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ON THE COVER: Voltage check on the underchassis of a television receiver, Kodachrome by Avery Slack.

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NBC's experimental ultra-high-frequency television station KC2XAK at Bridgeport, Conn. Engineer Vic Barry is at the controls and technician John Piorek logging the dial.
Kodachrome by Avery Stack.

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Larry Le Kashman and his daughter Patricia in a Christmas scene at his station W2IOP. Kodachrome by Avery Slack.

WATCH FOR THE JANUARY ANNUAL TELEVISION NUMBER

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Kodachrome by Avery Jacks.

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Bob Gunderson and test gear in his radio lab, sound studio and ham shack at the Institute for the Education of the Blind, New York, N. Y. Kodachrome by Avery Stock

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Miniature magnetron and tuner, with its power supply and a wavemeter, in a test setup.
Kodachrome original by Avery Slack

August, 1951


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October, 1951 |

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The new mobile television service station of Appliance Distributors, Inc., Chicago, with technician Ben Schneider at the service bench.

Ektachrome original by Fran Byrne

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Paul Chirlian, New York University, and the antenna designed by the university's Electrical Engineering College to range from 100 kc to 4,000 mc. Ektachrome original by Avery Slack

November, 1951

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The television truck designed to increase the number of students who might be able to "see" a military problem under actual field conditions. (Color photo courtesy of RCA.)
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ON THE COVER
Model Claudia Laymon compares the quality of two Audioneer-controlled musical selections. Battery of speakers is part of the demonstration room described in the article on page 36. Color original courtesy: Allied Radio Corporation

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**ON THE COVER**
An action photograph (taken during the actual broadcast of the Today show from the studio in the RCA Exhibition Hall, New York City. Garroway is the middle one of the three standing men. Color original by Avery Slack
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ON THE COVER (See page 50)
The transistor sawtooth oscillator which was developed by Dr. H. Gunther Rudenberg for Raytheon. The transistor is behind the magnifying glass and its output is delineated on the cathoderay scope screen.

Color original courtesy of Raytheon Mfg. Co.

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Measurements and tests on new uhf TV antennas on roof of one of the RCA buildings at Camden, N. J. Vertical bars at rear are part of Philadelphia bridge, not a new antenna.

Color original courtesy of RCA
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CORRECTION
There is an error in the diagram of the portable receiver in the article “A More Compact Battery Portable” on page 90 of the September issue. The 15,000- and 120,000-ohm resistors in the last two audio stages should return to the negative side of the 4.5-volt battery—not the positive side as in the diagram.
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HEARING AIDS REPAIRED

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DECEMBER, 1956

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emitter and collector, and housed in the same package. This of course takes less space, less time to install; is cheaper to make and cheaper to use than sep- rate semiconductor components.

The new device comes in TO-3 and TO-41 (similar to TO-3 for shape and orientation of connections) packages with a variety of voltage and current ratings to suit particular applications. The diagram shows the simplest of sev- eral possible transistor ignition circuits suggested by Bendix for the Ignistors. The devices must be heat-sunk with a thermal resistance of about 2°/watt.

Rectangular color CRT here
The long-awaited 23-inch rectangular-color TV picture tube is here. Motorola announced the new tube in a full-page ad in the Sunday, April 12 New York Times.


Compared to the standard 21-inch round tube, the new one has 274 square inches of viewing area, according to Motorola, instead of 261. The tube is 5.2 inches shorter than the conventional design. It is made by National Video Corp.

Tiniest diodes?
A diffused-junction diode with a double-glass hermetic seal may turn out to be the last of its kind. The conventional diodes are so bulky that it is difficult to imagine complete diode assemblies any smaller (see photo)—these are about .060 inch in diameter and .030 inch high.

The design is available from Hughes Aircraft Semiconductor Div in 10 varieties covering ratings up to 100 volts and 300 ma with 2-msec switching speeds. The diode consists of a glass ring, which contains the silicon die already sealed in a layer of glass, and two metal end caps. It can replace several dozen existing diode types.

Sylvania plans 90° color CRT
Samples of a new 90°, rectangular color TV picture tube are expected to be available late in 1964, according to Merle W. Kremer, general manager of the Electron Tube Div of Sylvania.

Tentative specifications are being made available to manufacturers so that they can get started on cabinet designs.

For the time being, Sylvania intends to continue producing its 21-inch 70° round tube.

END
**POTENT NEW PRE-AMPS FROM WINEGARD**

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- **Can Be Used on Any TV Antenna for Black and White, Color or FM**

AP1ST SPECIFICATIONS:  
- **Gain:** flat 33DB per band. SIGNAL OUTPUT: 2,000,000 MV. INPUT IMPEDANCE: 75 ohm. OUTPUT IMPEDANCE: 75 ohm, 117V 60CP. 1.8 watts. List price only $79.95.
- **AP2S0T** (300 ohm) and AP27ST (75 ohm). SPECIFICATIONS:  
  - **Gain:** flat 16DB per band. BANDPASS: 54MC-108MC, 174MC-216MC. INPUT IMPEDANCE: 300 ohm. OUTPUT IMPEDANCE: 300 ohm, 117V 60CP. 1.8 watts. List prices: AP2520T only $44.95, AP27ST only $49.95. Ask your distributor or write today for spec. sheets.

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**Tran-Transceiver/Type Probe (Burke)**

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CJ Service Clinic
Corr Correction
NB News Briefs
NR Clipboards
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TTO Try This One
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This is the all-new, all-transistor Schiber Recital Model—the most versatile electronic organ available today. Its 32 voices (plus amazing "Library of Stops"), 6 couplers and 5 pitch registers delight professional musicians...make learning easier for beginners. Can be used to ready-built organs selling from $500 to $600.

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Sutheim

JUNE, 1963

Small World (Sutheim) 49

This formula gives an acceptable close value only when the series feedback resistor is much larger than the resistor (or other ac impedance) across which the feedback is applied—usually the cathode resistor (or part of it) of an earlier stage. Generally, the series resistor is about 20 times the value of the cathode resistor, and since you will generally be using 10% resistors, the computation isn’t too critical anyway (10% voltage equals approximately 1 dB).

If there is a phase-shifting capacitor across the series feedback resistor, it must be changed also. Its value is found by the inverse relationship

\[ C_2 = \frac{1}{2 \pi f R_2 Z_2^*} \]

(Note that Z1 and Z2 are interchanged.)

—Radioelectronics (Australia)

CORRECTION

It looks like our EQ (editorial quality?) slipped when editing this column; the May issue. The polarity of diode D1 was inadvertently reversed in the diagram for the first question. This error was noticed by quite a few sharp-eyed readers. The first report it was E. Nowak, Jr., of Saginaw, Mich. We are sorry if this error made the problem harder to solve.

C2 = C1 \sqrt{\frac{Z_1}{Z_2^*}}

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Improve your tape recorder techniques and get more mileage out of your tapes. Norelco's Carry-Corder 150 portable Cassette tape recorder shown here is typical of the newest generation of popular type of battery-operated units. See page 60.

Join the FET set with this sensitive field strength meter. You can tune it to a specific frequency and gauge the output of most any CB, ham or commercial transmitter. See page 48.

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Too Much Contrast, No Control
The picture in an RCA CT631 got gradually darker; color, sound, etc. ok. Brightness control works, but contrast control doesn’t seem to have much effect. Video peaking control has very little effect if any. Contrast control checks ok. Video output tube ok. Where is this?—H. T., Houston, Tex.

The contrast control here comes into play, type of "variable degeneration" type, like so many others. What it actually does is move a big electrolytic cathode-bypass capacitor up and down on the cathode resistor. If this capacitor opens, your picture will be "pale," and the control will have no effect.

However, you have the opposite effect: too much contrast. Note that this circuit actually has three branches: the contrast control itself; a small fixed peaking network, 270 ohms and 680 pF in series; and the video peaking network. I have a distinct feeling that something is shorted in here.

If the electrolytics were shorted, the control would still show some effect. Therefore, the short is most apt to be "at the top of the control" or

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200 1.75 1.40
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X-Ray Detector is great for that final check before you button up the back of the TV. . . . see page 36

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Interesting in photography? Then here's a little meter for your gadget bag. Use it once and you'll wonder how you ever got along without it.

November 1971

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ON THE COVER
Electronic music organs have been around for quite awhile, but portable organs are really unique. This one is completely self-contained with speaker, battery and keyboard, and it covers a five-octave range. The construction details start on page 31.

Spice up your car with this Digital LED Clock. The construction details start on page 13.

You can’t compare noise specs for Hi-Fi gear unless you know how they are measured. An in-depth look at how noise measurements are made starts on page 49.
ON THE COVER

40-channel CB went into effect January 1, 1977. Right now, all kinds of 40-channel gear is on sale. The 40-channel dial on our cover symbolizes this development. To bring you all the latest information we have produced the special 16-page section starting on page 69 of this issue.

THIS TEST SIGNAL was used to test a new concept in speaker design. Get the whole story. See story starting on page 64.

PITCH BENDER BOARD is important part of keyboard synthesizer. See page 58.

As a service to readers, Radio-Electronics publishes available plans or information relating to newsworthy products, techniques and scientific and technological developments. Because of possible variances in the quality and condition of materials and workmanship used by readers, Radio-Electronics disclaims any responsibility for the safety and proper functioning of reader-built projects based upon or from plans or information published in this magazine.
ON THE COVER
That's Len Feldman sitting in JVC's special biphonic chair. If you want to know what he is hearing, see our special story starting on page 40.

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A 2650-based microcomputer with impressive features. Built on a single PC board, the microcomputer contains RAM, ROM, video and cassette interface. Add a power supply, keyboard and video monitor for a complete working system. Get started in the microcomputer revolution today. Construction details starts on page 31 of this issue.

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**SELECTING THE RIGHT MULTIMETER for servicing is important.** Tips start on page 57.

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**VERSATILE XR-2206 FUNCTION GENERATOR** is put through its paces in practical circuits you can build. Story starts on page 36.

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**SYMmetry Adjust**

**WAVEform Adjust**

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ON THE COVER
Programmable divider provides a wide range of frequency division by using three cascaded 555-timer IC stages. The divisor is selected by three 10-turn potentiometers and indicated by an LED readout. Complete story starts on page 37 of this issue.

THIS KEYBOARD CONTROLS channel selection and programs a new TV set to automatically switch channels for you. It's an important part of Heath's programmer system. For full details turn to page 49.


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**ON THE COVER**

Another great construction project from *Radio-Electronics*. This one updates your TV set with an on-screen digital readout of the time. The clock is built around a character generator from National Semiconductor that provides you with a choice of either a 4- or 6-digit readout of the time. Get started today; turn to page 35.

**ELECTRONIC SLOT MACHINE** you'll want to build. Digital readout of the score plus realistic odds makes this a great addition to your game room. Construction details start on page 39.

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Biorhythm clock keeps you up to date on good versus bad days. Three-color digital readout tells at glance where you are in your Physical, Intellectual and Sensitivity cycles. For full details on how to build your own turn to page 33.


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RIGHT-HAND POLARIZED TV signal can bring better TV reception in US. For the whole story turn to page 38 now.

Interrupt Page Monitor is one aspect of the Z-80 microprocessor. For more data on the Z-80 see Computer Corner on page 78


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ON THE COVER

Sitting atop the stereo receiver is this month's featured construction project. It provides a digital readout of the frequency that the receiver is tuned to. Works with AM/FM receivers; and, when not displaying frequency, it's a digital clock. For complete details on how to build your own, turn to page 21.

HANDY TOOLS AND GADGETS for the hobbyist, experimenter and service technician that will make life a little easier and will give your work a professional look. Story starts on page 33.

HOW TO TEST PHONO CARTRIDGES yourself by using readily available test records. The waveforms shown are recorded on a test record to test for IM distortion. For the whole story, turn to page 51.

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Radio-Electronics
THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS
Electronics publishers since 1908

FEBRUARY 1978 Vol. 49 No. 2

ON THE COVER
We've combined an Apple II hobby computer, an RCA Videotape machine and an RCA 19-inch color TV to put this month's cover together. We used the VTR to record the many different color displays the Apple produced. For more info on hobby computers turn to page 45. If it's the VTR you want to know about turn to page 52.

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ON THE COVER
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A BASIC DIGITAL PANEL METER. Turn to page 40 to see how to build this and then turn it into a complete digital multimeter.

B.I.C.’s MODEL FM-10 BEAM BOX indoor FM antenna. R-E’s Hi-Fi Lab puts it through its paces. For a complete report, turn to page 66.


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Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS
Electronics publishers since 1908

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ON THE COVER
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NEW RIAA EQUALIZATION CURVES. Note the rolloff in playback response in the low-frequency region. For full details turn to page 52.

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ON THE COVER
That's a 12-band graphic equalizer you can build for your stereo system. It's just about everything a graphic equalizer should be plus it's fun to build. Check it out. Turn to page 37 now.

FIRST QUARTER
LORD THROUGH THIS HOUR,
BE THOU OUR GUIDE
SO, BY THY POWER
NO FOOT SHALL SLIDE.

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IF YOU ARE PROTOTYPING you’ll need sockets like these plus a lot of other hardware. Find out what’s available and where you can get it. Turn to page 57.


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**ON THE COVER**

When you want to keep track of long-distance phone charges, the first thing you need is a record of how long you’ve been talking. Digi-Toll does just that. It also reminds you, with a bright red digital readout right at your phone, of how long you’ve been talking. See construction details starting on page 69.

---

**LED BAR GRAPH** is a nifty substitute for an analog meter... and it's easy to read. Turn to page 78.

---

**CABINETS FOR PROJECTS** helps answer that problem question of “What cabinet should I use?” Five pages of listing start on page 73.

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ON THE COVER
Unique darkroom timer counts down in either seconds or minutes and seconds. Precise digital readout and audible pulses too. See page 33.


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ON THE COVER
Sitting on a background of video modulators is a digital thermometer add-on for a digital multimeter. It's a highly accurate instrument that reads out in both °C and °F at the flip of a switch. Story starts on page 29.

Simple Test Circuit is used to set up your new digital darkroom timer. For details on how to build the timer turn to page 33.

New Phono Cartridge plays stereo discs so well that it earns a "Superb" from our test lab. For all the details turn to page 44.


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A low-cost build-it-yourself capacitance meter you'll want on your bench. Get all the details. Turn to page 37 now.

Final Assembly of Flue-Bug. Spend a few dollars and save a bundle. Story starts on page 41.

ATV Research Pixe-Plexer. One of many video modulators reviewed in this issue. Turn to page 47.


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THE COVER
Compact function generator has a place on every readers bench. It delivers sine, square and triangle waves with minimal distortion. Build your unit from the details in this issue. The article starts on page 37.

VIDEOCASSETTE RECORDER ARE IN. This Q & A story answers typical user questions about this exciting new consumer electronics product. For all the answers, fast-forward to page 62.

KEEP IC PROJECTS SMALL. It’s easy to do once you know the basics. This month’s Hobby Corner tells all. Turn to page 80 now.


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ON THE COVER
That brick wall is made up of a large number of very special telephones. Take a look at the circuitry and how it works. Just turn to page 37.

NEW METAL-PARTICLE TAPE promises higher output levels with lower distortion. Story starts on page 49 and presents full details.

WIRED-OR/WIRED-AND is just one kind of digital circuit covered in digital troubleshooting story on page 41.


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The editors and staff of Radio-Electronics join in sending holiday greetings and our best wishes for a happy new year.

DESIGNING DIGITAL CIRCUITS from scratch. The step-by-step approach starts on page 63.
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ON THE COVER
Liquid crystal digital multimeters appear to be the wave of tomorrow. They may be inexpensive, highly accurate, offer multiple ranges and are readily available. In this issue we examine the circuitry and IC that have made this possible. For more info see the story starting on page 41.

PERSONAL COMPUTERS are the first two words out of the mouths of electronics activists these days. If you want to learn why they think computers first, our "Your Own Computer" Special Section that starts on page 47 is must reading.


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ON THE COVER
Videodisc by Magnavox. The background is the MCA optical videodisc itself. The player is superimposed. At the top right you can see it in action. At the bottom the disc is being inserted. For more information on this system as well as the RCA system turn to page 37.
(Cover photos supplied by Magnavox)

THIS IS ONE OF THREE marvelous construction projects specially designed just for April 1, 1979. The one shown here is a one-station intercom. For full construction details along with two more turn now to page 48.
ON THE COVER
A Time/Voltage Calibrator is a must if you have digital test equipment. It’s the only way available to most of us to keep our test gear calibrated. Learn how to build your own calibrator. Story starts on page 35.

PACE 8117 is a computerized CB transceiver. For more data see our new Communications Corner on page 68.

TITANIUM DISULFIDE COMPOUND is used in new Exxon rechargeable lithium battery. Read the whole story starting on page 44.


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ON THE COVER

Intelligent Thermostat can save you big fuel dollars. It not only adjusts the temperature several times a day, but it also sets it at different levels on different days of the week. Interested? Read all about it starting on page 35.

INTERFACE DEVICE provides matching and isolation between telephone and Telecorder. Want to build Telecorder? Story starts on page 82.

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**ON THE COVER**

Using an infrared sensor that clips to your finger, this Heart Rate Monitor provides a direct readout of your pulse rate in beats-per-minute. It also "beeps" to provide an audible indication. Sounds interesting? Read about it starting on page 35.

**HEART WAVEFORM** is detected by Heart Rate Monitor circuit to provide a direct readout in beats-per-minute. To see how it works, turn to page 35.

**COMPLEX WAVEFORMS** are needed to compare the performance of DC amplifiers. To find out why, turn to page 47.

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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 pots in authors' backyard. To find out what's being broadcast and the frequencies, turn to page 47.

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**THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS**

Electronics publishers since 1908

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Lab grade instrument with true-RMS and temperature.
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Polytonic Percussion Synthesizer
Easy-to-build modular system simulates congas, bongos, wood blocks and timpani. James J. Barbarelo

Adaptive Noise Filter
Part 2: Dynamic variable-cutoff low-pass filter removes the snap, crackle and pop from records and tapes. Tim Skormond & Gene Garrison

Home Reception Via Satellite
What's up there that you might want to watch. As many as 40 channels of more television than you've ever seen before. Robert B. Cooper, Jr.

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Electronic amplification for weak signals is feasible. Herb Friedman

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ON THE COVER
Fascinating percussion synthesizer simulates a variety of percussion instruments. Modular accessories make it even more valuable. Circuits are straightforward...construction is easy...equipment is inexpensive. Full details begin on page 43.

Commercial satellite TV receiving station uses huge dish and supersensitive receiver, but you can build your own. Story starts on page 47.

Build this adaptive noise filter to remove the snap, crackle and pop from your records and tapes.


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ON THE COVER

The photograph shows the front cover of the first issue of Radio-Craft (which eventually changed its name to Radio-Electronics). That first issue was printed in 1929 and to celebrate this occasion, we've put together a memorable look at those 50 years. The voyage starts on page 39.
ON THE COVER

This is one of the most exciting computer projects we've seen. It will enable you to interface almost any prototype circuit to a TRS-80 computer. Modified, it can probably do the same job for any other computer system. If you've got a computer, this story is must reading. If you don't own a computer, read this article first....story starts on page 43.

TELEPHONE DIALER Roundup. Some even come equipped with a calculator and clock. Story starts on page 48.

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**ON THE COVER**

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**FREEDOM DIALER** is just one of the many electronic telephone dialers covered in this issue. To see them all turn to page 42.

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ON THE COVER

The radio-controlled R2-D2™ robot toy manufactured by Kenner Products contains two PC boards, 3 motors, a 3-cell battery pack and even a speaker, but it has nowhere near the capability of a true android. To find out what a household android would require and how you can go about designing your own, turn to page 37.

IDENTIFYING UNMARKED IC's can be a real headache unless you know how to go about it. The full story starts on page 45.

THIS INEXPENSIVE SATELLITE ANTENNA makes backyard reception of satellite TV a reality. If you’re interested in building an inexpensive earth station, turn to page 55.


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The LED bar-graph audio power level meter shown is not a wattmeter, but a level indicator that is calibrated to your amplifier's clipping level. Use the device to protect your amplifier and speakers from power overloads. Shown in contrast to the LED bar-graph display is an analog power level meter. Get started building your own LED bar-graph power level meter today. Construction details start on page 43.

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JANUARY—DECEMBER 1979

To present the maximum number of articles to our readers, we have not published the Annual Index as part of this issue. A 4-page brochure containing this index is available for those who need one. To get your free copy, send a stamped self-addressed envelope (legal size) to:

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**ON THE COVER**

Featured on our newly designed cover is OK Machine and Tool Corporation's Just Wrap tool shown being used to wire wrap a prototype board. Also shown is Vector Electronics P183 forming and cutting tool.

Wire-wrap construction has many advantages over printed circuit boards for prototype construction. However, there are also several disadvantages. To find out how to overcome many of these disadvantages and how to make your wire-wrap projects faster, easier and sturdier, turn to page 46.

---

**SUPER CLASS-A AMPLIFIER uses new circuit techniques to radically reduce crossover distortion without any of the drawbacks associated with negative feedback. To discover how it's done, turn to page 57.**


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ON THE COVER

Even though it costs less than $125 to build, the triggered oscilloscope contains some rather nifty features. For example, a reference display of the zero volt DC level. To find out more and to get started building your own, turn to page 39.

MULTI-LINGUAL VOICE SYSTEM from Votrax can talk to you in seven languages. To find out what other speech synthesizer equipment is available, turn to page 44.

IF BANDPASS FILTER provides satellite TV receiver with the required selectivity. To find out the other missing components of the receiver, turn to page 47.


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ON THE COVER
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IT LOOKS COMPLICATED, and in fact, it is! It's the transport mechanism of a Betamax videocassette recorder. But don't let looks scare you off. To find out how to troubleshoot and fix it, turn to page 65.

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ON THE COVER

This unique function generator uses phase-locked-loop technology to overcome many of the shortcomings of commercially available units. Frequency stability is superb. Sine, square, and triangular waveforms are provided via a 50-ohm output jack. The generator also has a separate set of outputs to drive TTL loads.

TELEVISION—from the drawing board to a reality. Shown above is the Jenkins Projection Radvisor, developed in 1931. For a look at the history of television, turn to page 43.

DIGITAL AUDIO for the 1980’s. The squarewave response of Toshiba’s PCM recorder shows the improved performance of this new audio technology. For the rest of the details, turn to page 63.


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THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

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ON THE COVER

Sitting on the desk in front of the window is the thermostat portion of the Environmental Control System. This system connects to your heating, air conditioning and ventilating systems and controls their operation in accordance with inside and outside temperature, and humidity. Energy savings of up to 20% can be realized with this system. Get started building yours today. The construction details starts on page 43.

COAX VS. TWINLEAD for your TV antenna. Shown above is one of 9 steps in making ideal coaxial connections. For the other 8 steps and the full story, turn to page 48.

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HANDS FOR THE UNICORN-1 ROBOT are sole-noid activated. For details on how to assemble the manipulator arms and hands, turn to page 55.

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CIRCUIT DESIGN STATION
Prototype and debug your circuits using this battery-powered design station. James Barbarello

BUILD YOUR OWN ROBOT

A BYTE OF POWER AC CONTROLLER
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A winning circuit application from our readers.

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ON THE COVER
Digital dashboards, trip computers and microprocessors—electronics is finding its way into automobiles. This first part of a four-part series will explore how electronics is being applied to the automobile and its impact on the driver. For an in-depth look at digital dashboards, turn to page 45.

USING EQUIPMENT you already have, you can pinpoint the location of faults along coaxial transmission cables. This technique is especially useful for buried cables. For the complete story, turn to page 67.

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Electronics publishers since 1908

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JANUARY—DECEMBER
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To present the maximum number of articles to our readers, we have not published the Annual Index as part of this issue. A 4-page brochure containing this index is available for those who need one. To get your free copy, send a stamped self-addressed envelope (legal size) to:

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FIND OUT HOW laser videodisc players handle the complex signals inscribed on those shiny platters. The story starts on page 67.

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**ELECTRONIC SERVICING is entering a new era. Discover how a small shop can provide the services of a large organization. Story starts on page 79.**

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ON THE COVER

To understand how computers and microprocessor-based equipment works, it is necessary to understand how microprocessors work and how they're programmed. This month, we evaluate several single-board computers and the supplied documentation to determine how effective each one is as a learning tool. The story starts on page 45.

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The first integrated circuit made its appearance 20 years ago. It held four transistors. Today, devices containing well over 50,000 transistors are available and IC's with several hundred thousand transistors on a single silicon chip are in the planning stage. Learn where we've been and where we're headed. The story starts on page 41.

ALTHOUGH PRICES are slowing coming down, satellite TV antennas still represent a substantial investment. You can build the B-Ball for under $750, using readily available materials. Plans for this antenna begin on page 45.

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ON THE COVER

A reverberation system adds a sense of realism to any hi-fi system by duplicating the echoes associated with large concert halls. The reverberation device described in this issue is based on analog bucket-brigade IC's and it expands your listening room into a full-sized concert hall. The construction details start on page 43.

LISTENING TO A SCANNER receiver is becoming a popular pastime. This month we look at programmable scanners starting on page 53.

3D TELEVISION is just one of the amazing products that we describe. All are close to commercial introduction. Take a close look at this and other products starting on page 49.


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Flat-screen displays to make truly-portable, or "skinny" large-screen, TV's have been long awaited. Now, not one, but two, totally different means for achieving that goal have been demonstrated in working prototypes. The story of how those displays function starts on page 39.

**MANY FINE RECORDINGS** have been made without using noise-reduction techniques. A dynamic noise-reduction system can improve their sound. Find out how the process works starting on page 90.

Due to lack of space in this issue, Part 3 of the Programma-2 RF generator project will appear next month. We apologize for any inconvenience that may cause.

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**ON THE COVER**

Television has already revolutionized the way we live. A second TV revolution is now under way with the introduction of videotex. Videotex will allow you to use your TV set to receive information on almost any subject you desire—news of all sorts, local special events, and even restaurant menus. In addition, it will permit you to transact much of your personal business—shopping, banking, etc.—from home. For a look at what's in store, turn to page 43.

VIRTUALLY ALL STEREO records contain very-low-frequency signals that can be annoying to listen to and, potentially, can damage your sound system. A low-frequency filter will remove those signals, and plans for such a device begin on page 47.

SOMETIMES IT'S DESIRABLE to connect several TV sets to the same VCR. If you have a master-antenna setup, you can use it for that purpose. Several methods for taking advantage of your MATV facilities are described, starting on page 72.


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Season's Greetings

The editors and staff of Radio-Electronics join in sending holiday greetings and our best wishes for a happy new year.

On the Cover

CBS's new CX noise-reduction system for records is the latest happening in hi-fi—and the system works! Build our CX decoder and take advantage of the new CX records. They're available now and more are being introduced every day. Turn to page 43.
ON THE COVER

Here's a video accessory that you can build for your videocassette recorder. It reforms the video sync pulse and produces rock-steady pictures from pre-recorded videotapes. To get started, turn to page 45.

SPECIAL 32-PAGE SECTION covering Video Entertainment. Complete coverage of all the products that make up a video-entertainment center and what the future may bring. Story begins on page 48.

VIDEOTEX PART 3

Due to space limitations caused by the Special Video-Entertainment Section, we were unable to include the conclusion of the Videotex Series. Videotex Part 3 will appear, however, in our next issue.


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ON THE COVER
A completely self-contained PROM programmer for storing your programs in reusable 2716 EPROM's. This project is a must for experimenting with microprocessors and designing microprocessor based projects. Construction details start on page 45.

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To present the maximum number of articles to our readers, we have not published the Annual Index as part of this issue. A 4-page brochure containing this index is available for those who need one. To get your free copy, send a stamped self-addressed envelope (legal size) to:

Radio-Electronics
Annual Index
45 East 17th Street
New York, NY 10003

Any requests postmarked on or before April 30 are free. After that date there is a 50c fee. Questions and comments about anything other than the index that are included with your request cannot be handled. Send them separately to our Editorial Offices.


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Soon, for about the price of a good turntable, you'll be able to have true digital sound reproduction in your listening room. Len Feldman

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ON THE COVER
So far, the only way you could hear real digital sound reproduced on your own equipment was to invest in a $3000 PCM attachment for your VCR. Shortly, though, digital audio, using your existing amplifier and speakers, will be available for about the cost of a good turntable. New techniques—particularly in the area of laser scanning—will put 60 minutes of ultra-high-fidelity audio on one side of a disc you can hold in the palm of your hand. To find out what's in store, and how it works, turn to page 39.

GOOD UHF TELEVISION RECEPTION has always been more difficult to get than VHF. Part of the solution lies in a good antenna system. An antenna-mounted preamplifier can also help. A preamp you can build that offers 25-dB of gain is described starting on page 50.

OPERATIONAL AMPLIFIERS (OP-AMPS) are an important—but frequently misunderstood—member of the IC family. Learn what makes them so useful and how to work with them beginning on page 54.


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The video titler is a graphics and alphanumeric character generator for the amateur videophile. Connect it to your VCR and video camera setup and use it to add titles to your home video movies. Get started today building this microprocessor-based video accessory. The story starts on page 39.

A SIMPLE COLLISION DETECTOR is just one of six easy-to-build projects for your car that were designed especially for April 1. Turn to page 46.

IBM'S PERSONAL COMPUTER is just one of the many hardware systems covered in this month's special section. Both hardware and software are covered. Turn to page 51.
SPECIAL FEATURE 57 DESIGN ANALOG CIRCUITS
A new 11-part back-to-basics series. Each month we'll cover analog components and tell you how to apply them. This month, its thermistors and varistors. Mannie Horowitz

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ON THE COVER
Build this high-quality satellite TV receiver for under $500. Add a satellite TV antenna and LNA for a complete satellite earth station. The kit comes with a pre-aligned IF strip and LNA power supply. Get started building your satellite receiver today. Turn to page 49.

HOW TO DESIGN analog circuits is a new 11-part series on analog components and how to apply them. This month, thermistors and varistors are covered. The story starts on page 57.

AUTOMATIC POWER SWITCHER solves the problem of having to turn on multiple power switches in your hi-fi or computer system. Throw one switch and the power switcher does the rest automatically. Construction starts on page 54.


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Turn your listening room into a "sonic stage" with this easy-to-use imager. Joel Cohen

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ON THE COVER
A lot has been written recently about "sonic imagers." Those devices modify the sound reproduced by your stereo system so that it appears to come from outside of, behind, and even in front of your two speakers—in fact, the speakers almost seem to disappear. To find out how you can build your own stereo image expander for under $100, turn to page 45.

STEREO AND BILINGUAL programs are regularly broadcast on Japanese and German TV. The German system uses a technique quite different from the former, and it may be better. Learn how it works, starting on page 58.

HOW ACCURATE is your test equipment? You can check out volt- and ohmmeters—as well as oscilloscopes—with the easy-to-build pocket-size calibrator described, beginning on page 49.


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A behind-the-scenes look at the Radio-Electronics Videogame Testing Laboratory. Many long hours were spent gathering data for this month's special section on video and handheld electronic games. For an overall look at what's available in video and handheld games, turn to page 49.

PIN DIODES are just one of the many specialized diodes covered in this month's installment of the analog-design series. The story starts on page 72.


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ON THE COVER
Up to now, about the only way you could add video to your telephone conversation was to go to one of a very few specially equipped Bell System centers. Even then, you could only talk with someone in another similarly equipped center—not a particularly convenient setup. Build a Picture Phone, and you can exchange pictures with anyone, anytime, anywhere, as long as both of you have one, and a telephone. The story starts on page 43.

GOOD VHF and UHF TELEVISION RECEPTION depends on many factors. Choosing the best system or configuration for your particular situation can be difficult, but for information that will make the task easier, turn to page 49.

THE SOUND QUALITY of even the best stereo systems can only be as good as the signal that is input from the phonograph cartridge. Find out more about phono cartridges, and whether you are getting the most out of yours. The story begins on page 61.

For those of our readers who have been awaiting the second part of our article on the stereo image expander, we promise that it will run in next month's issue.


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ON THE COVER

Using an opto-electronic sensor that attaches to your finger, this battery-powered monitor displays your heart rate in beats-per-minute on a digital display. Knowing how your heart rate varies under different circumstances can give you an idea of your physical condition. Get started building yours today. The story starts on page 45.

HOW TO PROPERLY BIAS a transistor circuit is the subject of this month’s analog design series. Must reading if your designs are to function the first time you plug them in. The story starts on page 59.

HOW TO TROUBLESHOOT AND REPAIR portable cassette recorders. The best results are obtained with a logical troubleshooting approach. The story starts on page 66.


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ON THE COVER
Microcomputers—for the home and for business—come in all sizes and prices. You can pay as little as $100 (or less!) or as much as $6000 (or more). To help you make an intelligent choice in selecting a computer that meets both your needs and your budget, our Special Section, "Your Own Computer," groups computers and computer systems by price. Also included are descriptions of software and services that you may find useful. And, to round things out, there's a discussion of 8-bit vs. 16-bit computers. "Your Own Computer" starts on page 43.

BUBBLE MEMORIES COMBINE the read/write features of RAM with the non-volatility of ROM, and approach tape and disk systems in storage capacity. Find out how they work and how they're used starting on page 39.

DERATING CIRCUIT-COMPONENTS can extend their life and make the equipment in which they're used more reliable. This month's Service Clinic covers that topic, beginning on page 150. Due to lack of space we are unable to include Part 2 of the "Heart-a-Matic" in this issue. It will appear next month.


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SEASON'S GREETINGS
The editors and staff of Radio-Electronics join in sending holiday greetings and our best wishes for a happy new year.

ON THE COVER
If you like to tape those vintage black-and-white movies that show up late at night on TV—but don’t like to tape the commercials that accompany them—this automatic commercial editor is for you! It watches the movie along with your VCR and, when a commercial turns up, stops the tape until the movie begins again. The result is a tape of the movie, and nothing else. It’s easy to build, and will...literally...provide you with hours of pleasure. Get started building your own editor. Plans begin on page 43.

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ON THE COVER

The plug-programmable Programma III allows you to perform static and dynamic testing of all TTL and CMOS digital IC's, and presents you with a graphic visual indication of the logic state at each pin of the IC under test. Instructions for building this valuable addition to your test equipment begin on page 39.

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JANUARY—DECEMBER 1982

To present the maximum number of articles to our readers, we have not published the Annual Index as part of this issue. A 4-page brochure containing this index is available for those who need one. To get your free copy, send a stamped self-addressed envelope (legal size) to:

Radio-Electronics
Annual Index
45 East 17th Street
New York, NY 10003

Any requests postmarked on or before April 30 are free. After that date there is a $0.05 fee. Questions and comments about anything other than the index that are included with your request cannot be handled. Send them separately to our Editorial Offices.

Because of space restrictions, the second part of the "Automatic Commercial Editor" will not appear in this issue. It will appear next month.


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JANUARY 1983   Vol. 54 No. 1

Radio-Electronics, THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Electronics publishers since 1908

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ON THE COVER

Once considered a dream, the computer-controlled airplane has become a reality, with the introduction of the Boeing 757/767 aircraft into commercial service. This month, we’ll take you into the cockpit of that fascinating airplane, and show you the systems and features that help make it one of the most sophisticated in the sky.


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ON THE COVER
Portable shortwave receivers with features like microprocessor-controlled PL, tuning and digital readouts, and pocket-sized shortwave receivers with "big" radio performance, were once just dreams. Both types are now realities, as you'll see in our story on pocket-sized and portable shortwave receivers. The article begins on page 49.

IF YOU'RE LOOKING for a DVM for your workbench, one of those described here may be for you. Thanks to the use of LSI IC's, the circuits are small and inexpensive to build. This story begins on page 56.

EVEN THOUGH MODERN RADIOS are sleek, and are great performers, there's something about the old ones that makes most of us feel nostalgic. Find out how you can restore an old radio's original sound and appearance starting on page 56.


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ON THE COVER
The fascinating world of microcomputers—whether it be a simple entry-level machine for education or entertainment, or a complex, full-featured computer for your business—there’s something there for everyone. And there’s something for everyone in our Special Section, “Your Own Computer.” This month we take an in-depth look at the hardware and the things you should know before you buy. To round things out, “Your Own Software” takes a look at one of the most popular types of software—the electronic spreadsheet—and a look at some software you may never have heard of, but that’s surprisingly useful and/or inexpensive. It all starts on page 57.

A CUSTOM CASE will give your project a professional look and get the attention it deserves. It can be surprisingly easy and inexpensive to build if you know how. Find out more starting on page 49.

COMING NEXT MONTH
On Sale April 19
• Build A Talking Clock. This clock not only tells the time, it says it.
• Car Alarm. Connect it to your car to help keep the burglars away.
• All About LSI Music Synthesizers. A look at the different ICs available to build your own music synthesizers.
• And more.


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ON THE COVER
Timepieces have come a tremendous way in the past few years—from wind-up and electric clocks to those with LED and LCD displays and—now—to clocks with no display at all! The talking alarm clock featured in this issue will announce the time either automatically or on request, and can also be set to tell you when it’s time to get up. Modern speech-synthesis ICs make it extremely easy to build, as you’ll find out starting on page 57.

THE MAINSTAY of today’s popular music is the synthesizer. Once incredibly difficult and expensive to design and build, its current popularity is due in part to the versatility built into the LSI ICs that are found at its heart. The story of those ICs can be found on page 65.

COMING NEXT MONTH
On Sale May 19
• Special Videogames Section: What’s new for 1983... and what’s in store for the future.
• Add-on RAM. A non-volatile 8K memory expansion you can build for your Timex/Sinclair 1000.
• LF Loop Antennas. The next installment on our continuing series on VLF-LF receiving techniques.
• And lots more!


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ON THE COVER
Electronic games, both video and handheld, have been extremely popular for several years now. But this past year has seen the introduction of more videogame consoles, hardware add-ons, and game software than in all previous years combined. This month, we present a special section dedicated to helping you find your way through the evermore-confusing world of electronic games. We’ll tell you what’s new, what’s hot, and how to get the most out of your videogame system. The section begins on page 55.

FRONT PANEL of the audio frequency-response meter. This instrument will, among other things, allow you to set your tape recorder’s bias and equalization controls with extreme precision. The story starts on page 51.

COMING NEXT MONTH
On Sale June 16
• Automotive navigation systems. With these computer-based systems you’ll never get lost again.
• Loran-C. A look at this fascinating low-frequency, long-range navigational system.
• Add-on RAM. The article on how to add 8K of non-volatile RAM to your Timex/Sinclair 1000, bumped from this issue because of lack of space will appear in July.
• And lots more!


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ON THE COVER

To most drivers, one of the most exasperating experiences is getting lost in completely unfamiliar territory. But an independent California inventor and a giant Japanese automobile manufacturer are hard at work trying to make that situation a thing of the past. If their efforts are successful, it won't be long until a common automotive accessory will be a navigational computer complete with a video display. This month, we'll preview the future and take a look at both systems. The story begins on page 43.

COMING NEXT MONTH

On Sale July 19
A special section devoted to electronics and photography. Among the things we'll look at are:
- The Sony Mavica system
- Autofocus and autoexposure electronics
- Electronics in the darkroom And lots more!


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www.americanradiohistory.com
ON THE COVER
One field that has been strongly affected by microelectronics is that of photography. Once-bulky equipment is now built right into pocket-size cameras. And, in the darkroom, microprocessors are making things as easy as 1-2-3. Sony has even unveiled a completely filmless electronic-photography system. All that, and more, is covered in our special section on electronics and photography beginning on page 57.

AS YOUR CAR creeps along in the stop-and-start summertime traffic, its most dangerous enemy is probably the heat. And you have no idea how badly your engine is suffering until the "idiot light" marked "TEMP" comes on...and the radiator blows its top! This digital temperature gauge will let you know at any time exactly how hot the engine is, and allow you to cool things off before it's too late. Construction details start on page 92.

COMING NEXT MONTH
On Sale August 18
- The Pianometric. An attention-getting programmable music maker you can build yourself.
- ECL. A tutorial on emitter-coupled logic.
- Plus lots more!

Because of lack of space, the installment of "Analog Design" scheduled to appear this month will appear in next month's issue.


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**ON THE COVER**

Projects that are built just for fun are sometimes enjoyed most of all. But what's even better is a fun project that can teach you something new. The Pianomatic mini player-piano does just that. Sure to be an entertaining conversation piece when it is finished, building it will introduce you to such topics as computer memory organization and retention, digital logic, keyboard encoding and decoding, and the like. As a bonus, the techniques you'll pick up here can easily be adapted for use in your own designs. The story begins on page 43.

**THE KOALAPAD** from Koala Technology, Inc., allows you to control your computer's cursor movement by just tracing on the touch-sensitive pad. It's just one of the most innovative products of the past year as honored at the Summer CES. Turn to page 49 to find out more about it, and others similarly honored.

**COMING NEXT MONTH**

On Sale September 15

Our special supplement: Your Own Computer. Among the things we'll look at are:

- Hardware—a comprehensive look at systems, and their cost!
- Word-processing software
- Software and hardware compatibility
- Everything you need to know about CP/M
- And lots more!
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A round-up of the computer systems currently available, organized in price categories from under $500 to over $4500. Marc Stern

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ON THE COVER

There's little doubt that personal computers have become the fastest growing segment of the consumer-electronics market. In the past year many new companies have been founded, and scores of new machines have been introduced. In addition, most of the "established" manufacturers (in this industry that's anyone that's been around longer than two years) have either unveiled new systems, or beefed-up their existing ones, to remain competitive. The result has been greatly increased selection, generally lower prices, and just about utter confusion for the consumer. That's where this special section comes in—it's designed to help you make sense out of the jumble of systems by summarizing what's available. To help make comparisons easier, everything is organized by list price. The section begins on page 75.

TO OUR READERS

Due to our large computer-hardware section, several articles that were originally scheduled for this issue could not appear, due to space limitations. Those articles will be published in coming months.

COMING NEXT MONTH

On Sale October 20
- Test Equipment. A look at what's new and unusual.
- Audio Tape. Audio-cassette tapes and how they differ.
- How To Design Analog Circuits. All about filters.
- And lots more!


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When you think about the products in the various different categories of electronic products—be they video, audio, broadcast, or what have you—there are always some that shine above the rest. The reason why they are thought of as superior may be due to a sophisticated design, the use of state-of-the-art technology, better reliability or accuracy, or any one of a number of similar reasons. The same holds true, of course, for test instruments. This month we bring you a special look at the ultimate in sophisticated or unusual test instruments. The story begins on page 59.

FEW PEOPLE REALIZE that the quality of your TV sound is limited only by the quality of your TV's audio section. Unfortunately, the quality of the audio in an average set is just not very good. But there is something you can do about it—build the TV sound converter and get audio quality you never thought possible from your TV. The story starts on page 45.

COMING NEXT MONTH
On Sale November 17
- Video Color Processor. An accessory you can build for your home-video system.
- Digital TV. A look at this fascinating new technology.
- Designing Analog Circuits. Another installment in our back-to-school series.
- And lots more!


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### ON THE COVER

If you're like many home-video hobbyists, your videotapes leave something to be desired. Your colors may appear washed out, the picture is filled with noise, or, perhaps your edits are far from smooth. Well, there's a way around those problems, whether you're making new tapes or duplicating old ones. With the color processor you can create fade-ins and fade-outs, reduce background noise, and you can vary color saturation from black-and-white to full chrominance. The article describing its construction—which is only one of our special video features this month—begins on page 49.


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ON THE COVER

To say that cable-TV has undergone tremendous growth over the past few years would be an understatement.

One of the biggest reasons for that growth is the presence on cable of first-run movies and live sporting events. Of course, that programming is most often offered as a premium service, which means that the viewer must pay a charge to receive it. To prevent unauthorized reception, the material is scrambled. This month, we'll use an experimental descrambling circuit to illustrate the theory behind the techniques used to encode video signals. The story begins on page 47.

ELECTRIC POWER GENERATION is among the most important areas of electronics. One method of power generation that has received quite a bit of attention is MHD. This month, we'll show you the theory behind that technique and build a working model of an MHD generator. The story begins on page 51.

COMING NEXT MONTH

On Sale February 21

- Video Test Generator, A valuable instrument for video servicing.
- Airplane Landing Systems. A look at landing systems and the electronics behind them.
- And lots more!


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**SPECIAL FEATURE**  49  INSTRUMENT LANDING SYSTEMS
Though many people are afraid to fly, airplanes are the safest way to go—thanks to Instrument landing systems. Bill Sewell

**BUILD THIS**  
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This test generator can be used not only for TV servicing. You can use it to service just about any video equipment. Gene Roseth

54  AUDIO-FREQUENCY GENERATOR
Use this AF generator with digital frequency readout to test your audio system. Richard Schroeder

59  NO MORE WRONG NUMBERS
Build this telephone add-on and never be bothered by wrong numbers or unwanted telephone sales calls again! Gary McClellan

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**ON THE COVER**
There are many manufacturers who sell TV test equipment such as dot-pattern generators. But if you want to service video equipment other than TVs, then you need something more. This month we'll describe how to build and how to use a full-feature video test generator. You can use it to test VCR's, monitors, video amplifiers—just about any video equipment. It not only generates standard test patterns. It even has provision for external inputs (from a computer, for example) so that you can create your own test patterns for your own specific purpose. The story begins on page 43.

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KNOWING ABOUT LINEAR IC's and how to use them in your designs can greatly improve your enjoyment of electronics. But if you missed out on learning about those devices, where can you get the information you need to use them successfully? One place is in our new back-to-school series on designing with linear IC's. It all begins on page 89.

COMING NEXT MONTH
On Sale April 19

- Automotive Exhaust Analyzer. A unique device to help get your car ready for those tough emissions tests.

- 3-D TV. A look at what's coming in 3-D television.

- Home Control Computer. Part 2 of our build-it-yourself computer.

- And lots more!


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ON THE COVER
Does your state require that your car pass an annual emissions test? In those states that do, many "do-it-yourselfers" are beginning to feel left out. After all, who else but the state-licensed inspection shop can make the emissions test? If you build this month's featured project, you'll be able to keep tabs on your own emissions—even while you're driving.

The story begins on page 47.

WILL THERE EVER BE A 3-D TV system that will give us more than eye strain? Carl Laron, our Associate Editor takes a look at three systems that look promising. Each has its own advantages—and drawbacks. But one thing is sure: You'll be hearing a lot more about these systems in the future. But read about them here first, starting on page 57.

COMING NEXT MONTH
On Sale May 22

- Satellite TV. A special section that deals with antennas, downconverters, receivers, and more, including a look at DBS.
- Repairing PC Boards. It's easy—we'll show you
- Tuning Microwave Downconverters. It's easier than you think and you don't have to perch yourself on your roof!
- And lots more!


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ON THE COVER
Satellite TV offers a lot of attractions, what with its promise of nearly unlimited viewer selection of TV programming. But is it for you? This month, Radio-Electronics turns its attention to satellite-TV, with a special section devoted, among other things, to home reception of satellite signals. It all begins on page 45.

COMING NEXT MONTH
On Sale June 21
- Energy Miter. This useful project will help you get the most out of your air conditioning system.
- Interfacing the ZX81. Put your Timex/Sinclair computer to work with this practical interface.
- A Unique Ammeter. Here's a DC clamp-on ammeter you can build.
- Repairing PC Boards. Fixing those broken PC boards is easier than you think.
- And lots more!


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You can save money on your air-conditioning bills and stay comfortable at the same time. No, it's not magic—it's what's known as time cycling. The energy miser lets your air conditioner operate more efficiently than it does when it is controlled by just a thermostat. Best of all, you can build the device just in time for the hot weather! The story begins on page 43.

THE TIMEX SINCLAIR 1000 or ZX81 has been described as being worse than a toy. Well, it doesn't have to be. You can put your ZX81 to work as a control computer with as many features as your imagination permits. This month, Interfacing basics are discussed, and an Interface circuit is presented. The story begins on page 57.

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• Electronics And The Heart. The heart may have more in common with electronic devices than you think.

• An Infrared Transmitter/Receiver. How many uses for one can you come up with?


• And lots more!


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- Sonic Motion Detector. It uses sound to detect motion. Great for use with a burglar alarm.
- Electronics Measurements in Medicine. A look at the electronic instruments used to monitor our health.
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INFRARED COMMUNICATIONS is used these days in a wide variety of remote-control applications. This month we'll show you how you can add remote control to just about anything by building an Infrared transmitter/receiver pair. The story starts on page 57.

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To present the maximum number of articles to our readers, we have not published the Annual Index as part of this issue. A 4-page brochure containing this index is available for those who need one. To get your free copy, send a stamped self-addressed envelope (legal size) to:

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in Fig. 8-a) in the center series arm. This is the most important bandpass filter in the receiver and it must be aligned correctly.

Check the filter in the receiver by listening with the headphones for a stable signal within the 16.45 to 17.1 MHz range. The 11th harmonic at 16.5 MHz of the band 5 (refer to Fig. 4-d) oscillator/divider output of 1.5 MHz will be satisfactory.

Tune across the band while monitoring the DC voltage on the detector AGC line. The voltage should rise very rapidly to more than 5 volts, hold steady, and then drop rapidly to zero. With a frequency counter connected to capacitor C48 and a voltmeter calibrated in decibels on the AGC line, verify that your filter output matches the curve in Fig. 9.

Obtain an RF signal generator and an RF voltmeter. Mount the four inductors on the copper-clad side of the 1 x 3-inch board 4. Then connect the end capacitors (fixed and variable) as shown in Fig. 10. To check the LC resonant circuit at each end, set the RF generator to the filter's mid frequency (16,772 MHz) and adjust the 1—16 pF capacitor in parallel with the 110 pF capacitor that forms C1 for a peak reading (parallel resonance) on the RF voltmeter.

Now connect inductor L4 and the two capacitors forming C2 (a 39 pF capacitor in parallel with a 1 to 16 pF capacitor) shown in Fig.11. Set the RF signal generator for 17,897 MHz and adjust for a null (series resonance). Repeat this step with L5 and C3 tuning for a null at 15,713 MHz. Then without changing capacitor settings, connect the filter components in their final positions as shown in Fig. 8-b. Frequencies for the other bands are shown in Table 2.

The first mixer converts each of the popular shortwave bands to the 16.45 to 17.1 MHz range. The mixer in this receiver is a double-balanced mixer.

**Filter construction**

Build the four crystal-controlled oscillators that tune the six bands of the receiver by referring to the schematics in Fig. 4. Note that 7 MHz-crystals are used in both the band 1 and 2 oscillators (XTAL 7 and XTAL 8), but a 10 MHz crystal (XTAL9) is used in the band 3 oscillator (Fig. 4-c). The oscillator in Fig. 4-d is able to provide three different frequencies because of its output countdown circuit (IC8, IC9, IC10 and IC11).

Filter details are given in Table 2. Filters are built with fixed-value capacitors and tuning is accomplished by adjusting the position of the wire turns on the toroid cores. Compressing the turns to less than 360 degrees of the toroid's circumference increases its inductance and lowers their resonant frequency.

For example, compressing a coil whose turns are spread out over 360° down to about an angle of coverage of about 120 degrees increases the inductance 75%, shifting the frequency 32% lower. Follow the procedure outlined for the first IF band-pass filter, but use the frequencies listed in Table 2. Filter components are mounted directly on the 6 x 3 1/4-inch circuit board 1. (See Figs. 1 and 2.)

**Automatic gain control**

Refer to Fig. 3 and build the automatic gain control (AGC) circuit last. It allows this receiver to cope with a wide range of signal strengths while the listener tunes across the band. The volume control knob can be left in a fixed position and all tuning can be done with the TUNE control.

Set the 10K potentiometer, R68, for 5 volts DC at the cathode of diode D5 with no signal input to the receiver. This level will increase to about 6 volts in the presence of strong signals, causing a reduction in the gain of the IF amplifiers. Refer to Fig. 12 and build the 9.83 MHz crystal filter on board 5 whose dimensions are given in Table 1.

**Precision tuning dial**

Cut and bend a mounting bracket for the air-dielectric tuning capacitor C49 from aluminum stock and drill a hole in it to accept the capacitor shaft and two holes at its base flange 1/4 inch back from the front edge so it can be mounted to the baseplate as shown in Fig. 13. (Capacitor C49 is part of the variable-frequency oscillator circuit.)

Mount tuning capacitor C49 on the bracket positioned about 1 1/4 inches behind the front panel as shown in Fig. 13. The tuning capacitor is rotated by an assembly shown in Fig. 13 consisting of a 3-inch diameter pulley turned by a nylon cord wound over the tuning knob spindle and located in the vee-groove of the pulley.

The pulley can turned from sheet plastic in a lathe or a suitable one might be obtained from electronic salvage. Two slots cut in the edge of the pulley allow the cord ends to pass through the wall of the vee-groove for fastening. A small continued on page 86
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**Volume 66**

**Electronics NOW**

**Abbreviations:** (AUD) Audio Update; (C) Construction; (CC) Computer Connections; (D) Department; (DB) Drawing Board; (ED) Editorial; (ER) Equipment Reports; (HH) Hardware Hacker; (LET) Letters; (OA) Q & A; (WN) What’s News

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— John Lovine

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A simple way to get up to -12 volts for your projects and experiments. — Robert Ziller

34 NEGATIVE VOLTAGE CONVERTER
A simple way to get up to -12 volts for your projects and experiments. — Robert Ziller

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Except when dealing with the simplest of circuits, electronics projects invariably turn out best when a PC board is used. The problem is that making the board is often more work than building the project itself. And if you need to make several of the same board, the task can get to be overwhelming. This month, we present a project that can simplify at least one part of the task. It is a precision x/y drilling table that lets you make perfectly centered holes on even the tiniest of pads. Best of all, at under $100 to build (including drill), it costs just a fraction of what a commercial unit would command. — James J. Barbarelo

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When it comes to auto theft, the statistics tell a cold, almost staggering story. What they don’t tell is the gut-wrenching feeling you get when you discover that you have just become a statistic. This month, we present a project that could help prevent that from happening to you. Called the Guardian, it is an electronic watchman that keeps an eye on your car when you can’t, and alerts you if trouble is pending. As a bonus, it uses a sensing technique that keeps false alarms to a minimum.

— Anthony J. Caristi

BUILD THE GUARDIAN

It triggers your security system into action any time your telephone line is cut.

— James Melton

PHONE LINE MONITOR

A precision, computer-controlled drilling table that simplifies the task of making PC boards.

— James J. Barbarello

BUILD THE PC DRILL

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If you're like many, you probably have several telephones scattered around the house. After all, telephones are relatively inexpensive these days, and doing that can be a great convenience. That is, unless you answer a call in one part of the house that's intended for someone in another. Then, you have to find whomever the call is for, tell them to pick up the phone, and go back to the first phone and hang it up. If you have a teenager, or anyone else who gets a lot of calls, that can become a real nuisance. Well, while this month's cover story won't stop the phone from ringing, it can make the rest a lot easier to deal with. It is a PBX system that's ideal for a home or small office. Best of all, it uses the existing telephone wiring for easy installation.

— John G. Koller

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— Robert B. Whitaker

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Are you tired of radio stations that play everything except the music you like, or have you ever envisioned yourself as a budding Howard Stern or Rush Limbaugh? If so, here's the perfect vehicle to get you on the air, even if only in a small way. It is an FM-stereo transmitter that offers several advantages over similar units, including better fidelity and sound quality, freedom from frequency drift, and more. Yet, it is easy to build either from scratch or from an available kit. You can also use it to pipe the music to every radio in your home or office, as a wireless FM microphone, and in many other ways.
— William Sheets, K2MQJ and Rudolf F. Graf, KA2CW

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While driving this summer, have you hit the gas pedal only to find that the pick-up you expect is missing? Or have you noticed that your vehicle is not getting the gas mileage it normally does? The reason for that, in many cases, is your car's air conditioner. One solution would be to stop using it—hardly acceptable, especially on those scorching 90-degree days. Another, better, solution would be to build this month's cover project, the Smartbox. That unit synchronizes the air conditioner's operation to the engine, improving your car's performance when accelerating or climbing, and saving money in the process.

— Anthony J. Caristi

Use this reaction timer as a game of skill, or to see if you've had a few too many.

— John Fleischer

Capture, decode, and display telephone tones on any personal computer.

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**31 BUILD THE POOR MAN'S PLASMA GLOBE**

Since its earliest days, mankind has been fascinated by lightning and other kinds of high-voltage discharges. Even today, high-voltage experiments and displays remain among the most popular areas of the electronics hobby. This month, we present a way to have a little high-voltage fun of your own, without breaking the bank to invest in exotic display devices or electronics. In fact, the project uses a common incandescent light bulb as the display device. You can also use the circuit for other high-voltage experiments and displays, including a Jacob's Ladder.

— Robert Iannini and Marc Spiwak

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— Stephen J. Bigelow

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— Larry Ball

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It has happened to all of us: We get in our car, turr the key in the ignition, and nothing happens. The battery is dead. The fix is simple; all we need is a set of jumper cables, a good Samaritan, and we are set—or are we? The truth is that this seemingly simple procedure results in many serious injuries and damaged automobiles each year. Well, thanks to this month’s cover project, the Jumper Cable Wizard, that’s all in the past. Not only will this device make sure your cables are connected properly before disaster can strike, it also lets you check the condition of your car’s battery and alternator.

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— Tom Fox

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— Bill Green

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BUILD THE LAZER FAZER
Give your car’s LIDAR detector a check up, then use this device to play a fun game.
— Douglas Page

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Measure wind speed with a device that uses no moving parts.
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ON THE COVER

35 BUILD THE ASTRO-TREKER

Every once in a blue moon, a project crops up that has nearly no practical applications, yet still is so impressive that everyone who sees it in action wants to try it for themselves, or better still, get one for themselves. This month's cover story is just such a project. Called the Astro-Treker, it puts the user at the controls of a simulated hovercraft. But this is no video game; instead it is an electromechanical device that obeys all the laws of physics, and is as hard to master, and fun to do, as flying a helicopter or even piloting a lunar lander. It can even be modified to provide a variety of different diversions and games, and makes a great Christmas gift.
— G. Randy Stone

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Many, if not most, Americans have a love affair with their cars. They wax; they wash; then try every new performance-enhancing gizmo or gadget that comes down the pike. Still, every so often, it seems like our favorite chariot's get-up-and-go has got-up-and-went. What gives? Is our car just having a bad day? Was that premium gas we just purchased not up to snuff? Or are we simply playing mind games with ourselves? This month's cover story gives you a way to quantitatively measure your car's acceleration and cornering ability and to make sure all is as it should be. — Dan Harrison

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Use your joystick as a mouse. It works with any PC and any software application.
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33 **Build a High-Performance Logic Analyzer**

If you've done any amount of digital-circuit troubleshooting, you no doubt know how valuable an instrument a logic analyzer can be. But if you've ever shopped for an analyzer, you also know how expensive a top-flight unit can be. Yes, there are a number of lower-cost PC add-ons that can be bought or built, but most have limitations; either they have a low sampling rate or have only a few sampling channels. That is until now. This month's cover story introduces a PC-based logic analyzer that features a 40-MHz maximum sampling rate, 16 channels, and more. Even better, it's expandable. — Robert G. Brown

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This month we show you the first steps in bringing your cherished treasure back to life.

— Phil Van Praag

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In the lab, on the workbench, or around the house, there are many instances where we need to gather information over a period of time. The traditional approach is to use a computer to first collect that information, and later to analyze it. But is it really a good idea to tie up an expensive piece of hardware like a computer for hours, days, weeks, or even longer? Of course not, and thanks to the Data Monitor there is now a better, lower-cost way to perform the information-gathering part of the task. What's more, through the use of simple plug-in modules, it can be configured to handle virtually any data-collecting application.
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37 BUILD THE INFOCARD CARD SCANNER

We've seen them in airports, office buildings, laboratories, and anywhere else where it is important to restrict access to any area to only those who have legitimate business there. We've also used them on an almost daily basis to gain access to our money at an ATM and even to buy groceries or gas. What we are talking about are the now ubiquitous swipe cards that are used to provide an extra measure of security to people, places, and information. In this month's cover story, we'll show you how to add that same type of security with a system that can be integrated with computers, locks, and more. — J. J. Barbarello

Consumer Electronics Show roundup and a look at how the new large-screen, flat TVs work.

Are fuel cells the technology that will replace today's polluting internal-combustion engine? — Bill Suzuki

It's a time to honor those who have shown a commitment to the electronics-servicing profession, and an opportunity to join their ranks. — Alice Brown
BUILD A DIGITAL STORAGE OSCILLOSCOPE
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Individuals have been fascinated with the concept of sending their words and ideas to others located at some distant point since the days of our earliest ancestors. Of course, these days radio, especially AM radio, is not exactly a cutting-edge technology. However, the medium still holds a lot of fascination for many. After all there are millions of ham-radio operators worldwide. Then there's the phenomenon of "pirate" radio. This month, we present a modern version of an all-time classic. It's a low-power AM transmitter that meets FCC part 15 requirements. It won't let you challenge the "big boys," but it could make you the most popular "jock" on your block.

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There has never been a better time to be a videophile. For one thing, in recent years there has been an explosion of high-quality video sources, such as DSS, DVD, S-VHS VCRs, laser discs, digital camcorders, and more. But there is one catch: To get the highest-quality images from those sources you need to use something other than standard composite video. Most often, that something is S-video, and most high-end gear is equipped to handle those signals. This month, we present a unit that lets up to four devices share S-video signals from a single source. It's great for things such as tape dubbing, or as the heart of a multi-room S-video system.
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An economical and easy-to-build instrument that's equally at home in the field or on your workbench.
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One look at your heating bill and you know that you have a problem. Despite all of the insulation and weather stripping you’ve installed, some of your expensive heat is clearly escaping, but from where? You could painstakingly search every inch of your work, but that could take hours, and you might still not find the weak spot. Now there’s a better way—the Heat Detector. It will make quick work of the task as it can easily pinpoint even tiny temperature differences. It can also be used to find hot spots on circuit boards, car engines, and more. — Skip Campisi

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35 BURN YOUR OWN MICROCONTROLLERS

As if you did not already know it, a quick look at the pages of this or any other electronics magazine will reveal that microcontrollers are at the heart of many projects and products these days. The reason is simple: One microcontroller can replace handfuls of active and passive components and do their job better and more economically. However, they do present one problem - they need to be programmed to do their job. Actually, that is no problem at all as this month's featured project will prove. Called the "No Parts" PIC Programmer, it is possibly the simplest and easiest solution to programming some of the most popular microprocessors on the market. — Michael A. Covington

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"HOT WHEELS" IN SPACE

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Even in normal times, everyone always talks about the weather. But this year has been something else again. Between El Niño, La Niña, killer tsunamis, increased tornado activity, a predicted very active hurricane season, paralyzing ice storms, scorching heat waves, droughts, and more, it seems like no one is talking about anything else — and, at least this month, that includes us! Our cover story this month is a circuit that can give you a few precious extra minutes to prepare in the face of an approaching storm. It monitors the airwaves for the telltale RF crackle caused by dangerous lightning and signals that trouble is on the way when it detects it. — Kenton Chun

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A Solar-Powered Robot Bug

If you are a fan of science fiction, you know that the literature is full of tales of robots. In most cases, those robots are creatures that faithfully mimic the behaviors of a living creature—Man. Well, while such robots are still science fiction, robots themselves are very real and have been for some time. Most are industrial devices that perform repetitive tasks either under direct control of a person or by following a set program. But there is another, more interesting class of robot—the kind that reacts to its environment just like simple creatures do. While such robots are a far cry from the robots of fiction, if human-like robots ever become real, these robot creatures—including the subject of this month's cover story—will be remembered as their early ancestors. — David Williams

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31 A MICROCONTROLLER-BASED PRECISION PULSE GENERATOR

If you do any amount of benchtop design or troubleshooting, you know how important it is to have a reliable, accurate source of test signals at your disposal. It would also be handy to have one with as wide a range as possible. This month's cover story is just such a unit. And, as a bonus, it is inexpensive and easy to build.

The secret to that is a PIC microprocessor, and a careful balance of hardware and software. The result is a compact unit that can produce pulses as short as 100 nanoseconds, and is accurate to nearly 100 ppm. — Tom Napier

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**The Real McTube**

Whether you miss the good old days or are just looking for a different sound for your music, this month's cover project is one you won't want to pass up. It is an easy-to-build vacuum-tube-based amplifier that's perfect for the "retro" musician. It also makes it easy to experiment with the vintage sound and mellow distortion that tube amplifiers produce, and could perhaps settle the question, at least in your own mind, of whether tubes are really better than semiconductors.
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ON THE COVER

32 The Y2K Bug...And a Few Other Worries

Unless you've been in hiding the last little while, you've no doubt are aware of the so-called Y2K bug that some feel could end civilization at midnight on December 31. Well, while nothing that dire is likely to really happen, the end of the century could still cause headaches for many, especially computer users. This month we look at what's behind the Y2K problem, ratchet up your paranoia level just a little bit more by introducing you to a couple of other less publicized but still nasty date-related surprises, and show you how to get through the coming "bug season" painlessly as possible—if you don't count your New Year's Day hangover. — Bob Dyball and Greg Swain

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You may have heard about radio pirates on the news or from an acquaintance, or you might have heard one of their broadcasts, but what is it that makes these clandestine broadcasters so interesting to listeners and the authorities? In this month's cover story, we take a behind-the-scenes look at the ever-changing world of unlicensed radio stations, the motivations of the individuals who run them, why they are so well loved by those who listen to them, why the government wants to shut them down at all costs, and where you can hear them for yourself. — Andrew Yoder

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DJ MixMaster
Have you ever wondered why some party DJs seem to sound better than the competition? Have you ever tried your hand at spinning tunes at a party only to find your efforts less than stellar? Well, the answer may lie largely in the mixing board. A good one can help anyone sound great; a less ideal one will make your mixes sound, well, less than ideal. The problem is that a good board can be very expensive, unless you build this month's cover project: A professional-grade mixing board with top-notch sound and some features not found on even the best commercial products.
— Jules Hyckebusch

The RF Informant
This tiny, easy-to-build signal sniffer can do anything from finding hidden RF bugs and other transmitters to testing a microwave oven for leakage. — Rick Duker

Prototype
A "pill" monitor, ultracapacitors, super-fast on-the-job training, a long-distance spectral analyzer, and more.

Measuring Capacitors and Inductors at RF Frequencies
To get the right results you need to use the right techniques.
— Joseph J. Carr

A Super-Safe Smart Crosswalk
A new safety system that could help pedestrians avoid getting that "run down" feeling when crossing busy streets.
— Bill Siuru

How to Succeed in Soldering
These tips and hints could be just what you need to get perfect results every time.
— Skip Campisi, Jr.
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Say "automated home" and many will conjure up an image of cartoon-character George Jetson's house. Well, we're not quite there yet, but we're coming closer. For example, consider the venerable X-10 standard. Though it's been with us since the late 1970s, products using the standard are still very viable, and new capabilities are being added all the time. Its one shortcoming, however, is that it is difficult to control the various modules in a system in a unified, logical way—until now. This month's cover story is an expandable controller that lets you take complete control of your X-10 system and your home. — Christopher A. Nielsen

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29 The Wild Mouse
Often individuals have more than one hobby or interest, and often those hobbies or interests intersect. One common example of that is music and electronics. While the price of music-related electronics is lower than ever, if you like picking up a soldering iron when you are not playing your guitar, this month's cover project is one you'll surely want to try. It's an easy-to-build guitar-effects box that can dramatically change the sound of your instrument with the tap of a button. — Steve Daniels

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Most noise-reduction techniques require that the original source material be specially encoded. One example of that is Dolby noise reduction that is often used with pre-recorded audio tapes. However, there are countless other audio sources that suffer from white noise—or hiss—that could benefit from some noise reduction...and this month's cover project provides it. The Universal Noise-Reduction System is easy to install and does not require pre-processed material to be effective. It also features an audio compressor that can be used to reduce the volume of excessively-loud TV commercials.

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Recent events in Turkey and elsewhere around the world have once again shown us that the solid Earth is not nearly as solid as we often assume. If in light of such things you want to keep a closer eye on the ground under your feet, or if you want to investigate earthquakes and similar natural phenomena, then you'll want to build this month's cover project. It is a computer-based seismic detector that's great in the lab, and—since it is battery powered and portable—even better in the field. — Ron Newton

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When it comes to measuring the speed of a rotating object, nothing can take the place of a stroboscope—and that just scratches the surface of the possible applications for that piece of test gear. However, commercial units are often expensive and are line operated, making field use difficult. But why buy when you can build? This month’s cover project is an easy-on-your-wallet stroboscope that’s a snap to put together yourself. Even better, it is battery powered making it completely portable. — Skip Campisi

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