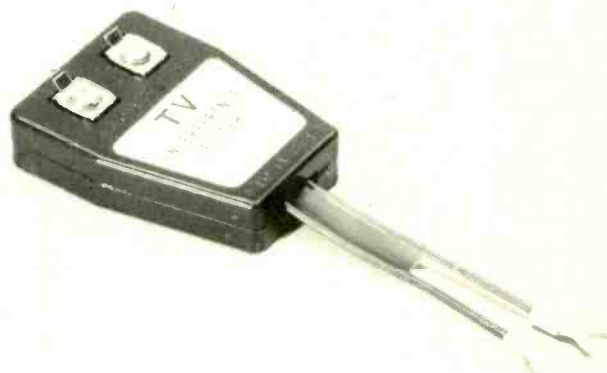


FIG. 1—TV INTERFERENCE FILTER is inserted in the antenna lead-in.

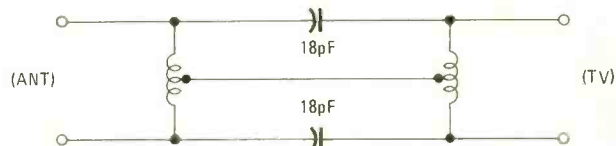


FIG. 2—INTERFERENCE FILTER is a high-pass filter that attenuates signals below 54 Hz.



FIG. 3—CB TRAP is a series filter that eliminates 27-MHz CB signals.

suppressing the spark-tearing of the picture caused by electrical appliances; again, no improvement.

Internally, the TV interference filter is a constant-k high-pass filter, attenuating all signals below 54 MHz (Channel 2). The schematic diagram is shown in Fig. 2. It should be effective in preventing front-end overload from signals below 54 MHz, but it has no effect on interfering signals in the TV frequency bands, which is where the majority of interference originates!

## CB interference trap

Turning the CB transceiver on transmit next to the antenna



# ems ects

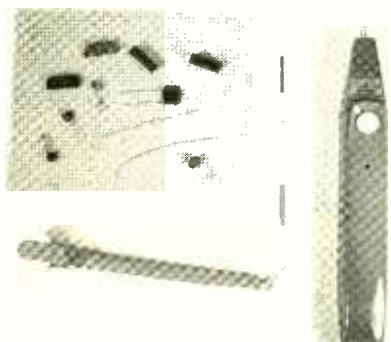
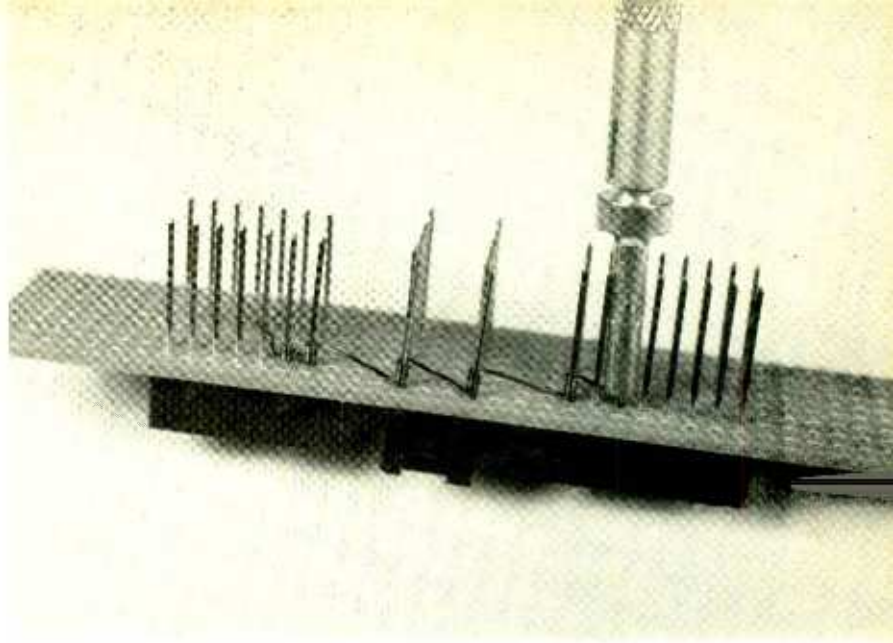


FIG. 3—PENCIL WIRING SYSTEM also requires perforated board and soldering iron.

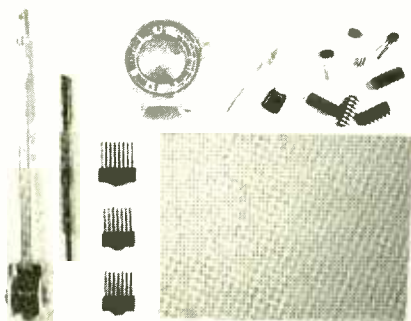


FIG. 4—TWO TECHNIQUES are available for wire-wrap construction. The tools and materials required for both techniques are shown.

pinching it against the board using a chisel-like tool or an *Xacto* knife or other type of blade.

So far, we have not mentioned stripping the wire. This is because the wire has a special insulation that *vaporizes* at a temperature of about 750°F, making wire-stripping unnecessary. You only have to touch the wire with a hot iron to melt the insulation so that solder can be applied.

Quite obviously, the great advantages to the pencil wiring method are its simplicity and speed. It is ideal for most modern

digital and analog circuits. As you might expect, the disadvantage is the limited wire size—gauges No. 32 through No. 38 are usually available. Therefore, pencil wiring would not be suitable for constructing a 2-amp power supply.

## Wire-wrapping

There are two wire-wrapping methods, and the tools and materials for both are shown in Fig. 4. One method (Type 1) resembles the CSH system, although it is much faster.

The first wire-wrapping method (Type 1) requires that the wire be cut and stripped. Fortunately, these operations are simplified by the wire dispenser and stripper shown in Fig. 5. OK Machine and Tool's refillable wire dispenser has a built-in cutter and stripper that saves a lot of time. The other device has a stripper built into the handle of the double-ended wrap/unwrap tool. Kits are also available containing various lengths of pre-cut and pre-stripped wire.

Wiring is performed by simply wrapping the wire around the terminal. In case of error or modification, the other end of the tool can be used to *unwrap* the connection.

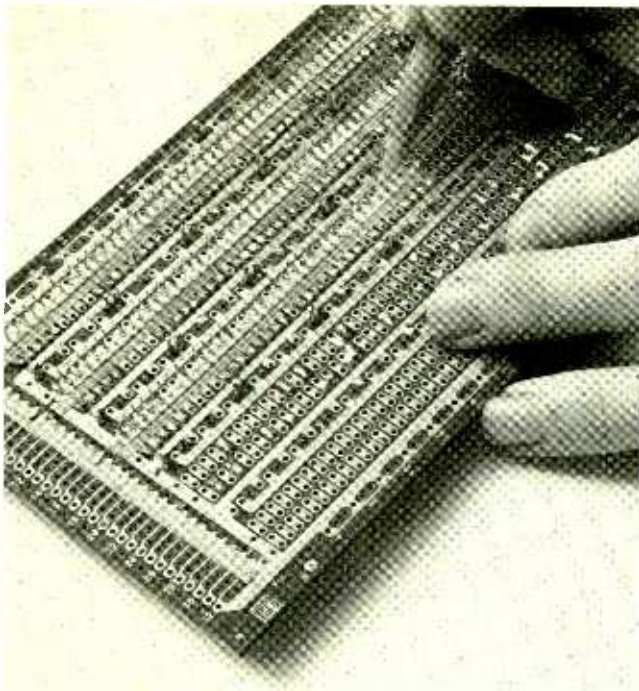
The second wire-wrapping method (Type 2) is called slit-and-wrap wiring and is accomplished with a tool from Vector Electronics that resembles a wiring pencil. This wire is also contained in a spool mounted on one end of a hollow shaft through which the wire passes. The business end of the tool not only wraps the wire but *slits* the insulation as it does so, allowing contact to be made with the terminal.

The slit-and-wrap technique has two decided advantages over the Type 1 method. First, cutting and stripping are *not* required. Second, continuous daisy-chain connections can be made (see Fig. 6). These two factors greatly improve convenience and time-saving (and there are also motor-driven wrapping tools).

You will note that no mention has been made of soldering. The ultra-speed of the wire-wrapping system (the slit-and-wrap technique especially) results from the fact that there is *no soldering*. As strange as it may seem, a properly wrapped connection is *at least* as stable mechanically, and has as low a resistance as a soldered connection.

The wire-wrapping system is not a cure-all, however. It has some disadvantages: The wire is of limited size, although typically a little heavier than pencil wire (but, as previously noted, this is seldom a problem). What is more important is that connections must be made on special wrapping posts.

Wire-wrapping *cannot* be performed on component leads. The wrapping posts must have sharp edges to dig into the



**UNIVERSAL PC BOARD and wiring pen manufactured by Vero Electronics, Inc.**

wrapped wire. This means using special wire-wrapping sockets and through-board posts for mounting discrete components.

#### Printed-circuit boards

There is some confusion about the meaning of the term PC board because both *universal* and *dedicated* boards can be called PC boards. In order to distinguish between the two types, the adjective "universal" is included for that type of board. (An unqualified PC board generally refers to a dedicated board—that is, one designed for use with a specific circuit.)

The PC board wiring technique is the simplest and quickest technique of all. It would win hands down over the others except for two factors: First, modifications are more difficult (although not impossible) to make on PC boards. It is just a matter of cutting the traces and substituting actual wires, and, with reasonable care, this procedure works quite well.

The more important difficulty is making the PC board itself. At the outset, the copper-clad board is plain and undrilled. Somehow the circuit must be placed on the board—either by drawing, transferring, pasting-up, or using a photosensitive process. Next, the unwanted copper must be removed—by etching, grinding, or even sawing. Finally, the PC board must be drilled for component mounting.

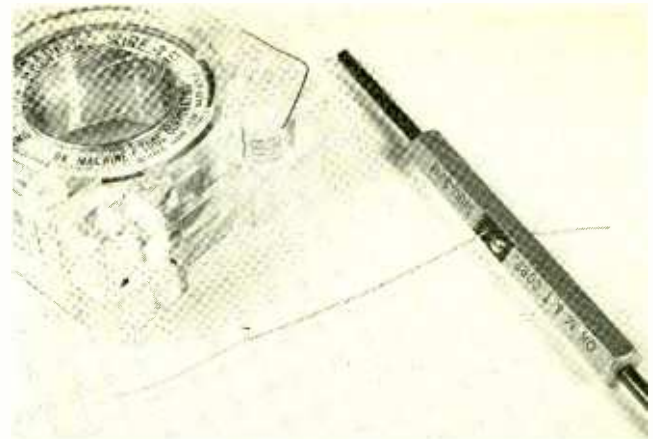
Several excellent methods have been devised for constructing PC boards. Everyone should become familiar with them in order to be able to select the correct one. However, there is *no* presently available *fast* method of doing the job.

Time can be saved only when a quantity of identical boards must be constructed, which is a rare situation for the individual builder. Even ordering a preconstructed board takes time. In spite of all this, time and effort are not always the most important considerations, so PC board wiring should not be overlooked.

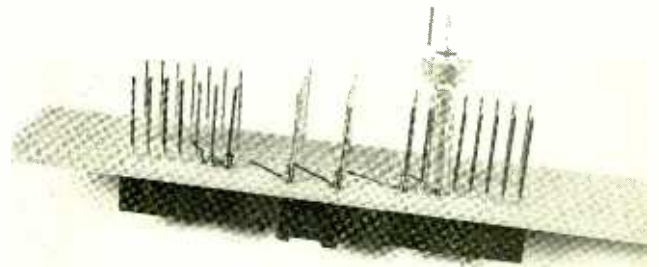
#### Material sources

For your convenience, some of the manufacturers of tools and materials needed for the various wiring systems are listed in Table 1. Listed under each name are applicable tools, identification numbers and the latest prices (subject to change). Each manufacturer also produces materials and accessories, so request a catalog from each one.

You can sometimes find these items in many mail-order catalogs. There may also be sources in your own area, such as retail



**FIG. 5—WIRE DISPENSER and wrap/unwrap tool available from OK Machine and Tool Corp.**



**FIG. 6—SLIT-N-WRAP tool from Vector Electronics has wire stripper built-in so the wire is automatically stripped as it is wrapped.**

**TABLE 1—MANUFACTURERS of tools and materials for various wiring systems**

<b>OK Machine &amp; Tool Corp., 3455 Conner St., Bronx, NY 10475:</b>	
<b>CIRCLE 148 ON FREE INFORMATION CARD</b>	
WSU-30—Wrap/unwrap tool, \$6.95, plus materials, accessories, boards.	
JWK-6—Just Wrap kit, \$24.95.	
<b>Vector Electronics Co., Inc., 12460 Gladstone Ave., Sylmar, CA 91342:</b>	
<b>CIRCLE 149 ON FREE INFORMATION CARD</b>	
P-178-1—Wiring pencil, \$7.95.	
P-183—Chisel knife and forming tool, \$1.95.	
P-180—Slit-N-Wrap tool, \$24.50, plus materials, accessories, boards, kits.	
<b>Vero Electronics, Inc., 171 Bridge Rd., Hauppauge, NY 11787:</b>	
<b>CIRCLE 150 ON FREE INFORMATION CARD</b>	
79-1732G—Wiring pen, \$8.00.	
58-2808J—Wrap tool, \$21.70, plus materials, accessories, boards, kits.	

stores and electronic supply distributors. If you cannot locate what you need, you can write the manufacturer.

#### Summary

Knowledge is, indeed, a powerful thing. You can save yourself much "fussin' an' cussin'" if you know enough about the four major wiring systems to pick the right one at the right time. Choosing the wrong one can result in anything from frustration to disaster. After all, old Murphy's Law says that something will go wrong anyway—you don't have to make it worse by selecting the wrong one from the start!

Every electronics hobbyist should not only read about, but *try out* each wiring system. That way, you *really* know. Don't take someone else's word—even mine—because we may have different expectations. Try all of them and then you can choose the system you need when you need it.

**R-E**



## New FM Tuner CIRCUITS

*During the last few years the sound quality developed by the FM detector and stereo decoder has improved noticeably. Here is a look at some state-of-the-art circuits that make this possible.*

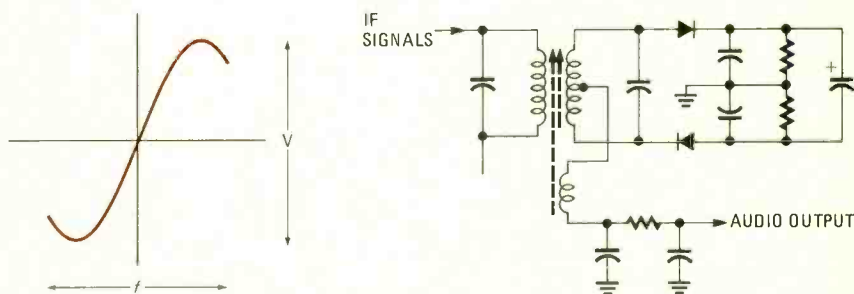
**LEN FELDMAN**  
CONTRIBUTING HI-FI EDITOR

IT WASN'T VERY LONG AGO THAT AN FM tuner capable of delivering an audio signal with less than 1.0% total harmonic distortion at the output of its ratio detector or discriminator was considered to be a very high-quality product. Today, it is not uncommon to find FM tuners with distortion as low as 0.1%, even in the stereo FM mode. Despite such giant reductions in overall distortion of FM signal reception, some manufacturers continue to explore other innovative ways to improve FM reception.

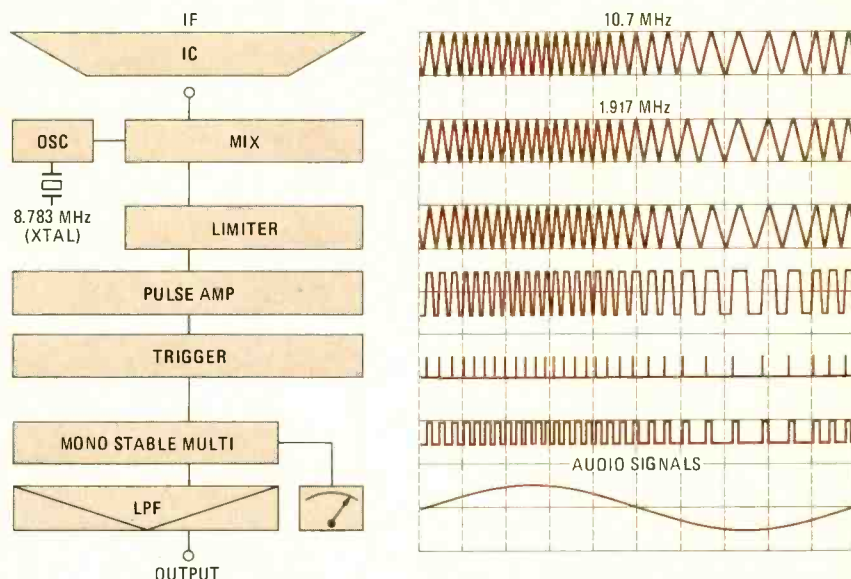
For example, Kenwood Electronics (1315 E. Watsoncenter Rd., Carson, CA 90745) has developed a separate tuner, the *model KT-917*, that achieves a distortion rating of 0.05% in the monophonic mode and 0.09% in the stereophonic mode at any audio frequency from 50 Hz to 10 kHz. Several new and unusual circuits are responsible for this additional lowering of overall distortion; we'll examine four of these new circuits.

### Pulse-count detector

Conventional discriminators and ratio detectors, which have been in use since FM broadcasting began, use tuned circuits which first convert the FM signal into one that varies in amplitude. Non-linear devices (diodes) then rectify the frequency-dependent AM signal to recover the original audio modulation. Both steps in this process are inherently non-linear. The discriminator (or ratio-detector) S-curve, formed by transformer-coupled tuned circuits, is a continuous curve (see Fig. 1). It is this curve that converts frequency variations into varia-



**FIG. 1—CONVENTIONAL DISCRIMINATOR** has a nonlinear S-curve characteristic to convert FM signals into AM signals.



**BLOCK DIAGRAM OF PULSE COUNT DETECTOR**

**FIG. 2—PULSE COUNT DETECTOR** is a digital circuit that performs the function of a conventional discriminator but with much less distortion.

tions in amplitude. By restricting the FM deviation to a portion of this curve, linearity is approached but not fully realized. The second step in the demodulation process uses a diode's nonlinear characteristics for rectification. Here, with careful attention given to input-signal amplitude, linearity is again approached but not totally realized.

A pulse-count detector system, on the other hand, is theoretically linear. In this system each individual waveform (at the IF) is converted to a pulse of uniform amplitude and duration. An integrating circuit counts these pulses and averages the count over a given time interval; the output is proportional to the pulse count. A block diagram of the Kenwood pulse-count detector system is shown in Fig. 2. The pulse count rises as a linear function of frequency, and the counting process remains linear until there is no space left between pulses. This point of saturation occurs far beyond maximum deviation. The system uses no nonlinear analog elements. It is a digital system in that the precision-pulse formers use digital techniques. The pulse counter is a form of digital-to-analog converter.

In applying this technique to FM demodulation, Kenwood found that the best detector efficiency can be achieved when demodulation occurs at a frequency much lower than 10.7 MHz (the normal FM IF). Therefore, a second converter is incorporated to heterodyne the IF down to 1.96 MHz. This causes the deviation to be much greater compared with the center frequency, and suits the operating characteristics of the digital processors. Referring to Fig. 2, note the 1.96-MHz signal is shaped into narrow triggering spikes (one for each cycle) that drive a one-shot multivibrator. The multivibrator produces output pulses of uniform amplitude and duration. Only the frequency or density of pulses varies. A low-pass filter performs the pulse-counting function, producing an audio output that is determined solely and linearly by pulse count.

There is an additional performance advantage to this system. The multivibrator

is either off (zero volts) or on (supply voltage). In either state, no noise is produced, since the system is sensitive to noise only at the instant of triggering. This results in an important reduction in overall noise. Furthermore, since there are no tuned circuits the pulse-count detector never needs alignment and is not affected by temperature or humidity.

Figure 3 shows the differential gain for a conventional ratio detector and for a pulse-count detector. Note that ratio-detector gain varies as the frequency deviates farther and farther away from the center, while the pulse-count detector gain remains linear over a very wide frequency range.

### Distortion detection loop

With distortion caused by nonlinear detection virtually eliminated by the pulse-count detector, the one remaining possible source of distortion is the IF system of the FM tuner. In many FM tuners an indicator displaying center-tuning makes use of a balanced detector whose output voltage goes to zero when the converted signal is at the center of the detector's response. The drive from this circuit controls the deflection of the familiar zero-center tuning meter, or an AFC (Automatic Frequency Control) system, if one is used. This system works on the assumption that the IF response is perfectly symmetrical and has the same center frequency as that of the detector driving the tuning meter. Unfortunately, this is not always the case.

The DDL (Distortion Detection Loop) system developed by Kenwood examines distortion and adjusts local oscillator frequency to place the converted IF signal precisely where it should be for minimum distortion. The block diagram of Fig. 4 shows that the local oscillator is frequency-modulated by an internally generated 95-kHz signal that contains 10% positive and negative deviation components.

To avoid interference with the selected incoming channel, the 95-kHz signal was chosen to be five times the 19-kHz pilot-signal frequency. It is mixed with the selected carrier signal in order to place

frequency-modulated signals on the upper and lower skirts of the IF response curve. After FM detection, original test signals and any distortion (which appears as twice the 95-kHz signal) are extracted by a high-pass filter and applied to a synchronized detector where the original test signals and distortion components are compared. If an imbalance exists a DC error voltage is produced; this voltage is filtered and applied to the same varactor diode used to add the frequency-modulated injection signal to the local oscillator. This error voltage corrects the local oscillator's center frequency to balance the DDL phase detector. In this way the DDL system monitors the distortion by injecting test signals that accompany the selected channel through the IF system. It serves to balance the distortion and to place the selected channel at the precise mid-point of the IF passband.

To prevent interference with normal tuning, a logic-control circuit interrupts DDL control until manual tuning places a selected channel in the approximate center of the IF passband. Inputs to the control logic are a touch detector that is linked to the tuning knob, a noise detector that monitors IF output, and the output of the high-pass filter that delivers the recovered injection signals to the DDL phase detector. When the operator releases the tuning knob, the DDL system starts working, and a light is turned on to indicate that tuning for minimum distortion has occurred.

### Sample-and-hold decoding

In the conventional stereo FM decoding process, the (L-R) and -(L-R) audio information is recovered from the positive and negative excursions of the 38-kHz composite-signal envelope. In such switching systems the (L-R) and -(L-R) information is recovered in the form of averaged 38-kHz components. In the course of filtering the ripple components of the 38-kHz signal to reclaim the original modulation some sacrifice in stereo separation normally occurs.

In a newly developed sample-and-hold technique, the 38-kHz signal envelope is examined in short bursts at a rate that is determined by the 38-kHz signal produced by a phase-locked-loop (PLL) system. The recovered levels, in terms of modulation envelope voltage, are stored in a capacitor that is effectively disconnected from the sampling switch after the sampling burst has passed. This voltage value is retained by the capacitor until the next sampling burst arrives. The capacitor then charges or discharges to the new envelope voltage value. As a result the envelope is traced in the form of horizontal voltage steps, as shown in Fig. 5. This represents a more accurate reproduction of the modulation envelope voltage. The resultant ripple component is lower and little filtering is required.

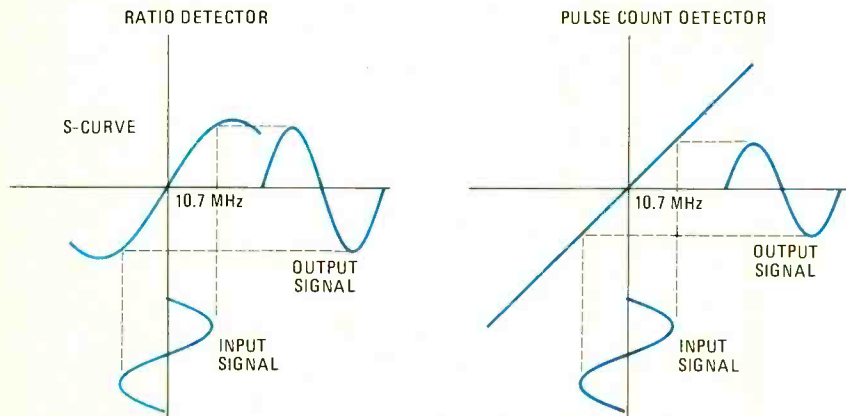
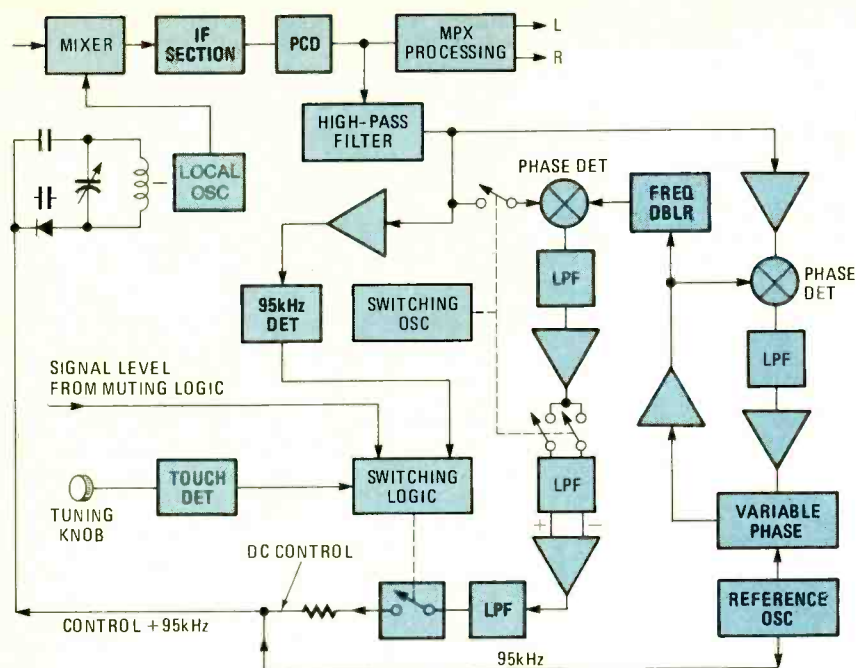


FIG. 3—TRANSFER CHARACTERISTICS for the conventional ratio detector and for the new pulse count detector.





BLOCK DIAGRAM OF DISTORTION-DETECTION LOOP (DDL)

FIG. 4—DISTORTION DETECTION LOOP senses the distortion level at the output of the detector and adjusts the local oscillator frequency for minimum distortion.

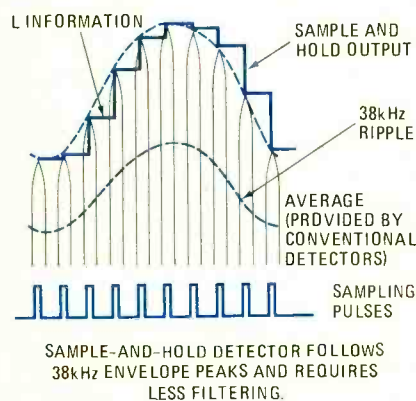


FIG. 5—SAMPLE-AND-HOLD stereo decoding circuit output follows the 38-kHz envelope and requires less filtering than conventional techniques.

### Two-speed phase-locked loop

Another form of distortion can be introduced into stereo decoding circuits that use a phase-locked loop circuit to regenerate the 19-kHz and 38-kHz carrier signals during decoding. Ideally, the regenerated 38-kHz subcarrier signal should be immune to noise-induced frequency jitter. To reduce such frequency jitter, some designers narrow the bandwidth of the phase-locked loop, 19-kHz capture range. This approach makes it more difficult for the PLL circuit to lock onto the incoming pilot-carrier signal. Opening the bandwidth to allow fast and reliable capture of the pilot signal, on the other hand, increases the possibility of pilot jitter; this normally peaks at around 200 Hz to produce high-order audible intermodulation. In the Kenwood stereo decoder (shown in the block diagram of Fig. 6) a dual time-constant filter is used in the PLL circuitry: a wide filter

for acquisition; followed by a narrow filter, which is inserted after lockup (of the pilot signal) to keep tight and jitter-free control of the regenerated pilot signal.

Figure 6 also demonstrates the way in which this PLL circuit eliminates any residual 19-kHz signals from the recovered audio outputs. Removal of this high-frequency signal is important because the presence of 19-kHz components in the output signals can produce beat frequencies during tape recordings (the 19-kHz harmonics can beat with the tape deck's bias oscillator); and can also cause improper tracking of built-in Dolby or other types of noise-reduction circuits. The conventional way of removing the 19-kHz pilot signal from the audio output signals is by using a simple low-pass filter. For the filter to be effective at 19 kHz, however, it must also rolloff response at

lower audio frequencies, beginning at around 10 kHz or 12 kHz. The decoding system shown in Fig. 6 does not use such simple filters. Instead, a sample of the regenerated 19-kHz signal from the two-speed phase-locked loop is applied to a subtractor circuit in the decoder input section. Here, the original pilot signal and the regenerated 19-kHz pilot signal are 180 degrees out-of-phase. By adjusting the out-of-phase 19-kHz signal so that it is equal in amplitude to the incoming 19-kHz signal (part of the overall detected composite stereo signal), the two 19-kHz components cancel each other out without affecting audio frequency response.

Manufacturers of high-fidelity FM equipment such as Kenwood and others seem to be able to develop more and more improved circuits to provide audibly better FM reception in the home. Unfortunately, only a few FM broadcast stations are able to transmit clean enough signals to allow state-of-the-art hi-fi FM tuners and receivers to perform optimally. The truth is that the performance of most FM receivers today is limited by the antiquated transmission equipment used by a majority of FM stations, not to mention the scratched recordings, worn styluses, and hum-and-noise in studio consoles and cables that many stations continue to transmit.

R-E

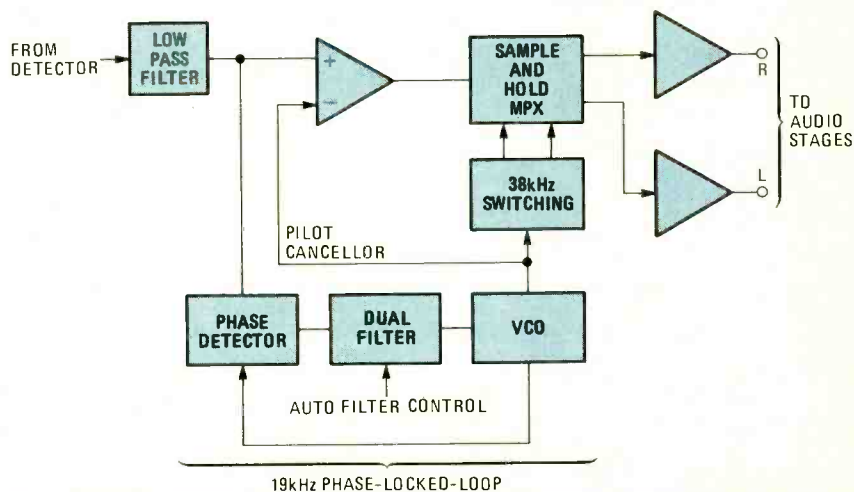


FIG. 6—BLOCK DIAGRAM of the Kenwood stereo decoder designed to eliminate pilot jitter. Two filters, one narrowband and the other wideband, provide a jitter-free regenerated pilot signal.

## Radio-Electronics Audio Lab Tests



CIRCLE 106 ON FREE INFORMATION CARD

## SONY STR-V7 AM/FM Receiver

LEONARD FELDMAN  
CONTRIBUTING HI-FI EDITOR

SONY CORPORATION HAS DEVELOPED ITS MOST powerful stereo receiver to date, the *model STR-V7* (see Fig. 1). This receiver's control layout has been carried over from earlier Sony models. The tuning knob and master volume control are conveniently placed in the upper right-hand side of the panel, and the POWER on/off pushbutton is located at the upper left-hand side. In between these controls are placed three meters—the center meter acts as either a signal-strength meter (when a pushbutton adjacent to the tuning knob is depressed) or, used with the meter on the left, as one of a pair of power-output meters directly calibrated in watts across an 8-ohm load. The third meter, next to the volume control, serves as a center-of-channel tuning indicator in the FM listening mode.

The FM dial scale is linearly calibrated with markings at every 200 kHz, while below it is a nominally calibrated AM scale. Above these scales are a series of indicator lights that denote program source as well as stereo FM reception. The remaining controls and switches are located along the bottom section of the panel. Adjacent to the usual headphone output jack at the extreme left is a SPEAKER selector

switch. Next to this control are three toggle switches for the low-cut and high-cut filters and for bypassing the BASS and TREBLE controls. Next come a rotary BALANCE control, LOUDNESS and MODE (stereo/mono) switches, TAPE switch and FUNCTION selector switch. The TAPE mode switch permits you to monitor either of two connected tape decks as well as to copy tape from one deck to another. The FUNCTION switch has two phono settings: for magnetic cartridges, or, alternatively, for moving-coil cartridges. Three additional toggle switches on the lower right-hand side of the panel are used for varying FM-IF selectivity (both normal and narrow bandwidths), for FM muting and for activating the built-in Dolby FM decoding circuitry.

The upper left of the rear panel contains antenna terminals for 300-ohm or 75-ohm coaxial FM transmission lines and for connecting to an external AM antenna. A useful addition is an antenna lead-in clamp that retains the antenna line and protects it from strain. Nearby are a built-in ferrite-bar AM antenna, pivotable in two planes, and a chassis ground terminal. Near the two pairs of phono inputs is a two-position slide switch that selects either

MM (Moving Magnet) or MC (Moving Coil) cartridge operation. The tape-input and tape-output jacks are located in the lower left of the rear panel. On the right-hand side are located two sets of spring-loaded, color-coded speaker-connection terminals, while just below are two AC receptacles (one switched and one unswitched). No external access to fuses is provided. A view of the rear panel is shown in Fig. 2.



The owner's manual contains virtually no information regarding the circuit design and no schematic diagram is provided. From a quick examination of the internal construction of the unit and an analysis of the block diagram (which is provided), we learned that the FM front-end uses a four-section tuning capacitor, and has separate filter systems for the normal and narrow bandwidth IF settings of the front-panel selectivity switch. The multiplex decoder comprises a phase-locked-loop circuit followed by low-pass filters to eliminate subcarrier products at the output. The AM circuit uses a single IC and a two-gang tuning capacitor. The Dolby FM decoding circuitry is also incorporated in a single IC. Power-output circuits are protected by electronic and mechanical-relay circuitry. The latter also serves to delay turn-on for a few seconds to prevent thumps and other noises from reaching the loudspeakers. Figure 3 is a diagram that shows how this receiver can be hooked up to associated components.

### FM measurements

Table 1 contains the measurements made for the FM tuner section of the *model STR-V7*. While usable sensitivity was poorer than claimed, the more important 50-dB quieting specification proved to be better than claimed, with readings of 2.3  $\mu$ V (12.4 dBf) in mono and 38  $\mu$ V (36.8 dBf) in stereo as opposed to the 2.8  $\mu$ V and 40  $\mu$ V claimed by Sony. On the other hand, the signal-to-noise ratio at strong signal levels failed to reach the manufacturer's specified levels. Even more surprising (and

### MANUFACTURER'S PUBLISHED SPECIFICATIONS:

#### FM TUNER SECTION:

**Usable Sensitivity:** 9.3 dBf (1.6  $\mu$ V) **50-dB Quieting:** mono, 14.2 dBf (2.8  $\mu$ V); stereo, 37.3 dBf (40  $\mu$ V). **S/N Ratio:** mono, 75 dB; stereo, 70 dB. **Frequency Response:** 30 Hz to 15 kHz,  $\pm 0$  dB. **Selectivity:** normal, 50 dB; narrow: 80 dB. **Capture Ratio:** 1.0 dB. **AM Suppression:** 60 dB. **Image Rejection:** 80 dB. **IF Rejection:** 100 dB. **Spurious Rejection:** 100 dB. **Muting Threshold:** 5  $\mu$ V (19.2 dBf). **Distortion, Mono:** normal, 0.08% at 100 Hz and 1 kHz, 0.1% at 10 kHz; narrow, 0.2% at 100 Hz, 1 kHz and 10 kHz. **Distortion, Stereo:** normal, 0.15% at 100 Hz and 1 kHz, 0.3% at 10 kHz; narrow, 0.4% at 100 Hz and 1 kHz, 0.6% at 10 kHz. **Stereo Separation:** normal, 40 dB at 100 Hz, 48 dB at 1 kHz, 43 dB at 10 kHz; narrow, 35 dB at 100 Hz, 40 dB at 1 kHz, 37 dB at 10 kHz.

#### AM TUNER SECTION:

**Usable Sensitivity:** 100  $\mu$ V (external antenna). **S/N Ratio:** 50 dB. **Harmonic Distortion:** 0.5%. **Selectivity:** 40 dB. **Image and IF Rejection:** 40 dB.

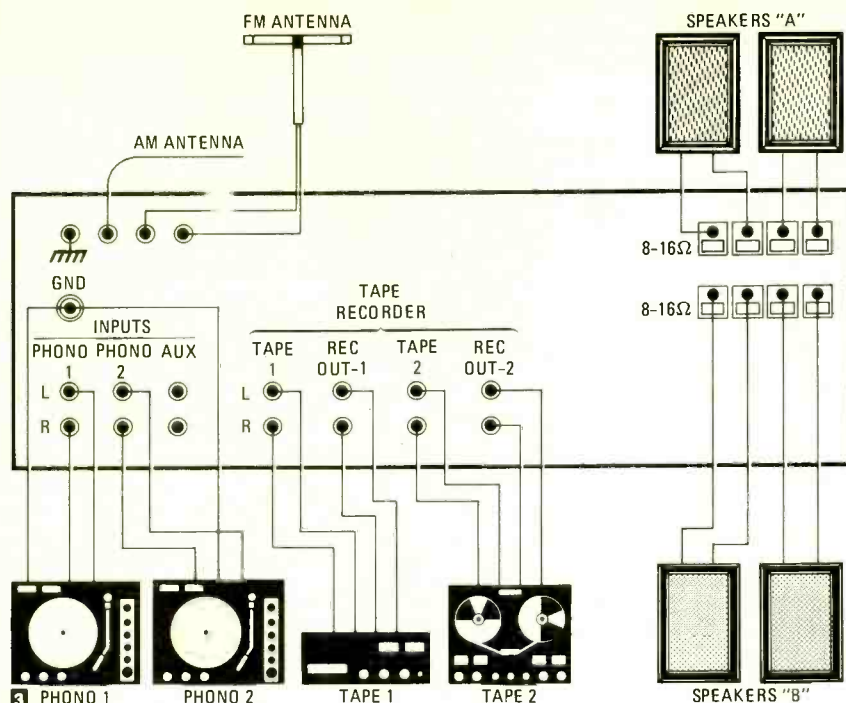
#### AMPLIFIER SECTION:

**Power Output:** 150 watts-per-channel, 8 ohms, 20 Hz to 20 kHz. **Rated THD:** 0.07%. **IM Distortion:** 0.07%. **Input Sensitivity:** phono, 2.5 mV and 0.25 mV; high level, 150 mV. **S/N Ratio (Phono, A-Weighted):** 80 dB and 65 dB (moving coil); high level, 100 dB. **Frequency Response:** phono, RIAA,  $\pm 0.5$  dB; high level, 5 Hz to 50 kHz,  $\pm 0$ ,  $-2$  dB. **Tone Control Ranges:**  $\pm 10$  dB at 100 Hz and 10 kHz. **Filter Cut-Off Frequencies:** 50 Hz and 9 kHz, 6 dB-per-octave.

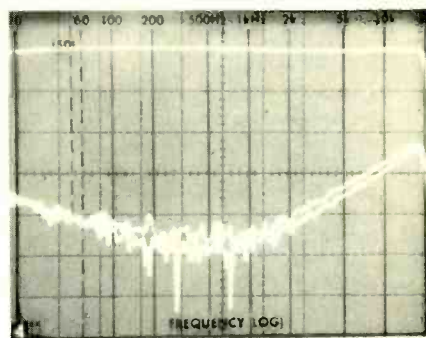
#### GENERAL SPECIFICATIONS:

**Dimensions:** 20½ W × 7½ H × 17¼ inches D. **Net Weight:** 48 lbs., 6 oz. **Power Requirements:** 120 volts, 60 Hz, 250 watts. **Suggested Retail Price:** \$820.





watts-per-channel at mid-frequencies (and somewhat more than its rated power at high frequency), it was barely able to deliver its rated power at 20 Hz. Dynamic headroom



measured a moderate 1 dB. The manufacturer's specifications for S/N ratio and input sensitivity are reported by Sony in a manner that does not yet reflect the new IHF Measurement Standards for Audio Amplifiers. Therefore, you should not attempt to compare the input sensitivity values and signal-to-noise

disappointing) were the relatively small differences observed between distortion readings measured in the normal and narrow bandwidth modes. And, whereas we normally expect THD readings to be poorer in stereo than they are in mono, the opposite was true with this receiver. There is no easy way to determine whether this is the result of two types of distortion "tending to cancel each other out" or not. Stereo separation, while certainly adequate for all listening purposes, also fell short of published claims, both for the normal and narrow IF bandwidth settings; and, again, the differences were relatively small when shifting from one selectivity setting to the other.

Muting threshold and stereo-switching threshold (and, hence, usable stereo sensitivity) were all set a bit too high—at around 12  $\mu$ V (26.8 dBf). Sony specifications call for a 5- $\mu$ V threshold. The frequency response of the FM section was excellent, with deviations of no more than 0.5 dB from 30 Hz to 15,000 Hz, as shown in the top trace in Fig. 4. The lower trace in Fig. 4 shows the separation (or, more properly, the crosstalk) in stereo FM. Two scope sweeps were taken: one for the normal IF mode, the other for the narrow mode; and results agree fairly well with the static point-by-point measurements discussed above and shown in Table 1.

Figure 5 shows the built-in Dolby FM decoder action. At higher modulation levels (see the upper trace), frequency response is virtually flat, while at progressively lower modulation levels, the appropriate treble attenuation is introduced automatically by the Dolby circuitry.

Figure 6 shows only the frequency-response curve of the AM section. In this respect, the model STR-V7 is neither better nor worse than most competitive units. You should not expect anything resembling hi-fi performance from this minimal AM section.

## Amplifier measurements

Table 2 shows the results of measurements made on the amplifier/preamplifier control section. While the power-amplifier section delivered considerably more than its rated 150

TABLE 1

## R.E.A.L. SOUND PRODUCT TEST REPORT

Manufacturer: Sony Corporation

Model: STR-V7

## FM PERFORMANCE MEASUREMENTS

### SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE

IHF sensitivity, mono ( $\mu$ V) (dBf)	1.9 (10.8)
Sensitivity, stereo ( $\mu$ V) (dBf)	12.0 (26.8)
50-dB quieting signal, mono ( $\mu$ V) (dBf)	2.3 (12.4)
50-dB quieting signal, stereo ( $\mu$ V)	38 (36.8)
Maximum S/N ratio, mono (dB)	70
Maximum S/N ratio, stereo (dB)	68
Capture ratio (dB)	1.2
AM suppression (dB)	60
Image rejection (dB)	83
IF rejection (dB)	100+
Spurious rejection (dB)	100+
Alternate channel selectivity (dB)	80/48 (narrow)

R-E Measurement	R-E Evaluation
1.9 (10.8)	Good
12.0 (26.8)	Fair
2.3 (12.4)	Excellent
38 (36.8)	Fair
70	Good
68	Average
1.2	Very good
60	Excellent
83	Very good
100+	Superb
100+	Superb
80/48 (narrow)	Very good

### FIDELITY AND DISTORTION MEASUREMENTS

Frequency response, 50 Hz to 15 kHz ( $\pm$ dB)	0.5
Harmonic distortion, 1 kHz, mono (%)	0.22/0.2
Harmonic distortion, 1 kHz, stereo (%)	0.08/0.085
Harmonic distortion, 100 Hz, mono (%)	0.3/0.28
Harmonic distortion, 100 Hz, stereo (%)	0.14/0.10
Harmonic distortion, 6 kHz, mono (%)	0.16/0.25
Harmonic distortion, 6 kHz, stereo (%)	0.20/0.25
Distortion at 50-dB quieting, mono (%)	1.0/1.0
Distortion at 50-dB quieting, stereo (%)	0.3/0.3

### Narrow/broadband

0.5	Excellent
0.22/0.2	Fair
0.08/0.085	Excellent
0.3/0.28	Fair
0.14/0.10	Good
0.16/0.25	Good
0.20/0.25	Very good
1.0/1.0	Fair
0.3/0.3	Good

### STEREO PERFORMANCE MEASUREMENTS

Stereo threshold ( $\mu$ V) (dBf)	12.0 (26.8)
Separation, 1 kHz (dB)	45/45
Separation, 100 Hz (dB)	42/41
Separation, 10 kHz (dB)	25/27

### Narrow/broadband

12.0 (26.8)	Fair
45/45	Very good
42/41	Very good
25/27	Fair

### MISCELLANEOUS MEASUREMENTS

Muting threshold ( $\mu$ V) (dBf)	12.0 (26.8)
Dial calibration accuracy ( $\pm$ kHz at MHz)	75 at 108

12.0 (26.8)	Fair
75 at 108	Very good

### EVALUATION OF CONTROLS, DESIGN, CONSTRUCTION

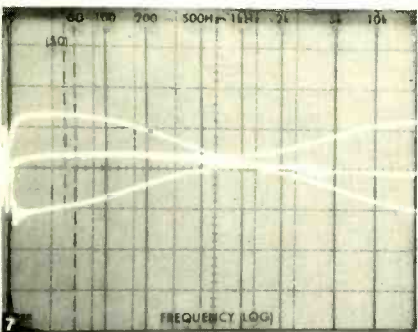
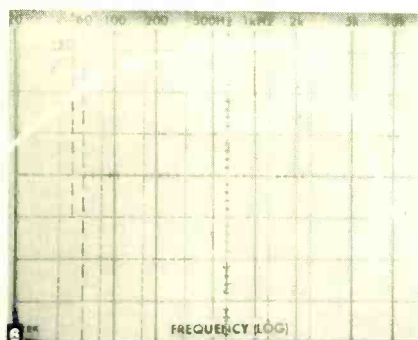
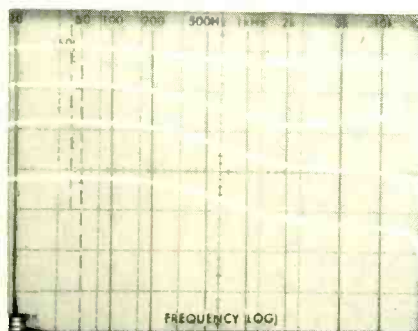
Control layout	Excellent
Ease of tuning	Excellent
Accuracy of meters or other tuning aids	Very good
Usefulness of other controls	Very good
Construction and internal layout	Excellent
Ease of servicing	Very good
Evaluation of extra features, if any	Very good

### OVERALL FM PERFORMANCE RATING

Good

values indicated in Table 2 with those shown by the manufacturer. The measured values should be judged on their own merits and compared with those obtained for other products that have been measured using the new IHF Standards. The RIAA equalization was as nearly perfect as we have ever measured, and phono overload was a much-more-than-adequate 230 mV (Sony's specification list makes no claims for this important parameter).

Tone controls operated fairly normally, with the pivot frequency of both the BASS and TREBLE control set at around 1 kHz, as shown in Fig. 7. (Note: In this and all other scope photos, one vertical division on the scope face equals 10-dB difference in amplitude.) Figure 8 is a scope photo of the high-cut and low-cut filter action. The high-cut filter has little audible effect upon hiss and scratch, while the low-cut filter, although it does help reduce turntable rumble, also considerably affects the lower bass frequencies in music programming. Both



filter circuits use only a minimal 6 dB-per-octave roll-off slope. Figure 9 depicts the loudness-control circuit at various master volume-control settings (approximately 10-dB apart), in which both treble and bass frequencies are boosted as volume control settings are reduced. The treble accentuation has been kept at moderate levels compared with the bass boost.

**TABLE 2**  
**AMPLIFIER PERFORMANCE MEASUREMENTS**

	R-E Measurement	R-E Evaluation
<b>POWER OUTPUT CAPABILITY</b>		
RMS power/channel, 8-ohms, 1 kHz (watts)	164.7	Excellent
RMS power/channel, 8-ohms, 20 Hz (watts)	150.0	Fair
RMS power/channel, 8-ohms, 20 kHz (watts)	155.0	Good
RMS power/channel, 4-ohms, 1 kHz (watts)	N/A	N/A
RMS power/channel, 4-ohms, 20 Hz (watts)	N/A	N/A
RMS power/channel, 4-ohms, 20 kHz (watts)	N/A	N/A
Frequency limits for rated output (Hz-kHz)	20-20	Fair
Dynamic headroom (dB)	1.0	Good
<b>DISTORTION MEASUREMENTS</b>		
Harmonic distortion at rated output, 1 kHz (%)	0.058	Very good
Intermodulation distortion, rated output (%)	0.17	Good
Harmonic distortion at 1-watt output, 1 kHz (%)	0.055	Very good
Intermodulation distortion at 1-watt output (%)	0.04	Very good
<b>DAMPING FACTOR AT 8 OHMS, 50 Hz</b>	45	Very good
<b>PHONO PREAMPLIFIER MEASUREMENTS</b>		
Frequency response (RIAA $\pm$ dB)	0.1	Superb
Maximum input before overload (mV)	230	Excellent
Hum/noise, A-wt'd, referenced to 1-watt or 0.5-volt output, for 5-mV input (dB)	71	Good
<b>HIGH-LEVEL INPUT MEASUREMENTS</b>		
Frequency response (Hz-kHz, $\pm$ dB)	3.3-40	Excellent
Hum/noise A-wt'd, re: 0.5 or 1W out, 0.5V in (dB)	71	Very good
Residual noise, A-wt'd, minimum volume, re: 1w out (dB)	81	Very good
<b>TONAL COMPENSATION MEASUREMENTS</b>		
Action of bass and treble controls	See Fig. 7	Good
Action of secondary tone controls		N/A
Action of high- and low-cut filters	See Fig. 8	Fair/Good
<b>COMPONENT MATCHING MEASUREMENTS</b>		
Input sensitivity, phono 1/phono 2, re: 1w or 0.5v out (mV)	0.16/0.02	
Input sensitivity, high level, re: 1w or 0.5v out (mV)	9.8	
Output level, tape outputs, at rated output (mV)	9.8	
Output level, headphone jack, at rated output (mV or mW)	700 mV	
<b>EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN</b>		
Adequacy of program source and monitor switching		Excellent
Adequacy of input facilities		Excellent
Front panel layout		Superb
Action of controls and switches		Very good
Design and construction		Excellent
Ease of servicing		Good
<b>OVERALL AMPLIFIER PERFORMANCE RATING</b>		Good

**TABLE 3**  
**R.E.A.L. SOUND PRODUCT TEST REPORT**

Manufacturer: **Sony Corporation**

Model: **STR-V7**

**OVERALL PRODUCT ANALYSIS**

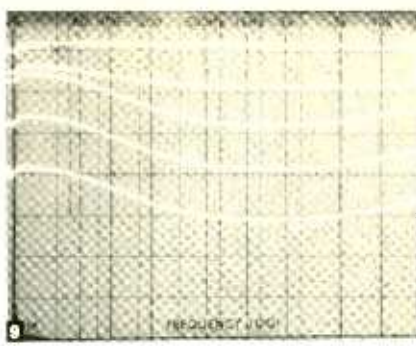
Retail price	<b>\$820</b>
Price category	<b>High</b>
Price/performance ratio	<b>Fair</b>
Styling and appearance	<b>Excellent</b>
Sound quality	<b>Good</b>
Mechanical performance	<b>Excellent</b>

**Comments:** Sony's top-powered receiver for 1979 left us with mixed emotions. On the one hand, the control and front-panel layout was excellent. Controls functioned smoothly and accurately, and although such top-of-the-line features as a subsonic filter and a mid-range tone control were missing, there were ample input and output facilities including built-in Dolby decoding for Dolby FM broadcasts (a feature which is worth about \$100.00).

What was disappointing was the tuner performance and, to a lesser degree, some of the measurements made on the amplifier section. Even after Sony went to the trouble of incorporating selectable IF bandwidth for the FM tuner, we found very little difference in distortion and separation capability between the two selectivity settings even though the readings themselves approached published specifications. The FM reception was not poor; it was, in fact, quite good, but no better than we have heard from receivers costing far less.

Table 2 shows that the amplifier just barely equaled its power-output specifications at the frequency extremes. We expect a certain degree of conservatism and reserve power in receivers selling for more than \$800. This is not to criticize the sound the receiver produces when driving even low-efficiency speakers. Nor can we overlook the incorporation of a built-in "head amp" or pre-preamplifier, which will appeal to audiophiles who prefer moving-coil cartridges. It seems that the rising value of the Japanese yen (and the sinking U.S. dollar) is at last causing Japanese hi-fi manufacturers to drive up the prices of their products to levels that no longer yield the superb price/performance ratios of a year or two ago.





## Summary

Table 3 contains our overall product evaluation as well as summary comments regarding this Sony receiver. The *model STR-V7* is, in

many ways, an excellent instrument insofar as human engineering is concerned. Its controls are well placed and smooth operating. If it cost perhaps two hundred dollars less (or even one

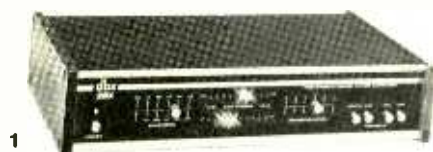
hundred dollars less) we might be more enthusiastic about its performance. As it is, we do feel that the *model STR-V7* is priced too high for what it does. We do recognize that prices of all Japanese products have been skyrocketing owing to the drastic shifts in currency exchange rates; but, in most cases, technology has kept pace with rising costs and tends to offset them. We now seem to be reaching the point where costs are rising more rapidly than advances in circuitry are able to keep them down.

In summary, we believe that only the more innovative manufacturers are going to succeed in this changing audio market, and, the new Sony *model STR-V7* receiver, while certainly adequate in every sense, lacks the features and state of the art performance one would expect from a receiver in such a high price bracket.

R-E

# Radio-Electronics Audio Lab Tests

## dbx, Inc. Model 2BX Dynamic Expander



CIRCLE 107 ON FREE INFORMATION CARD

JUST ABOUT EVERY HIGH-FIDELITY PROGRAM source we listen to suffers from a lack of dynamic range. Tape recordings and even the very best discs cannot contain the wide range of audio levels that exists in a live musical performance. Such a dynamic range may well reach 80 dB or 90 dB—from the softest passages to the loudest—in any given performance. And since most of what we hear on FM radio originates from tapes or discs, the same holds true for that program source.

One way of combatting this problem is to add a dynamic expander to your stereo component system. An expander "senses" the sound level of program material and, in simple terms, makes the "louds" louder and the "softs" softer. In the past, expanders suffered from an effect described as "pumping and breathing." In other words, you could hear the expansion process taking place, as an effect in itself, over and above the actual improvement in dynamic range afforded to the reproduced sound of the musical program.

dbx, Inc. (71 Chapel Street, Newton, MA

02195) specializes in expanders and noise-reduction devices. The company's new two-band expander, the *model 2BX*, is shown in Fig. 1. The unit is intended for connection to a stereo component system via either the tape-input/tape-output jacks on a receiver or integrated amplifier, or by being interposed between a separate preamplifier/amplifier in separate-component systems.

The front panel of the *model 2BX*, which is finished in black and silver, has a POWER on/off switch and an indicator light on the left-hand side. A slide-control knob labelled EXPANSION to the right adjusts the degree of linear expansion—from 1.0 (no expansion) to 1.5 (50% expansion, in which every 2-dB change for input signals results in a 3-dB change at the output).

The most important innovation of this expander is its use of two separate frequency bands. Low frequencies are handled by one expansion circuit, while high frequencies are controlled by another circuit. (We'll discuss the importance of this feature later on in this

RADIO-ELECTRONICS AUDIO LAB

**R.E.A.L.  
SOUND**

RATES

DBX, INC. 2BX DYNAMIC EXPANDER

**EXCELLENT**

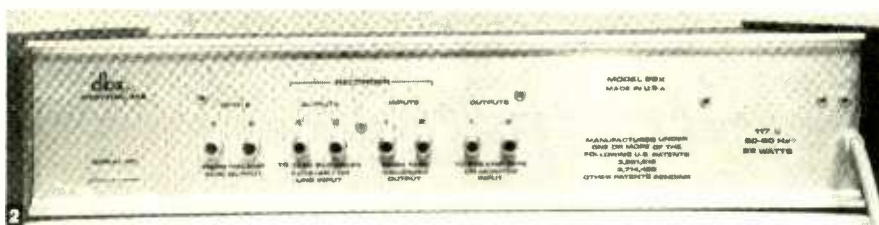
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article.) Two rows of LED's (five amber LED's and five red LED's per bank) indicate what is happening within each frequency band. The illumination of the amber lights in either row indicates that the signal frequencies are being *downward* expanded (i.e., low-level signals are lowered even more), while the illumination of the red LED's means that instantaneous signals are being expanded upward (loud signals are being made still louder).

The TRANSITION LEVEL control to the right of the rows of LED's determines the threshold or transition point between upward or downward expansion, and can be varied over a wide range to take care of a variety of program levels and types of music. Next to this control, two pushbuttons let you compare source and taped results, and two others let you select whether you want the expansion to occur *after* the tape outputs on the rear panel or ahead of them (for pre-expansion prior to taping).

The rear panel is shown in Fig. 2.

Part of the reason why less-sophisticated expanders tend to breathe or pump audibly is due to their attack-and-release times. While a rapid attack-and-release time may be good for



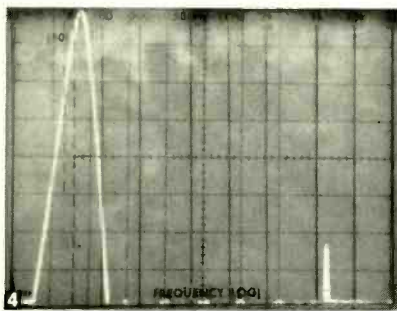
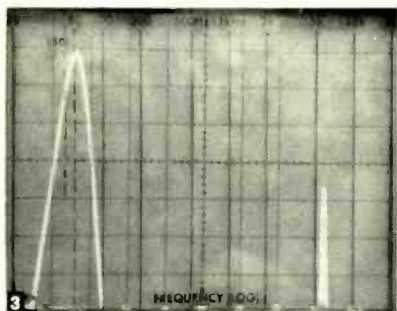
## MANUFACTURER'S PUBLISHED SPECIFICATIONS:

**Expansion Ratio:** 1.0 to 1.5, linear, in dB. **Transition Level Range:** 30 mV to 3.0 volts. **Frequency Response (at 1.0:1.0 Expansion):** 20 Hz to 20 kHz,  $\pm 0.5$  dB. **Harmonic Distortion (at 1.0:1.0 Expansion):** 0.2% (20 Hz to 20 kHz). **IM Distortion (at 1.0:1.0 Expansion):** 0.15%. **Input Impedance:** 50,000 ohms. **Maximum Output Level:** 6.0 volts. **Power Requirements:** 117 volts, 50 to 60 Hz, 20 watts. **Dimensions:** 17 3/4" W  $\times$  3 3/4" H  $\times$  10 1/2" D. **Weight:** 8 lbs., 5 oz. **Suggested Retail Price:** \$450.

some types of music, different attack-and-release times may be desirable with other types of music. The *model 2BX*'s attack-and-release times actually follow the rate of change of the program envelope. In addition, attack-and-release times are scaled differently in each pair of frequency bands to provide an expansion characteristic that best suits the music.

As for the division of program material into two frequency bands, consider what would happen if in a given instant, a bass drum beat, or a series of beats, were to be sensed by a single-band expander. The level-detection circuits would momentarily increase the gain of the system, and, if other instruments or a vocalist's signal were also present, the entire program level would be expanded, resulting in an unnatural sort of heaving or breathing. By separating the lower frequencies from the mid-and high frequencies, the *model 2BX* does not allow the bass tones to influence vocals or mid-range instruments.

To demonstrate how the expander is able to handle different frequencies differently, we fed in a mixture of 60 Hz and 7 kHz (readily available from our IM Distortion Analyzer).



With our spectrum analyzer set to its higher sensitivity mode (2 dB of amplitude per-vertical-division), we first examined the output with the expansion control set for 1.0 (no expansion). Figure 3 shows the response from 20 Hz to 20 kHz. Note that the 60-Hz component at the output is some 7-dB greater than the 7-kHz contribution to the overall signal.

Next, the threshold control was set so that the 60-Hz signal caused the first "upward-expansion" LED to light up. Since the high-frequency component was considerably lower in amplitude, amber lights in the high-frequency row of LED's lit up, indicating downward expansion. We advanced the expansion control to 1.5 (that is, to maximum expansion) and examined the output signal again, as shown in the scope photo of Fig. 4. Note that the low-frequency component has been expanded by some 2 dB (one vertical division). By contrast, the high-frequency component was actually downward-expanded by more than 3 dB. Thus,

TABLE 1

## R.E.A.L. SOUND PRODUCT TEST REPORT

Manufacturer: **dbx, Inc.**

Model: **2BX**

### EXPANDER PERFORMANCE MEASUREMENTS

SPECIFICATIONS	R-E Measurement	R-E Evaluation
Expansion ratio range (%)	0 to 50	Excellent
Transition level range (volts)	0.015-3.0	Excellent
Frequency response at 1:1 expansion (Hz-kHz, $\pm$ dB)	20-35, 0.5	Excellent
THD at 1:1 expansion (%)		
at 20 Hz	0.022	Excellent
at 1 kHz	0.02	Very good
at 20 kHz	0.02	Excellent
THD at maximum expansion (%)		
at 20 Hz	0.1	Very good
at 1 kHz	0.037	Excellent
at 20 kHz	0.045	Excellent
IM distortion, 1:1 expansion (%)	0.02	Excellent
IM distortion, maximum expansion (%)	0.18	Good
Maximum output level (volts)	7.0	Very good
<b>SUBJECTIVE EVALUATIONS</b>		
Attack time		Excellent
Decay time		Very good
Noise-reduction effect		Very good
Effectiveness of controls		Excellent
Ease of installation		Very good
Ease of use		Excellent
Additional features		Very good
<b>OVERALL EFFECTIVENESS OF EXPANDER</b>		<b>Excellent</b>

TABLE 2

### OVERALL PRODUCT ANALYSIS

Retail price	\$450
Price category	Medium/high
Price/performance ratio	Very good
Styling and appearance	Excellent
Sound quality	Excellent
Mechanical performance	Very good

Comments: The *model 2BX* expander goes a long way towards overcoming the chief objection many serious audiophiles have had against "add-on" dynamic expanders. It produces very little "breathing and pumping"—a rise and fall of the background noise level as the gain of variable-voltage-controlled amplifiers changes. Much of the improvement comes from the two-band design of the unit, and from its carefully programmed attack-and-delay times. The only expander that goes one step beyond this expander is dbx's *model 3BX*, which sells for \$200 more and divides the music frequency spectrum into three separate bands.

The effectiveness of the *model 2BX* will vary depending upon the type of music being reproduced. Obviously, not all program sources have been subjected to the same degree of compression and peak-limiting. It is important, therefore, to experiment with the *model 2BX* and to use its few front-panel controls to select the best overall effect for each type of musical program source. With FM radio programs, it was hardly ever necessary to alter the threshold setting once the unit was set up since FM modulation levels tend to remain fairly constant. With phonograph records, however, the average groove modulation can vary over a wide range from one disc to another, which is especially true in direct-to-disc records. The unit's secondary benefit—noise reduction—is clearly evident with all program material, but its chief virtue lies in its ability to restore missing dynamic range from just about any music program source. Once you experience the sound of music played through an expander such as this one, you may find not using it may make music sound extremely bland and unexciting.

the difference in levels between the two signal components is now around 12 dB. No single-band expander could have achieved these results.

### Lab measurements

The few lab measurements we made on the *model 2BX* are summarized in Table 1. It is clear that the distortion produced by the device is so low as to be inaudible, even when the maximum expansion is used. Frequency response is uniform over more than the audio spectrum, and therefore does not affect the tonality of reproduced program material.

The overall product analysis is shown in Table 2, along with our summary comments.

The *model 2BX* is easy to install and use. It covers an adequate adjustment range, and we

believe any expansion beyond 1.5:1 range would tend to make any reproduced music sound unnatural or artificial. A side benefit that should not be overlooked is the unit's ability to serve as a noise-reducing device. Since, with a properly adjusted threshold it provides both downward as well as upward expansion, residual noise levels (such as tape hiss or record-surface noise) that the detection circuits perceive as "low-level" signals are expanded downward and become less audible.

The *model 2BX* is a carefully engineered device that will appeal to serious music lovers who recognize the dynamic-range limitations of present-day program sources. Even though such devices may one day become obsolete, until that happens, the *model 2BX* provides the best alternative.

R-E



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RE-8

# HOBBY CORNER

## How to modify an alarm clock for multiple alarms and long-term alarms.

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

IN A PREVIOUS ARTICLE WE DISCUSSED how to build a "slow" digital clock to measure weeks, months or years. I hope you have had an opportunity to build the recommended oscillator and experiment with your own slow clock. Now it is time (!) to add some refinements to it with a few additional simple circuits. Each of the circuits described here can be added to *either* a slow *or* a regular clock.

### Multiple alarm

A serious shortcoming of any alarm clock—slow or regular—is that it can be set to go off at one time only. Suppose, for example, you set your slow clock to go off at 10 am on the 18th of next month to remind you to have the car inspected. How then can you be reminded of your wife's birthday two weeks earlier and of your dental checkup three weeks later?

You *could* build several clocks, but a better solution would be to add more alarms to the one clock. Then, you could set each alarm for a different time. What you need is a way to build changeable *interfaces* between the clock IC output and an audio oscillator or LED's.

First, let's examine carefully the way a 7-segment readout creates the digits. The segments are designated by the letters shown in Fig. 1. Segments *b* and *c* are on to display a "1"; segments *a*, *b*, *g*, *e* and *d* display a "2" and so on. If you wrote all these letters and numbers down and studied the list, you would discover that there are certain short combinations that identify each digit exclusively.

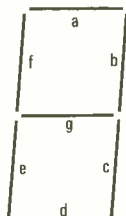


FIG. 1

For example, segments *a* and *f* are off (lo, 0) simultaneously *only* when digit 1 is being displayed. Segment *d* is on (hi, 1) while segment *f* is lo only when digit 3 is displayed. Such a short definitive pattern

TABLE 1

Digit	Segments	
	on/hi/1	off/lo/0
0	f	g
1		a,f
2		c,f
3	d	f
4	f	a,d
5		b,e
6		a,b
7	a	f,g
8	b,e,f,g	
9	a,f	d,e

exists for each digit, and some digits even have more than one pattern. One useful set of patterns is shown in Table 1; and the alarm circuits we'll describe are based on this set. Note that the hi and lo (1 and 0) states are for a clock using common cathode displays; just reverse these for common anode displays.

With the segment information shown in Table 1, you're halfway to building the circuit. All you need now are a few gates and an audio or visual indicator.

Let's build a circuit to remind yourself when the clock shows 7 hours and 20 minutes, whatever date or time that stands for. (You can use the same principles to set an alarm for any "time.")

The circuit in Fig. 2 lights the LED only when the hours digit is "7" and the 10's-of-minutes digit is "2." Trace out

the action of the gates to see how it accomplishes this. Of course, other gate combinations will produce the same result. Just use what is most convenient for you.

In Fig. 2, the 1's and 0's indicated in parentheses show the state of each line at 7:20. The LED requires no limiting resistor when it is used with CMOS gates unless the +V-supply is higher than 14 volts or so. The inset shows how to connect an LED that you want to light when the line goes high.

The input lines are connected to the digit drive pins of the clock IC. The top input line goes to segment *a* of the *hours* output, etc. If you have to use a segment connection on more than one alarm circuit, don't worry—you can add any practical number with no change in operation.

On a 12-hour clock you can use the AM/PM pin as a gate input to distinguish between 7:20 and 19:20, for example. On a 24-hour clock, you can use segments *b* and *g* as shown in Table 2.

TABLE 2

10's Hrs. Digit	Segments	
	hi	lo
Blank		b
1	c	
2	g	

Depending upon your clock's digital-drive circuit, you may find that the IC pin does not go high or low enough to switch the gate inputs. This may happen when there are current-limiting resistors between the pins and the digits. If you find this happens, simply replace the resistors with values up to 2K. The decrease in

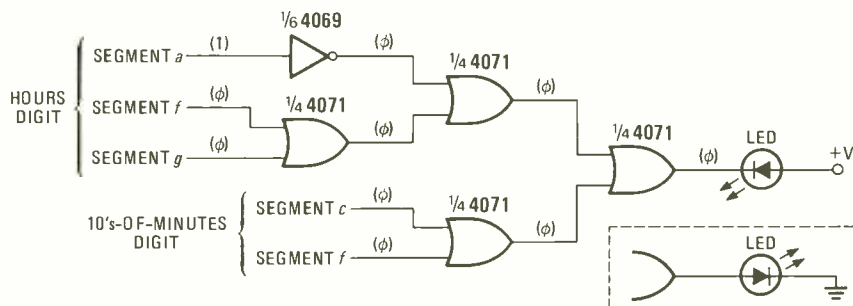


FIG. 2



digit brightness will be very little, but the changed load will allow the pin voltage to swing more.

I used LED's as alarm outputs on my clock. The LED's are arranged on a small panel next to labels on which is marked what each alarm is set for. You may want to use audible indicators with or without LED's to show which alarm is sounding off. A suitable audio oscillator can be made in many ways: by using transistors, unijunctions, 555's, etc. (See previous "Hobby Corners" and other articles if you need an oscillator circuit suitable for use as an alarm.)

Of course, you will have to change gate and clock IC connections whenever you wish to set an alarm for another "time." One approach is to use a bank of switches. Another method is to use a small section of solderless breadboard for cross-patching connections. Because changing alarm connections are made so seldom on a slow clock, I just tack-solder the connections as I need them.

A normal, real-time clock can be made into a multiple-alarm unit using the circuits described above for a slow clock. However, the inconvenience of resetting the alarms makes this of questionable value. With a normal clock, a more practical approach would be to use gates to pick off, say, 30-minute "ticks" that would drive counters, with the appropriate outputs being selectable through a switch or patch-cords.

#### Long-term alarm

Suppose you want to leave your digital clock *unmodified* so that it displays the time, yet also provides a reminder for next week or next year. This problem is relatively simple to solve using a few "external" components.

For example, suppose you want an alarm set at exactly 3 pm 43 days from now. First, if the clock has a built-in alarm circuit, disconnect the alarm from the clock IC output; then set the alarm for 3 pm.

Next, use the IC alarm pin to drive one or more counters. Finally, connect the counter output(s) to enable the original alarm circuit (or some other indicator) after 43 pulses (produced by 43 24-hour periods) have elapsed.

There is a wide variety of CMOS counters to choose from. There are standard counters, programmable counters, and even counters that can count up to 16,384 (for instance, the 4020 IC)! For proper functioning, you may have to invert the output of the IC alarm pin, depending upon your use of a positive-edge or negative-edge triggering counter, otherwise, the alarm may be 12 hours fast or slow when triggered on next month.

Note that you can use this same alarm technique with a slow clock (described last month) to count times of any desired length.

R-E

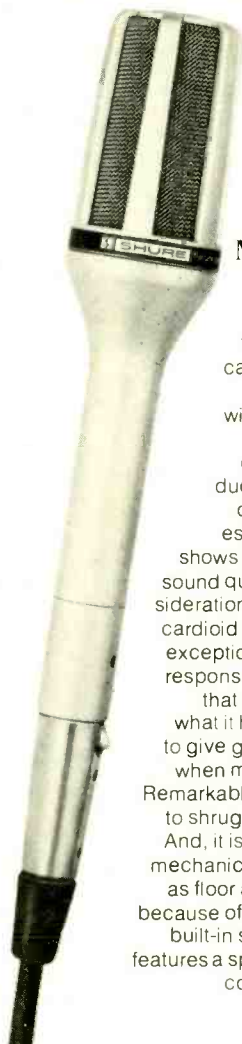


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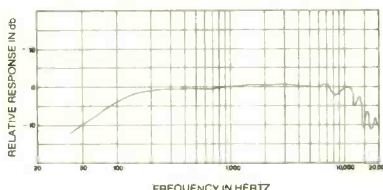
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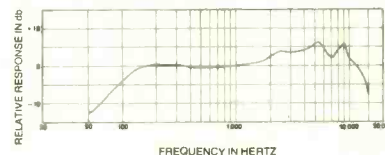
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# communications corner

## Are the new computerized CB's really computerized?

HERB FREIDMAN, COMMUNICATIONS EDITOR

AS EXPECTED, THE FIRST "COMPUTERIZED" CB transceivers—those incorporating a microprocessor—are the higher-priced, high-performance models. A natural question, however, is: "Does computerization improve communications?" (After all, communications is what CB is all about.)

The answer, unfortunately, is *no*. Computerization has essentially no effect on communications, at least not at the present time. At best, it is simply an operating aid or convenience. And, depending on your particular application, computerized CB can be a decided convenience or inconvenience.

The microprocessors—generally shown in schematics as a *box outline* with many connections protruding from each side—are basically user-programmable channel-selection (switching) circuits much as you might find in late-model VHF scanners before they also were computerized. At the touch of a button, the transceiver tunes through all 40 channels,



FIG. 1

stopping on busy or clear channels. The touch of another button lets you step through the channels one at a time; or by pressing a combination of pushbuttons, you can direct-access a particular channel. All this can be done (and has been done) with individual IC's; we don't really need the large-scale integration of a microprocessor. Although the use of a single IC does increase reliability.

The real difference between a comput-

erized CB and a scanning CB is in the *memory*. The microprocessor permits you to program a specific group of channels to be scanned in a specific order. As a general rule, most CB microprocessors contain from 5 to 10 channel memories. Some manufacturers chose to make one of the memories Channel 9, which actually means you have less user-selected channel memory. The advantage is that you can receive the emergency-only channel at the push of a button.

The microprocessor also features keyboard entry, whereby a keypad similar to those used on *Touch-Tone* telephones provides the means to select channels, program memories and to choose the various functions.

Most of the "computerized" transceivers use each keypad switch for two purposes, as if the designer couldn't stand to see a switch with a *single* numeral or function printed above or below. As you might expect, this produces complexity beyond what is generally needed, which tend to confuse the consumer.

One of the few manufacturers who opted to go "the other way" (i.e., using

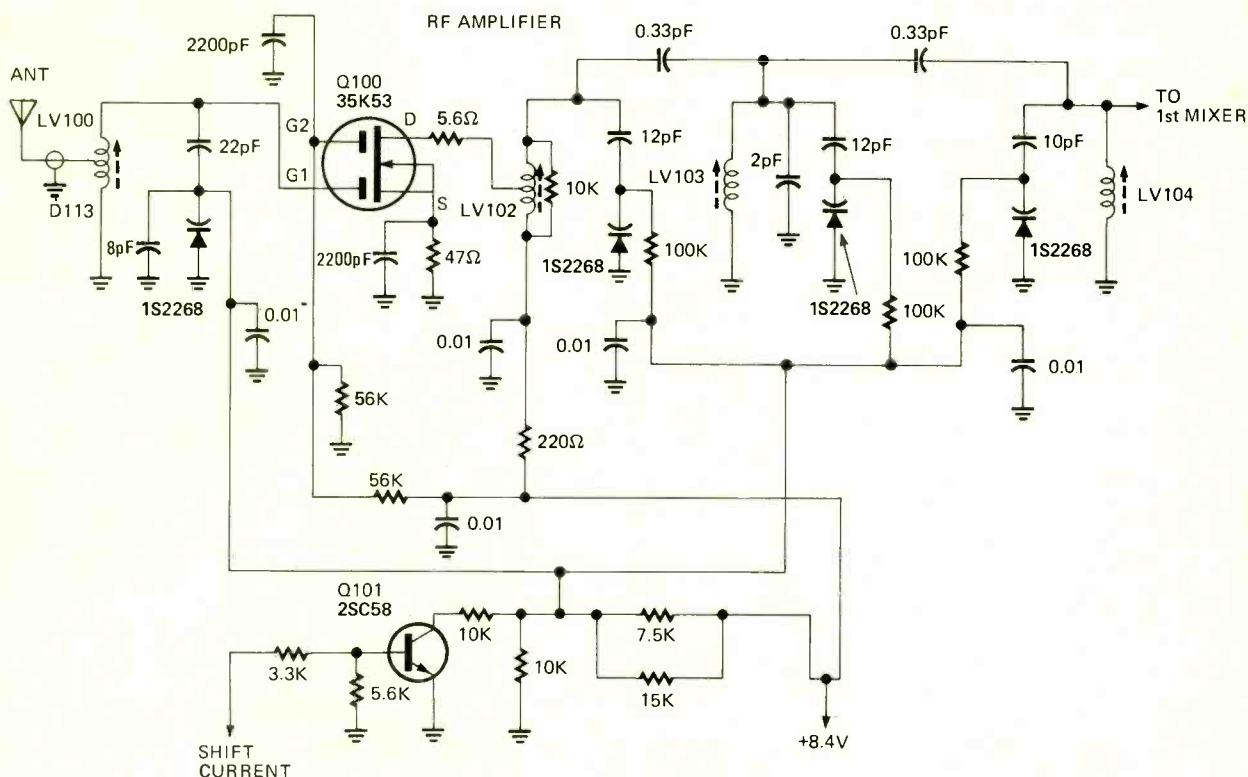


FIG. 2



the microprocessor for what many would consider the most important functions) is Robyn, whose uncluttered keypad from the model SB-540D AM/SSB Base Station is shown in Fig. 1. In this unit push-buttons M1-M5 handle the memories, which can be programmed in any sequence at any time. You can scan only the memory channels by pressing the MEMO SCAN switch, or you can directly tune to a memory by first pressing the MEMO RECALL switch that also permits you to reprogram any memory at any time. The SCAN DELAY switch *holds* the channel while it is in the scan mode so the tuning doesn't skip to the next memory or channel during the pause between transmissions. If there is no activity on the channel, the scan delay releases and the scanning resumes.

The Robyn keypad is presently the easiest to use and understand. It is almost self-explanatory, something that cannot necessarily be claimed of keypads of other computerized CB's.

But regardless of the complexity and sophistication of a microprocessor-controlled CB, the transceiver remains essentially the same in terms of reception and transmission as those of other CB's: Computerization has no effect on sensitivity, selectivity, RF output or modulation. Essentially, the microprocessor simply provides memory and scanning on a single IC, rather than on several. And if the microprocessor is simply a substitute for several IC's previously used in VHF receivers, and if it has no effect on communications specifications, do we in fact truly have computerized CB transceivers? Does computerization of only operating conveniences justify the term "computerized"? We'd like to hear your opinion—pro or con—so just drop us a short note. (Address all correspondence to: Communications Corner, Radio-Electronics, 200 Park Avenue South, New York, NY 10003.—Editor)

### Look Ma, no tuning capacitor!

If you ever had the need for relatively widely spaced VHF coverage (approximately 150 MHz–170 MHz) you know that you can generally peak the tuned circuits—such as the receiver's front end—for maximum performance to the low, middle or high side while experiencing reduced performance somewhere within the unit's frequency range. Generally, scanners are peaked for the center of the frequency band and you take whatever performance you can get at the frequency extremes.

While "letting the ends take care of themselves" is fine for hobbyist and semi-professional receivers, things should not take care of themselves if a life might depend on optimum performance. For instance, commercial VHF radios, such as those used on all kinds of ocean-going craft, optimize performance on *all* frequencies; it's handled very easily now that

the phase-locked-loop (PLL) digital-frequency synthesizer is almost universal in all multifrequency receivers. In fact, because the PLL digital synthesizer is so convenient and competitively priced, it's used in many hobby/professional scanners such as those manufactured by Regency, Electra and Radio Shack; and even a hobbyist can enjoy optimum sensitivity from one end of the frequency band to the other.

While the tuning of the synthesizer is electrical, it doesn't require variable tuning capacitors or even trimmers. And it's the lack of a tuning capacitor that makes it all possible.

The Fig. 2 schematic shows how this can be accomplished. The circuit shown represents the front end of a commercial ship-to-shore VHF radio. The four diodes with the parallel-line capacitor symbol at the cathode end are *varactors*—diodes whose anode/cathode capacitance can be precisely controlled by an applied DC voltage. The varactor capacitance represents only a small part of the total capacitance needed to tune each resonant circuit using adjustable coils LV100–LV104. A fixed capacitor in series with each varactor, in addition to stray capacitance, establishes the minimum circuit capacitance for the L–C network. Note that the DC supply for each varactor originates at a common source—the collector circuit of transistor Q101.

When the user sets the frequency selector(s) of the VHF radio, a *shift* current is applied to the base of Q101, which, in turn, changes the transistor's collector-emitter current that flows through R110–R111. This causes a variation in the voltage available at the junction of R110–R111 that is the "control" voltage for the varactors. The varactors' capacitance changes simultaneously, tuning each L–C network to the operating frequency.

While commercial radios apply a fixed-shift voltage so that the receiver tunes to one specific frequency, the same idea is used in the digitally controlled scanning monitors. As the scanning frequency sweeps within the chosen limits, the PLL circuits also provide a sawtooth (or sweeping) waveform (increasing or decreasing the DC voltage) to the front-end varactors, thereby tuning the front end precisely to the frequencies being tuned. When the radio is in the manual mode, the PLL circuit applies a fixed voltage to the varactor diodes, tuning the front end to whatever frequency you selected (or "punched in").

Essentially, the digital-frequency synthesizer allows you to tune precisely to the operating frequency, rather than settle for a broadband adjustment. It is one of the important differences between a broad-tuned crystal-controlled VHF monitor and continuously tuned digitally controlled VHF scanner.

R-E

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# computer corner

## 8085 A look at the 8085 and how it compares to the 8080.

P. RONY, C. TITUS, D. LARSEN, J. TITUS\*

PAST COLUMNS HAVE LOOKED AT SOME applications of the 8085 central processing unit and some of IC's that are among the 8085 family. Now let's take a closer look at the 8085 and how it compares with the 8080.

One of the 8085's main features is that it is software-compatible with the 8080 machine codes. Thus, a 303 code is a jump (JMP) instruction in both systems. (The 8085 has two additional instructions to be discussed later.) Basic 8080 systems generally include a clock generator and a status latch circuit for external control. These functions are now provided for within the 8085. A simple R-C network or a crystal can be used directly with the 8085 to generate the necessary clock pulses. Many of the control signals required by external devices are now generated in the 8085 IC, further reducing the amount of external logic required.

There is a price to pay for this, though. The 8085 uses one set of eight lines to transmit both data and address information. In some systems, it may be necessary to latch the address bits (A7-A0) so that they are readily available for use. An Address Latch Enable signal (ALE) is output by the 8085 to control such a latch circuit. This type of bus multiplexing was also done in the 8008, the first general-purpose 8-bit microprocessor IC.

The 8085 provides the high-address bits (A15-A8) on eight output pins. These signals have no other purpose and they are not multiplexed. They are equivalent to the A15-A8 lines in an 8080-based computer. Some other 8085 input and output signals such as interrupt (INTR), interrupt acknowledge (INTA), RESET, HOLD, hold-acknowledge (HLDA), and READY operate as they do in 8080 systems. Two new 8085 outputs include CLOCK OUT, a TTL-compatible clock signal of one-half the system clock frequency, and RESET OUT, which can be used to reset other system components. The RESET OUT signal is derived from the reset input to the 8085.

\*This article is reprinted courtesy American Laboratories. Dr. Rony, Department of Chemical Engineering, and Mr. Larsen, Department of Chemistry, are with the Virginia Polytechnic Institute & State University. Both Dr. C. Titus and Mr. J. Titus are with Tychon, Inc.

Three control signals manage the flow of data to and from memories and the CPU, as well as to and from I/O devices and the CPU. These signals are:  $\overline{IO/M}$ ,  $\overline{RD}$  and  $\overline{WR}$ . The  $\overline{IO/M}$  signal is used to indicate what type of device the 8085 is attempting to communicate with: logic 1 = I/O devices and logic 0 = memories. The  $\overline{RD}$  and  $\overline{WR}$  signals coordinate the reading or writing of data, respectively. These three signals are used directly by the 8085-compatible memory and by I/O devices such as the 8155 and 8355. In other systems, you may have to use these signals to generate the  $\overline{MR}$ ,  $\overline{MW}$ ,  $\overline{IN}$  and  $\overline{OUT}$  signals that were discussed previously. Figure 1 shows the gating.

In almost all 8080-based systems, in-

like interrupt input. These interrupts have their vector addresses placed within the address space 000 000 to 000 100. Some of these addresses are placed between the usual 8080 vector addresses, leaving only four bytes of storage space between interrupt vector addresses. These new interrupts act in the same manner as the normal 8080-like interrupts, which means you still need a stack.

The 8085 also has a single input pin and a single output pin on the IC itself that can be controlled directly by software. Of course, the 256 addressable I/O port capability is still maintained. The two single I/O connections can be used for a single sense input and a single control output. Additionally, they could be used for serial I/O to a terminal or a teletypewriter, with the actual serialization being done by software.

Two new, single-byte instructions al-

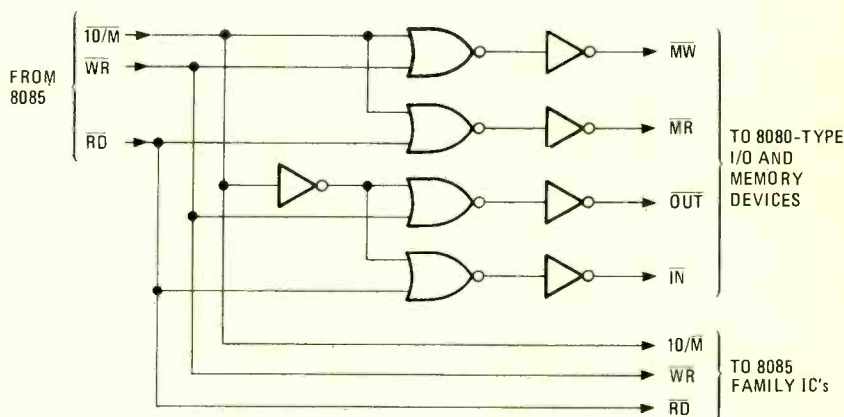


FIG. 1

errupts are implemented with an interrupt instruction port and restart instructions. The 8085 has four new interrupts that have been implemented. (See Table 1.) The overall priority of these interrupts from the highest to the lowest is as follows: TRAP, RST 7.5, RST 6.5, RST 5.5 and INT. The INT input is the usual 8080-

low you to manage the new interrupts and the two I/O lines, SID and SOD, (Serial Input Data and Serial Output Data). These instructions are: Set Interrupt Mask (SIM = 060) and Read Interrupt Mask (RIM = 040). The A-register is used as the source or the destination of the data bytes for each operation. R-E

TABLE 1—INTERNAL 8085 INTERRUPTS

Name	Restart Address	Characteristics
TRAP	000 044	Highest priority of all interrupts; nonmaskable, always "on"; both edge- and level-sensitive.
RST 5.5	000 054	Maskable, logic-1 sensitive
RST 6.5	000 064	Maskable, logic-1 sensitive
RST 7.5	000 074	Maskable, positive-edge sensitive



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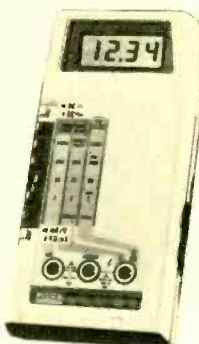
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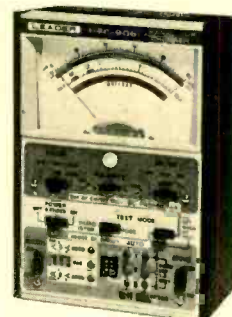
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# service clinic

*If the symptom is a horizontal bar, suspect the filter capacitors.*

**JACK DARR, SERVICE EDITOR**

EVERY ONCE IN A WHILE, AN OLD FAMILIAR problem crops up again. Back in the "old days," we used to run into one particular symptom at quite frequent intervals. This symptom was the horizontal bar on the TV screen. It usually measured from  $\frac{1}{4}$ -inch to  $\frac{3}{4}$ -inch high, and crawled slowly up the screen. The bar could be lighter or darker than the picture, and it showed up mainly in less-expensive black-and-white TV sets.

The cause of this symptom was a voltage pulse getting into the video stages, where it caused partial blanking (a dark bar) or an increase in brightness (a light bar). Since there was only a single bar, this was obviously a 60-Hz line phenomenon. Many of the DC power supplies were full-wave supplies; so ripple would create two bars. In that case, where does the single bar come from?

It comes from the high-current pulse that is drawn by the vertical-output stage, once for each field. If this voltage isn't filtered out and gets into the video amplifiers, it causes the bar to appear. The bar crawls up the screen because of the very small difference between the vertical frequency of the picture and the local 60-Hz line ripple.

The major cause of this problem in the older sets was poor DC power supply filtering; that is, defective filter capacitors or poorly designed filter circuits. In some old TV sets, I have had to add as much as 100  $\mu$ F of capacitance in order to get rid of the bar. Now, the same symptom is showing up in late-model solid-state TV sets. The "Service Clinic" mailbag has received quite a few questions on this problem.

The basic cause is still apparently that voltage pulse from the vertical-output stage getting into the video stages, which happens because the pulse isn't being filtered out. There is one *new* cause, but the reason is the same (more on this later).

Here, the scope is the best tool to use for a quick test. You don't have to scope the video-stage signals because you know that pulse is there just from looking at the screen. Scope the DC supply to the vertical-output stage and look for the voltage pulse. If it appears there, check the large

filter capacitor that *should* be there. You can also go back to the filter output of the DC power supply and look at the ripple waveform. The amplitude of this waveform should be very low—typically, only 1.2 volt or so maximum. It should be stationary and usually looks like a sawtooth. If too much vertical signal is managing to get back into this, the waveform will slowly writhe and bend. Here again, this is due to the small phase difference between the 60-Hz frequency and the vertical frequency.

This usually means that one or more of the filter capacitors is not working properly. High power factor is a common cause; this reduces the filtering efficiency of the capacitor. One odd reaction occurs in these cases. If the defective capacitor does have high power factor, you can bridge it with a good one but it won't help! To make sure, unhook the original capacitor and put in a new one that's just as large or larger.

Now, here's the new wrinkle. In newer sets, particularly those with modules or separate circuit-board assemblies, the crawling bar can be caused by a very small difference in *ground potential* between the grounds on a board and the main chassis ground on the motherboard. In some sets, you can clear this up by adding a heavy jumper between board ground and the chassis, or by moving the ground-return point of a big capacitor from the board to the chassis. Check the service notes and modifications on the set; you may find this procedure is recommended.

Always examine all grounds very carefully. If they look suspicious, resolder them. I can vouch for this from recent bitter experience! My own antique model CTC-15 had exhibited an assortment of weird symptoms. I wasted quite a bit of time changing tubes, cleaning socket contacts, etc. One day, in desperation, I drew my trusty solder gun and resoldered all seven ground points on the color board. This cleaned up all the symptoms! So, if all else fails, try soldering grounds—you never can tell!

As I said before and repeat for emphasis, this pulse always appears in the video signal. All you have to do is find out the

cause and repair it. Changing filter capacitors is the answer in most cases; and fixing bad ground connections should take care of what's left! When replacing a capacitor, make sure that the replacement has an equal or higher voltage rating. **R-E**

## service questions

### DOUBLE TROUBLE

*Thanks for your letter concerning the problems I had in a General Electric chassis H-3. You confirmed my idea that the trouble was in the AGC. Checking out the AGC circuit completely, I found a 7-ohm short to ground on the AGC control itself. I took it off, took it apart and found . . . nothing! I put back after cleaning and it worked!*

*Now there was a picture, but it was weak and full of color blobs. This problem was due to a break in the +280-volt supply line, where focus resistor R554 goes to the +280-volt line. Apparently when the chassis was moved around, this resistor had been pushed over or moved enough to break the printed-circuit conductor to which it was soldered. Everything works fine now, and thanks for holding my hand!—W. McL., Phoenix, AZ.*

Glad to have been of some help!

### HALF A RASTER, BLOWN DIODES

*There are several problems in this Magnavox model T982. The scan board was a mess where D207, D208 and D209 are, and the three little chokes marked on the board had been replaced with small resistors, which were also burned up. I replaced the diodes with 2.5-amp diodes, and the resistors with 0.5-ohm types. When I turned the set on, only the top half of the raster showed with picture, color and sound all OK. Then I lost all the vertical sweep, and everything got hot.*

*Diode D208 had opened up again. I killed the -12.7-volt supply and checked capacitor C204 on the -12.7-volt supply; it was OK. Do you have any ideas?—M.D., APG, MD.*

A few. First, do not use stock diodes as substitutes for D207–D209. These diodes are fed from the flyback, and you *must* use fast-recovery diodes. The half-raster



problem is due to one of the transistors in the vertical-output stage (a complementary-symmetry circuit) being open or having lost the DC supply. One transistor is fed from the +16-volt line, the other transistor from the -12-volt line, and both these supplies come from the same area. Check for a possible shorted capacitor.

(Feedback: "Capacitor C203 was blown! That really helped!")

#### VOLTAGE OVERLOAD

*Please send help. This Zenith 25EC58 has a raster but no video. Resistor R355 is open. Replacing R355 blows the horizontal-output transistor and resistor R354 smokes. One side of diode CR221 reads +50 volts, the other side reads +250 volts. What's wrong!—A. C., Puerto Nuevo, PR.*

From the symptoms you describe, there's a short or an overload somewhere in the boost voltages, especially in the +240-volt supply that flows through R355. Check both boost diodes, CR221 and CR219. Make sure to use fast-recovery-type diodes for replacements in this and any other set using flyback-derived DC power supplies.

(Feedback: "Diode CR221 was very leaky. I replaced it, and changed CR219 just for luck. The set now works OK. Thanks a lot!")

R-E

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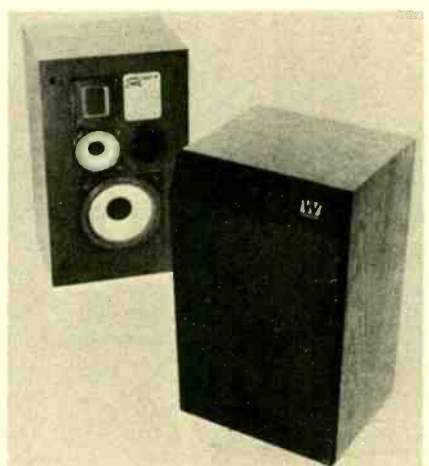
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# stereo products

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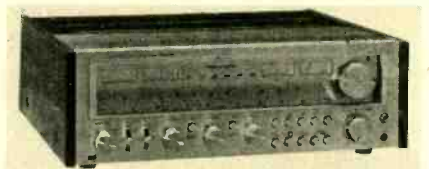
**HI-FI SPEAKER SYSTEM**, the *Wharfedale model Teesdale*, features an 8-inch woofer, a 4-inch mid-range cone and an isodynamic tweeter. Both the mid-range and tweeter were designed using laser beam holography techniques. The unit pro-



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vides a frequency response from 40 Hz to 26 kHz  $\pm 3$  dB, and an 87-dB sound-pressure level for 1 watt at 1 meter. The *Teesdale* comes in walnut veneer, measures 23  $\times$  13  $\frac{1}{2}$   $\times$  11-inches, weighs 31 lb., and has a suggested retail price of \$270.—**Rank Hi-Fi, Inc.**, 20 Bushes Lane, Elmwood Park, NJ 07407.

**AM/FM STEREO RECEIVER**, *Realistic model STA-2100*, provides 120 watts-per-channel into 8 ohms from 20 Hz to 20 kHz, with no more than 0.1% THD. Its features include bass, mid-range and treble controls; 25- and 75- $\mu$ s de-emphasis; multiplex filter; dual tape monitors and dubbing;



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DIN and phono tape-in/tape-out jacks; phono sensitivity switch; and high-cut and low-cut filters. The *model STA-2100* also includes built-in noise-reduction protection, plus AM signal-strength and FM center-channel meters and power meters.

The FM front end contains a MOSFET amplifier, ceramic filters and PLL circuitry. Specifications include: For the amplifier: Frequency response, 15 Hz—25 kHz  $\pm 2$  dB at 10 watts; IM distortion, 0.05% at 70 watts; S/N ratio, 70 dB

(phono); 75 dB (aux). For the FM section: IHF sensitivity, 1.6  $\mu$ V (10.1 dBf); capture ratio, 1.5 dB; alternate channel rejection, 75 dB; stereo separation, 52 dB at 1 kHz; THD, 0.1%, stereo, 0.05% mono. The *model STA-2100* measures 6  $\frac{1}{2}$   $\times$  20  $\frac{1}{2}$   $\times$  16  $\frac{1}{2}$  inches, and sells for \$599.95.—**Radio Shack**, 1400 One Tandy Center, Fort Worth, TX 76102.

**DIRECT-CONTROL TURNTABLES**, *Project 7 models AF977 and AF967*, are belt driven and use a phase-locked loop to control turntable speed. Selectable speeds are 33  $\frac{1}{3}$  RPM and 45 RPM. Speed variation is specified to be within  $\pm 0.002\%$ . The *model AF977* (shown) is an automatic single-play turntable with digital speed readout, and the *model AF967* is a semi-automat-



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ic unit. Wow-and-flutter in both turntables is 0.02% WRMS. Suggested retail prices: *model AF977*, \$399; *model AF967*, \$349.—**Phillips High Fidelity Labs, Ltd.**, Box 2208, Fort Wayne, IN 46801.

**FM TUNER PREAMPLIFIER**, *model Beta III*, uses FET's in all its stages to provide low noise and low distortion. The first stage of the equalization amplifier section uses a single-cascade dual-FET input stage and the last stage uses a 3-parallel, regulated current load source follower. The tone-control amplifier uses attenuators in the I/O stages for lowest S/N ratio.

Specifications include: For phono 1 and 2: frequency response, 30 Hz—15 kHz  $\pm 0.2$  dB; input sensitivity, 2.0 mV; input impedance,



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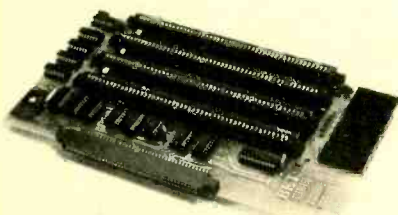
22,000, 47,000 and 100,000 ohms; S/N ratio, 81 dB (at input reference level of 2 mV); and THD, less than 0.004%. The unit is rack-mountable and comes with matte black front panel. The *model Beta III* measures 19  $\times$  2  $\frac{1}{2}$   $\times$  13 inches and weighs 13 lbs. \$399.—**Nikko Audio**, 16270 Raymer St., Van Nuys, CA 91406. R-E



# computer products

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**INTERFACE/MOTHERBOARD, Betsi**, comes as a kit or assembled. Attaches to any PET computer to provide, on a single board, both interface and S-100 motherboard with four slots. Unit allows most S-100 compatible boards to be plug-compatible with PET. The board features a dynamic memory controller that allows use of Expandoram board for expansion to 32K of



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memory, plus sockets and address decoding for 8K of PROM (Intel 2716).

Kit includes single-sided board, owner's manual, plus all components and one 100-pin connector. Assembled, the *Betsi* comes with four 100-pin connectors and manual. Price: kit, \$119; assembled, \$165.—**Forethought Products, P.O.** Box 8066, Coburg, OR 97401.

**LOGIC ANALYZER KIT, model LTC-2**, contains three high-speed (10-ns) digital troubleshooting tools—the *model LP-3* logic probe, the *model DP-1* digital pulser and the *model DM-1* logic monitor. The *model LP-3* probe features 0.5-megohm input impedance, switch-selectable TTL/DTL and CMOS/HTL thresholds, LED indicators, built-in pulse stretcher and memory switch. The *model DP-1* provides single-pulse or



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100-hz-pulse operation and a TTL/CMOS mode switch. The *model LM-1* monitor clips onto standard 14- or 16-pin DIP IC's; LED's show pin state.

Accessories include probe tips, adapters, ground leads, operator's manuals and guides—all housed in rugged plastic case. Suggested retail price: \$235.05.—**Continental Specialties Corp.**, 70 Fulton Terrace, New Haven, CT 06509.

**DATA ACQUISITION/PROCESS CONTROL SYSTEM, Real World Interface System** (available as kit or assembled) is designed for use with both mini- and microcomputers, with typical applications in environmental control, robotics and automated assembly-line testing. The system cabinet contains a power supply, card cage and motherboard for up to 12 plug-in modules, including A/D



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and D/A converters and a computer interface card. Plug-in modules contain from 8 to 32 I/O channels (the *Current Probe* has 4 I/O channels). Plug-in module price range: kits, \$65—\$125; assembled, \$79.50—\$150. Cabinet with power supply, motherboard and parallel CPU interface, \$299 for the kit; \$360, assembled.—**General Computer Technology**, 400 S. Lipan, Denver, CO 80223.

**DISC SOFTWARE, model SL80-10F** text editing system, *model SL80-11F* text processing system and *model SL80-12F* mnemonic assembler, are designed for the 8080 microcomputer and operate under the CP/M disc operating system. The text editor features block move and copy, tabs, overlays, append and restrictive column searches. The text processor provides over 50 commands covering pagination, margin/indent settings, spacing, titling, centering and justification. New instructions can be implemented with conditional commands, number registers, terminal prompts and a loop command. A separate data file can be read for information required by the text file. The mnemonic assembler supports standard pseudo op-codes, plus paging, titling, hex or octal listings, line numbers, etc. All programs include user's manual, source listing and an 8-inch disc. Prices: *model SL80-10F* editor, \$40; *model SL80-11F* processor, \$50; *model SL80-12F* assembler, \$40.—**Technical Systems Consultants, Inc.**, P.O. Box 2574, West Lafayette, IN 47906.

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# communications products

More information on communications products is available from manufacturers of items identified by a Free Information number. Free Information Card is inside the back cover.

**MOBILE CB TRANSCEIVERS**, the *McKinley*, *Thomas J.*, and *Andrew J.*, all provide a 4-watt AM power output (the *McKinley* has a 12-watt



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SSB output) and -60 dB spurious rejection. Both the *Thomas J.* and *Andrew J.* transceivers have 100% modulation. The *McKinley* unit (shown) features standard controls plus a clarifier. The *Thomas J.* unit has standard controls, plus a

Channel 9 priority switch and an SWR meter. The *Andrew J.* unit contains a combination transmit/receive light and variable RF gain control. Prices: the *McKinley*, \$269.95; the *Thomas J.*, \$159.95; the *Andrew J.*, \$119.95.—**President Electronics, Inc.**, 16691 Hale Ave., Irvine, CA 92714.

**MORSE CODE COPIER**, model *DE-150*, is designed to operate with communications receivers and transceivers and features a built-in 100-Hz bandpass filter with 800-Hz center frequency. Other features include an 8-character 5 × 7 dot



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matrix LED display and 50- to 60-word-per-minute copying capability. Comes with built-in 115-VAC power supply, patch cord and output monitor jack and measures 2 × 10 × 4 inches. Suggested retail price: \$425.—**Dynamic Electronics, Inc.**, Box 896, Hartselle, AL 35640.

**MARINE TRANSCEIVER**, model *T1 2100*, is a fully synthesized solid-state VHF/FM unit with programmable scan feature that enables simulta-



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neous channel monitoring. The unit also provides 55-channel transmit and 76-channel receive capabilities (includes 4 weather stations) and operates on all USA and international channels. Keyboard automatically selects simplex, duplex, 1-

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watt or receive-only operation. Other features include high-visibility displays, squelch and remote control. Suggested retail price: \$795.—**Texas Instruments, Inc.**, P.O. Box 226080, Dallas TX 75266.

**AM/FM CUSTOM ANTENNAS**, models KL-16F, NL-15-B, PM-95H, PM-21D, PM-30, PM-58, is a complete line of OEM-styled customized antennas for imported autos. The antennas are in-



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tended for BMW, Datsun, Fiat, Mazda, Saab, Honda, Subaru, Toyota and VW. All models (model PM-95H designed for the Honda Accord is shown) feature stainless steel masts, shielded bodies and cables, and heavy chrome-plated hardware. Suggested retail price range: \$5-\$7.50.—**Harada Industry of America, Dept. P**, 145 E. Albertoni St., CA 90746. **R-E**

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## AC OUTLET CHECKER

continued from page 53

ance only if the outlet box itself is grounded.

What happens all too often is that the adapter gives the user a false sense of

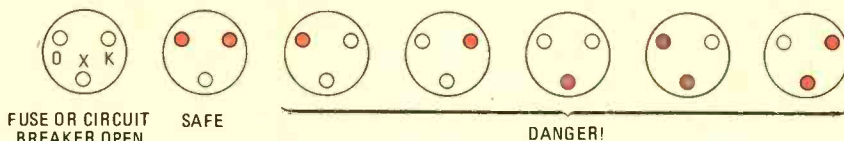


FIG. 2—HOW THE LIGHTS INDICATE different conditions. Indications are same as in Table 1.

security and he tends to forget the safety precautions he once observed. Unwittingly, he has created a system that can potentially be even more dangerous than the original.

How then do you know when the system is safe? It's simple; just hook the adapter up as it will be used, then plug the Outlet Polarity Checker into it. If the adapter checks out OK, all is well and it can be used with confidence. If not, the best remedy is to rewire the outlet to the proper 3-wire configuration. Figure 2 shows the various combinations of lights.

The same method can be used to check that the neutral (white) wire in a 2-wire system is grounded. Connect the green lead of the adapter to a known ground and then test it. If it checks out OK, then the ground is grounded. If not, you will get a "no ground" indication.

The Outlet Polarity Checker is a one-evening project. In most cases it can be made entirely from junk-box parts. For DS1, DS2 and DS3 you can use neon lamp assemblies with built-in current-limiting resistors. It is recommended that DS1 ("O") and DS3 ("K") have amber or clear lenses, and that DS2 ("X") have a red lens. The plug and cable can be cut from any 3-wire polarized (grounding) cord. The completed checker is housed in a small Bakelite case. You can use transfer lettering to label the panel for a professional appearance. **R-E**

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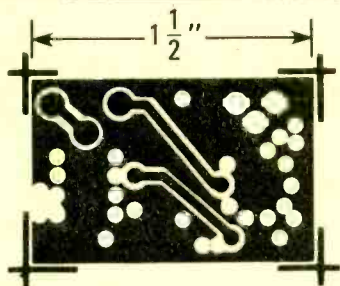


FIG. 8—TOP SIDE of the board for the true-RMS converter.

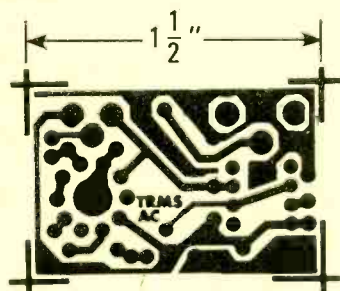


FIG. 9—PATTERN for the bottom side of the TRMS converter board.

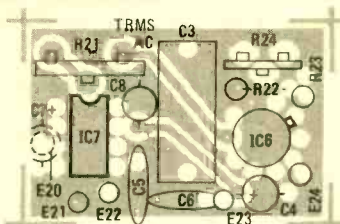


FIG. 10—HOW PARTS ARE POSITIONED on the TRMS converter board.

ment and check all solder connections for cold joints and possible bridges. Plug in the instrument, apply power and check for +5V, -5V and -8 volts at the output pins of the three voltage regulators.

If the correct supply voltages are obtained, then remove power from the instrument and install all remaining IC's in their sockets taking care to observe proper pin orientation.

### Calibration

Table 2 shows the calibration sequence for the multimeter. The ADC voltage reference is calibrated by allowing the meter to read a known voltage between 1 and 2 volts and adjusting R9 until the known value is obtained. (Use the 2-volt range.) The known voltage can be from a voltage reference source or a standard cell, or a stable voltage calibrated by another digital voltmeter or a fresh mercury cell (1.35 volts). The temperature references must be calibrated by another voltmeter, measuring between the test point indicated in Table 2 and the -5-volt supply. Known resistors are supplied with the kit of parts (see parts list) to calibrate the resistance ranges.

There are two adjustments for the AC converter calibration. Trimmer R24 is

continued on page 80

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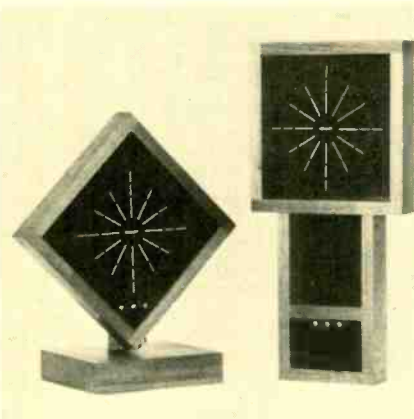
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### PRECISION DMM

continued from page 79

TABLE 2—MULTIMETER CALIBRATION SEQUENCE

Step No.	Calibrate	Pot No.	Switches	Display
1	ADC Reference	R9	S5, S7	Known input voltage between 1 and 2 volts DC or 1.35 volts from a fresh mercury battery cell.
2	Celsius Reference	R36	S2	2.732 volts measured from arm of R36 to —5-volt supply using an external voltmeter.
3	Fahrenheit Reference	R33	S3	4.594 volts measured from arm of R33 to —5-volt supply using an external voltmeter.
4	Celsius Range	R29	S2	.0000° (ice water bath) 100.00° (boiling water)
5	Fahrenheit Range	R31	S3	Adjust R31 to equal Celsius range using conversion equation.*
6	2000-ohm Range	R15	S4, S7	Adjust to equal known resistance.
7	20,000-ohm Range	R14	S4, S8	Adjust to equal known resistance.
8	200,000-ohm Range	R13	S4, S9	Adjust to equal known resistance.
9	2-megohm Range	R12	S4, S11	Adjust to equal known resistance.
10	20-megohm Range	R10	S4, S11	Adjust to equal known resistance.
11	AC Offset	R24	S5, S6, S7	0.0000V with input shorted or with pins 2 and 4 of IC6 shorted.
12	AC Calibration	R25	S5, S6, S7	Adjust to equal known AC input voltage (RMS value, not peak).

\* °C = 5/9 (°F - 32)

°F = (9/5 × °C) + 32

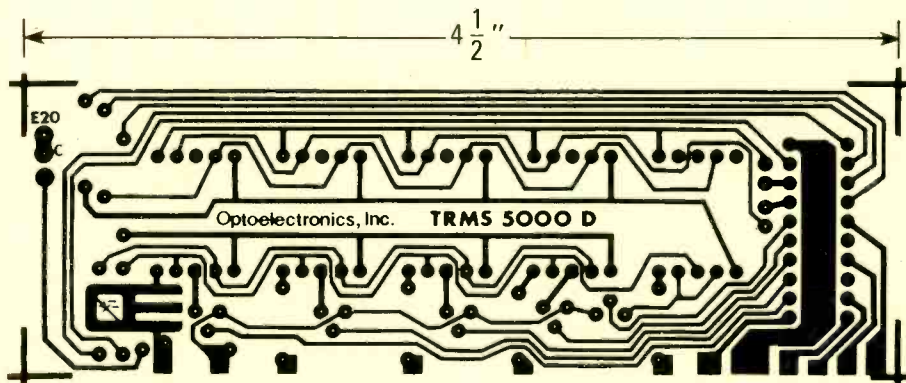


FIG. 11—FULL-SIZE PATTERN for the display board. All components are mounted on the front surface.

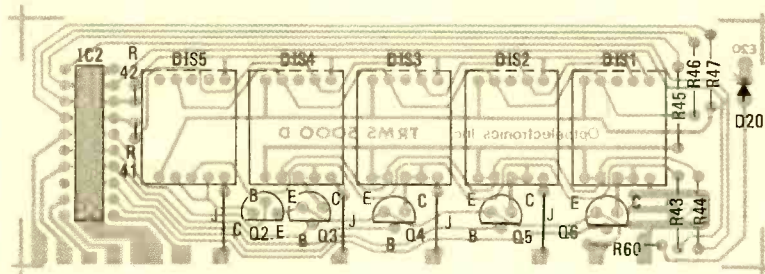


FIG. 12—DISPLAY BOARD parts placement. The IC is the display segment driver. The transistors are used in digit multiplexing.

the offset or zero trim, which is adjusted with the input shorted. There is a possibility of significant noise pickup due to the high input impedance of buffer IC7, so it may be necessary to short the input pin to IC6 by shorting pin 4 to pin 2 while

adjusting the offset to zero. Trimmer R25 is used to fine adjust the AC calibration with a known RMS value AC voltage applied to the input. If a calibrated AC voltage is not available, the pot should be centered for accuracy.

R-E



# books

**UNDERSTANDING DIGITAL ELECTRONICS**, Texas Instruments Learning Center. Texas Instruments, Inc., Box 3640, M.S. 84, Dallas, TX 75285. 265 pp. 5 1/4 x 8 1/4 in. Softcover \$3.95.

Finding out how digital electronics work by using a handheld calculator is the goal of this book, and a step-by-step approach explains circuits, from the most basic to the very sophisticated. Because it is really a self-teaching course, the book should be read chapter by chapter; self quizzes are provided at the end of each chapter (with the answers in the back of the book); and a glossary of special terms and a bibliography are also provided.

**THE INCREDIBLE SECRET MONEY MACHINE**, by Don Lancaster. Howard W. Sams & Co., Inc., 4300 W. 62nd St., Indianapolis, IN 46268. 159 pp. 5 1/4 x 8 1/4 in. Softcover \$5.95.

This is not a "get-rich-quick" book, but rather a "cookbook" and guide on how to turn your own full-time small-scale computer, technical or craft business into a successful enterprise. Written in tongue-in-cheek yet down-to-earth style, the book contains helpful hints on how to reduce your taxes, not pay a utility bill, get totally free insurance, and many other necessary adjuncts to running a successful "secret money machine."

**HOW TO BUILD YOUR OWN STEREO SPEAKERS: CONSTRUCTION, APPLICATIONS, CIRCUITS AND CHARACTERISTICS**, by Christopher Robin. Reston Publishing Co., Div. of Prentice-Hall Co., Reston, VA 22090. 193 pp. 6 1/4 x 9 1/4 in. Hardcover \$15.95.

The title of this book says it all—it is a "how-to" guide for hobbyists and professional engineers who want simple step-by-stop instructions on constructing a state-of-the-art speaker enclosure. The book also includes data on acoustics, planning and designing speaker crossover networks, and basic woodworking. Dimensional drawings and photographs accompany the text; and the back of the book contains several appendixes and a complete glossary of terms.

**TAPED EDITING**, by Joel Tall. Elpa Marketing Industries, Inc., Thorens & Atlantic Aves., New Hyde Park, NY 11040. 32 pp. 5 1/4 x 8 1/4 in. Softcover \$2.

This little book explains in detail all the ins and outs of audio and video tape splicing. It also gives you helpful tape editing hints such as how to run the tape backward in order to recognize speech sounds. Other chapter topics deal with splicing and editing procedures, speech characteristics and how to work within the limits of hearing sensitivity.

**BASIC FOR HOME COMPUTERS**, by Bob Albrecht, LeRoy Finkel and Gerald R. Brown. John Wiley & Sons, Inc., 605 Third Ave., New York, NY 10016. 336 pp. 6 1/4 x 10 in. Softcover \$5.95.

This book is a self-instruction course in the BASIC programming language for home computer applications; it does not require access to an actual computer. The version of BASIC used is *Microsoft BASIC* developed for the Altair MITS. Some of the topics covered are assigned statements, stored programs and branching; subscripted variables, double subscripts; string variables and functions; and subroutines. Each chapter contains a self-test section, and there is a final self-test in the back, together with appendixes containing lists of computing periodicals, BASIC functions and ASCII character codes.

**S S I MICROCOMPUTER SOFTWARE GUIDE**. S S I Publications, 4327 East Grove St., Phoenix, AZ 85040. 140 pp. 5 1/4 x 8 1/4 in. Softcover \$7.95 (also available on mini-floppy disc).

This book is a must for anyone planning a microcomputer system for business, home or education applications. It consists of a listing of over 2200 software programs, alphabetically arranged from ASCII (codes, displays, etc.) to Zip Code (mail-code sorting & printing). The 236 classifications are drawn from discs, cassettes, books, paper tapes, listings, pamphlets and magazines; and the back of the book contains a list of 130 microcomputer software sources and addresses.

**BUGBOOK VIII, 8080/8085 SOFTWARE DESIGN WITH 190 SOFTWARE SOLUTIONS**, by Christopher A. Titus. E&L Instruments, Inc., 61 First St., Derby, CT 06418. 288 pp. 6 x 9 in. Softcover \$9.

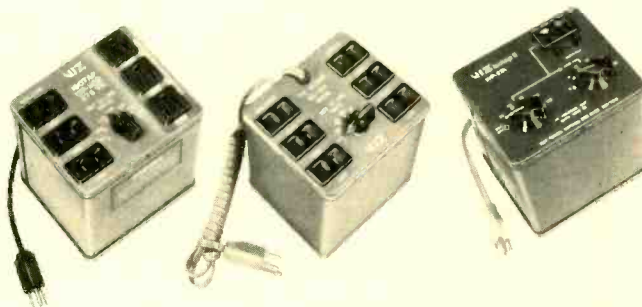
This detailed treatment of assembly language programming for 8080- and 8085-based computers contains many elementary and advanced instructions. It analyzes and discusses programming techniques for mathematical routines, number system conversions, command decoders, arrays and tables, interrupt programming, etc. Many complete and tested programs in standard mnemonics are included. **R-E**

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2SA 493	45	53	59	2SB 405	30	35	40	2SC 715	30	35	40	2SC 1310	20	27	30	2SD 315	60	70	80
2SA 495	30	35	40	2SB 407	80	90	100	2SC 717	35	40	45	2SC 1312	20	27	30	2SD 325	60	70	80
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2SA 505	50	64	70	2SC 435	90	110	120	2SC 731	2.50	2.70	2.90	2SC 1317	20	27	30	2SD 380	5.20	5.40	5.95
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2SA 539	40	45	50	2SB 471	1.10	1.25	1.40	2SC 738	20	27	30	2SC 1335	50	55	60	2SD 427	1.80	2.00	2.25
2SA 545	45	53	59	2SC 472	2.10	2.50	2.80	2SC 756	1.50	1.80	2.00	2SC 1342	45	53	59	2SD 525	90	110	1.10
2SA 561	30	35	40	2SB 473	80	90	100	2SC 756A	1.50	1.80	2.00	2SC 1344	45	53	59	2SD 526	60	70	80
2SA 562	30	35	40	2SB 474	70	80	90	2SC 763	35	40	45	2SC 1358	4.20	4.40	4.90	2SK 19BL	50	55	60
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2SA 683	30	35	40	2SB 596	1.10	1.40	1.50	2SC 871	35	40	45	2SC 1567	60	70	80	LA 4051P	1.80	2.00	2.25
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This is the top-of-the-line SWITCHCRAFT multi-gang switch. It has SIX push buttons. Button 1 is SPST, momentary switch; and releases any button that has been depressed. Switches 2 and 3 lock when depressed and release when switches 1—4—5 or 6 is depressed. Switches 4—5 & 6 are interlocked, depress any one of them releases the others. Switch 2 is SPST normally open. Switch 3 is SPDT & SPST normally open. Switch 4 is DPDT. Switch 5 is DPDT & 3 SPST normally open switches. Switch 6 is DPDT & SPST normally open. A fantastic feature of this switch is that any of the switch sections may be removed from its initial position and placed on another push button; and ganged so that more combinations are possible on any of the push buttons. This switch has the special SWITCHCRAFT LOCKOUT feature which prevents operation of more than one push button at a time. Switchcraft catalog price (in 1976) was \$29.48. Delta's original price \$6.95.

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Delta's This switch is the same physical shape as the one shown above, except this momentary switch has only TWO switches. Compact, low-silhouette design. Only 1 1/4" H. & 3 5/8" behind panel. Plunger on 5/8" centers. Features 2 momentary switches. The first is a momentary on-off switch. Second has 4 functions, the 1st is a momentary on-off, the 2nd is a SPDT, the 3rd & 4th section are DPDT momentary. The catalog price is \$9 ea. No. 6412R

**\$1** Each

**1/2 OFF!**

**BEAM-X Counters!**

Delta's original price \$13.95 **\$6.95**

2 for \$12

**With 3 Nixie Tubes!**

This counter was originally used by a large mfg. of copying machines. Function: the number of copies desired was preset by dials & the machine then made this number of copies—displaying the count on the NIXIE tubes. When the preset number was reached, the counter stopped the machine. These counters were removed from the copiers & replaced by new models. Input: 115VAC and uses 24V logic. This unit contains 5 BEAM-X switching tubes, its own power supply, plus a 200 VDC & 6.3 VAC supply. It contains 3 Burroughs NIXIE tubes, type B5092A which currently sells for \$1.7 each. We supply diagram of BEAM-X tubes, operating instructions and some application data. We are selling these counters at this low price because of the minor defects that some of these counters have. Unfortunately we do not have the time to test or make the minor repairs needed to make the counters operational. 6 1/2 x 6 1/2 x 11 1/2". Wt. 7 lbs. Beam X Tubes worth \$50. apiece if you can find 'em.

**40 FOR \$6.**

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No. 8902R

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4-5T	16 Pin Solid State	1.6	16.0	16.00
4-5T	18 Pin Solid State	1.8	18.0	18.00
4-5T	20 Pin Solid State	2.0	20.0	20.00
9-5T	22 Pin Solid State	2.2	22.0	22.00
9-5T	24 Pin Solid State	2.4	24.0	24.00
9-5T	26 Pin Solid State	2.6	26.0	26.00
9-5T	28 Pin Solid State	2.8	28.0	28.00
9-5T	30 Pin Solid State	3.0	30.0	30.00
9-5T	32 Pin Solid State	3.2	32.0	32.00
9-5T	34 Pin Solid State	3.4	34.0	34.00
9-5T	36 Pin Solid State	3.6	36.0	36.00
9-5T	38 Pin Solid State	3.8	38.0	38.00
9-5T	40 Pin Solid State	4.0	40.0	40.00
9-5T	42 Pin Solid State	4.2	42.0	42.00
9-5T	44 Pin Solid State	4.4	44.0	44.00
9-5T	46 Pin Solid State	4.6	46.0	46.00
9-5T	48 Pin Solid State	4.8	48.0	48.00
9-5T	50 Pin Solid State	5.0	50.0	50.00
9-5T	52 Pin Solid State	5.2	52.0	52.00
9-5T	54 Pin Solid State	5.4	54.0	54.00
9-5T	56 Pin Solid State	5.6	56.0	56.00
9-5T	58 Pin Solid State	5.8	58.0	58.00
9-5T	60 Pin Solid State	6.0	60.0	60.00
9-5T	62 Pin Solid State	6.2	62.0	62.00
9-5T	64 Pin Solid State	6.4	64.0	64.00
9-5T	66 Pin Solid State	6.6	66.0	66.00
9-5T	68 Pin Solid State	6.8	68.0	68.00
9-5T	70 Pin Solid State	7.0	70.0	70.00
9-5T	72 Pin Solid State	7.2	72.0	72.00
9-5T	74 Pin Solid State	7.4	74.0	74.00
9-5T	76 Pin Solid State	7.6	76.0	76.00
9-5T	78 Pin Solid State	7.8	78.0	78.00
9-5T	80 Pin Solid State	8.0	80.0	80.00
9-5T	82 Pin Solid State	8.2	82.0	82.00
9-5T	84 Pin Solid State	8.4	84.0	84.00
9-5T	86 Pin Solid State	8.6	86.0	86.00
9-5T	88 Pin Solid State	8.8	88.0	88.00
9-5T	90 Pin Solid State	9.0	90.0	90.00
9-5T	92 Pin Solid State	9.2	92.0	92.00
9-5T	94 Pin Solid State	9.4	94.0	94.00
9-5T	96 Pin Solid State	9.6	96.0	96.00
9-5T	98 Pin Solid State	9.8	98.0	98.00
9-5T	100 Pin Solid State	10.0	100.0	100.00

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Part No.	Description	1	10	100
4-5T	8 Pin Solid State	0.8	8.0	8.00
4-5T	14 Pin Solid State	1.4	14.0	14.00
4-5T	16 Pin Solid State	1.6	16.0	16.00
4-5T	18 Pin Solid State	1.8	18.0	18.00
4-5T	20 Pin Solid State	2.0	20.0	20.00
9-5T	22 Pin Solid State	2.2	22.0	22.00
9-5T	24 Pin Solid State	2.4	24.0	24.00
9-5T	26 Pin Solid State	2.6	26.0	26.00
9-5T	28 Pin Solid State	2.8	28.0	28.00
9-5T	30 Pin Solid State	3.0	30.0	30.00
9-5T	32 Pin Solid State	3.2	32.0	32.00
9-5T	34 Pin Solid State	3.4	34.0	34.00
9-5T	36 Pin Solid State	3.6	36.0	36.00
9-5T	38 Pin Solid State	3.8	38.0	38.00
9-5T	40 Pin Solid State	4.0	40.0	40.00
9-5T	42 Pin Solid State	4.2	42.0	42.00
9-5T	44 Pin Solid State	4.4	44.0	44.00
9-5T	46 Pin Solid State	4.6	46.0	46.00
9-5T	48 Pin Solid State	4.8	48.0	48.00
9-5T	50 Pin Solid State	5.0	50.0	50.00
9-5T	52 Pin Solid State	5.2	52.0	52.00
9-5T	54 Pin Solid State	5.4	54.0	54.00
9-5T	56 Pin Solid State	5.6	56.0	56.00
9-5T	58 Pin Solid State	5.8	58.0	58.00
9-5T	60 Pin Solid State	6.0	60.0	60.00
9-5T	62 Pin Solid State	6.2	62.0	62.00
9-5T	64 Pin Solid State	6.4	64.0	64.00
9-5T	66 Pin Solid State	6.6	66.0	66.00
9-5T	68 Pin Solid State	6.8	68.0	68.00
9-5T	70 Pin Solid State	7.0	70.0	70.00
9-5T	72 Pin Solid State	7.2	72.0	72.00
9-5T	74 Pin Solid State	7.4	74.0	74.00
9-5T	76 Pin Solid State	7.6	76.0	76.00
9-5T	78 Pin Solid State	7.8	78.0	78.00
9-5T	80 Pin Solid State	8.0	80.0	80.00
9-5T	82 Pin Solid State	8.2	82.0	82.00
9-5T	84 Pin Solid State	8.4	84.0	84.00
9-5T	86 Pin Solid State	8.6	86.0	86.00
9-5T	88 Pin Solid State	8.8	88.0	88.00
9-5T	90 Pin Solid State	9.0	90.0	90.00
9-5T	92 Pin Solid State	9.2	92.0	92.00
9-5T	94 Pin Solid State	9.4	94.0	94.00
9-5T	96 Pin Solid State	9.6	96.0	96.00
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### TEXAS INSTRUMENTS GOLD EDGEBOARD CONNECTORS

Part No.	Description	1	10	100
4-5T	8 Pin Solid State	0.8	8.0	8.00
4-5T	14 Pin Solid State	1.4	14.0	14.00
4-5T	16 Pin Solid State	1.6	16.0	16.00
4-5T	18 Pin Solid State	1.8	18.0	18.00
4-5T	20 Pin Solid State	2.0	20.0	20.00
9-5T	22 Pin Solid State	2.2	22.0	22.00
9-5T	24 Pin Solid State	2.4	24.0	24.00
9-5T	26 Pin Solid State	2.6	26.0	26.00
9-5T	28 Pin Solid State	2.8	28.0	28.00
9-5T	30 Pin Solid State	3.0	30.0	30.00
9-5T	32 Pin Solid State	3.2	32.0	32.00
9-5T	34 Pin Solid State	3.4	34.0	34.00
9-5T	36 Pin Solid State	3.6	36.0	36.00
9-5T	38 Pin Solid State	3.8	38.0	38.00
9-5T	40 Pin Solid State	4.0	40.0	40.00
9-5T	42 Pin Solid State	4.2	42.0	42.00
9-5T	44 Pin Solid State	4.4	44.0	44.00
9-5T	46 Pin Solid State	4.6	46.0	46.00
9-5T	48 Pin Solid State	4.8	48.0	48.00
9-5T	50 Pin Solid State	5.0	50.0	50.00
9-5T	52 Pin Solid State	5.2	52.0	52.00
9-5T	54 Pin Solid State	5.4	54.0	54.00
9-5T	56 Pin Solid State	5.6	56.0	56.00
9-5T	58 Pin Solid State	5.8	58.0	58.00
9-5T	60 Pin Solid State	6.0	60.0	60.00
9-5T	62 Pin Solid State	6.2	62.0	62.00
9-5T	64 Pin Solid State	6.4	64.0	64.00
9-5T	66 Pin Solid State	6.6	66.0	66.00
9-5T	68 Pin Solid State	6.8	68.0	68.00
9-5T	70 Pin Solid State	7.0	70.0	70.00
9-5T	72 Pin Solid State	7.2	72.0	72.00
9-5T	74 Pin Solid State	7.4	74.0	74.00
9-5T	76 Pin Solid State	7.6	76.0	76.00
9-5T	78 Pin Solid State	7.8	78.0	78.00
9-5T	80 Pin Solid State	8.0	80.0	80.00
9-5T	82 Pin Solid State	8.2	82.0	82.00
9-5T	84 Pin Solid State	8.4	84.0	84.00
9-5T	86 Pin Solid State	8.6	86.0	86.00
9-5T	88 Pin Solid State	8.8	88.0	88.00
9-5T	90 Pin Solid State	9.0	90.0	90.00
9-5T	92 Pin Solid State	9.2	92.0	92.00
9-5T	94 Pin Solid State	9.4	94.0	94.00
9-5T	96 Pin Solid State	9.6	96.0	96.00
9-5T	98 Pin Solid State	9.8	98.0	98.00
9-5T	100 Pin Solid State	10.0	100.0	100.00

### Panasonic DISC CAPACITOR KIT

Part No.	Description	1	10	100
4-5T	8 Pin Solid State	0.8	8.0	8.00
4-5T	14 Pin Solid State	1.4	14.0	14.00
4-5T	16 Pin Solid State	1.6	16.0	16.00
4-5T	18 Pin Solid State	1.8	18.0	18.00
4-5T	20 Pin Solid State	2.0	20.0	20.00
9-5T	22 Pin Solid State	2.2	22.0	22.00
9-5T	24 Pin Solid State	2.4	24.0	24.00
9-5T	26 Pin Solid State	2.6	26.0	26.00
9-5T	28 Pin Solid State	2.8	28.0	28.00
9-5T	30 Pin Solid State	3.0	30.0	30.00
9-5T	32 Pin Solid State	3.2	32.0	32.00
9-5T	34 Pin Solid State	3.4	34.0	34.00
9-5T	36 Pin Solid State	3.6	36.0	36.00
9-5T	38 Pin Solid State	3.8	38.0	38.00
9-5T	40 Pin Solid State	4.0	40.0	40.00
9-5T	42 Pin Solid State	4.2	42.0	42.00
9-5T	44 Pin Solid State	4.4	44.0	44.00
9-5T	46 Pin Solid State	4.6	46.0	46.00
9-5T	48 Pin Solid State	4.8	48.0	48.00
9-5T	50 Pin Solid State	5.0	50.0	50.00
9-5T	52 Pin Solid State	5.2	52.0	52.00
9-5T	54 Pin Solid State	5.4	54.0	54.00
9-5T	56 Pin Solid State	5.6	56.0	56.00
9-5T	58 Pin Solid State	5.8	58.0	58.00
9-5T	60 Pin Solid State	6.0	60.0	60.00
9-5T	62 Pin Solid State	6.2	62.0	62.00
9-5T	64 Pin Solid State	6.4	64.0	64.00
9-5T	66 Pin Solid State	6.6	66.0	66.00
9-5T	68 Pin Solid State	6.8	68.0	68.00
9-5T	70 Pin Solid State	7.0	70.0	70.00
9-5T	72 Pin Solid State	7.2	72.0	72.00
9-5T	74 Pin Solid State	7.4	74.0	74.00
9-5T	76 Pin Solid State	7.6	76.0	76.00
9-5T	78 Pin Solid State	7.8	78.0	78.00
9-5T	80 Pin Solid State	8.0	80.0	80.00
9-5T	82 Pin Solid State	8.2	82.0	82.00
9-5T	84 Pin Solid State	8.4	84.0	84.00
9-5T	86 Pin Solid State	8.6	86.0	86.00
9-5T	88 Pin Solid State	8.8	88.0	88.00
9-5T	90 Pin Solid State	9.0	90.0	90.00
9-5T	92 Pin Solid State	9.2	92.0	92.00
9-5T	94 Pin Solid State	9.4	94.0	94.00
9-5T	96 Pin Solid State	9.6	96.0	96.00
9-5T	98 Pin Solid State	9.8	98.0	98.00
9-5T	100 Pin Solid State	10.0	100.0	100.00

### THE MA1023 by NATIONAL SEMICONDUCTOR

Part No.	Description	1	10	100
4-5T	8 Pin Solid State	0.8	8.0	8.00
4-5T	14 Pin Solid State	1.4	14.0	14.00
4-5T	16 Pin Solid State	1.6	16.0	16.00
4-5T	18 Pin Solid State	1.8	18.0	18.00
4-5T	20 Pin Solid State	2.0	20.0	20.00
9-5T	22 Pin Solid State	2.2	22.0	22.00
9-5T	24 Pin Solid State	2.4	24.0	24.00
9-5T	26 Pin Solid State	2.6	26.0	26.00
9-5T	28 Pin Solid State	2.8	28.0	28.00
9-5T	30 Pin Solid State	3.0	30.0	30.00
9-5T	32 Pin Solid State	3.2	32.0	32.00
9-5T	34 Pin Solid State	3.4	34.0	34.00
9-5T	36 Pin Solid State	3.6	36.0	3



7400 TTL			
SN7400N	16	SN7470N	29
SN7401N	18	SN7471N	29
SN7402N	18	SN7472N	35
SN7403N	18	SN7473N	35
SN7404N	18	SN7474N	35
SN7405N	18	SN7475N	35
SN7406N	18	SN7476N	35
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SN7408N	29	SN7478N	35
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SN7708N	50	SN7778N	50
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CD4000	23	C/MOS	CD4070	55
CD4001	23	CD4001	CD4071	23
CD4002	23	CD4026	89	
CD4006	1.19	CD4029	1.19	
CD4007	25	CD4030	49	
CD4009	49	CD4035	99	
CD4010	49	CD4040	1.19	
CD4013	23	CD4041	1.25	
CD4012	25	CD4042	99	
CD4013	39	CD4043	89	
CD4014	1.39	CD4044	89	
CD4015	1.19	CD4046	1.79	
CD4016	49	CD4047	2.50	
CD4017	1.19	CD4048	1.35	
CD4018	99	CD4049	49	
CD4019	49	CD4050	49	
CD4020	1.19	CD4051	1.19	
CD4021	1.39	CD4052	1.19	
CD4022	1.19	CD4055	2.95	
CD4023	23	CD4059	9.95	
CD4024	79	CD4060	1.49	
CD4025	23	CD4066	79	
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74C324	39	74C507 2.49
74C325	39	74C508 2.49
74C326	39	74C509 2.49
74C327	39	74C510 2.49



## Transistor Checker



— Completely Assembled —  
— Battery Operated —

The ASI Transistor Checker is capable of checking a wide range of transistor types, either "in circuit" or out of circuit. To operate, simply plug the transistor to be checked into the front panel socket, or connect it with the alligator clip test leads provided. The unit safely and automatically identifies low, medium and high-power PNP and NPN transistors. Size: 3 1/2" x 6 1/4" x 2 1/2". "C" cell battery not included.

Trans-Check \$29.95 ea.

## Custom Cables & Jumpers



### DB 25 Series Cables

Part No.	Cable Length	Connectors	Price
DB25P-4-P	4 ft.	2-DP25P	\$15.95 ea.
DB25P-4-S	4 ft.	1-DP25P/1-25S	\$16.95 ea.
DB25S-4-S	4 ft.	2-DP25S	\$17.95 ea.

### Dip Jumpers

Part No.	Cable Length	Connectors	Price
DJ14-1	1 ft.	1-14 Pin	\$1.59 ea.
DJ16-1	1 ft.	1-16 Pin	1.79 ea.
DJ24-1	1 ft.	1-24 Pin	2.79 ea.
DJ14-1-14	1 ft.	2-14 Pin	2.79 ea.
DJ16-1-16	1 ft.	2-16 Pin	3.19 ea.
DJ24-1-24	1 ft.	2-24 Pin	4.95 ea.

For Custom Cables & Jumpers, See JAMECO 1979 Catalog for Pricing

## CONNECTORS

### 25 Pin-D Subminiature

DB25P (as pictured)	PLUG (Meets RS232)	\$2.95
DB25S	SOCKET (Meets RS232)	\$3.50
DB51226-1	Cable Cover for DB25P or DB25S	\$1.75

### PRINTED CIRCUIT EDGE-CARD

156 Spacing - 1 in. Double Row Out — Brackets Contacts — Pins .054 to .070 P.C. Cards	
15/30	PINS (Solder Eyelet) \$1.95
18/36	PINS (Solder Eyelet) \$2.49
22/44	PINS (Solder Eyelet) \$2.95
50/100 (.100 Spacing)	PINS (Wire Wrap) \$6.95
50/100 (.125 Spacing)	PINS (Wire Wrap) R681-1 \$6.95

## 4-Digit Clock Kit

- Bright .35" ht. red display
- Sequential flashing colon
- 12 or 24 hour operation
- Extruded aluminum case (black)
- Pressure switches for hours, minutes & hold functions
- Includes all components, case and wall transformer
- Size: 3 1/4 x 1 1/4 x 1 1/4

JE730 \$14.95

## Jumbo 6-Digit Clock Kit

- Four .63" ht. and two .30" ht. common anode displays
- Uses MM5314 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 30 feet
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6 1/4 x 3 1/4 x 1 1/4

JE747 \$29.95

## JE701

### 6-Digit Clock Kit \$19.95

## REMOTE CONTROL TRANSMITTER & RECEIVER



- Can be used as remote control for TV
- Use 1 for your own channel, other for TV
- Transmitter & Receiver 30 ft. range
- Thousands of uses for remote control applications
- Transmitter uses a 1.5V battery
- Battery included

\$19.95

## Digital Stopwatch Kit

- Use Intersil 7206 Chip
- Plated thru double-sided P.C. Board
- LED display (red)
- Times to 99 min. 59.99 sec. with auto reset
- Quartz crystal controlled
- Three stopwatches in one: single event, split (cumulative) & Taylor (sequential timing)
- Uses 3 penlite batteries
- Size: 4.5" x 2.15" x .90"

JE900 \$39.95

## MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES		MICROPROCESSOR MANUALS	
8080A	CPU	M-280	User Manual \$7.50
8212	8-Bit Input/Output	M-CDP1802	User Manual 7.50
8214	Priority Interrupt Control	M-2650	User Manual 5.00
8216	8-Directional Bus Driver		
8224	Control Generator/Driver		
8226	Bus Driver		
8228	System Controller/Bus Driver		
8230	System Controller		
8231	Prog. Comm. 1/0 (USART)	2513(2140)	Character Generator (upper case) \$9.95
8253	Prog. Interval Timer	2513(3021)	Character Generator (lower case) 9.95
8255	Prog. Periph. 1/0 (PPI)	2516	Character Generator 10.95
8257	Prog. DMA Control	MMS230N	2048-Bit Read Only Memory 1.95
8259	Prog. Interrupt Control		
8800/6800 SUPPORT DEVICES		ROM'S	
MC6800	MPU	1101	256X1 Static \$1.49
MC6802CP	MPU with Clock and Ram	1103	1024X1 Dynamic 1.99
MC6810API	128KB Static Ram	2101(8101)	256X4 Static 3.95
MC6821	Periph. Inter. Adapt (MC6820)	2102	1024X1 Static 1.75
MC6828	Priority Interrupt Controller	2102	1024X1 Static 1.95
MC6830L8	1024X8 Bit ROM (MC68A30-8)	2112	256X4 Static MOS 4.95
MC6850	Asynchronous Comm. Adapter	2112	1024X4 Static 450ns 9.95
MC6852	Synchronous Serial Data Adapt.	2114	1024X4 Static 450ns low power 10.95
MC6860	0-600 bps Digital MODEM	2114-3	1024X4 Static 300ns low power 11.95
MC6862	2400 bps Modulator	5101	256X4 Static 7.95
MC6880A	Quad 3-State Bus Trans. (MC68T86)	5280/2107	4096X1 Dynamic 4.95
		7489	16X4 Static 1.75
MICROPROCESSOR CHIPS—MISCELLANEOUS		745200	256X1 Static Tristate 4.95
2801(7801)	CPU	93421	256X1 Static 2.95
CDP1802	CPU	UPD414	4K Dynamic 15 pin 4.95
2650	MPU	(MX4027)	
6502	CPU	UPD416	16K Dynamic 16 pin 9.95
8035	8-Bit MPU w/clock, RAM, 1/0 lines	(MX4116)	
8085	8-Bit MPU	TMS1044	4K Static 14.95
TMS9900UL	16-Bit MPU w/hardware, multiply & divide	45N1	
		TMS4045	1024X4 Static 14.95
		2117	16,384X1 Dynamic 350ns (house marked) 9.95
		MMS262	2KX1 Dynamic 471.00
SHIFT REGISTERS		PROM'S	
MM500H	Dual 25 Bit Dynamic	1702A	2048 FAMOS \$5.95
MM503H	Dual 50 Bit Dynamic	21761NTEL	16K* EPROM 59.95
MM504H	Dual 16 Bit Static	TMS2516	16K* EPROM 49.95
MM506H	Dual 100 Bit Static	(2716)	*Requires single +5V power supply
MM510H	Dual 54 Bit Accumulator	48X8	EPROM 89.95
MM5010H	500/512 Bit Dynamic	2708	8K EPROM 29.95
2504T	1024 Dynamic	2716 T.1	16K* EPROM 29.95
2518	Hex 32 Bit Static		*Requires 3 voltages: -5V, +5V, +12V
2522	Dual 132 Bit Static	5203	2048 FAMOS 14.95
2524	512 Static	6301/17611	1024 Tristate Bipolar 3.49
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3341	Cable Register File (TTL static)	74188	256 TTL Open Collector 2.95
74LS570	4X4 Register File (TTL static)	74S287	1024 Static 3.95
A-Y-5-1013	30K BAUD UART'S		

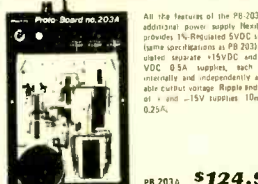
## CONTINENTAL SPECIALTIES

### Proto Board 203



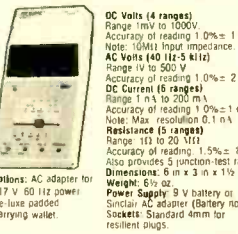
Model Number	L x W x H (Inches)	Price
PB-5	6.0 x 4.5 x 1.4	\$15.95
PB-100	6.0 x 4.5 x 1.4	\$19.95
PB-101	6.0 x 4.5 x 1.4	\$22.95

### Proto Board 203A



Model Number	L x W x H (Inches)	Price
PB-102	7.0 x 4.5 x 1.4	\$26.95
PB-103	9.0 x 6.0 x 1.4	\$44.95
PB-104	9.8 x 8.0 x 1.4	\$54.95

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PDM35: Digital Multimeter (completely assembled)	\$59.95
PDM-AC: 117V AC Adapter	6.95
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## 100 MHz 8-Digit Counter



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- Includes components, hardware & instructions
- Size: 3 1/2" x 5" x 2 1/2"

JE200 \$14.95

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- Transmit Channel Frequencies: Switch selectable: Low (normal) = 1070 space, 1270 mark, High = 025 space; 2225 mark
- Receive Sensitivity: -46 dbm acoustically coupled
- Transmit Level: 15 dbm nominal, Adjustable from -6 dbm to -20 dbm
- Receive Frequency Tolerance: Frequency reference automatically adjusts to allow for operation between 1500 Hz and 2400 Hz (EIA RS-232C or 20 mA current loop receiver is optional and non-polar)
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- Physical: All components mount on a single 5" by 9" printed circuit board. All components equipped, is optoisolated and non-polar

Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align.

## TRS-80 16K Conversion Kit

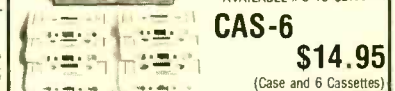
Expand your 4K TRS-80 System to 16K. Kit comes complete with:

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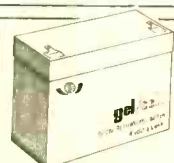
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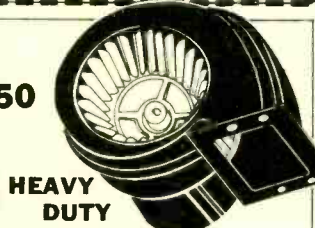
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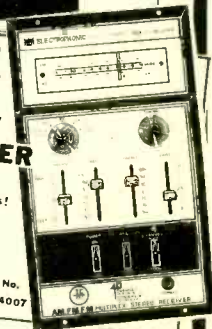
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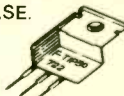
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Resolution: 10 Hz @ 0.1 sec gate, 1 Hz @ 1 sec gate  
Readout: 8 digit, 0.4" high LED, direct readout in mHz  
Accuracy: adjustable to 0.5 ppm  
Stability: 2.0 ppm over 10" to 40" C. temperature compensated  
Input: BNC, 1 megohm/20 pF direct, 50 ohm with CT-600  
Overload: 50VAC maximum, all modes  
Sensitivity: less than 25 mV to 65 MHz, 50-150 mV to 630 mHz  
Power: 110 VAC 5 Watts or 12 VDC @ 400 ma  
Size: 6" x 4" x 2", high quality aluminum case, 2 lbs  
ICS: 13 units, all socketed

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The UN-KIT, only 5 solder connections

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DC-9

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4013	.35	7447	.65
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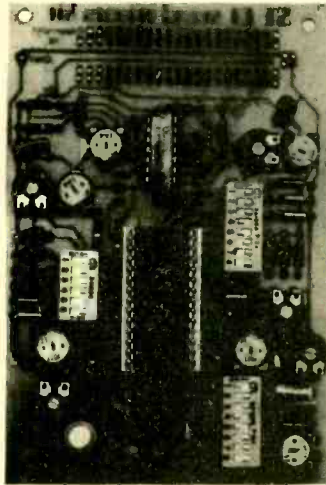
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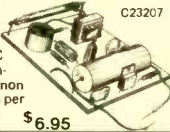
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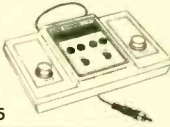
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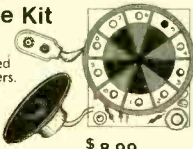
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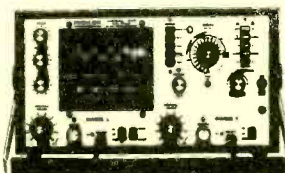
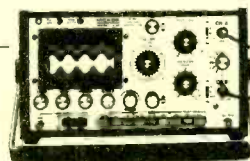
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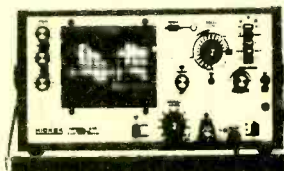
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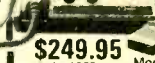


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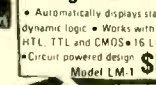


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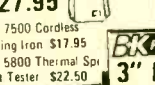


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**HICKOK  
Function  
Generator**  
Model 270  
**\$169.15**

**Weller  
Controlled  
Output  
Soldering  
Station**  
Model 1432P  
Reg. \$780.00  
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with probes

**15MHz  
3" Dual Portable  
Trace  
Scope**  
Model 1432P  
Reg. \$780.00  
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with probes

**SENCORE  
POCKET CRICKET  
TRANSISTOR/FET TESTER**  
Reg. \$125.00  
**\$99.95**  
TF 40

**Magnifier  
LAMP**  
Model MG 10A  
**\$49.50**

**700 Series**  
Precision ground and polished magnification lens. Uses 22W T-8 Circine fluorescent.  
Model MG 10A  
**\$49.50**

**30MHz  
Portable  
Frequency  
Counter**  
Reg. \$120.00  
**\$59.95**

**AM/FM  
Cassette  
Stereo**  
CAS 888  
**\$57.50**

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stitution  
Box \$51**  
Model 2910

**Call TOLL FREE  
(800) 645-9518**

**FREE  
1979  
Catalog**

**Auto Stereo 40 Watt  
Power Booster  
POW-40** Reg. \$39.95 **\$24.95**

**VOM Multimeters**  
**20K ohm/v \$19.95**  
with mirrored scale.

**1K ohm/v \$9.95**

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Advertised Price"**

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Add \$3.00 for shipping and insurance  
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residents add, approx sales tax

**FREE  
1979  
Catalog**



## DIGITAL AUTO SECURITY SYSTEM

4 DIGITS  
PERSONAL CODE!!

- proximity triggered
- voltage triggered
- mechanically triggered



### 3-WAY PROTECTION!

This alarm protects you and itself! Entering protected area will set it off, sounding your car horn or siren you add. Any change in voltage will also trigger the alarm into action. If cables within passenger compartment are cut, the unit protects itself by sounding the alarm.

**SPECIAL \$19.95**

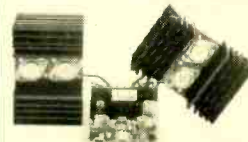
ALL UNITS FACTORY ASSEMBLED AND TESTED—NOT A KIT!

## 100 W CLASS A POWER AMP KIT

Dynamic Bias Class "A" circuit design makes this unit unique in its class. Crystal clear, 100 watts power output will satisfy the most picky fans. A perfect combination with the TA-1020 low T.I.M. stereo pre-amp.

Specifications:

- \*Output power : 100W RMS into 8-ohm  
125W RMS into 4-ohm
- \*Frequency response: 10Hz - 100 KHz
- \*T.H.D.: less than 0.008%
- \*S/N ratio: better than 80dB
- \*Input sensitivity: 1V max.
- \*Power supply:  $\pm 40V$  @ 5amp



TA-1000 KIT  
\$51.95  
Power  
transformer  
\$15.00 each

## LOW TIM DC STEREO PRE-AMP KIT TA-10-20

Incorporates brand-new D.C. design that gives a frequency response from 0Hz - 100KHz  $\pm 0.5dB$ ! Added features like tone defeat and loudness control let you tailor your own frequency response. Independent I.C. regulated power supplies to eliminate power fluctuation! Specifications: \*T.H.D. less than .005% \*T.I.M. less than .005% \*Frequency response: DC to 100KHz  $\pm 0.5dB$  \*RIAA deviation:  $\pm 0.2dB$  \*S/N ratio: better than 70dB \*Sensitivity: Phono 2MV 47K/Aux. 100mV 100K \*Output level: 1.3V \*Max output: 15V \*Tone control: bass  $\pm 10dB$  @ 50Hz/treble  $\pm 10dB$  @ 15Hz \*Power supply:  $\pm 24 D.C.$  @ 0.5A

Kit comes with regulated power supply, all you need is a 48V C.T. transformer @ 0.5A

ONLY \$44.50

X\*FORMER  
\$4.50



## THE MOST ADVANCED TIMEPIECE OF ITS KIND IN THE WORLD!

LCD Quartz Alarm Chronograph with calendar and dual time zone!! Watch is the same as Seiko but you pay a lot more for the name! Features:

- \* 24 hour alarm
- \* Chronograph counts up to 12 hrs. 59 mins 59.9 sec.
- \* Precision of chrono up to 1/10 sec indicated by 10 moving arrows!!
- \* Lap time (with chrono running uninterrupted)
- \* Time displays by LCD for hour, min, sec, day, date of the week and AM/PM.
- \* Calendar gives out date-day
- \* Dual time zone for any two cities of the world at your own choice.
- \* With light switch to allow you to see the time in the dark!



\$65.50

ONE YEAR FULL WARRANTY!

## PROFESSIONAL FM WIRELESS MICROPHONE

TECT model WEM-16 is a factory assembled FM wireless microphone powered by an AA size battery. Transmits in the range of 88-108MHz with 3 transistor circuits and an omni-directional electric condenser. Element built-in plastic tube type case; mike is 6 1/4" long. With a standard FM radio, can be heard anywhere on a one-acre lot; sound quality was judged very good. \$16.50



### sanwa

- COMPACT —
- LIGHTWEIGHT —
- ULTRASLIM —
- BATTERY CHECKER
- LED TESTER —

T-55D (w/o temp probe)

\$44.50

T-55THD (temp probe)

\$66.50



### SPECIFICATIONS:

Ranges: 150mV, 500mV, 1.5V, 5V  
DC Voltage: 15V, 50V, 250V, 1kV (AII 20k  $\Omega$  /V)  
25kV (Using HV probe)  
DC Current: 50 $\mu$ A, 2.5mA, 25mA, 250mA (500mV drop)  
AC Voltage: 15V, 50V, 500V 19k  $\Omega$  /V  
AC Current: 6mA, 60mA (2V and 55mV drop)  
Resistance: 10k  $\Omega$ , 100k  $\Omega$ , 1M  $\Omega$ , 5M  $\Omega$  (max. cabinet)  
100k  $\Omega$ , 1k  $\Omega$ , 10k  $\Omega$ , 50k  $\Omega$  (mid scale)  
Load Current: 30mA, 3mA, 300mA  
Load Voltage: 3V, 3V, 3V  
Decibels: -10 to +55dB  
Batt Check: 0.9 to 1.5V (10  $\Omega$  load) (available)  
Temperature: -50 to +100°C and 0 to +200°C (Probe not supplied with T-55D)

Accuracy: DC Voltage:  $\pm 2.5\%$  f.s.d.  
DC Current:  $\pm 2.5\%$  f.s.d.  
Batt Check:  $\pm 2.5\%$  f.s.d.  
AC Voltage/Power on 1.5V range:  $\pm 5\%$  f.s.d.  
AC Voltage/Power above 1.5V range:  $\pm 3.5\%$  f.s.d.  
AC Current:  $\pm 5\%$  f.s.d.  
Resistance/Temperature:  $\pm 3\%$  of arc  
Dimensions: 146 x 97 x 28 mm thick  
Weight: 240g  
Instrument supplied with Batteries 1.5V (UM 3 or R6) x2  
Fuse & Spare: 500mA, 250V  
Temperature Probe (T-55THD only)

## HICKOK LX303 DIGITAL LCD MULTIMETER

- 3 1/2 digits display
- 200 hours 9V battery life
- Auto zero; polarity; overrange indication
- 100mV DC F.S. sensitivity
- 19 ranges and functions
- D.C. volt: 0.1 MV to 1000 V
- A.C. volt: 0.1 V to 600 V
- Resistance: 0.1  $\Omega$  to 20 M  $\Omega$
- D.C. current: 0.01  $\Omega$  A to 100 MA

CALL FOR OUR DISCOUNTED PRICE



### 60W + 60W



### COMPLETED UNIT—NOT A KIT!

OCL pre amp. & power stereo amp. with bass, middle, treble 3-way tone control. Fully assembled and tested, ready to work. Total harmonic distortion less than 0.5% at full power. Output maximum is 60 watts per channel at 8  $\Omega$ . Power supply is 24 - 36V AC or DC. Complete unit

Assembled \$49.50 ea.

\$ 8.50 ea.

Power transformer



POWER TRANSFORMER \$6.50 EACH

## 30W 30W STEREO HYBRID AMPLIFIER KIT

It works in 12V D.C. as well! Kit includes 1 PC SANYO STK-043 stereo power amp. IC LM 1458 as pre amp, all other electronic parts, PC Board, all control pots and special heat sink for hybrid. Power transformer not included. It produces ultra hi-fi output up to 60 watts (30 watts per channel) yet gives out less than 0.1% total harmonic distortion between 100Mz and 10KHz. \$32.50 PER KIT

## MARK IV 18 STEPS LED POWER LEVEL INDICATOR KIT

This new stereo level indicator kit consists of 36 4-color LED (18 per channel) to indicate the sound level output of your amplifier from -36dB ~ +3dB. Comes with a well-designed silk screen printed plastic panel and has a selector switch to allow floating or gradual output indicating. Power supply is 6 ~ 12V D.C. with THG on board input sensitivity controls. This unit can work with any amplifier from 1W to 200W!

Kit includes 70 pcs. driver transistors, 36 pcs. matched 4-color LED, all other electronic components, PC board and front panel.



MARK IV KIT \$31.50

## JUMBO 1" LED ALARM CLOCK MODULE

- Assembled - not a kit!
- Features:
- \* 1" 4 digits red LED display
  - \* 12 hours real time format
  - \* 24 hours alarm audio output (just add speaker)
  - \* Power failure indicator
  - \* Count down timer 59 mins.
  - \* 12-16V AC 50/60 Hz input
  - \* 10 min. snooze control



Red Display \$8.50 each  
Green Display \$10.50 each

Transformer \$1.75

## ELECTRONIC DUAL SPEAKER PROTECTOR

Cut off when circuit is shorted or overload to protect your amplifier as well as your speakers. A must for OCL circuits.

KIT FORM

\$8.75 EA.



## FM WIRELESS MIC KIT

It is not a pack of cigarettes. It is a new FM wireless mic kit! New design PC board fits into a plastic cigarette box (case included). Uses a condenser microphone to allow you to have a better response in sound pick-up. Transmits up to 350 ft.! With an LED indicator to signal the unit is on.

KIT FORM \$7.95





## SUPER 15 WATT AUDIO AMP KIT



**ONLY \$23.50 each**

Uses STK-015 Hybrid Power Amp

Kit includes: STK-015 Hybrid IC, power supply with power transformer, front Amp with tone control, all electronic parts as well as PC Board. Less than 0.5% harmonic distortion at full power 1/2dB response from 20-100,000 Hz. This amplifier has QUASI-Complementary class B output. Output max is watt (10 watt RMS) at 4Ω.

**REGULATED DUAL VOLTAGE SUPPLY KIT**  
±4 ~ 30V DC 800 MA adjustable, fully regulated by Fairchild 78MG and 79MG voltage regulator I.C. Kit includes all electronic parts, filter capacitors, I.C., heat sinks and P.C. board.

**\$12.50 PER KIT**

### MANY SOUND DECISIONS!



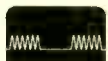
\$3.60 EACH

Solid state sound indicator operating voltage 6V DC 30mA. Small size approximately 1/2" x 1 1/4".

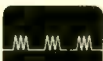
Model EB2116 (Continuous)  
Model EB2126 (Slow Pulse)  
Model EB2136 (Fast Pulse)



Continuous



Slow pulse



Fast pulse

### 1Watt AUDIO AMP

All parts are pre assembled on a mini PC Board. Supply Voltage 6 ~ 9V D.C. SPECIAL PRICE \$1.95 ea.

### "FISHER" 30 WATT STEREO AMP

MAIN AMP (15W X 2)

Kit includes 2 pcs. Fisher PA 301 Hybrid IC all electronic parts with PC Board, Power supply ± 16V DC (not included). Power band with (KF 1% ± 3dB). Voltage gain 33dB. 20Hz ~ 20KHz.

Super Buy Only \$18.50

### 5W AUDIO AMP KIT

2 LM 380 with Volume Control. Power Supply 6 ~ 18V DC. ONLY \$6.00 EACH

### WE FOUND THE CASE FOR THE FM MIC!

Small nice looking aluminum case size like a pack of cigarettes. It is an intercom Audio amp inside with a mic jack, a mini toggle switch on top, can be used for many projects. We give you the circuit data as well.

VERY SPECIAL PRICE 2 for \$4.99

### Sub-Mini Size CONDENSER MICROPHONE

FET Transistor Built-in \$2.50 each

### ELECTRONIC ALARM SIREN

COMPLETE UNIT

Ideal for use as an Alarm Unit or hookup to your car back up to make a reverse indicator. Light Output up to 130dB. Voltage Supply 6 ~ 12V \$7.50

### SOUND ACTIVATED SWITCH

All parts completed on a PC Board. SCR will turn on relay, buzzer or trigger other circuit for 2 ~ 10 sec. (adjustable). Ideal for use as door alarm, sound controlled toys and many other projects. Supply voltage 4.5V ~ 3V D.C. \$1.75 ea/2 for \$3.00

### LINEAR SLIDE POT

500KΩ SINGLE Metal Case 3" Long 2 FOR \$1.20

Rechargeable NI-CD Batteries Pak 6AA NI-CD in a flat pack gives you a total of 7.2V 450MA output \$5.25 PER PACK

### BATTERY POWERED FLUORESCENT LANTERN

#### FEATURES

- Circuitry: designed for operation by high efficient, high power silicon transistor which enable illumination maintain in a standard level even the battery supply drops to a certain low voltage.
- 9" 6V cool/daylight miniature fluorescent tube.
- 8 x 1.5V UM-1 (size D) dry cell battery.
- Easy sliding door for changing batteries.
- Stainless reflector with wide angle increasing illumination of the lantern.

\$10.50 EACH MODEL 888 R

### PROFESSIONAL CASE



for our 0-30V Power Supply. It is a nice looking metal cast case with giant 4" volt/amp meter; output blinding post and fuse holder, on/off switch and line cord!

ONLY \$21.50 EA.

CASE 030

### POWER SUPPLY KIT

0-30V D.C. REGULATED



Uses UA723 and ZN3055 Power TR output can be adjusted from 0-30V, 2 AMP. Complete with PC board and all electronic parts.

0-30 POWER SUPPLY \$10.50 each

Transformer for Power Supply, 2AMP 24V x 2 \$8.50

### 12V DC MINI RELAY

6V SPDT 2AMP 1.30  
12V SPDT 3AMP 1.60  
12V DPDT 2AMP 2.50  
12V 4PDT 3AMP 3.50



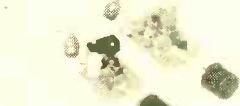
### SUB-MINI SIZE SPDT RELAY

Ideal for use in mini circuits, contact rated at 1amp 125V AC. Coil resistance 300Ω, standard 0.1" lead spacing allows it to plug into a 14 pin I.C. socket!



12V DC type \$2.50 ea.  
5V DC type \$3.50 ea.

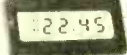
### ULTRA SONIC SWITCH KIT



Kit includes the Ultra Sonic Transducers, 2 PC Boards for transmitter and receiver. All electronic parts and instructions. Easy to build and a lot of uses such as remote control for TV, garage door, alarm system or counter. Unit operated by 9-12 DC.

\$15.50

### LCD CLOCK MODULE!



- 0.4" LCD 4 digits display
- X'tal controlled circuits
- D.C. powered (1.5V battery)
- 12 hr. or 24 hr. display
- 24 hr. alarm set
- 60 min. countdown timer
- Dual time zone display
- Stop watch function

NIC1200 \$24.50 EA.

### I.C. TEST CLIPS

Same as the E Z clips With 20 Long Leads in Black and Red Colors \$2.75 per pair



### BECKMAN FET

### LIQUID CRYSTAL DISPLAY

Overall size 2" x 1.2" 0-5" characters reflective type



737-01



739-04



739-03

Model 737-01 - for clock 4 digits with PM, alarm, snooze, colon indicators.

Model 739-04 - for panel meter 4 digits.

Model 739-03 - for panel meter 3 1/2 digits with ± sign and over range indicator.

All displays include zeber connectors and front bezel. With data sheets. Your choice—any model \$7.50 EACH

### FLUORESCENT LIGHT DRIVER KIT

12V DC POWERED

Lights up 8 ~ 15 Watt Fluorescent Light Tubes Ideal for camper, outdoor Auto or Boat



Kit includes high voltage coil, power transistor, heat sink, all other electronic parts and PC Board, light tube not included! WITH CASE ONLY \$6.50 PER KIT

### MINI-SIZED I.C. AM RADIO

Size smaller than a box of matches! Receives all AM stations Batteries and ear phone included

Only \$10.50



### SOUND GENERATOR I.C.

T176477

Creates almost any type of sound—gun shot, explosion, train, car crash, star war, birds, organ ext. A built-in audio amplifier provides high level output. Operates from one 9V battery, 28 pin dip; we supply the datas. \$2.90 EACH

### Sub Mini Size PANEL METER

500 U.A. ONLY \$1.20 ea



### ELECTRONIC SWITCH KIT CONDENSER TYPE

Touch On Touch Off uses 7473 I.C. and 12V relay \$5.50 each



### TRANSFORMERS

ALL 117-VOLT INPUT



30V 4AMP \$7.50 EA.  
36V CT 3AMP \$8.50 EA.  
48V CT 3AMP \$8.50 EA.  
24V CT 3AMP \$8.50 EA.  
24V CT 0.5AMP \$1.80 EA.  
12V CT 0.5AMP \$1.80 EA.  
12V CT 120MA \$1.25 EA.

### AC POWER SUPPLY

Wall Type Transformer



12V AC Output 200MA \$2.75 EA.  
16V CT AC Output 100MA \$2.10 EA.  
6V DC Output 120MA \$1.90 EA.  
12V DC Output 100MA \$1.90 EA.

### PROFESSIONAL PANEL METERS



A. 0-50UA 8.50 ea  
B. 0-30VDC 8.50 ea  
C. 0-50VDC 8.50 ea  
D. 0-3ADC 9.00 ea  
E. 0-100VDC 9.00 ea

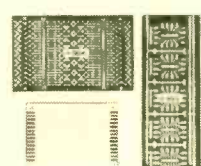
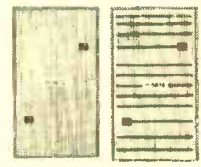
TYPE MU-52E ALL METERS WHITE FACE WITH BLACK SCALES. PLASTIC COVER.

### HEAVY DUTY CLIP LEADS

10 pairs - 5 colors Alligator clips on a 22" long lead. Ideal \$2.20/pack for any testing.



### UNIVERSAL PROTOBOARDS "CIRCUIT FIT"

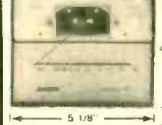


All Boards are made of High Quality G10 Fiber-glass and Phenolic. Pre-drilled in .042" diameter holes on 0.1" centers with tin plated copper eyelet and finger edge connectors (single sided) to allow any kind of standard components to fit board.

H-5612 3 1/2" x 6" 1.70  
H-5616 3 1/2" x 6" 1.70  
H-5606 3 1/2" x 6" 1.50  
H-5602 2 1/2" x 6" 1.50

### GIANT SIZE VU METER

1MA movement 3 1/2" scale length. Scale in VU -20db to +3db. Meter face 5 1/8" x 2 3/8" with a "smoke" plastic cover.



SPECIAL

\$8.50 Each

### PUSH-BUTTON SWITCH

N/Open Contact Color: Red, White, Blue, Green, Black 3/\$1.00 N/Close also 50¢ ea. LARGE QTY. AVAILABLE



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8/79

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1984



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4010	- 45	4028	- 80	4520	1.00	74C165	1.25		
4011	- 22	4029	- 95	74C05	27	74C171	1.30		
4012	- 22	4030	- 35	74C02	27	74C174	1.20		
4014	1.20	4035	97	74C08	30	74C175	1.20		
4015	- 1.00	4042	85	74C10	27	74C193	1.40		
4016	45	4044	85	74C06	27	74C197	1.40		
4017	- 1.00	4049	75	74C42	90	74C202	50		
4018	- 90	4050	45	74C73	37	74C214	1.90		
4019	- 45	4051	1.10	74C74	50				
4020	- 1.10	4053	1.10	74C83	1.30				
4021	- 1.10	4055	1.25	74C86	50				
4022	- 1.00	4066	70	74C90	95				

1488 RS232 INTERFACE	\$1.40	UPD101-4K STAT RAM	9.95
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2509 TRI STATE STAT. SR	1.35	5280/21078 4K DYN RAM	3.40
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740309 HC 80175 DYN SR	1.35	AVS 103 VARY	5.25
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21021 1480 Hz	1.25	CONVERT	9.95
MW5210 4K 1 DYN	3.48	PT 1482 PSAT	6.95
KC4020P	1.95	80564	1.75
2101 1.254 + 4 STAT	2.45	82512	2.75
2111 1.256 + 4 STAT	3.45	82516	2.75
2101 1.256 + 4 STAT	2.75	82228	4.95
211446 STAT RAM 160 nH	8.50	82565	16.00
211716K DYN RAM	7.95	8251	12.50

ICRYSTALS \$3.45 ea.		RIBBON CABLE	
2.000 MHz 6.144 MHz		FLAT (COLOR CODED)	
4.000 MHz 8.000 MHz		#30 WIRE	
3.57 MHz 10.000 MHz		26 cond. .50/ft	
5.000 MHz 20.000 MHz		40 cond. .75/ft	
6.000 MHz		50 cond. .90/ft	

CTS 206-8 eight position dip switch	\$1.60
CTS 206-4 four position dip switch	\$1.45
LIGHT ACTIVATED SCR's to 18, 200V 1A.	\$7.70

SILICON SOLAR CELLS	
4" diameter 4V at 1 AMP	\$10.00

FND 359 C.C. 4" \$6.00	LED READOUTS
FCS 8024 4 digit	DL-704 C.A. 3" \$7.75
C.C. 8" display	DL 747 C.A. 6" \$15.00
FND 503 C.C. 5" \$5.85	HP3400 8" CC \$19.95
FND 510 C.A. 5" \$5.85	HP3405 8" CA \$19.95
DL 704 3" C.C. \$5.85	

Terms: FOB Cambridge, Mass. Send 25¢ for our catalog featuring Transistors and Rectifiers. Send Check or Money Order. Include Postage, Minimum Order \$5.00, COD's \$20.00.

PRINTED CIRCUIT BOARD	
4" x 8" DOUBLE SIDED EPOXY BOARD 1/16" thick	\$52/60
7 WATT LD-65 LASER DIODE 1R	\$8.95
2N 3820 P FET	\$4.45
2N 6457 N FET	\$4.45
2N2646 UJT	\$4.45
ER 930 TRIGGER DIODES	\$4.00
2N 6078 PHOC UJT	\$5.65
MINIATURE MULTI-TURN TRIM POTS	
100, 1K, 2K, 5K, 10K, 20K, 50K, 200K, 1Meg, 2Meg, 5.75 each 3/\$2.00	

25 watt Infra Red Pulse Laser Diode (Spec sheet included)	\$24.95
VERIPAX PC BOARD	\$12.95
Our new Prototyping is a hi density 4" x 6" single sided 1/16" epoxy board. It will hold 40, 24, 16 (34 units), 14 + 8 pin IC's. There are three buses, +5V, ground and a floating bus. There is a pad for a TO-220 regulator. There is a 22 pin edge connector with .156" spacing.	
FP 100 PHOTO TRANS	\$5.50
RED YELLOW GREEN LARGE LED's 2"	6/\$1.00
TIL 118 OPTO-ISOLATOR	\$7.75
MCT-6 OPTO ISOLATOR	\$8.80
1 WATT ZENERS: 3.3, 4.7, 5.1, 5.6, 9.1, 10, 12, 15, 18, or 22V	6/\$1.00
MCM 6571A 7 x 9 character gen	\$10.75

UNIVERSAL 4Kx8 MEMORY BOARD KIT	\$9.95
32-2102-1 fully buffered, 16 address lines, on board decoding for any 4 of 64 pages, standard 44 pin bus, may be used with F-8 & KIM	

Silicon Power Rectifiers									
PRV	1A	3A	12A	50A	125A	250A			
100	06	14	35	90	370	5.00			
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600	11	30	80	200	850	12.50			
800	15	35	100	250	1050	16.50			
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7404	- 32	7415	- 67	74157	87				
7405	- 32	7416	- 65	74161	87				
7406	- 32	7480	45	74162	120				
7408	- 32	7483	87	74163	87				
7409	- 32	7485	139	74164	127				
7410	- 32	7486	42	74165	142				
7411	- 32	7489	187	74173	180				
7412	- 32	7490	83	74174	142				
7413	- 32	7491	87	74175	127				
7414	- 32	7492	64	74176	112				
7415	- 32	7493	64	74177	112				
7416	- 32	7494	87	74180	87				
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74LS08	74LS159	LM 339	-70
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74LS26	74LS177	LM 555	110
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74LS28	74LS179	LM 555	110
74LS29	74LS180	LM 555	110
74LS30	74LS181	LM 555	110
74LS31	74LS182	LM 555	110
74LS32	74LS183	LM 555	110
74LS33	74LS184	LM 555	110
74LS34	74LS185	LM 555	110
74LS35	74LS186	LM 555	110
74LS36	74LS187	LM 555	110
74LS37	74LS188	LM 555	110
74LS38	74LS189	LM 555	110
74LS39	74LS190	LM 555	110
74LS40	74LS191	LM 555	110
74LS41	74LS192	LM 555	110
74LS42	74LS193	LM 555	110
74LS43	74LS194	LM 555	110
74LS44	74LS195	LM 555	110
74LS45	74LS196	LM 555	110
74LS46	74LS197	LM 555	110
74LS47	74LS198	LM 555	110
74LS48	74LS199	LM 555	110
74LS49	74LS200	LM 555	110
74LS50	74LS201	LM 555	110
74LS51	74LS202	LM 555	110
74LS52	74LS203	LM 555	110
74LS53	74LS204	LM 555	110
74LS54	74LS205	LM 555	110
74LS55	74LS206	LM 555	110
74LS56	74LS207	LM 555	110
74LS57	74LS208	LM 555	110
74LS58	74LS209	LM 555	110
74LS59	74LS210	LM 555	110
74LS60	74LS211	LM 555	110
74LS61	74LS212	LM 555	110
74LS62	74LS213	LM 555	110
74LS63	74LS214	LM 555	110
74LS64	74LS215	LM 555	110
74LS65	74LS216	LM 555	110
74LS66	74LS217	LM 555	110
74LS67	74LS218	LM 555	110
74LS68	74LS219	LM 555	110
74LS69	74LS220	LM 555	110
74LS70	74LS221	LM 555	110
74LS71	74LS222	LM 555	110
74LS72	74LS223	LM 555	110
74LS73	74LS224	LM 555	110
74LS74	74LS225	LM 555	110
74LS75	74LS226	LM 555	110
74LS76	74LS227	LM 555	110
74LS77	74LS228	LM 555	110
74LS78	74LS229	LM 555	110
74LS79	74LS230	LM 555	110
74LS80	74LS231	LM 555	110
74LS81	74LS232	LM 555	110
74LS82	74LS233	LM 555	110
74LS83	74LS234	LM 555	110
74LS84	74LS235	LM 555	110
74LS85	74LS236	LM 555	110
74LS86	74LS237	LM 555	110
74LS87	74LS238	LM 555	110
74LS88	74LS239	LM 555	110
74LS89	74LS240	LM 555	110
74LS90	74LS241	LM 555	110
74LS91	74LS242	LM 555	110
74LS92	74LS243	LM 555	110
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32K	MBC-032-16	SBC-032	1125
64K	MBC-064-16	SBC-064	1795

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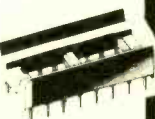


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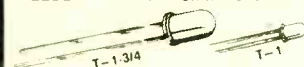
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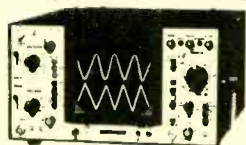
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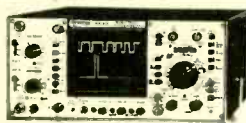
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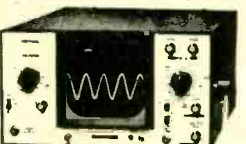
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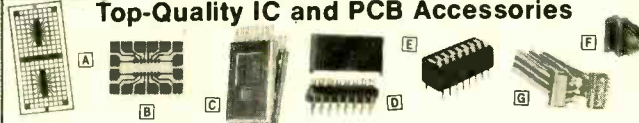


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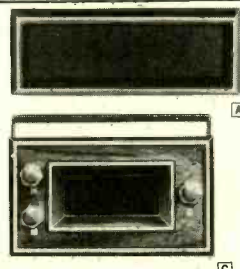
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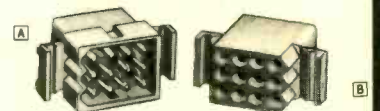
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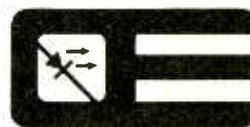
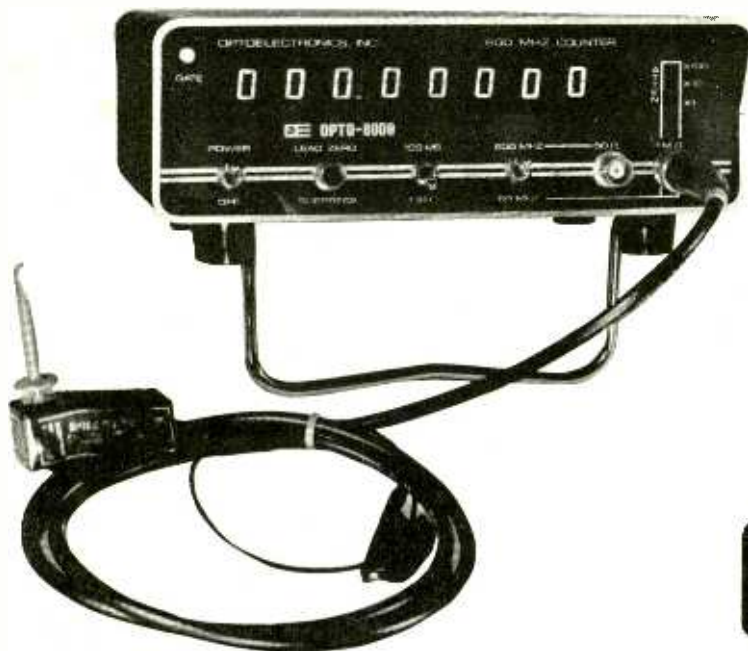
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