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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.
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 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 snappied 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 works 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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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.

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NRI is the only home study school to give you the actual "hands-on" training you need to handle servicing problems on tomorrow's electronic equipment. Because only NRI includes this designed-for-learning, 25" diagonal color TV with electronic tuning, built-in digital clock, and computer programmer as part of your training. With this advanced feature, you can pre-program an entire evening's entertainment... even key lock it in to control children's viewing.

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Exclusive Designed-for-learning Concept

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AUGUST 1979

11
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 to 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 Intercom—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

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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 2'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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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 the 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 slapped 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 mehgs 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 mehgs to no more than 50K. Unfortunately, this will increase standby current to about 250 μA, but it will prevent dampness and condensation from defeating the system.

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

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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 using 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-connection 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 even 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 milliamps. 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 fuse 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.)

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CIRCLE 21 ON FREE INFORMATION CARD
Sinclair Radionics Model DM350 DMM

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, N.J. 07015.

The unit 1 tested was the model DM350 bench digital multimeter (shown). This unit is one of a pair; the model DM350 has a 3-1/2-digit display and the model DM450 has a 4-1/2-digit display. Otherwise, the meters are identical, except for the greater resolution of the 4-1/2-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 μA to 10 A. 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 milliamperes 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 μA. A 2-μA scale is produced by pressing the V and the mA pushbuttons in plus the 200-μA pushbutton. For a 20-μA 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 highest 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.

The model DM350 is a good diagnostic instrument, easy to run. All you need is a scope (of any kind) and connect the model DM350 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 good or bad. Several manufacturers have adopted this testing method, and their service manuals show the typical patterns that are found in various stages.

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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The length of the horizontal line. The pattern will get smaller as you switch from HIGH 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 Utah 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 5 1/4-inch minifloppy diskettes. 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 Star trek 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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<thead>
<tr>
<th>WD-30-TRI</th>
<th>DISPENSER WITH WIRE</th>
<th>$5.95</th>
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<tbody>
<tr>
<td>R-30-TRI</td>
<td>TRI-COLOR REPLACEMENT SPOOLS</td>
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Realistic Model DX-300 Receiver

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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 20 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; A/M/LSB/USB/CW detection modes, a selectivity of ±3 kHz (-6 dB) and ±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 high; it was virtually unusable in the single-sideband or continuous-wave modes within a one-hour warmup period (the specifications warn the user of this).

Proper adjustment for each frequency range (it tunes in 1-kHz increments) is cumbersome. After the frequency range to be tuned is selected, the megahertz dial ring must be turned 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
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 not 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-coupling 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 tuning 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 for 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 shortwave 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.

R-E

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Book 5: Structure of calculators; keyboard encoding; decoding display data; register systems; control unit; program ROM; address decoding; instruction set; instruction decoding; control program structure.

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TABLE 1—TRMS-5000 DMM / THERMOMETER SPECIFICATIONS

<table>
<thead>
<tr>
<th>DC VOLTAGE</th>
<th>Range</th>
<th>Max. Reading</th>
<th>Accuracy 18°-28°C, 1 Year</th>
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<td></td>
<td>2V</td>
<td>1.9999V</td>
<td>.04% ± 1d*</td>
</tr>
<tr>
<td></td>
<td>20V</td>
<td>19.999V</td>
<td>.04% ± 2d</td>
</tr>
<tr>
<td></td>
<td>200V</td>
<td>199.99V</td>
<td>.04 ± 2d</td>
</tr>
<tr>
<td></td>
<td>1000V</td>
<td>1000.0V</td>
<td>.04 ± 2d</td>
</tr>
<tr>
<td>Maximum Input Voltage: 1040V</td>
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<table>
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<th>Range</th>
<th>Max. Reading</th>
<th>45 Hz–10 kHz</th>
<th>10 kHz–40 kHz</th>
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<th>High Ohms</th>
<th>Low Ohms</th>
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<td>± .05% ± 1d</td>
<td>± .10% ± 15d</td>
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<td>± .05% ± 1d</td>
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<td>± .1% ± 1d</td>
<td>± .15% ± 15d</td>
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<tr>
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<td>± .3% ± 2d</td>
<td>± .3% ± 15d</td>
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<td>Maximum Voltage Output: High 1.5V Low .5V</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Input Voltage: 150V RMS</td>
<td></td>
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<tr>
<td>Settling Time: 2 seconds to ± 1 digit of final reading except 10 seconds on megohm range.</td>
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<td></td>
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</tbody>
</table>

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 XTL1, 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 bandgap reference. 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 ±1000.0 volts while on any one range the ADC will see less than ±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 decade 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; 1 × for the 2-volt range, 10 × 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 section 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 sine-wave 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:

\[ V_{\text{rms}} = \text{Avg} \left[ \frac{V_{\text{in}}^2}{V_{\text{in}}} \right] \]

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

<table>
<thead>
<tr>
<th>DC AND TRMS AC CURRENT</th>
<th>Accuracy 18°–28°C, 1 Year</th>
</tr>
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<tbody>
<tr>
<td>Range</td>
<td>Max. Reading</td>
</tr>
<tr>
<td>2 mA</td>
<td>1.9999 mA</td>
</tr>
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<td>20 mA</td>
<td>19.999 mA</td>
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<tr>
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</tr>
<tr>
<td>2000 mA</td>
<td>1999.9 mA</td>
</tr>
<tr>
<td>10 Amp</td>
<td>10,000 A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TEMPERATURE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Celsius</td>
<td>Fahrenheit</td>
</tr>
<tr>
<td>Range:</td>
<td>-50.00° to +150.00°</td>
</tr>
<tr>
<td>Resolution:</td>
<td>.01°</td>
</tr>
<tr>
<td>Accuracy:</td>
<td>± .5°</td>
</tr>
<tr>
<td>Voltage Standoff:</td>
<td>Sensor tip to voltmeter common ±200 volts</td>
</tr>
</tbody>
</table>

**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 6¼"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 μA-per-degree-Kelvin. The Kelvin temperature scale starts at absolute zero and has Celsius-sized degrees such that 0°K = −273.2°C. The temperature sensor's current output is converted to a voltage, using scaling resistors R28, R29, R30 and R31. The output voltage (referred 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 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 °C or °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°C (−60.00°F) to 199.99°C or °F is obtained with the 4½-digit ADC. The sensor can be calibrated to within ±.2°C or 0° to 100° 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 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 79M08C 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 ½-inch common-anode red 7-segment LED digits with one FND508 ±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
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 resis-
tor 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 
ilines.

The multimeter's high-impedance in-
put is susceptible to noise pickup, espe-
cially 60 hertz, which is almost univer-
sally 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
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.
Adaptive Noise Filter

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

TABLE 1—SPECIFICATIONS (typical)

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attack time (to within 10% of final value)</td>
<td>1 ms</td>
</tr>
<tr>
<td>Decay time (to within 10%)</td>
<td>50 ms</td>
</tr>
<tr>
<td>Minimum bandwidth</td>
<td>800 Hz</td>
</tr>
<tr>
<td>Maximum bandwidth</td>
<td>30 kHz</td>
</tr>
<tr>
<td>THD (1 kHz, 1 (V_{rms}), max. sensitivity)</td>
<td>0.11%</td>
</tr>
<tr>
<td>S/N ratio re: 1 (V_{rms})</td>
<td></td>
</tr>
<tr>
<td></td>
<td>800 Hz, BW, 20 Hz to 20 kHz: -88 dBV</td>
</tr>
<tr>
<td></td>
<td>CCIR/ARM weighted: -98 dBV</td>
</tr>
<tr>
<td></td>
<td>30 kHz, BW, 20 Hz to 20 kHz: -85 dBV</td>
</tr>
<tr>
<td></td>
<td>CCIR/ARM weighted: -87 dBV</td>
</tr>
<tr>
<td>Effective noise reduction</td>
<td>CCIR/ARM weighted cassette tape noise: 14 dB</td>
</tr>
</tbody>
</table>

**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 moderate 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 (conducance 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...
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

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.

FIG. 2

FIG. 3

FIG. 4

TABLE I

<table>
<thead>
<tr>
<th>SPECIFICATIONS</th>
<th>DESIGNERS’ CLAIM</th>
<th>MEASUREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attack Time (ms)</td>
<td>1.0</td>
<td>0.8</td>
</tr>
<tr>
<td>Decay Time (ms)</td>
<td>50.0</td>
<td>40.0</td>
</tr>
<tr>
<td>Minimum Bandwidth (Hz)</td>
<td>800</td>
<td>800</td>
</tr>
<tr>
<td>Maximum Bandwidth (kHz)</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>THD (1V, Max. Sensitivity) (%)</td>
<td>0.11</td>
<td>0.12</td>
</tr>
<tr>
<td>1 kHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 Hz</td>
<td>N/A</td>
<td>0.3</td>
</tr>
<tr>
<td>20 kHz</td>
<td>N/A</td>
<td>0.11</td>
</tr>
<tr>
<td>S/N (re: 1V)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>800 Hz B.W.</td>
<td>88 dB (98 Wtd)*</td>
<td>90 dB (95 Wtd)</td>
</tr>
<tr>
<td>30 kHz B.W.</td>
<td>85.9 dB (87 Wtd)*</td>
<td>85 dB (90 Wtd)</td>
</tr>
<tr>
<td>Effective Noise Reduction</td>
<td>14 dB (Wtd)*</td>
<td>12 dB (Wtd)*</td>
</tr>
</tbody>
</table>

* 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.
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 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 resistor 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 frequency span.
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, R16 = 20,000 ohms
R5, R11 = 51,000 ohms
R10 = 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-2)
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 µF, 16 volts electrolytic, radial leads
C2, C5 = 0.047 µF, 50 volts, Mylar, 10%
C3, C6 = 5 µF, 10 volts, electrolytic, radial leads
C7, C8 = 0.01 µF, 50 volts, ceramic disc
C9, C10 = 0.01 µF, 50 volts, ceramic disc
C11, C14, C15, C17, C21, 022 = 0.1 µF, 50 volts, Mylar
C12 = 0.15 µF, 50 volts, Mylar, 5%
C13 = 0.033 µF, 50 volts, Mylar
C16 = 6.8 µF, 25 volts, tantalum, 10%, radial leads
C18 = 470 µF, 25 volts, electrolytic, radial leads
C19 = 10 µF, 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 = LM712CZ (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-112K)
L1 = adjustable inductor, 4.7 mH, Q = 35 at 11 kHz (TOKO CLN20 740 HM)
J1-J5 = 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 boards = $18.95
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.

| 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 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. Additionally, 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
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 630-1пе chassis, building cascade and cascode signal boosters with EBQ7’s and trying out every antenna I could lay my hands on—from stacked 10-element Yagi arrays to 12 wavelength 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 aluminum tubing, wire, electronics parts and bargain-base- ment-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 X 2 stakes in our sidelawn and backhanded 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-
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.

SPUTNIK, SCORE and all the satellites that followed them through 1963 had one common failure. 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.
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 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 wavetaps, 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 clutter 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 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...
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 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 multturn 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 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 weak than usual, check the lightning arrester, perhaps even replace it after a stormy season.
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 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! Justfastening the green lead under an outlet-plate mounting screw grounds the appli-

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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.

EYRAL "DOC" SAWAGE, K4SDS
HOBBY EDITOR

NOT SO LONG AGO THERE WAS ONLY ONE WAY TO WIRE AN ELECTRONIC PROJECT. 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. 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.

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 led to the next component and so forth, daisy-chain fashion. At the end of the chain, you cut the wire by
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 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 Systems 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.
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 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...
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 precut and prestripped 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
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. (A 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 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.
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-

![Block Diagram of Pulse Count Detector](image)

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.

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**FIG. 3—TRANSFER CHARACTERISTICS for the conventional ratio detector and for the new pulse count detector.**
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 output of the 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 styliuses, and hum-and-noise in studio consoles and cables that many stations continue to transmit. R-E
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 µV (12.4 dBf) in mono and 3.8 µV (36.8 dBf) in stereo as opposed to the 2.8 µV and 40 µV 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 dB (1.6 µV) 50-dB quieting: mono, 14.2 dB (2.8 µV), stereo, 37.3 dB (40 µV). S/N Ratio: mono, 75 dB; stereo, 70 dB. Frequency Response: 30 Hz to 15 kHz, ± 2 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 µV (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:**


**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, ± 0.5 dB; high level, 5 Hz to 50 kHz, ± 0.2 dB. Tone Control Ranges: ± 10 dB at 100 Hz and 10 kHz. Filter Cut-Off Frequencies: 50 Hz and 9 kHz, 6 dB-per-octave.

**GENERAL SPECIFICATIONS:**

- Power Requirements: 120 volts, 60 Hz, 250 watts. Suggested Retail Price: $820.
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 at a bit too high—at around 12 µV (26.8 dBf). Sony specifications call for a 5-µV 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 crossstalk) in stereo FM. Two 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.

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 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

---

**TABLE 1**

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

<table>
<thead>
<tr>
<th>Manufacturer: Sony Corporation</th>
<th>Model: STR-V7</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FM PERFORMANCE MEASUREMENTS</strong></td>
<td><strong>R-E</strong></td>
</tr>
<tr>
<td><strong>SENSITIVITY, NOISE AND</strong></td>
<td><strong>Measurement</strong></td>
</tr>
<tr>
<td>IHF sensitivity, mono: (µV) (dBf)</td>
<td>1.9 (10.8)</td>
</tr>
<tr>
<td>Sensitivity, stereo (µV) (dBf)</td>
<td>12.0 (26.6)</td>
</tr>
<tr>
<td>50-dB quieting signal, mono (µV) (dBf)</td>
<td>2.3 (12.4)</td>
</tr>
<tr>
<td>50-dB quieting signal, stereo (µV)</td>
<td>38 (36.8)</td>
</tr>
<tr>
<td>Maximum S/N ratio, mono (dB)</td>
<td>70</td>
</tr>
<tr>
<td>Maximum S/N ratio, stereo (dB)</td>
<td>68</td>
</tr>
<tr>
<td>Capture ratio (dB)</td>
<td>1.2</td>
</tr>
<tr>
<td>AM suppression (dB)</td>
<td>60</td>
</tr>
<tr>
<td>Image rejection (dB)</td>
<td>83</td>
</tr>
<tr>
<td>IF rejection (dB)</td>
<td>100+</td>
</tr>
<tr>
<td>Spurious rejection (dB)</td>
<td>100+</td>
</tr>
<tr>
<td>Alternate channel selectivity (dB)</td>
<td>80/48 (narrow)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>FIDELITY AND DISTORTION MEASUREMENTS</strong></th>
<th><strong>Narrow/broadband</strong></th>
<th><strong>Evaluation</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency response, 50 Hz to 15 kHz (± dB)</td>
<td>0.5</td>
<td>Excellent</td>
</tr>
<tr>
<td>Harmonic distortion, 1 kHz, mono (%)</td>
<td>0.22/0.2</td>
<td>Fair</td>
</tr>
<tr>
<td>Harmonic distortion, 1 kHz, stereo (%)</td>
<td>0.08/0.085</td>
<td>Excellent</td>
</tr>
<tr>
<td>Harmonic distortion, 100 Hz, mono (%)</td>
<td>0.3/0.28</td>
<td>Good</td>
</tr>
<tr>
<td>Harmonic distortion, 100 Hz, stereo (%)</td>
<td>0.14/0.10</td>
<td>Fair</td>
</tr>
<tr>
<td>Harmonic distortion, 6 kHz, mono (%)</td>
<td>0.16/0.25</td>
<td>Good</td>
</tr>
<tr>
<td>Harmonic distortion, 6 kHz, stereo (%)</td>
<td>0.20/0.25</td>
<td>Very good</td>
</tr>
<tr>
<td>Distortion at 50-dB quieting, mono (%)</td>
<td>1.0/1.0</td>
<td>Fair</td>
</tr>
<tr>
<td>Distortion at 50-dB quieting, stereo (%)</td>
<td>0.3/0.3</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>STEREO PERFORMANCE MEASUREMENTS</strong></th>
<th><strong>Narrow/broadband</strong></th>
<th><strong>Evaluation</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Stereo threshold (µV) (dBf)</td>
<td>12.0 (26.8)</td>
<td>Fair</td>
</tr>
<tr>
<td>Separation, 1 kHz (dB)</td>
<td>45/45</td>
<td>Very good</td>
</tr>
<tr>
<td>Separation, 100 Hz (dB)</td>
<td>42/41</td>
<td>Very good</td>
</tr>
<tr>
<td>Separation, 10 kHz (dB)</td>
<td>25/27</td>
<td>Fair</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>MISCELLANEOUS MEASUREMENTS</strong></th>
<th><strong>Evaluation</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Muting threshold (µV) (dB)</td>
<td>12.0 (26.8)</td>
</tr>
<tr>
<td>Dial calibration accuracy (± kHz at MHz)</td>
<td>75 at 108</td>
</tr>
</tbody>
</table>

**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 | Very good |
| Ease of servicing | Good |
| Evaluation of extra features, if any | Good |

**OVERALL FM PERFORMANCE RATING**

Excellent
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 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

<table>
<thead>
<tr>
<th>POWER OUTPUT CAPABILITY</th>
<th>R-E</th>
<th>R-E Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMS power/channel, 8-ohms, 1 kHz (watts)</td>
<td>164.7</td>
<td>Excellent</td>
</tr>
<tr>
<td>RMS power/channel, 8-ohms, 20 Hz (watts)</td>
<td>150.0</td>
<td>Fair</td>
</tr>
<tr>
<td>RMS power/channel, 8-ohms, 20 kHz (watts)</td>
<td>155.0</td>
<td>Good</td>
</tr>
<tr>
<td>RMS power/channel, 4-ohms, 1 kHz (watts)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>RMS power/channel, 4-ohms, 20 Hz (watts)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>RMS power/channel, 4-ohms, 20 kHz (watts)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Frequency limits for rated output (Hz-kHz)</td>
<td>20-20</td>
<td>Fair</td>
</tr>
<tr>
<td>Dynamic headroom (dB)</td>
<td>1.0</td>
<td>Good</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DISTORTION MEASUREMENTS</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Harmonic distortion at rated output, 1 kHz (%)</td>
<td>0.058</td>
<td>Very good</td>
</tr>
<tr>
<td>Intermodulation distortion, rated output (%)</td>
<td>0.17</td>
<td>Good</td>
</tr>
<tr>
<td>Harmonic distortion at 1-watt output, 1 kHz (%)</td>
<td>0.055</td>
<td>Very good</td>
</tr>
<tr>
<td>Intermodulation distortion at 1-watt output (%)</td>
<td>0.04</td>
<td>Very good</td>
</tr>
</tbody>
</table>

| DAMPING FACTOR AT 8 OHMS, 50 Hz          | 45        | Very good      |

<table>
<thead>
<tr>
<th>PHONO PREAMPLIFIER MEASUREMENTS</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency response (Hz-kHz, ± dB)</td>
<td>3.3-40</td>
<td>Excellent</td>
</tr>
<tr>
<td>Hum/noise, A-weighted, referenced to 1-watt or 0.5-volt output, for 5-mV input (dB)</td>
<td>71</td>
<td>Good</td>
</tr>
<tr>
<td>Maximum input before overload (mV)</td>
<td>230</td>
<td>Superb</td>
</tr>
<tr>
<td>Hum/noise, A-weighted, referenced to 1-watt or 0.5-volt output, for 5-mV input (dB)</td>
<td>71</td>
<td>Good</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HIGH-LEVEL INPUT MEASUREMENTS</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency response (Hz-kHz, ± dB)</td>
<td>0.16/0.02</td>
<td>Excellent</td>
</tr>
<tr>
<td>Input sensitivity, high level, re: 1w or 0.5v out (mV)</td>
<td>9.8</td>
<td>Good</td>
</tr>
<tr>
<td>Output level, tape outputs, at rated output (mV)</td>
<td>9.8</td>
<td>Good</td>
</tr>
<tr>
<td>Output level, headphone jack, at rated output (mV or mW)</td>
<td>700 mV</td>
<td>Good</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequacy of program source and monitor switching</td>
<td>Excellent</td>
<td>Excellent</td>
</tr>
<tr>
<td>Adequacy of input facilities</td>
<td>Excellent</td>
<td>Superb</td>
</tr>
<tr>
<td>Front panel layout</td>
<td>Excellent</td>
<td>Very good</td>
</tr>
<tr>
<td>Action of controls and switches</td>
<td>Excellent</td>
<td>Good</td>
</tr>
<tr>
<td>Design and construction</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>Ease of servicing</td>
<td>Good</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OVERALL AMPLIFIER PERFORMANCE RATING</th>
<th></th>
<th></th>
</tr>
</thead>
</table>

Table 3 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-ampifier, 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.

Radio-Electronics Audio Lab Tests

dbx, Inc. Model 2BX Dynamic Expander

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 "loudest" signal the "softest" 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 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...
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 a loud, dissonant sort of heavier 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 left 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, the difference in levels between the two signal components is now around 12 dB. No single-band expander could have achieved these results.

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 tonal quality of reproduced program material.

The overall product analysis 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.

---

**TABLE 1**

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

**EXPANDER PERFORMANCE MEASUREMENTS**

<table>
<thead>
<tr>
<th>SPECIFICATIONS</th>
<th>R-E Measurement</th>
<th>R-E Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expansion ratio range (%)</td>
<td>0 to 50</td>
<td>Excellent</td>
</tr>
<tr>
<td>Transition level range (volts)</td>
<td>0.015-3.0</td>
<td>Excellent</td>
</tr>
<tr>
<td>Frequency response at 1:1 expansion (Hz-kHz, ±dB)</td>
<td>20-35, 0.5</td>
<td>Excellent</td>
</tr>
<tr>
<td>THD at 1:1 expansion (%)</td>
<td>0.02</td>
<td>Excellent</td>
</tr>
<tr>
<td>at 20 Hz</td>
<td>0.02</td>
<td>Excellent</td>
</tr>
<tr>
<td>at 1 kHz</td>
<td>0.02</td>
<td>Excellent</td>
</tr>
<tr>
<td>at 20 kHz</td>
<td>0.02</td>
<td>Excellent</td>
</tr>
<tr>
<td>THD at maximum expansion (%)</td>
<td>0.1</td>
<td>Excellent</td>
</tr>
<tr>
<td>at 20 Hz</td>
<td>0.037</td>
<td>Excellent</td>
</tr>
<tr>
<td>at 1 kHz</td>
<td>0.045</td>
<td>Excellent</td>
</tr>
<tr>
<td>at 20 kHz</td>
<td>0.02</td>
<td>Excellent</td>
</tr>
<tr>
<td>IM distortion, 1:1 expansion (%)</td>
<td>0.18</td>
<td>Excellent</td>
</tr>
<tr>
<td>Maximum output level (volts)</td>
<td>7.0</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

**SUBJECTIVE EVALUATIONS**

- Attack time: Excellent
- Decay time: Good
- Noise-reduction effect: Very good
- Effectiveness of controls: Excellent
- Ease of installation: Excellent
- Ease of use: Very good
- Additional features: Excellent

**OVERALL EFFECTIVENESS OF EXPander**

**TABLE 2**

**OVERALL PRODUCT ANALYSIS**

<table>
<thead>
<tr>
<th>RETAIL PRODUCT</th>
<th>$450</th>
<th>Medium/high</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price category</td>
<td>Very good</td>
<td>Excellent</td>
</tr>
<tr>
<td>Price/performance ratio</td>
<td>Sound quality</td>
<td>Excellent</td>
</tr>
<tr>
<td>Staging and appearance</td>
<td>Mechanical performance</td>
<td>Very good</td>
</tr>
</tbody>
</table>

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 2BX 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 subject 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.
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AC VOLTS (40Hz to 5kHz): 0.1V to 600V; Accuracy: ±1.0% rdg ±0.5% f.s. (−2dB max. at 5kHz); Max. input: 600V
RESISTANCE (6 LOW POWER RANGES): 0.1Ω to 20MΩ; Accuracy: ±0.5% rdg ±0.5% f.s. (±1.5% rdg on 20MΩ range); input protected to 120VAC all ranges
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RE-8
How to modify an alarm clock for multiple alarms and long-term alarms.

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.

![Figure 1](image)

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 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.

![Figure 2](image)

**Table 1**

<table>
<thead>
<tr>
<th>Digit</th>
<th>on/hi/1</th>
<th>off/lo/0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>f</td>
<td>g</td>
</tr>
<tr>
<td>1</td>
<td>a,f</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>c,f</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>d</td>
<td>f</td>
</tr>
<tr>
<td>4</td>
<td>f</td>
<td>a,d</td>
</tr>
<tr>
<td>5</td>
<td>b,e</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>a,b</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>a</td>
<td>f,g</td>
</tr>
<tr>
<td>8</td>
<td>b,e,f,g</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>a,f</td>
<td>d,e</td>
</tr>
</tbody>
</table>

**Table 2**

<table>
<thead>
<tr>
<th>10's Hrs. Digit</th>
<th>Segments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>c</td>
</tr>
<tr>
<td>2</td>
<td>g</td>
</tr>
</tbody>
</table>

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
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.

---

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CIRCLE 59 ON FREE INFORMATION CARD

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*August 1979*
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, communication 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, 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 computerized 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
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 pushbuttons 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 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 cancels 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 some hobbyists 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.
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 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 8088, 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 8085 input and output signals such as interrupt (INT), interrupt acknowledge (INTA), reset, 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.

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: IO/M, RD and WR. The 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 RD and 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 MR, MW, IN and OUT signals that were discussed previously. Figure 1 shows the gating.

In almost all 8080-based systems, interrupts 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-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-

---

**TABLE 1—INTERNAL 8085 INTERRUPTS**

<table>
<thead>
<tr>
<th>Name</th>
<th>Restart Address</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRAP</td>
<td>000 044</td>
<td>Highest priority of all interrupts, nonmaskable, always &quot;on&quot;, both edge- and level-sensitive.</td>
</tr>
<tr>
<td>RST 5.5</td>
<td>000 054</td>
<td>Maskable, logic-1 sensitive</td>
</tr>
<tr>
<td>RST 6.5</td>
<td>000 064</td>
<td>Maskable, logic-1 sensitive</td>
</tr>
<tr>
<td>RST 7.5</td>
<td>000 074</td>
<td>Maskable, positive-edge sensitive</td>
</tr>
</tbody>
</table>

---

*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.
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**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>DC Volts</th>
<th>AC Volts</th>
<th>Hz Current</th>
<th>AC Input</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1 V</td>
<td>0.1 V</td>
<td>0.1 A</td>
<td>0.1 A</td>
<td></td>
</tr>
<tr>
<td>150 V</td>
<td>400 V</td>
<td>10 A</td>
<td>10 A</td>
<td></td>
</tr>
<tr>
<td>250 V</td>
<td>750 V</td>
<td>2 A</td>
<td>2 A</td>
<td></td>
</tr>
<tr>
<td>300 V</td>
<td>1000 V</td>
<td>1.2 A</td>
<td>1.2 A</td>
<td></td>
</tr>
<tr>
<td>500 V</td>
<td>2000 V</td>
<td>50 A</td>
<td>50 A</td>
<td></td>
</tr>
</tbody>
</table>

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- Output: 0 to 10 V
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AUGUST 1976
If the symptom is a horizontal bar, suspect the filter capacitors.

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 ¼-INCH TO ½-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 BRIGHNESS (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 µF 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 SCOPES 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 THE WAVEFORM, IT WILL SLOWLY WRITE 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 WRETCH. 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 MAGNAVOX MODEL CTU-15 HAD EXHIBITED AN ASSEMBLMENT 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 RESOLDERING 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.

ervice 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, look it apart and found . . . nothing! I put it 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 checkboxes 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 R395 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!”)

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HI-FI SPEAKER SYSTEM, the Wharfedale model Trosdale 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-
vides a frequency response from 40 Hz to 26 kHz ± 3 dB, and an 87-dB sound-pressure level for 1 watt at 1 meter. The Trosdale comes in walnut veneer, measures 23 x 13-1/2 x 11-inches, weighs 31 lbs., and has a suggested retail price of $270.—

REMARK Hi-Fi, Inc., 20 Bushes Lane, Elmwood Park, NJ 07407.

AM/FM STEREO RECEIVER. Realistic model STA-2100, provides 120 watts-per-channel in 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-μs 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, plus AM signal-strength and FM center-channel meters and power me-
ters.

The FM front end contains a MOSFET amplifi-
er, ceramic filters and PLL circuitry. Specifi-
cations include: For the amplifier: Frequency re-

sponse, 15 Hz—25 kHz ±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 μV (10.1 dB); 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' x 20'/x 16'/x 15-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 33⅓ RPM and 45 RPM. Speed variation is specified to be within ±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% WRM. Suggested retail prices: model AF977, $399; model AF967, $349.—Philips 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-

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

**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 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. The built-in pulse stretcher and memory switch. The model DP-1 provides single-pulse or 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.

**DISC SOFTWARE, model SL80-10F**
- Text editing system, model SL80-11F text processing system and model SL80-12F mnemonic assemblers, 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 restrict and page 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.

**MODEL 1650 $275**
- Functions as three separate power supplies
- 5V DC, 5A fixed output
- Two separate (A and B) 0 to 25VDC outputs at 0.5A
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**CIRCLE 121 ON FREE INFORMATION CARD**
- 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.

**CIRCLE 122 ON FREE INFORMATION CARD**
- 100-nz-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.

**CIRCLE 123 ON FREE INFORMATION CARD**
- Includes single 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.

**CIRCLE 124 ON FREE INFORMATION CARD**
- 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. The built-in pulse stretcher and memory switch. The model DP-1 provides single-pulse or 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.
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 TRANSEIVERS, the McKinley, Thomas J., and Andrew J., all provide a 4-watt AM power output (the McKinley has a 12-watt 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., 16651 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 X 7 dot 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 X 10 X 4 inches. Suggested retail price: $425.—Dynamic Electronics, Inc., Box 896, Hartselle, AL 35640.

MARINE TRANSCEIVER, model TI-2100, is a fully synthesized solid-state VHF/FM unit with programmable scan feature that enables simultaneous 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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August 1979
AC OUTLET CHECKER
continued from page 53

Once only if the outlet box itself is
grounded.
What happens all too often is that the
adapter gives the user a false sense of
security and he tends to forget the safety
precautions he once observed. Unwitting-
ly, he has created a system that can poten-
tially 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.

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

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 trans-
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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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AMELECT Clock Models CL7401A and CL7402 are available with complete sound.

FEATURING:
1. A realistic tic-toc sound: hear the seconds go by.
2. Beautiful, modified Westminster chimes have synthesized sounds composed of six frequencies. Four notes are provided on the quarter hour, eight notes on the half hour, twelve notes on the three quarter hour, and sixteen notes on the hour.
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4. Chime volume, tic-toc volume, pitch and decay are adjustable.

Available assembled or in kit form. Can easily be added to any Amelect Clock.

Silent Models

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<tr>
<th>Kit</th>
<th>Assembled</th>
<th>With Base</th>
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<tr>
<td>CL 7401A</td>
<td>$55.00</td>
<td>$75.00</td>
</tr>
<tr>
<td>CL 7402</td>
<td>$71.50</td>
<td>$95.00</td>
</tr>
</tbody>
</table>

Chimes Models

| CL 7401A | $94.00 | $114.00 |
| CL 7402 | $110.50 | $140.00 |

Indiana residents include 4% sales tax.

Shipping and Handling $3.50
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RADIO-ELECTRONICS

PRECISION DMM
continued from page 79

TABLE 2—MULTIMETER CALIBRATION SEQUENCE

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

°C = 5/9 (°F − 32)
°F = (9/5X°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.
null
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(Please print each word separately, in block letters.)

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Indicating Lamp, and 3/8" Tapered Glass Surface for
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Use for D.C. or A.C. applications. Interchangeable
heats. Ordering Information: Cat. No. 920U5150

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LASER DIODES

Rated - 5 Watt
Waveband - 940 nm
Cat. No. 920U2300

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$1

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1/4" $1.95
3/8" $2.50
1/2" $3.50
3/4" $5.99

ORDER:

HOW TO ORDER

MECHANICAL

CIRCLE 15 ON FREE INFORMATION CARD
<table>
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<th>MODEL</th>
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**FLOPPY DISK DRIVES**

- **1. VISTA V-60 MINI/DISK FOR TRS-80**
  - 23% More Storage
  - Capacity: 40 tracks
  - Faster Drive
  - Up to 4 Times Faster
  - Write Protect
  - Kit: $349.95

- **2. FLOPPY DISK SYSTEM**
  - Built-in 800K Drive
  - Case & P/S
  - V-999 $999.00

- **EXPANDORAM MEMORY KITS**
  - Write Protect
  - Power Supply
  - Phantom
  - Expandable 8K to 16K, 32K, 64K, 128K, 256K, 512K

- **IMS STATIC RAM BOARDS**
  - Memory Mapping
  - Low Power
  - Phantom
  - Assembled and tested

- **ANAXE PRINTER**
  - Model OP-9000 compact, parallel or serial, Sprocket feed, 80 cols.
  - 8x10 in., b-directional
  - New only: $499.00

- **VERBATIM® DISKETTES**
  - 40 tracks
  - 800K in 10 minute
  - 30 tracks

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**APPLE/EXIDY/EXPANDO**

- **1. TRS 80 16K UPGRADE KIT**
  - For Level I or Level II
  - $62.95

- **2. TRS 80 TO S-100 PET TO S-100 ADAPTER**
  - Allows PET/TRS 80 to be interfaced to S-100 Bus
  - $189.95

- **3. KEYBOARD ASCII ENCODER**
  - New Surplus key encoder.
  - $49.95

- **4. UV "Eeprom" Eraser**
  - Model UV-31 $64.95

- **5. TARBELL FLOPPY INTERFACE**
  - IBM Model 27/Dual Disk Drive
  - $216.95

- **6. BYTE USER 8K EPROM BOARD**
  - Power on Jump
  - Assembly and tested
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- **7. S-100 FLOPPY DRIVE**
  - 8 bit expandable with 8K com.
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**ACOUSTIC MODEM**

- **1. NODON CAT**
  - 2,300 32,700 baud
  - $119.95

**ACOUSTIC COUPLER SPECIAL**

- **1. DISK DUMP UNIT**
  - SPECIAL PURCHASE
  - $19.95

**DATA BOOKS**

- **1. COMPUTER BOOKS**
  - 3010 Computer System
  - 3010 Disk System
  - 3010 Language System

- **2. DATA TRS-80 COMPUTER BOOKS**
  - 4000M Time Sharing System
  - 4000M Computer System
  - 4000M Language System

**MICROPROCESSORS**

- **1. STATIC RAM HEADQUARTERS**
  - $74.95

**SOCKETS**

- **1. LPT CONNECTORS**
  - $79.95

**DISPLAYS/OPTO/LED'S**

- **1. LED'S**
  - Pack of 2 $5.95

**CRYSTALS**

- **1. MICROCHIPS**
  - Time Saver TV Guide
  - $9.95

**WAVEFORM GENERATORS**

- **1. TRANSPONDER**
  - 20 MHz

**FLOPPY DISK I/O**

- **1171-01 I/O & Monitor**
  - $129.95

**COMPUTER SPECIALS**

- **1. PET SPECIAL**
  - 4-Port Card
  - $49.95

- **2. ATTACHMENT PET USERS**
  - PET Computer Kit
  - $49.95

**MONTHLY IC SPECIALS**

- **1. CYCLOPS**
  - $9.95

**TV CHIPS**

- **1. TV SOURCE**
  - $29.95

**ADDRESSES**

- **1. P.O. BOX 17329 Irvine, California 92713**
  - Phone (714) 558-8813
  - TWX: 910-595-1565

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Outstanding Performance

Incredible Price $89.95

CIRCUIT

The CT-50 is a versatile and precision frequency counter which will measure frequencies to 60 MHz and up to 600 MHz with the CT-500 option. Large scale integration, CMOS circuitry and solid state display technology have enabled this counter to match performance found in units selling for over three times as much. Low power consumption, typically 300-400 ma makes the CT-50 ideal for portable frequency counter applications.

Features of the CT-50 include: large 8 digit LED display, RF shielded all metal case, easy pushbutton operation, automatic decimal point, fully socketed IC chips and input protection to 50 volts to insure against accidental burnout or overload. And, the best feature of all is the ease at which the CT-50 can be assembled into a compact, easy to step instructions guide you to a finished unit you can rely on. Order your today!

CT-50 - 60 MHz counter kit $59.95
CT-50KT - 60 MHz counter kit wired and tested $95.95
CT-600 - 600 MHz scaler option, add 29.95

OP-AMP SPECIAL

741 minidip 12/3.00 $12.00
CD-3, 12 hour clock $22.95
CD-3 wired and tested $29.95
110V AC adapter $3.95

VIDEO TERMINAL

A completely self-contained, stand alone video terminal card requires only an ASCII keyboard and TV set to become a complete terminal unit. Two units available: common features are: single 9V supply, TTL compatible control and baud rates (to 9600), complete keyboard and control circuitry. Error parity control and display. And generates serial ASCII plus parallel keyboard input. The 3216 is 32 columns by 16 lines. Includes two memory buffers. The 6416 is 64 columns by 16 lines, with scrolling, upper and lower case (optional) and has RS-232-20mA loop interfaces on board. Kit includes sockets, ferrite beads, and complete documentation.

RE 3216, terminal card $19.95
RE 6416, terminal card $18.95
Lower Case option: 6416 only $12.95
Power Supply Kit $14.95
Video-RF Modulator, VD-1 $6.95
Assembled, tested units $6.00

CALENDAR ALARM CLOCK

The clock that's got it all: 6-5 LEDs, 12 or 24 hour display, 24 hour alarm, 4 year calendar, battery backup and lots more. The super 7001 chip is used. Size 5x4x2 inches. Complete kit, less case (not available) DC $9.49

30 Watt 2 mtr PWR AMP

Simple Class C power amplifier features 8 times gain. 1 W in for over 150 W out for 30 ore. Max output of 35 W is incredible value. Complete with all parts, easy to assemble and easy to repair.

PA-1: 30 Wp power amp kit $22.95
TR-1: RF sensed TR Relay kit $6.95

FM WIRELESS MIKE KIT

Transmits up to 300 ft to any FM broadcast radio. Use any type of mike. Runs on 3 to 9 V battery. Type FM-2 has added sensitive mic pre-amp. FM-1 kit $5.95.

FM-2 kit $9.50

COLOR ORGAN/MUSIC LIGHTS

See music come alive with 3 different lights flicker with music. One light for each of 3 different music notes and up to 1500W for the highs. Each channel individually adjusted and attenuated to any level up to 300W. Great for parties band music, rock n roll and more.

Complete set $79.95

FM LINKY BLINKY KIT

A great attention getter which allows badges, buttons, warning lights, anything runs on 3 to 15 volts.

Complete kit $5.95

SUPER SLEUTH

A super sensitive FM pickup which will pick up a pin drop at 15 feet. Great for monitoring baby room or at a small group, complete amplifier full kit.

Wires: 8 to 10 volts input. Complete kit: EN-9 $5.95

SIREN KIT

A great instrument kit which produces three tones and down and downward when activated. Complete kit: PS-1LT $5.95

SPECS:
Frequency range flat from 6 to 65 MHz, with CT-600: 200 KHz at 6 sec. 1K Hz at 1 sec. Baud rates 8 digits 94" high LED, 16 digits in 18 cm. Accuracy adjustable to ±0.5 ppm

For additional information on this kit, call our FAX and ORDER line at 716-271-6487.

FM MINI MIKE KIT

A super high performance FM microphone kit that transmits a stable signal up to 300 yards with exceptional audio quality by means of its built in equalizer and mike kit includes microphone, on-off switch, antenna, battery and super instructions. This is the finest available unit.

FM-3 wired and tested $12.95

FM LINKY BLINKY KIT

Wired and tested clocks add $10.00 to kit price.

Ramsays famous MINI-KITS

FM-3 TRANSISTORS 10116
0.02, 100 2.00 Micro
0.05, 200 1.50 Micro
0.1, 1000 1.00 Micro
1.0, 10,000 0.50 Micro

CT-50 TRANSISTORS 10121
10, 200 2.00 Micro
100, 2000 1.00 Micro
200, 20,000 0.50 Micro

Ramsay Electronics
BOX 4072, ROCHESTER, N.Y. 14610

PHONE ORDERS (716) 271-6487

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Mini-Multimeter

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MODEL LX303
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CIRCLE 49 ON FREE INFORMATION CARD
100 W CLASS A POWER AMP KIT

Dynamic Bipolar Class "A" circuit design makes this unit unique in its class. Crystal clear, 100 watts output power will satisfy the most picky fans. A perfect combination with the TA1020 low T.O.A.K. pre-amp.

Specifications:
- Output power: 100W RMS into 4-ohm
- Frequency response: 10Hz - 100KHz
- T.H.D.: less than 0.006%
- S/N ratio: better than 80dB
- *Power supply: 240V @ 5amp

TA-1000 KIT $51.95

Power transformer $15.00 each

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 Seko Box you pay $30.00 for the name! Features:
- 24 hour alarm
- Chronograph counts up to 12 hrs., 59 mins. 59.9 sec.
- Precise of chronograph in 1/10 sec. indicated by moving arrow!!
- Lap time (with chronograph running uninterruptedly)
- Time displays by LCD for hour, min. sec. day, date, day of the week and AM/PM.
- Calendar gives date 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;

The elderly, the young, the blind, the deaf, all can enjoy the comfort and sophistication of a personal timepiece.

SPECIAL $19.95

ALL UNITS FACTORY ASSEMBLED AND TESTED—NOT A KIT!

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 conden-
ser. Used in-built plastic tube type case; mike is 6"/15cm long. With a standard FM radio, can be heard anywhere on a one-acre lot; sound quality was judged very good.

$16.50

HICKOK LX303 DIGITAL LCD MULTIMETER

- 3½ digit 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 V to 1000 V
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- Resistance: 0.1Ω to 20 MΩ
- D.C. current: 0.001A to 100 A

CALL FOR OUR DISCOUNTED PRICE

$60.00

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

Incorporates brand-new D.C. design that gives a frequency response from 0Hz to 100KHz ±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 0.006% *Frequency range: DC to 100KHz ±0.5dB *RIAA deviation: ±0.2dB *S/N ratio: better than 80dB *Sensitivity Phono 2MV 47K/Aux. 100MV 100K *Output level: 1.3V *Max output: 15V Tone control: +10dB @ 50Hz/teeble +10dB @ 15kHz *Power supply: 24 D.C. @ 0.5A

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

ONLY $44.50

$14.00

MARK IV 18 STEPS LED POWER LEVEL INDICATOR KIT

This new stereo level indicator kit consists of 36 color LED (18 per channel) to indicate the sound level output of your amplifier from -36dB to +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 kit can work with any amplifier from 1W to 200W!

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

MARK IV KIT $31.50

JUMBO 1" LED ALARM CLOCK MODULE

Assembled—not a kit!

Features:
- 4 digit LED display
- 12 hour AM/PM time format
- 24 hour alarm audio output (just plug speaker)
- Power failure indicator
- Count down time: 50 mins.
- 12/60V AC 50/60Hertz input
- 10 min. snooze control
- Red display $10.50 each
- Green display $8.50 each
- Transformer $1.75

FM WIRELESS MIC KIT

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

KIT FORM $7.95

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 100Hz and 10KHz.

$32.50 PER KIT

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 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!

CIRCLE 33 ON FREE INFORMATION CARD
SUPER 15 WATT AUDIO AMP KIT

Uses STK-015 Hybrid Power Amp
Kit includes: STK-015 Hybird 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 and response from 20-100,000 Hz. This amplifier has QUASI-Complimentary class B output, Output max is watt (10 watt RMS) at 4Ω.

ONLY $23.50 each

REGULATED DUAL VOLTAGE SUPPLY KIT
3.9 to 30V DC 800 mA adjustable, fully regulated by Fairchild 7814G and 7914G 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!
Solid state sound indicator operating voltage 6V DC 30µA. A small fuse approximately 0.5" x 1.5". Model EB2116 (Continuous) Model EB2118 (Slow Pulse) Model EB2136 (Fast Pulse)

$3.60 EACH

1 Watt AUDIO AMP
All parts are pre-assembled on a mini PC Board
Supply Voltage 6V - 9V DC
SPECIAL PRICE $1.55 ea.

“FISHER” 30 WATT STEREO MP
Main Amp 1SK X 7
IC included. Pcb (single sided) is designed for use with different parts and DC supply voltages. Includes parts list and instructions, with $1.20 (not included), Power Supply +15V (±1%), 12V DC 20mA, 6 Volt 200mA, 6 Volts 200mA. Power Supply Only $11.50

5W AUDIO AMP KIT
2 LS 6,No 405 and Collo Q - Q Power Supply 6V - 18V DC
ONLY $6.00 EACH

WE FOUND THE CASE FOR THE FM MIC!
Small yet looking aluminum case lets you use a pack of cigarettes, TV remote control or watch our antique box for many projects. We give you the circuit diagram.

SUB-MINI SIZE SPDT RELAY
Ideal for use in mini circuits, contact rated at 1Amp 12V DC. Coil resistance 350Ω, standard 0.1" lead spacing allows it to plug into a 1/4 pin I.C. socket. 12V DC type $2.50 ea. 5V DC type $3.50 ea.

ULTRA SONIC SWITCH KIT
Kit includes the Ultrasonic Transducers, 2 PC Board for transmitter and receiver. All electronic parts and instructions. Easy 50 IC and a lot of fun uses as remote control for TV, garage door opener 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


$2.75 per pair

BECKMAN FET LIQUID CRYSTAL DISPLAY

Overall size 2" x 1.25" 0.5" characters reflective type

Model 737-01 — for clock 4 digits with PM, alarm, snooze, 0-20 degree indicators.
Model 739-04 — for panel meter 4 digits.
Model 739-03 — for panel meter 3 digits with 0-20 degree and over range indicator.

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

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Kit includes high voltage coil, power transistor, heat sink, all other electronic parts and PC Board, light new included. $19.50 EACH

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10 pairs — 5 colors Alligator clips on a 2" long lead. $2.20/pack for any testing.

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Mini-Sized I.C. AM RADIO

Size small for that box of matches! Receives all AM stations Batteries and ear phone included.

Only $10.50

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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, 78 pin dip, we supply the data. $2.90 EACH

MINI SIZE PANEL METER

500 UA

ONLY $1.20 ea.

ELECTRONIC PASSIVE KIT

500 UA

ONLY $1.20 ea.

All parts are made of High Quality 50 Fiber-glass and Phenolic. Printed in 0.012" diameter lines on 0.1" centers with 10 mil copper over 0.008" thicknesr (large size) to allow you to select standard components in 10 board. $7.45 ea.

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H-5614 3 1/4" x 7/8" 1.70
H-5616 3 1/4" x 7/8" 1.90
H-5626 3 1/4" x 7/8" 1.90
H-5634 3 1/4" x 7/8" 1.90
H-5666 3 1/4" x 7/8" 2.30
H-5696 3 1/4" x 7/8" 2.70
H-5698 3 1/4" x 7/8" 2.70
H-5699 3 1/4" x 7/8" 2.70

GIANT SIZE VU METER

1MA movement 3 1/2" scale length. Scale in VU 20db to +10db. Meter face 3 1/8" x 3 2/8" with a "smoke" glass cover.

$8.50 EACH

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INTERFACE SUPPORT CIRCUITS

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<td>2102LP</td>
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<td>2101PC</td>
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**MOS Static RAM's**

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<td>32 PIN</td>
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**MOS Dynamic RAM's**

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<td>AY3-1015</td>
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<td>LED220</td>
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<td>T31012</td>
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<td>T31017</td>
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