BUILD A SINEWAVE DESCRAMBLER
BUILD THE R-E ROBOT
A personal robot you can customize

COMPUTERS IN ELECTRONICS
Computers on the workbench
Computer-aided electronic design

TOUCH-TONE CONTROL
DTMF encoding and decoding technique

BUILD A CLOSED-CAPTIONS DECODER
Get more from your TV

TV DESCRAMBLER
How to build a sinewave decoder

PLUS:
★ Ask R-E
★ Video News
★ Satellite TV
★ New Products
★ Robotics
★ COMPUTER DIGEST
New GPS Series: Tek sets the pace with SmartCursors™ and push-button ease.

Work faster, smarter, with two new general purpose scopes from Tektronix. The four-channel, 100 MHz 2246 and 2245 set the new, fast pace for measurements at the bench or in the field. They're easy to use and afford, by design.

On top: the 2246 with exclusive integrated push-button measurements. Measurements are accessed through easy, pop-up menus and implemented at the touch of a button. Measure peak volts, peak-to-peak, ± peak, dc volts and gated volts with new hands-off convenience and on-screen readout of values.

SmartCursors™ track voltmeter measurements in the 2246 and visually indicate where ground and trigger levels are located. Or use cursors in the manual mode for immediate, effortless measurement of waveform parameters.

Both scopes build on performance you haven't seen at the bandwidth or prices. Lab grade features include sweep speeds to 2 ns/div, vertical sensitivity of 2 mV/div at full bandwidth for low-level signal capture. Plus trigger sensitivity to 0.25 div at 50 MHz, to 0.5 div at 150 MHz.

Accuracy is excellent: 2% at vertical, 2% at horizontal. And four-channel capability includes two channels optimized for logic signals.

Best of all, high performance comes with unmatched convenience. You can see it and feel it—in the responsive controls and simple front-panel design, in extensive on-screen scale factor readouts, and in simplified trigger operation that includes Tek's Auto Level mode for automatic triggering on any signal. Start to finish, the GPS Series saves steps and simplifies tasks.

Get out in front! Call toll-free today to order, to get more details or a videotape demonstration.

1-800-433-2323
In Oregon, call collect 1-627-9000

<table>
<thead>
<tr>
<th>Features</th>
<th>2246</th>
<th>2245</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandwidth</td>
<td>100 MHz</td>
<td>100 MHz</td>
</tr>
<tr>
<td>No. of Channels</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Scale Factor Readout</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>SmartCursors™</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Volts Cursors</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Time Cursors</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Voltmeter</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Vertical Sensitivity</td>
<td>2 mV/div</td>
<td>2 mV/div</td>
</tr>
<tr>
<td>Max. Sweep Speed</td>
<td>2 ns/div</td>
<td>2 ns/div</td>
</tr>
<tr>
<td>Vert/Hor Accuracy</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Trigger Modes</td>
<td>Auto Level, Auto, Norm, TV Field, TV Line, Single Sweep</td>
<td></td>
</tr>
<tr>
<td>Trigger Lever: Readout</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Weight</td>
<td>6.1 kg</td>
<td>6.1 kg</td>
</tr>
<tr>
<td>Warranty</td>
<td>3-year on parts and labor including CRT</td>
<td></td>
</tr>
<tr>
<td>Price</td>
<td>$2400</td>
<td>$1875</td>
</tr>
</tbody>
</table>

Copyright ©1986, Tektronix, Inc. All rights reserved. TTA-409

CIRCLE 92 ON FREE INFORMATION CARDS

www.americanradiohistory.com
DECEMBER '86

SPECIAL SECTION:

45 COMPUTERS ON THE WORKBENCH
Learn how computers can be used as powerful oscilloscopes, and more. Robert Grossblatt

49 COMPUTER-AIDED ELECTRONICS DESIGN
Computer-aided design software can end the drudgery of electronic-circuit design. And it's fun to use, too! Robert Grossblatt

BUILD THIS

54 R-E ROBOT
Introducing the R-E Robot, a powerful servant that you can customize for almost any application. Steven E. Sarns

61 CLOSED-CAPTION DECODER
Part 2. This month we get to work and build the unit. J. Daniel Gifford

73 PC SERVICE
Circuit boards for the closed-caption decoder and the sinewave descrambler.

TECHNOLOGY

6 VIDEO NEWS
Inside the fast-changing video scene. David Lachenbruch

79 SATELLITE TV
Breaking Videocypher. Bob Cooper, Jr.

81 ROBOTICS
More on vision systems. Mark J. Robillard

CIRCUITS AND COMPONENTS

57 TV DESCRAMBLING

65 DTMF ENCODING AND DECODING
New IC's make the power of DTMF signalling available to all. Dale Nassar

71 HOW TO DESIGN OSCILLATOR CIRCUITS

86 DRAWING BOARD
A remote-control system. Robert Grossblatt

88 SERVICE CLINIC
Signal tracing. Jack Darr

89 SERVICE QUESTIONS
Solutions to servicing problems.

RADIO

84 ANTIQUE RADIOS
Letters from our readers. Richard D. Fitch

COMPUTERS

following page 74 COMPUTER DIGEST
V20 vs. 8088, interfacing, and more.

EQUIPMENT REPORTS

24 Beckman Circuitmate LP25
Logic Probe

28 Beckman Circuitmate PR41
Logic Pulser

DEPARTMENTS

112 Advertising and Sales Offices
112 Advertising Index
20 Ask R-E
113 Free Information Card
8 Letters
90 Market Center
38 New Products
4 What's News

Annual Index
January Thru December 1986
Begins on page 75

SEASON'S GREETINGS

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

POSTMASTER: Please send address changes to RADIO ELECTRONICS, Subscription Dept., Box 55115, Boulder, CO 80321-5115

www.americanradiohistory.com
This month we begin a continuing series detailing a versatile, powerful robot you can design and build yourself. The R-E Robot has several characteristics that set it apart from commercially available units or kits. For one, it can be customized to meet the demands of almost any user application. Further, it is backed by a powerful onboard computer that makes use of a custom robot control language. That language makes it possible to control the robot using simple commands. To help get the most out of the project, we have set up a special section of our computer of a custom robot control language. That language makes it possible to control the robot using simple commands. To help get the most out of the project, we have set up a special section of our computer bulletin-board (RE-BBS) for the rapid exchange of sources, applications, software, and updates among our readers, the author, and the editors. To learn more, turn to page 54.

**Next Month**

**THE JANUARY ISSUE IS ON SALE DECEMBER 2**

**BUILD THE R-E ROBOT**

**HOW TO APPLY FOR A PATENT**
Learn how to patent your next brainstorm.

**BUILD A NINE-STATION INTERCOM**
A sophisticated, versatile communications system for the home or office.

**TV SIGNAL SCRAMBLING**
Part 7 looks at descramblers for the gated-pulse and outband systems.

**AUDIO UPDATE**
Larry Klein joins our staff as Audio Editor with the first installment of his new column.

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 sale and proper functioning of reader-built projects based upon or from plans or information published in this magazine.

Since some of the equipment and circuits described in RADIO-ELECTRONICS may relate to or be covered by U.S. patents, RADIO-ELECTRONICS disclaims any liability for the infringement of such patents by the making, using, or selling of any such equipment or circuit, and suggests that anyone interested in such projects consult a patent attorney.
NEW! Lower Price Scanners

Communications Electronics, the world’s largest distributor of radio scanners, introduces new lower prices to celebrate our 15th anniversary.

Regency® MX7000-GR
List price $699.95/CE price $469.95

Regency® Z60-GR
List price $299.95/CE price $195.95/SPECIAL $150.95
6-Band, 60 Channel/Handheld Scanners BANDS: 30-50, 88-108, 118-136, 144-174, 440-512 MHz. The Regency Z60 covers all the bands plus all the frequencies for a total of eight bands. The Z60 also features an alarm clock, and priority control as well as AC/DC operation.

Regency® Z45-GR
List price $259.95/CE price $159.95/SPECIAL $119.95
7-Band, 45 Channel/No-crystal scanners BANDS: 30-50, 88-108, 118-136, 144-174, 440-512 MHz. The Regency Z45 is very similar to the Z60 model listed above however it does not have the commercial FM broadcast band. The Z45, now at a special price from Communications Electronics.

Regency® RH250B-GR
List price $869.00/CE price $595.95/SPECIAL $395.95
10 Channel 25 Watt Transceiver/Handheld Scanners BANDS: 26-28, 88-108, 118-136, 144-174, 440-512 MHz. The Regency RH250B is a ten channel VHF handheld scanner. It has a low cost and is capable of 25 watt transmission. It has a built in battery backup. The RH250B makes an ideal radio for any police or fire department volunteer because of its low cost and high performance.

NEW! Bearcat® 50XL-GR
List price $159.95/CE price $114.95/SPECIAL $99.95
10-Band, 10 Channel/Handheld Scanners BANDS: 26-28, 88-108, 118-136, 144-174, 440-512 MHz. The Uniden Bearcat 50XL is an economical, handheld scanner with 10 channels covering ten frequencies. It features a keyguard switch to prevent accidental entry and words. Also order part #B50 which is a rechargeable battery pack for $14.95. A plug-in wall charger is included for $24.95. A carrying case is $24.95 and also order optional cigarette lighter cable part #PSO for $14.95.

NEW! Scanner Frequency Listings
The over 90 scanner frequency listings will help you find all the action your scanner can listen to. These new listings include Police, fire, ambulances, rescue, local government, private business, hospitals, emergency medical channels, new media, low power radio, ham radio, long distance radio, common carriers, AT&T mobile telephones, utility companies, general mobile radio services, marine radio, public utility, CB radio, CB radio, CB radio, CB radio, CB radio, CB radio, CB radio, CB radio, CB radio, CB radio, CB radio, CB radio, CB radio, CB radio, and more. The new frequency listings feature call up intercom references as well as radio frequency listings by radio name, police codes, and radio frequencies. All frequencies are listed with a corresponding call sign, police code, or radio name. Order your scanner now.

NEW! Bearcat® 800XL-GR
List price $499.95/CE price $317.95
12-Band, 40 Channel/Scanner Priority control/CB/DC Frequency 26-54, 185-174, 446-622, 806-912 MHz. The new Bearcat 800XL is an advanced CB scanner with great performance at a low CE price.

NEW! Bearcat® 210XW-GR
List price $339.95/CE price $209.95/SPECIAL $149.95
25 Channel/Scanner 5 watt AM scan scanner. A new scanner to add to your collection of Bearcat scanners. This scanner is a great value and is a great addition to your collection of Bearcat scanners.

NEW! Bearcat® 145XL-GR
List price $179.95/CE price $102.95/SPECIAL $69.95
10-Band, 10 Channel/Scanner W/Regency Weather Page/Weather Band: 26-28, 185-174, 446-622, 806-912 MHz. The Bearcat 145XL is a great value scanner. It has a built in battery and high performance. It has a built in battery and is equipped with a touch of a key. Order your scanner from CE today.

TEST ANY SCANNER
Test any scanner purchased from Communications Electronics with our “no questions asked” 30 day return policy. If you’re not completely satisfied, return it in as purchased for a full refund of shipping charges and realize credit.

For credit card orders call 1-800-USA-SCAN

Information on our Complete Line of Radios & Electronics is available from:

COMMUNICATIONS ELECTRONICS INC.

Consumer Products Division
P.O. Box 1045
Ann Arbor, Michigan 48106-1045 U.S.A.
Call 800-USA-SCAN or outside U.S., 313-787-6888

CIRCLE 79 ON FREE INFORMATION CARD

December 1986

www.americanradiohistory.com
Closed-circuit "citizens band"

Subscribers to the CompuServe Information Service, based in Columbus, OH, have available a "closed-circuit" form of CB radio called the CB Simulator. Any of the 280,000 CompuServe subscribers can—by typing GO CB—switch to a CB menu that makes it possible to scan a complete listing of all persons speaking on all 36 channels of the band, and to join conversations on any of the bands. Private conversations may be held off-channel, as well.

The connect rate for the CB Simulator is $6.00 per hour from 6 P.M. to 8 A.M. weekdays, and all day Saturdays, Sundays, and holidays. For weekday service between 8 A.M. and 6 P.M. the rate is $12.50 per hour.

Numerous friendships have been made over the simulator, and at least two weddings have been reported.

Fast computer chips with "quasicrystals?"

Scientists from three departments of the University of Michigan, supported by a $1.5-million grant from the National Science Foundation, are working to produce extremely fast computer chips and other advanced micro-electronic devices. They are working with a variety of metallic and semiconductor materials, sandwiched to form multilayered chips called superlattices.

In the past, researchers have depended on making semiconductor devices smaller and circuit leads shorter to make faster computers and other electronic devices. Already chips have been made that crowd more than a million electronics devices on a silicon chip less than a centimeter on a side.

Having reached the limit in reducing size, scientists are now seeking new ways of speeding up computers and other electronics equipment. Under the new grant, U of M scientists will focus on building and testing the properties of superlattices made of synthetic "quasicrystals," new materials invented at the University. The atoms of faster quasicrystals have a predictable arrangement that falls between the repeating patterns of crystals and the total disarray of glasses.

The research will also examine properties of metallic superlattices, with potential applications in modern superconducting devices. Research will also involve building and testing heterostructures, materials similar to superlattices but with fewer layers, that can be manipulated to produce a variety of electrical and optical effects.

New transparent conductor uses organic materials

The first transparent polymeric conductor is under development by Honeywell. Made in a thin film, it is versatile enough to defrost a car window or control a building's temperature by reflecting heat and cold. It is made from the polymer polydiiodocarbazole (PDICZ) doped with bromine and formed into film from 1 to 30 microns thick.

By varying the thickness of the film and the level of doping, Honeywell has varied the conductivity from insulating levels to conductivity appropriate for such applications as defrosting car windows. Light transmission is from 60 to 90 per cent.

The new film can be made more readily and more easily than earlier inorganic types, and it can be made with greater surface areas and thicknesses. Therefore it is expected to be considerably lower in cost than present types.

New devices authenticate money transfer messages

Researchers at the National Bureau of Standards Institute for Computer Sciences and Technology have completed the first validation of a security device that will be used to authenticate messages used for the electronic transfer of funds.

This validation is part of a program to help protect the billions of dollars in Federal funds that are transferred electronically every year.

NBS developed the test methods to ensure that devices used to transfer funds electronically comply with federal standards for computer data authentication and with the American National Standard for Financial Institution Message Authentication. The validation system can be used to test equipment remotely through an electronic interconnection with NBS.

Further information can be obtained from Miles Smid, Institute for Computer Sciences and Technology, National Bureau of Standards, A216 Technology Bldg., Gaithersburg, MD 20899.

High-efficiency solar panels

Solar panels designed to operate four or five times more efficiently than the best photovoltaic cells currently available, and at only a fraction of the cost, are currently under development by Massachusetts inventor Alvin Marks, and by Westinghouse.

Lepcon, the preliminary design patented by Marks, consists of a glass panel covered by millions of aluminum or copper strips, each less than a micron wide. Energy in the sunlight striking the panel is transferred to the electrons in the metal strips, generating electricity. Lumeloid, also patented by Marks, uses a similar approach, but substitutes film-like sheets of plastic.

WHAT'S NEWS
HAMEG Oscilloscopes with Component Tester

2-year warranty

HM 203-6 DC to 20MHz $489.00
- Rectangular screen, internal grid line 6 x 10 cm.
- Deflection: 5mV/cm to 20V/cm
- Timebase: 0.5s/cm to 0.25/cm
- Component Tester
  - Test voltage: max. 8.5Vrms (open circuit)
  - Test current: max. 24mA rms (shorted)

HM 204-2 DC to 20MHz $629.00
- Component Tester
  - Deflection: 5mV/cm to 20V/cm
  - Timebase: 0.1 us/cm to 0.5s/cm
- Component Tester
  - X-Magnification x 5
  - Y-Magnification x 10
- Sweep delay: 100 ns to 0.1 s.
- Calibrator: Square-wave generator, 1kHz/1MHz switchable, linear±5% for probe compensation, output voltages 0.2V and 2V±1%.

HM 605 DC to 80 MHz $999.00
- Component Tester
  - Deflection: 5mV/cm to 20V/cm
  - Timebase: 0.1 us/cm to 0.5s/cm
- Component Tester
  - X-Magnification x 5
  - Y-Magnification x 10
- Sweep delay: 100 ns to 0.1 s.

Digital Storage

- Operating modes: Refresh and Single with Reset (incl. LED indication for Ready). Hold Ch.I, Hold Ch.II, 1024x8 bit for each channel.
- Sample rate: max. 100kHz. Resolution: vertical 28 pts/cm, horizontal 100 pts/cm.
- Option: Interface for plotter.
- Component Tester

Digital Storage

- Operating modes: XY, Roll, Refresh, Single (LED ind.), Hold Ch.I, Hold Ch.II, Plot I and Plot II with read-out check on screen. Backing storage. Dot joining button. 2 x 1024 x 8 bit for each channel.
- Sample rate: max. 20MHz. Resolution: vertical 28 pts/cm, horizontal 200 or 100 pts/cm.
- Plotter output: vertical 0.1V/cm, horizontal 0.1V/cm.
- Output impedance: 100Ω each. Portability: TTL/CMOS compatible.
- Output speed: 5-10/20/10-20/40 s/cm.
- Option: Lithium battery for memory backup.

HM 205 $799.00
Real-time - See 203-6 Specifications

HM 208 $2,380.00
HM 208-I $2,860.00
(with IEEE interface)
Real-time - See 203-6 Specifications

ATTACHES TO ALL HAMEG SCOPES ON THIS PAGE

HM 8001 2 BAY Mainframe $225.00
HM 8002 4 BAY Mainframe $400.00
HM 8011-2 Digital Multimeter 4½ digits $298.00
HM 8014 Milli Ohm Meter $298.00
HM 8021-2 Counter, 0.1Hz-1Hz $324.00
HM 8027 Distortion Meter $248.00
HM 8030-2 Function Gen. 0.1Hz-1MHz $288.00
HM 8032 Sine Wave Gen. 20Hz-20MHz $288.00
HM 8035 Pulse Generator, 2Hz-20MHz $455.00
HM 8037 Low Dist. Sine Gen. 5Hz-50kHz $248.00
HM 8040 Triple Power Supply $278.00
HM 8045 Oscilloscope Calibrator $378.00

CIRCLE 125 ON FREE INFORMATION CARD
CALL US TOLL FREE
1-800-732-3457
IN CALIFORNIA TOLL FREE
1-800-272-4225

Hitachi
Leader
Polaroid
Simpson

Prices subject to change without notice.

www.americanradiohistory.com
• Picture-in-Picture. Digital circuitry is making possible a number of hot new features in VCR's, the most spectacular of which is Picture-In-Picture, or PIP. That feature heretofore has been found only in a few digital TV sets. Now PIP VCR's are being introduced one after the other—the first three by RCA, Hitachi, and Sears, with others to come later. All three of the first PIP VCR's are made by Hitachi. RCA's is the most sophisticated and contains nine dynamic RAM's with a total storage capacity of more than two megabits.

Using the hand-held remote-control unit, the user can superimpose a smaller picture in any corner of the main picture. The main picture may be the VCR tape playback, and the smaller picture can be from the VCR's TV tuner or from the video input terminal. The two pictures may be exchanged at will, and either one may be frozen, thanks to built-in field storage. The same field storage is used for fast motion without sound bars; there are unique special effects, such as "mosaic" and "posterization." The Hitachi and Sears recorders also have PIP but their special effects are limited. The RCA VCR uses two DRAM's for the PIP field memory, and six to enhance picture stability. The first PIP VCR's will sell for $500 to $700, depending on what other features are included.

• Interactive VCR. Worlds of Wonder, Inc., which brought us Teddy Ruxpin, the talking teddy bear, plans to introduce a unique computer attachment that will make any VCR interactive. Three years in development, it differs from programmable videodiscs in that the screen is never blanked during the interactive search. Special tapes for the system have four-way branching and give the effect of 20 tracks of information. There are four audio tracks, up to four branchable video tracks with motion, and up to 20 computer-generated tracks with limited motion. The entire attachment is scheduled to sell for less than $250 in a year or so, or could be built into a digital TV or VCR for $50 to $100. The first program cassettes will be educational, and several producers—the first being Heron Communications—are preparing programming. In addition, WOW is exploring the use of special cable TV programming for the interactive machine. That is possible because the system is completely linear. The tape is never required to stop or reverse itself. The system can give quizzes with questions selected at random, keep score, provide music with a still picture, change pictures in response to the viewer's choice, react to user-manipulated arrows or cursors, and so forth.

• The ultimate Beta. The most elaborate, and probably the best, consumer VCR ever introduced is a new Beta model by Sony. The quality results from the fact that Sony didn't worry much about compatibility. It improved on Superbeta by shifting the carrier up to 1.2 MHz in the Beta I speed, as opposed to Superbeta's 800 kHz, thereby providing resolution of better than 300 lines. A switch preserves one-way compatibility—playback of standard Beta I tapes. The machine has features never seen before on a half-inch machine, such as flying erase heads, a frame counter, a character generator with eight-page memory, and a programmable assembly editing system to put together up to eight segments with accuracy within two frames. It even has an on-screen calendar for programming. Sony sees its principle use in editing onto VHS, Beta or 8mm VCR formats. It lists at $1,700.

• Zenith adds Bose sound. Who says you need a ten-foot audio system to get good TV sound? Not Zenith or Bose. The two companies have united to produce a series of high-end 27-inch digital color sets with a folded waveguide woofer built into the back and occupying no space beyond the normal outside dimensions of the set. Two twiddlers—combination midband and tweeter speakers—are front-mounted below the TV screen. The sets have three amplifiers—a 25-watt to power the woofer and two 5-watt units for the twiddlers—and they have built-in World System Teletext reception. They'll sell for around $1,400 for a table model, or $1,700 for the best console.
What Pomona knows about banana plugs and adapters would fill a book.

For over 30 years the Pomona Electronics line of banana plugs, jacks and adapters has played a major role in our ability to stay on the leading edge of electronics test technology. Every year we add new banana plug products to make your life as a professional design engineer a little easier. And the complete line is listed in our 1986 General Catalog.

In our new book you'll find over 400 models that utilize or adapt banana plugs in some useful fashion: plugs, jacks, binding posts, adapters, patch cords and cables, in standard or miniature sizes. You name it and you'll probably find exactly what you need in our new catalog.

Here's how to get your copy of our 1986 General Catalog: Just circle the reader service number below; call us at (714) 623-3463; write us at Pomona Electronics, a division of ITT Corporation, 1500 East Ninth Street, P.O. Box 2767, Pomona, California 91769.

Our products are available through your favorite electronics parts distributor.
A few errors crept into the article “Build This Satellite-TV De-scrambler” in the October 1986 issue of *Radio-Electronics*. In Fig. 2, the schematic diagram, pin 14 of ICs 2 and 3 should be tied to -5 volts, not +5 volts as shown. Transistor R29 should be tied to +5 volts. Transistor Q7 is misidentified: It should be a 2N3904. Finally, the positions of Q5 and Q6 have been reversed. The unit identified as Q5 should be Q6, a 2N3906 PNP transistor.

In Fig. 3, the parts-placement diagram, two components are shown in the wrong location. Resistors R8 and R23 are shown vertically aligned; they should be mounted horizontally. Resistor R8 mounts between the top of what is shown as R8 and the top of what is shown as R23; resistor R23 mounts between the bottom of what is shown as R8 and the bottom of what is shown as R23.

Finally, a trace is missing from the PC pattern. It runs from the positive end of C5 to the center of jack J2. Replace that trace with a jumper.—Editor.

In regard to Anthony Stevens’ article, “Radar Speed-Gun Calibrator” (*Radio-Electronics*, August 1986), there seems to be a little information that he left out—and the reader should be aware of it.

On the first page of the article, he mentions that the Doppler shift is about 31 Hz per MPH of target velocity. That is correct, but he fails to point out that that amount of Doppler shift only applies to radar guns operating at the 10.525GHz frequency (X-band). He also does not inform the reader that the Gunn diode and microwave horn...
**SUPER VALUES from JOSEPH ELECTRONICS**

**Hitachi SCOPES**

Full 3-year warranty

- V1050F 100 MHz QUAD CHANNEL/8-TRACE DELAYED SWEEP SCOPE. The features you want and need: 500uV Sens., 2% Accuracy. 6" CRT has internal gridplate, 200V acceleration. One-touch sync of TV-V, TV-H Plus: autotrace. Variable hold-off, trace retention adjust. X-Y operation. 10K magnification. W/probes, dust cover.
  
  Reg. $1,595  
  Sale Price $1,198

- V650F 60 MHz TRIPLE-TRACE DELAYED SWEEP SCOPE. As above, except has 10KV acceleration. 1MV sensitivity, 3% accuracy. Triple trace. W/probes.
  
  Reg. $1,195  
  Sale Price $898

**FLUKE DMM'S**

- MODEL 8060A-4½ DIGIT, TRUE RMS DMM
  
  True RMS AC voltage and amp measurement. 0.04% basic accuracy. 100% basic DC accuracy. 0.04% basic AC voltage and current measurement. AC to 50 KHz. Conductance measurement. Frequency measurement. Top trace resolution is 1ppm. Low power off. 10000 Ohms. 0.001% basic DC accuracy throughout range. 3000mV full-scale sensitivity. 0.01% basic AC voltage and current measurement. AC to 50 KHz. Conductance measurement. Frequency measurement. Top trace resolution is 1ppm. Low power off. 10000 Ohms. 0.001% basic DC accuracy throughout range. 3000mV full-scale sensitivity.
  
  Reg. $529  
  Sale $498

- MODEL 8050A-4½ DIGIT, BENCH DMM
  
  False count, visual continuity tests, Relative reference offset, Low-power consumption, on all resistance ranges, Current measurement. 1A, 100mA, 10mA, 1mA, 100µA, 10µA, 1µA, 100nA, 10nA. 0.003% basic DC accuracy. True RMS AC voltage and current measurement. AC to 50 KHz. Conductance measurement. Frequency measurement. Top trace resolution is 1ppm. Low power off. 10000 Ohms. 0.001% basic DC accuracy throughout range. 3000mV full-scale sensitivity. 0.01% basic AC voltage and current measurement. AC to 50 KHz. Conductance measurement. Frequency measurement. Top trace resolution is 1ppm. Low power off. 10000 Ohms. 0.001% basic DC accuracy throughout range. 3000mV full-scale sensitivity.
  
  Reg. $349  
  Sale $308

**TEST INSTRUMENTS**

- Model 203 2 MHz Function Generator
  
  0.2 Hz to 2 MHz Function Generator. Sinus. Square, Triangle Waveforms. External Sweep 1000 Hz. 1 MHz, 50 Ohm Outputs. Variable DC Offset. Wt. 2.0 lbs. 10.2 x 6 x 2.5".
  
  Reg. $289  
  Sale $258

- Ultra-Portable Mini-Scope
  
  Model 1070
  
  10 MHz Full-Featured Oscilloscope. AC or Battery operated with internal battery charger. 10 mV Sensitivity, 21 Time Base Ranges. 10000 Ohms. 0.001% basic DC accuracy. True RMS AC voltage and current measurement. AC to 50 KHz. Conductance measurement. Frequency measurement. Top trace resolution is 1ppm. Low power off. 10000 Ohms. 0.001% basic DC accuracy throughout range. 3000mV full-scale sensitivity. 0.01% basic AC voltage and current measurement. AC to 50 KHz. Conductance measurement. Frequency measurement. Top trace resolution is 1ppm. Low power off. 10000 Ohms. 0.001% basic DC accuracy throughout range. 3000mV full-scale sensitivity.
  
  Reg. $385  
  Sale $338

- Model 8050A 600 MHz Frequency Counter
  
  6 Digit ½" LED Display. Wide Frequency Range: 5 Hz to 600 MHz. 10 MHz DMS Sensitivity throughout range. 2 ppm Time Base Accuracy. AC or Battery powered. 50 Ohm Outputs. 0.02% basic DC accuracy. True RMS AC voltage and current measurement. AC to 50 KHz. Conductance measurement. Frequency measurement. Top trace resolution is 1ppm. Low power off. 10000 Ohms. 0.001% basic DC accuracy throughout range. 3000mV full-scale sensitivity. 0.01% basic AC voltage and current measurement. AC to 50 KHz. Conductance measurement. Frequency measurement. Top trace resolution is 1ppm. Low power off. 10000 Ohms. 0.001% basic DC accuracy throughout range. 3000mV full-scale sensitivity.
  
  Reg. $340  
  Sale $308

- Model 8050A 200 MHz Handheld Counter
  
  Reg. $145  
  Sale $128

**CALL TOLL-FREE**

1-800-323-5923

FREE SHIPPING to U.S.

Shippable Destinations

**FREE 116 page Joseph Electronics discount instrument catalog with your order or on request!**

Joseph Electronics

8630 N. Milwaukee Ave.,

Niles, IL 60648

LIMITED TIME OFFER WHILE QUANTITIES LAST. PHONE TODAY TOLL-FREE!

1-800-323-5925 (In Illinois 1-812-297-4220)

VISA-MASTERCARD-DISCOVER

CARD WELCOME. OPEN ACCOUNT

ORDERS TO RATED COMPANIES.

ILLINOIS RESIDENTS ADD 7% TAX.

www.americanradiohistory.com
in the parts list will only work in conjunction with the X-band radar units—that is, assuming that they are the same ones as shown on the lead page of the article. Also not mentioned is whether or not a K-band diode and horn is available.

While the K-band output is mentioned in passing on page 42, he does not elaborate on any of the details. The K-band output is derived from a different divider chain, because the Doppler shift on that band is different than it is on the X-band for a target traveling at the same speed.

Although there are several K-band frequencies used, I used 24.5 GHz for my computation. That results in a Doppler shift of 73.1 Hz per MPH. That can be figured out by one of two methods. One is to multiply the ratio of 24.5 GHz to 10.525 GHz (2.328) by 31.4; the other is to use the formula for Doppler shift, DS:

$$DS = \frac{kHz/MPH}{2} \times \lambda$$

where $\lambda$ is the wavelength in centimeters, which equals $\frac{30}{\text{frequency in GHz}}$.

Another item of note from the “Ask-RE” column in that same issue. A reader asked about an IC that would convert from a RGB signal to a composite signal. The author of the column did not know of a chip for generating the sync. Refer to the article on Cable-TV de-scrambling on page 53, and you will find an IC to do just that. There is an article in a back issue of Ham Radio that provides complete construction instructions. I'm not sure which issue it was, but I think it came out four or five years ago.

And finally (I know, I know), my high school English teacher said never to start a sentence with and, who is the new advertiser on page 41 (Mr. Sestero refers to the NutriWheat Diet Program.—Editor). I'm sure that I speak for many of your faithful readers when I say that we don't need that kind of advertising in an electronics magazine. It reminds me of reading through the old Mechanix Illustrated magazines of 20 years ago. Please, let's not repeat that.

ROBERT T. SESTERO
Baltimore, MD

We start sentences with “and” regularly—in spite of what our high school English teachers said. We also use prepositions to end sentences with. Times change.—Editor

INACCURACIES
I am writing to correct some of the many inaccuracies in the article, “The Early Days of Radio,” by Martin Clifford, which appeared in the July issue. Hugo Gernsback must be turning in his grave! It is perhaps possible that some of them were due to editing, but I suspect that most came directly from the author, who hadn't done his homework. (By the way, the picture of an early radio station on the first page of the article is most interesting, and it would be pleasant to know something more about it. On the right side of the picture is a device that appears to be a microphone, either for a recording device or, perhaps, for radiotelephony. The instrument with a large dial at the center of the left side of the picture is also of interest.)
Here’s your chance to win a complete monitoring package from Regency Electronics and Lunar Antennas. 18 scanners in all will be awarded, including a grand prize of the set-up you see above: the Regency HX1500 handheld, the Z60 base station scanner, the R806 mobile unit, and a Lunar GDX-4 Broadband monitoring/reference antenna.

55 Channels to go!

When you’re on the go, and you need to stay tuned into the action, take along the Regency HX1500. It’s got 55 channels, 4 independent scan banks, a top mounted auxiliary scan control, liquid crystal display, rugged die-cast aluminum chassis, covers ten public service bands including aircraft, and it’s keyboard programmable.

Compact Mobile

With today’s smaller cars and limited installation space in mind, Regency has developed a new compact mobile scanner, the R806. It’s the world’s first microprocessor controlled crystal scanner. In addition, the R806 features 8 channels, programmable priority, dual scan speed, and bright LED channel indicators.

Base Station Plus!

Besides covering all the standard public service bands, the Regency Z60 scanner receives FM broadcast, aircraft transmissions, and has a built-in digital quartz clock with an alarm. Other Z60 features include 60 channels, keyboard programming, priority control, digital display and permanent memory.

Lunar Antenna

Also included in the grand prize is a broadband monitoring/reference antenna from Lunar Electronics. The GDX-4 covers 25 to 1300 MHz, and includes a 6 foot tower.

<table>
<thead>
<tr>
<th>Grand Prize</th>
<th>(1 awarded)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1—Regency Z60 Base station scanner</td>
<td></td>
</tr>
<tr>
<td>1—Regency HX1500 Handheld scanner</td>
<td></td>
</tr>
<tr>
<td>1—Regency R806 Mobile scanner</td>
<td></td>
</tr>
<tr>
<td>1—Lunar GDX-4 Antenna</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>First Prize</th>
<th>(5 awarded)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1—Regency Z60 Base station scanner</td>
<td></td>
</tr>
<tr>
<td>1—Regency R806 Mobile scanner</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Second Prize</th>
<th>(5 awarded)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1—Regency HX1500 scanner</td>
<td></td>
</tr>
</tbody>
</table>

Contest rules: Just answer the questions on the coupon, fill in your name and address, and send the coupon to Regency Electronics, Inc., 7707 Records Street, Indianapolis, IN 46226. Winners will be selected from all correct entries. One entry per person. No purchase necessary. Void where prohibited by law. Contest ends June 30, 1987.

1. The Regency Z60 is
   - [ ] a digital alarm clock
   - [ ] an FM radio
   - [ ] a scanner
   - [ ] all of the above

2. The Regency R806 is the world’s first ____________ controlled crystal scanner.

3. The Regency HX1500 features
   - [ ] 55 channels
   - [ ] Bank scanning
   - [ ] Liquid crystal display
   - [ ] all of the above

4. The Lunar GDX-4 antenna covers ___ to ___ MHz.

Name: ____________________________
Address: __________________________
City: __________ State: ______ Zipcode: ___________
I currently own ______ scanners.
Brands owned: ____________________

CIRCLE 182 ON FREE INFORMATION CARD
Perhaps the most glaring errors appear in Fig. 1 and Fig. 2, which show schematics for crystal receivers that cannot work. I think that those schematics were copied from other articles I have seen during the past few years; they were also written by someone who apparently did not understand electricity. In both of those figures, the crystal and the headset are wired in series with the antenna and ground, and there is no direct current return path. As a result, no current could or would flow in the headphones, hence no reception. There should also be a bypass capacitor across the phones, but that is of no importance in a receiver that can't work.

Figure 3, while also flawed, does correspond to early practice. The problem with it is that the headset is connected to the "hot" end of the tuning coil, and capacitance from headset to ground would affect tuning. That wouldn't be of much importance in a receiver with such poor selectivity, however. Fig. 4 is OK, but Fig. 5 has the same problem as Fig. 3; in addition, there should be a bypass capacitor between the potentiometer arm and the detector, but its omission was also typical of early receivers. Figs. 7 and 12 will work, although the use of a variable capacitor in series with the antenna will permit antenna circuit tuning and give much better selectivity.

A couple of other errors are less significant. The statement that "true solid-state receivers have been with us since 1916" would be more accurate if the date were 1906, when the Perikon detector was patented. The commercial use of crystal detectors in the following years was more limited by patent matters than by performance.

One more annoyingly incorrect statement is: "Early vacuum-tube rectifiers, such as the UX-201A and the UV-199 triodes, cost about $15.00." That statement contains three errors. First of all, those tubes were triode amplifiers and detectors, not rectifiers. Second, those particular tubes were not particularly early. Third, they never cost $15.00. The UV201, the predecessor to the UX201A, was announced in November, 1920, at a cost of $6.50. It was considered an amplifier, with the corresponding detector being the UV200, at $5.00. Although those were not the first tubes available to the public, they were the first sold by RCA, and correspond roughly to the beginning of broadcasting. The UV199 is of interest as an early "dry battery tube;" it was announced in December, 1922, and it cost $6.50. The UX201A was a relatively late tube, introduced at $2.50 in August, 1925, to replace the UV201A, which had been introduced at the same time as the UV199, and at the same price. The UV201A and the UX201A, like the UV199, had thoriated tungsten filaments, which greatly reduced the required filament power.

There is really no excuse for such a poor article, because many excellent reference books are available these days. For early vacuum tubes, I would recommend *Saga of the Vacuum Tube*, by Gerald Tyne, and 70 Years of Radio Tubes and Valves, by John Stokes.
PERFORMANCE
THAT IS OUT OF THIS WORLD...

...AT A DOWN TO EARTH PRICE

At last! Truly affordable test equipment with no compromise in design, and features you would expect to find only on oscilloscopes costing hundreds of dollars more! JDR Instruments presents two, new, high-performance models backed by a two year warranty and technical support which is only a phone call away. Perfect for the technician or advanced hobbyist, both models feature Dual Trace capability and a variety of operating and triggering modes, including CH-B Subtract and X-Y operation.

MODEL 2000 has a 20 MHz bandwidth and 20 calibrated sweeps ranging from .2s to .2μs. A convenient built-in component tester provides additional diagnostic power.

MODEL 3500 features a 35 MHz bandwidth and exceptional 1mV/DIV sensitivity. Delayed sweep and variable holdoff allow stable viewing of complex waveforms.

ORDER TOLL FREE
800-538-5000
800-662-6279 (CA)

JDR INSTRUMENTS
1224 South Bascom Avenue
San Jose, California 95128 (408) 995-5430

COPYRIGHT 1985 JDR INSTRUMENTS. EARTH PHOTO COURTESY OF NASA.
THE JDR INSTRUMENTS LOGO IS A REGISTERED TRADEMARK OF JDR MICRODEVICES. JDR INSTRUMENTS IS A TRADEMARK OF JUR MICRODEVICES.

www.americanradiohistory.com
Both are available from Antique Electronic Supply, 688 W. First Street, Tempe, AZ 85281. A couple of other interesting histories are The Development of Wireless to 1920, Arno Press, New York, 1977, and The Continuous Wave—Technology and American Radio, 1900–1932, by Hugh Aikens, also available from Antique Electronics Supply. Anyone seriously interested in historical radio and wireless should join the Antique Wireless Association, Holcomb, New York. Dues are $6.00 per year and include four issues of The Old Timer’s Bulletin, which contains excellent articles of historical interest. In addition to many want ads. Membership applications should be sent to Bruce Roloson, Box 212, Penn Yan, New York 14527.

EDWARD PHILLIPS
San Gabriel, CA

The circuits shown in Figs. 1 and 2 are correct, and they can and do work. Apparently Mr. Phillips doesn’t know the difference between a DC ground and an RF ground. The circuit is grounded for RF, and current will flow in those circuits even if a capacitor is inserted in series with the antenna lead-in.

Hugo Gernsback need not turn in his grave, because those circuits, and others like them (surprise! originally appeared in a book, How to Read Circuit Diagrams, published by Gernsback about 50 years ago.

It isn’t necessary to put a bypass capacitor across the headphones. There is enough capacitance between the turns of the wire in the headphone to supply by bypassing action for the carrier wave.

The headphones in Fig. 3 can be positioned before or after the crystal detector. The tuning is so extremely broad that the capacitance from headphones to ground is of little consequence.

I am well aware of the Perikon detector. However, it wasn’t until about 1919 or 1920 that the iron pyrites crystal detector became a household item. As far as the price of tubes is concerned, one must be aware that a new component is always at its highest price. As tube competition increased, and the supply of tubes went up, those early tubes dropped in price even lower than the figures Mr. Phillips stated.

I do not mind his comments on the article. What I do resent is the statement that Hugo Gernsback must be turning in his grave. That is arrogant and presumptuous, and implies that Mr. Phillips knew Gernsback. I doubt that he even met the man. I used to have lunch with Hugo Gernsback from time to time, and was also a guest in his home. I was in France with him, and together we visited a noted technical publisher in Paris. I have no doubt that he was his friend; I have a photograph from him inscribed, “To my friend, Martin Clifford.”

I was impressed with the books Mr. Phillips mentions in his letter. I would suggest that he take some time and read them.—Martin Clifford

continued on page 33
Which Way To YOUR Future?

Are you at a crossroads in your career? Have you really thought about it? Are you planning for your future, or perhaps refusing to face the subject? Which way will you go — down the same old road? Or are you ready for something else?

In electronics you can’t stand still. If you are not moving ahead, then you’re falling behind. At the crossroads of your career, various choices are available — and, yes, decisions have to be made.

Which road will you take — one that doesn’t go where you want to be, or one that leads to hard work but also to the better life? Ah, decisions, decisions!

Career decisions are so important that you need all the input you can get before locking-in on one of them. Grantham College of Engineering offers you one source of input which may help you in making that decision. It’s our free catalog.

Ask for our free catalog and you may be surprised to learn how it is easily possible to earn a B.S. degree in electronics without attending traditional classes. Since you are already in electronics (you are, aren’t you?), you can complete your B.S. degree work with Grantham while studying at home or at any convenient place.

But don’t expect to earn that degree without hard work. Any degree that’s worth your effort can’t be had without giving effort to the task. And of course it is what you learn in the process, as much as the degree itself, that makes you stand out above the crowd — that places you in an enviable position, prestige-wise and financially.

Grantham College of Engineering
10570 Humbolt Street
Los Alamitos, California, 90720

Put Professional KNOWLEDGE and a COLLEGE DEGREE in your Electronics Career through HOME STUDY

Grantham offers this program, complete but without laboratory, to electronics technicians whose objectives are to upgrade their level of technical employment.

Recognition and Quality Assurance

Grantham College of Engineering is accredited by the Accrediting Commission of the National Home Study Council, as a degree-granting institution.

All lessons and other study materials, as well as communications between the college and students, are in the English language. However, we have students in many foreign countries; about 80% of our students live in the United States of America.

Grantham College of Engineering
R-12-86
10570 Humbolt Street, Los Alamitos, CA 90720

Please mail me your free catalog which explains your B.S. Degree independent-study program.

Name
Address
City State Zip

This booklet FREE!

This free booklet explains the Grantham B.S. Degree Program, offered by independent study to those who work in electronics.
Only NRI Gives You System for Total

You get it all... training for America's fastest growing career opportunity... training to service all computers... training on a total computer system. And only NRI training gives you all the skills and confidence to become a complete computer service technician.

Today, you can't successfully repair a computer with confidence unless you know that the peripheral equipment is operating properly. Only NRI can give you the well-rounded training you need because only NRI gives you a complete computer system... computer, monitor, disk drive, printer, software, even test instruments like a digital multimeter and logic probe. It all adds up to training that builds the knowledge, competence and ability you need to succeed as a computer service specialist.

Get inside the IBM PC compatible Sanyo

As an NRI student, you'll get total hands-on training as you actually build your own Sanyo 550 Series computer from the keyboard up. As you assemble it, you'll perform demonstrations and experiments that will give you a total mastery of computer operations and servicing techniques. You'll do programming in BASIC language—even run and interpret essential diagnostic software. You'll prepare interfaces for peripherals such as printers and joysticks. Using utility programs, you'll check out the operation of the 8088 microprocessor. Step-by-step, NRI will guide you right into a high paying career in one of America's fastest growing fields.

New! Course now includes high performance printer

Only NRI includes an advanced dot matrix printer as part of your hands-on training. Working with it, you'll get practical experience in adding peripherals, perform experiments bringing to life operating principles, and then go on to learn critical maintenance and servicing techniques, including changing the print head.

MONITOR High resolution monochrome monitor displays 80 crisp characters per line. Does equally well displaying high resolution graphics.

PRINTER Advanced dot matrix printer prints four sizes of italics and standard type at up to 120 cps bidirectionally in Near-Letter-Quality mode.

SANYO 550 SERIES COMPUTER has powerful 8088 CPU, runs many IBM PC programs. Includes 256K RAM, double-sided double density disk drive, parallel printer port and detached intelligent keyboard.

FLOPPY DISK AND PROGRAM Software includes MS-DOS 2.11 operating system, Sanyo BASIC, two word processing programs, a powerful spreadsheet program, and several useful NRI written utility programs.
A Total Computer Systems Training

Understanding you can get only through experience
You need no previous knowledge to succeed with NRI. You start with the basics, rapidly building on the fundamentals of electronics with bite-size lessons to master advanced concepts like digital logic, microprocessors, and computer memories.

You'll reinforce this new understanding with hands-on practical demonstrations and experiments that give you real world experience. You'll use the exclusive NRI Discovery Lab to see what makes transistors tick... build and test working electronic circuits that duplicate key computer circuitry... and construct digital logic circuits that demonstrate computer performance.

Do it at home in your spare time
NRI trains you in your own home at your convenience. You learn at your own pace, backed at all times by your own NRI instructor and the entire NRI staff of educators and engineers. They're always ready to answer questions, give you guidance, follow your progress, and help you over the rough spots to keep you moving toward your goal.

100 page free catalog tells more... send today
Send the postage-paid reply card today for NRI's 100 page catalog that gives all the facts about computer training plus career training in robotics, data communications, TV/audio/video servicing, and many other fields. You'll see how NRI can give you the skills and confidence you need for advancement, a new career—even a service business of your own in the existing world of electronics. If the card is missing, write to NRI at the address below.

NRI SCHOOLS
McGraw-Hill Continuing Education Center
3939 Wisconsin Avenue
Washington, DC 20016
We'll give you tomorrow
**TV-RHOMBIC ANTENNAS**

Your response to the request for a balun for a TV rhombic left me puzzled. Whoever heard of a rhombic for TV frequencies? I thought that rhombics are used to obtain directivity at low frequencies when you have enough real estate to establish an "antenna farm." What are the dimensions for a TV rhombic? How does its performance compare with that of a Yagi?—O. K. H., New Strawn, KS.

When the desired TV stations are 75 to 150 miles or so away and all in nearly the same direction, a good rhombic can provide high gain while offering broader frequency response and a constant impedance over a broader range than a Yagi. Specifically, a rhombic provides high gain over a 2:1 frequency range; in other words, the design frequency ±50%. Although any antenna for receiving distant stations should be as high as practical, a rhombic two or three wavelengths above ground may outperform a high-gain Yagi on a much higher tower.

Rhombic antennas were widely used in remote areas in the early days of television; they're still not uncommon in many rural areas today. A rhombic with six wavelengths in each leg can provide 12 dB of gain in the forward direction and it can be small enough to fit on many residential lots. Some high-band and UHF TV rhombics are small enough to be mounted on a rotator on a tower.

The diagram of a rhombic for TV frequencies is shown in Fig. 1. The dimensions of each leg for receiving signals at various frequencies are shown in Table 1. A rhombic's beam-width is usually much narrower than that of a Yagi with equal gain, so you must be extremely careful to orient the antenna carefully to within a degree or two. Beam-width decreases and tilt angle increases with the number of wavelengths in each leg. For maximum gain, orientation must be accurate within ±3, ±4, and ±6.5 degrees for rhombics with six, four, and two wavelengths per leg, respectively.

The rhombic should be terminated by an 800-ohm non-inductive resistor. You can use two 390-ohm, 2-watt resistors in series.

**DARKROOM TIMER**

I need help in designing a darkroom timer for my enlarger. I'd like a countdown timer that can be set from 0 to 120 seconds in 0.1-
The design of a "dream" darkroom timer such as you describe is a project that would probably require much troubleshooting and several trips back to the drawing board before satisfactory performance is achieved. Unfortunately, we cannot undertake the R&D work needed to provide you with a foolproof design.

You can find some designs that do part of what you want in today's magazines. Consult the Applied Science and Technology Index and the Readers Guide to Periodical Literature in your local library. And try to get a copy of Intersil's Timers, Counters, and Display Drivers Applications Handbook. Write to Intersil at 10710 N. Tantau Ave., Cupertino, CA 95014. That 30-page booklet is chock full of circuits for programmable interval timers, stopwatch counters, and digital displays and drivers. If it is not available, try for a copy of Intersil's Hot Ideas in CMOS. Chapter 6 of that work contains data sheets, application notes, and circuits covering the firm's line of counters, timers, and display drivers.

**POWER DISTRIBUTION GRIDS**

For a college research project, I'm doing a study on the losses in electrical power over long-distance power lines. I need maps showing the power distribution grids throughout the United States. Where can those maps be obtained? — D. D., Bloomington, IN.

Try the "Chief Transmissions Engineer" or the "Director of Power Distribution" of your local power company. If he can't help, contact your Congressman or Senator. The type of information you're looking for is probably available through a governmental agency such as the Department of Energy, the Energy Information Administration, or the Federal Energy Regulatory Commission.

---

**Exclusive, triple patented dynamic cap and coil analyzing... guaranteed to pinpoint your problem every time or your money back**

The "Z METER" is the only LC tester that enables you to test all capacitors and coils dynamically — plus, it's now faster, more accurate, and checks Equivalent Series Resistance (ESR) plus small wire high resistance coils.

Eliminate expensive part substitution and time-consuming shootgun testing with patented tests that give you results you can trust every time. Test capacitor value, leakage, dielectric absorption, and ESR dynamically, with up to 600 volts applied for guaranteed 100% reliable results — it's exclusive — it's triple patented.

Save time and money with the only 100% reliable, in-or out-of-circuit inductor tester available. Dynamically test inductors for value, shorts, and opens, automatically under "dynamic" circuit conditions.

Reduce costly parts inventory with patented tests you can trust. No more need to stock a large inventory of caps, coils, flybacks, and ITHVIs. The "Z METER" eliminates time-consuming and expensive parts substituting with 100% reliable LC analyzing.

Turn chaos into cash by quickly locating transmission line distance to opens and shorts to within feet, in any transmission line. Test troublesome SCRs & TRIACs easily and automatically without investing in an expensive second tester. The patented "Z METER 2" even tests SCRs, TRIACs, and High-Voltage Diodes dynamically with up to 600 volts applied by adding the new SCR250 SCR and TRIAC Test Accessory for only $148 or FREE OF CHARGE on Kick Off promotion.

To try the world's only Dynamic LC Tester for yourself, CALL TODAY, WATS FREE, 1-800-843-3338, for a FREE 15 day Self Demo.
Super Disk Diskettes

Now...Diskettes you can swear by, not swear at.

Lucky for you, the diskette buyer, there are many diskette brands to choose from. Some brands are good, some not as good, and some you wouldn't think of trusting with even one byte of your valuable data. Sadly, some manufacturers have put their profit motive ahead of creating quality products. This has resulted in an abundance of low-quality but rather expensive diskettes in the marketplace.

A NEW COMPANY WAS NEEDED AND STARTED

Fortunately, other people in the diskette industry recognized that making ultra-high quality diskettes required the best and newest manufacturing equipment as well as the best people to operate this equipment. Since most manufacturers seemed satisfied to give you only the everyday quality now available, an assembly of quality conscious individuals decided to start a new company that would provide better and better diskettes. They called this product the Super Disk diskette, and you're going to love 'em. Now you have a product you can swear by, not swear at.

THEY MADE THE BEST DISKETTES EVEN BETTER

The management of Super Disk diskettes then hired all the top brains in the diskette industry to make the Super Disk product. Then these top bananas (sometimes called floppy freaks) established the highest standard of diskette quality and reliability. To learn the "manufacturing secrets" of the top diskette makers, they've also hired the best "magnetic media moguls" from competitors around the world. Then, with all of these world class, top-dollar engineers, physicists, research scientists and production experts (if they've missed you, send your resume to Super Disk) were given one directive...to pool all their manufacturing know-how and create a new, better diskette.

HOW SUPER DISK DISKETTES ARE MANUFACTURED

The Super Disk crew then assembled the newest, totally quality monitored, automated production line in the industry. Since the manufacturing equipment at Super Disk is new, it's easy for Super Disk to consistently make better diskettes. You can always be assured of ultra-tight tolerances and superb dependability when you use a Super Disk. While all our competitors that manufacture diskettes are free to include "non-warranted" bulk diskettes in cartons to a case. To save you even more, we also offer Super Disk bulk product where 100 or 500 diskettes are packed in the same box without envelopes or labels. Since we save packaging costs, these savings are passed on to you. For best value, you should order in increments of 100 diskettes. Quantity discounts are also available. Order 200 or more disks at the same time and deduct 1% of the order to 5% for orders of 5,000 or more.

Pay in advance for net 10 billing. For maximum savings, order in 10 packs.

Same as above, but bulk pack w/o envelope - 6507-8487HR = 0.79

DSHD Soft Sector w/Hub Ring Retail 10 pack 6491-HR = 0.74

= 1.14

SSHD Soft Sector w/Hub Ring Retail 10 pack 6491-HR = 0.74

For shipping charges add $5.00 per 100 diskettes and/or any fraction of 100 5.25-inch or 3.5-inch diskettes for U.P.S./R.P.S. ground shipping and handling in the continental U.S. or in Michigan. For Canada, Puerto Rico, Hawaii, Alaska, or APO/FPO delivery, shipping is three times the continental U.S. rate.

BUY YOUR DISKETTES FROM CE WITH CONFIDENCE

To get the last delivery of your diskettes, please your order directly to our order desk and charge it to your credit card. Written purchase orders are accepted from approved government agencies and most well rated firms at a 10% surcharge for net 10 billing. For maximum savings, your order should be prepaid. All sales are subject to availability, acceptance and verification. All sales are final. All prices in U.S. dollars. Prices and specifications are subject to change without notice. Our stock items may be discontinued on backorder or substituted for equivalent products. We are not responsible for typographical errors or omissions. Sales and promotions are not valid on orders outside the U.S. or in Michigan. All sales are final. A 10% surcharge for net 10 billing. For maximum savings, your order should be prepaid.

Diskettes that are not stock, and are not on our list, will be ordered from our suppliers. Diskettes that are not on our list, will be ordered from our suppliers.

Footnotes:

1. TOTAL SURFACE TESTING - For maximum reliability, & to lessen the likelihood of diskette errors, all diskettes must be tested 2,000 times at least. All Super Disk diskettes are 100% surface tested. Super Disk is so confident in their testing, they even test the tracks that are in between the regular tracks.

2. COMPLETE LINE OF PRODUCTS - Only for Super Disk to consistently make better diskettes. You can always be assured of ultra-tight tolerances and superb dependability when you use a Super Disk. While all our competitors that manufacture diskettes are free to include "non-warranted".

3. CUSTOMER ORIENTED PACKAGING - All Super Disk Diskettes are packaged 10 diskettes per pack for protection and 10 cartons to a case. The economy bulk pack is the hub ring 100 or 500 diskettes in a case without envelopes or labels.

4. LIFE-TIME WARRANTY - We stand behind our product, all diskettes made by Super Disk Inc. have a lifetime warranty. If any Super Disk diskette fails to meet factory specifications, Super Disk Inc. will replace it under the terms of the Super Disk warranty.

5. SUPER VALUE - With Super Disk you are getting maximum dependability, high quality, error-free disks are yours without the high cost.

Order toll free 800-USA-DISK

CIRCLE 188 ON FREE INFORMATION CARD
WIND-GENERATED POWER FOR SALE

As an experimenter, I've long been interested in wind-generated electrical power. The idea of putting up a windmill and generating power for my own use and for selling to the power company is very attractive. However, the power company requires that I install a synchronous inverter between the wind generator and the power line. Can you supply the schematic of a synchronous inverter?

D. B., Astoria, OR.

A windmill generator produces direct current that must be inverted (converted) to alternating current before it can be used to power most household appliances, and certainly before it can be fed into the public-utility power lines. A synchronous inverter is a type of motor-generator set. The American National Standards Institute describes a synchronous inverter as "An inverter that combines both motor and generator action in one armature winding. It is excited by one magnetic field and changes direct-current power into alternating-current power."

Engineers from our tri-state regional power company and from an electric-power co-operative say that if you have enough power available to interest them—several hundred thousand kilowatts—they would specify the inverter and you would have to have it built to their specifications.

PHILCO AM/FM SERVICE DATA

I need the schematic and service data for a Philco model N-1740-124 AM/FM radio that was manufactured around 1963. Can you help?

M. W., New Haven, CT.

The receiver that you are interested in is covered in Sams Photofact Set No. 794, Folder No. 8.

Other readers who need schematics and service data on many makes and models of consumer electronics products that were manufactured between 1946 and the present may find that information in a Sams Photofact folder.

You can call Sams toll-free at 800-428-SAMS and ask for the name and address of the Photofact distributor in your area. You may also be able to obtain information on availability of the data you need.

R. E.

Analyze defective waveforms faster, more accurately, and more confidently — every time or your money back

with the SC61 Waveform Analyzer
Patented $2,995

If you value your precious time, you will really want to check out what the exclusively patented SC61 Waveform Analyzer can do for you. 10 times faster, 10 times more accurate, with zero chance of error.

End frustrating fiddling with confusing controls. Exclusive ultra solid-state circuits, balanced noise cancelling sync amplifiers, simplified controls, and bright blue dual trace CRT help you measure signals to 100 MHz easier than ever.

Accurately and confidently measure waveforms from a tiny 5 mV all the way to a whopping 3,000 V without hesitation with patented ECL balanced noise cancelling sync amplifiers, simplified controls, and bright blue dual trace CRT help you measure signals to 100 MHz easier than ever.

End frustrating fiddling with confusing controls. Exclusive ultra solid-state circuits, balanced noise cancelling sync amplifiers, simplified controls, and bright blue dual trace CRT help you measure signals to 100 MHz easier than ever.

Accurately and confidently measure waveforms from a tiny 5 mV all the way to a whopping 3,000 V without hesitation with patented ECL balanced noise cancelling sync amplifiers, simplified controls, and bright blue dual trace CRT help you measure signals to 100 MHz easier than ever.

End frustrating fiddling with confusing controls. Exclusive ultra solid-state circuits, balanced noise cancelling sync amplifiers, simplified controls, and bright blue dual trace CRT help you measure signals to 100 MHz easier than ever.

End frustrating fiddling with confusing controls. Exclusive ultra solid-state circuits, balanced noise cancelling sync amplifiers, simplified controls, and bright blue dual trace CRT help you measure signals to 100 MHz easier than ever.

End frustrating fiddling with confusing controls. Exclusive ultra solid-state circuits, balanced noise cancelling sync amplifiers, simplified controls, and bright blue dual trace CRT help you measure signals to 100 MHz easier than ever.

End frustrating fiddling with confusing controls. Exclusive ultra solid-state circuits, balanced noise cancelling sync amplifiers, simplified controls, and bright blue dual trace CRT help you measure signals to 100 MHz easier than ever.

End frustrating fiddling with confusing controls. Exclusive ultra solid-state circuits, balanced noise cancelling sync amplifiers, simplified controls, and bright blue dual trace CRT help you measure signals to 100 MHz easier than ever.

End frustrating fiddling with confusing controls. Exclusive ultra solid-state circuits, balanced noise cancelling sync amplifiers, simplified controls, and bright blue dual trace CRT help you measure signals to 100 MHz easier than ever.

End frustrating fiddling with confusing controls. Exclusive ultra solid-state circuits, balanced noise cancelling sync amplifiers, simplified controls, and bright blue dual trace CRT help you measure signals to 100 MHz easier than ever.

End frustrating fiddling with confusing controls. Exclusive ultra solid-state circuits, balanced noise cancelling sync amplifiers, simplified controls, and bright blue dual trace CRT help you measure signals to 100 MHz easier than ever.

End frustrating fiddling with confusing controls. Exclusive ultra solid-state circuits, balanced noise cancelling sync amplifiers, simplified controls, and bright blue dual trace CRT help you measure signals to 100 MHz easier than ever.

End frustrating fiddling with confusing controls. Exclusive ultra solid-state circuits, balanced noise cancelling sync amplifiers, simplified controls, and bright blue dual trace CRT help you measure signals to 100 MHz easier than ever.
EQUIPMENT REPORTS

Beckman Circuitmate
LP25 Logic Probe

The easy way to
troubleshoot digital circuits

CIRCLE 9 ON FREE INFORMATION CARD

Card Size Digital Multimeter

puts an ace in your pocket.

TESTON'S CHECKMAN MINI
fits any shirt pocket. Carry it with you at all times
to test and measure AC/DC volts, ohms, and even diode checks. Self-contained in a
vinyl case, with probes attached, this compact 3½ digit multimeter folds to approx.
4.5"H x 3"W x 0.5"D and weighs only 3 oz. Always ready for action, the high quality
CHECKMAN MINI offers built-in autoranging, easy-to-read 0.4" high LCD, continuity/diode
testing, and low cost.

To order, for shipment within the USA, send check or
money order for $29.95 (CT residents add 7½% Sales tax) plus $1.50
for handling and shipping or call TOLL FREE: 1-800/221-5749.
FULL ONE YEAR WARRANTY.

SIBER HEGNER NORTH AMERICA INC.
5 Landmark Square, Stamford, CT 06901
Call TOLL FREE: 1-800/221-5749
In CT: 203/967-4441 Telex: 279653 SANDH UR

CIRCLE 192 ON FREE INFORMATION CARD

HOWEVER DIFFICULT IT IS TO DESIGN
digital circuits, it's even more diffi-
cult to get them working properly.
In a world where the delay of a few
microseconds can mean the dif-
ference between a hit and a miss,
pinpointing problems can be a
problem in itself. There are lots of
ways to debug circuits but all of
them have one thing in common—
you need tools to do the job.

If you can't afford an os-
cilloscope and a logic analyzer, all
is not lost: you can still do a good
amount of troubleshooting with a
logic probe. Once upon a time,
logic probes only indicated logic
highs and lows, and they did that
by using a resistor and an LED. To-
day's commercially available pro-
bes are a lot more sophisticated—
and a lot more useful.
The Circuitmate LP25 logic pro-
be from Beckman Industrial (630
Puenta Street, Brea, CA 92621) is an
inexpensive way to peek inside a
digital circuit. It has every one of
the features you'd like to see on a
probe and, wonder of wonders, a
reasonable price tag as well. At a
suggested list of $39.95, the LP25
will pay for itself the first time it
saves you hours of debugging.
The LP25 is extremely easy to use
and is compatible with any of the
logic families you might be using. A
small switch on the probe lets you
select either a TTL or CMOS detec-
tion threshold, which is necessary
because the industry standards for
those two families are different.
TTL specifications are less than 0.8
volt for a low and greater than 2.3
volts for a high. CMOS normally
switches at about 50% of the sup-
ply rail but the industry standard is
70% of Vcc for a high and 30% of
Vcc for a low. The TTL setting on
the probe also is good for use with
DTL, RTL, and HTL.
Electronics Paperback Books
EVERY BOOK IN THIS AD $6 OR LESS!

- BP123—> 25 SIMPLE AMATEUR BAND ANENNAS....$5.00. All are inexpensive to build, yet perform well. Dipoles, beams, triangle and even 8-pole monoband.
- BP128-20 PROGRAMS FOR THE ZX SPECTRUM & 16K Z80!...$5.75. Programs to run. Programs to have fun with. Even programs that will help you learn to write of your own.
- BP150—COL. DESIGN & CONSTRUCTION MANUAL....$5.95. How the hobbyist can build RF, IF, audio and power coils, choke transformers. Covers AM, FM and TV applications.
- BP188—> PRACTICAL STEREO & QUADROPHONY HANDBOOK....$3.00. A reference book for all frequencies in stereo and multi-channel sound reproduction.
- BP199—MINI-MATRIX BOARD PROJECTS...$5.00. Here are 20 useful circuits that can be built on a mini-matrix board that is just 24 holes by ten copper strips.
- BP217—HOW TO WRITE ZX SPECTRUM AND SPECTRUM + GAMES PROGRAMS....$5.95. A crystal-clear step-by-step guide to writing your own graphics games programs.
- BP219—> PRACTICAL ELECTRONIC BUILDING BLOCKS—Book 1...$5.75. Oscillators, Timers, Voltage Generators, Oscilloscopes, Comparators. Triggers and more.
- BP221—SOLID-STATE NOVELTY PROJECTS...$4.95. Fun projects include the 3-opticon, a musical instrument that is played by moving a light beam with your hand, and many more.
- BP222—SOLID STATE SHORT WAVE RECEIVERS FOR BEGINNERS...$5.00. Modern solid-state circuits that will deliver a fairly high level of performance.
- BP236—BASIC & PASCAL IN PARALEL...$5.45. Takes these two programming languages and develops programs in both languages simultaneously.
- BP234—CMOS IC PROJECTS....$5.25. Includes sections on multivibrators, amplifiers and oscillators, trigger circuits, special devices, and special effects.
- BP225—A PRACTICAL INTRODUCTION TO DIGITAL IC'S....$4.95. Mainly concerned with TTL devices. Includes many simple projects plus a logic circuit test set and a digital counter/timer.
- BP226—HOW TO BUILD ADVANCED SHORT WAVE RECEIVERS...$5.50. Full practical construction details of a number of receivers are preserved.
- BP227—BEGINNERS GUIDE TO BUILDING ELECTRONIC PROJECTS...$5.50. How to tackle the practical side of electronics so that you can successfully build electronic projects.
- BP224—ENGINEERS AND MACHINISTS REFERENCE TABLES...$2.25. Screw thread data, drill sizes, circle division, angles, spaces and more.
- BP232—FIRST BOOK OF PRACTICAL ELECTRONIC PROJECTS....$3.75. Projects include audio distortion meters, tube-type amplifiers, monofrequency and more.
- BP224—S2 PROJECTS USING IC 741....$5.25. Lots of projects built around this one versatile IC.
- BP231—HOW TO BUILD YOUR OWN METAL & TREASURE LOCATORS....$5.80. Electronic and practical details on the simple and inexpensive construction of metal detector, metal detector.

BP233—> ELECTRONIC CALCULATOR USERS HANDBOOK....$5.75. A valuable book for all calculator owners. Tells you how to get the most out of your calculator.
- BP226—S0 CIRCUITS USING GERMANIUM, SILICON & ZENER DIODES....$5.00. A collection of useful circuits you'll want in your library.
- BP237—50 PROJECTS USING RELAYS, SCRs & TRIACS....$5.85. Build reliability indicators, light modulators, warning devices, light dimmers and more.
- BP229—FET TRANSISTOR PROJECTS....$5.50. RF amplifiers, test equipment, tuners, receivers, tone controls, etc.
- BP222—SIMPLE LED CIRCUITS....$5.00. A large selection of simple applications for this simple electronic component.
- BP217—HOW TO DESIGN ELECTRONIC PROJECTS....$5.75. Helps the reader to put together from standard circuit blocks with a minimum of trial and error.
- BP220—AUDIO AMPLIFIER CONSTRUCTION....$5.75. Construction details for preamps and power amplifiers up through the 100-watt DC-coupled PED amplifiers.
- BP224—HOW TO MAKE WALKIE TALKIES....$5.00. Equipment for low-power hand-held or portable operation.
- BP225—PROJECTS IN OPTOELECTRONICS....$5.00. Includes infra-red detectors, transmitters, modulated light transmission and photographic applications.
- BP228—ELECTRONIC PROJECTS FOR BEGINNERS....$5.00. A wide range of easily completed projects for the beginner. Includes some no-soldering projects.
- BP229—POPULAR ELECTRONIC PROJECTS....$5.50. Radio, audio, household and test equipment projects are all included.
- BP231—ELECTRONIC MUSIC AND CREATIVE TAPE RECORDING....$5.50. Shows how you can make electronic music at home with the simplest and most inexpensive equipment.
- BP219—ELECTRONIC SECURITY DEVICES....$5.00. Includes both simple and more sophisticated burglar alarm circuits using light, infra-red and ultrasonics.
- BP230—SECOND BOOK OF CMOS IC PROJECTS....$5.00. More circuits showing CMOS applications. Most are of a fairly simple design.
- BP222—MichroPROCESSOR PRIMER....$5.00. We start by designing a small computer and show how we can overcome some shortcomings.
- BP228—PRACTICAL COMPUTER EXPERIMENTS....$5.00. Construct typical computer circuits using electron logic to form a basic understanding of how computers function.
- BP219—AN INTRODUCTION TO RADIO DXING....$5.00. How you can tune in these amateur and commercial broadcasts from around the world at the comfort of your home.
- BP224—ELECTRONIC PROJECTS FOR CARS AND BOATS....$5.00. Fabulous simple projects that you can use with your car or boat. All are designed to operate from 12-volt DC supplies.

ELECTRONIC TECHNOLOGY TODAY INC.
P.O. Box 240, Massapequa Park, NY 11762-0240

SHIPPING CHARGES IN USA & CANADA
$0.01 to $5.00...$1.00
$5.01 to $10.00...$1.50
$10.01 to $20.00...$2.75
$20.01 to $30.00...$3.50
$30.01 to $40.00...$4.75
$40.01 to $50.00...$5.75
$50.01 and above...$7.00

OUTSIDE USA & CANADA
Multi-list Shipping by 2 for sea mail
Multi-list Shipping by 4 for air mail
Total price of merchandise
Sales Tax (not available for Residents only)
Shipping (see chart)
All payments must
be in U.S. funds
Total Excised

Number of books ordered

Names ____________________________
Address ____________________________
City State Zip ____________________________

RE-1286

www.americanradiohistory.com
High and low logic levels are indicated with red and green LED's as well as high and low tones. Since the audio is generated by a small piezo element, the output level is rather low and you'll have to turn down your radio to hear it. The tones produced by the LP25 are about 2 kHz for a high and 1 kHz for a low. If you've never used a probe with an audio signal before, you'll wonder how you ever got along without one. It's really a tremendous convenience to be able to test circuit points without having to look at the probe.

The LP25 can do more than show logic levels. If you're looking at clock pulses, the probe indicators will not only modulate, but they'll also give you some idea of the waveform. Different types of waveforms will produce both different LED combinations and sounds. The instruction sheet has a small chart to use in understanding what the probe is telling you.

The frequency range of the LP25 goes from DC to 25 MHz but its state indicators are responsive only up to 200 kHz. For any higher frequencies, circuit conditions are shown on the pulse catcher. A yellow LED near the back of the probe will flash whenever a logic transition occurs and the circuitry will see pulses as narrow as 30 nanoseconds. If you're looking at clock pulses faster than 200 kHz, the high and low LED's may or may not light, but the yellow LED will be flashing so rapidly it will appear to be on constantly.

Since the pulse-detector circuitry is triggered by both positive- and negative-going transitions, the LED will be flickering at twice the clock rate. Although Beckman lists 25 MHz as the upper limit of the probe, it didn't start to get flakey until the test frequency was past 40 MHz.

The pulse-detection circuitry in the probe can be made either to reset itself after each detection or to latch. That is done using the PULSE/MEMORY switch on the probe. In normal use, you would put the switch in the PULSE position. But if you're looking out for an occasional glitch or pulse, flip the switch to MEMORY, and go out for a pastrami sandwich. If the pulse shows up, the probe will detect it and latch the LED on.

There's no way that a logic probe, even one like the LP25, can substitute for a more powerful instrument such as a scope. If you want to do heavy-duty circuit debugging, a scope is the way to go; but for quick and dirty troubleshooting, you'll have to do a lot of looking before you find something as simple and useful as Beckman's LP25. It's powerful, well made, and won't put a big hole in your wallet.

continued on page 28
HITACHI OSCILLOSCOPES

V-212
20 MHz Dual Channels
Convenient 0, 10, 90 and 100% amplitude markings, vertical mode triggering, 1mV/div. sensitivity & ±3% accuracy, TV sync separation circuit, X-Y mode, low drift.

$429.

V222
20 MHz Dual Channels
Same as above with DC offset to measure signals having DC components, CH1 output and DC offset voltage monitor outlet available for external counter or DVM*, alternate magnify function provides x1 and x10, sweep waveforms to be simultaneously displayed.

$511.

*The purchase of a Model V222 oscilloscope entitles you to purchase a Revere Model RDMT10 3 1/2 digit, 10 amp. scale digital multifunction tester for $359.95. Offer applies only to Hitachi Model V222.

ALLEN

"The ALLEN INDUSTRIAL ELECTRONICS GROUP highly recommends these fine Industrial Quality Hitachi Oscilloscopes"

Richard S. Viatton MSEE
Sales Manager
ALLEN
INDUSTRIAL ELECTRONICS GROUP

HITACHI
SAVE UP TO $850.00!

V1100A
100MHz/Quad Channels,
8-trace, delayed sweep, CRT readout, digital measurement.

$2260.

V1070A
100MHz/Quad Channels,
8-trace, delayed sweep, CRT readout. ............... $1610.

V1050F
100MHz/Quad Channels,
8-trace, delayed sweep.

$1395.

V650F
60MHz/Quad Channels,
delayed sweep. ............... $1057.

V422
40MHz/Dual Channels. $785.

VC6041UG
40MHz, sampling, dual channels, 1mV dual trace, 6" CRT, 4k words per channel.

GPIB option. ............... $5180.

VC6041UX
40MHz, digital storage, 1mV dual trace, 6" CRT, 4k words per channel. ............... $4380.

V509
50MHz, dual channels, mini portable, delayed sweep.

$1199.

V134
10MHz, dual trace, bi-stable storage. ............... $1395.

V209
20MHz, dual channels, AC-DC, mini portable. ............... $815.

THE 928 PAGE
WM. B. ALLEN
ELECTRONICS CATALOG
A $15.00 VALUE
FREE!
WITH ANY PURCHASE

WM. B. ALLEN SUPPLY COMPANY, INC.
ALLEN SQUARE
THE 300 BLOCK • NORTH RAMPART STREET
NEW ORLEANS • LOUISIANA 70112-3106
LOUISIANA TOLL FREE 800 462 9520 • NEW ORLEANS (504) 525 8222
CALL NATIONWIDE TOLL FREE
800 535 9593
24 HOURS A DAY!

CIRCLE 103 ON FREE INFORMATION CARD
A logic probe like the the LP23 is a very useful stand-alone circuit-debugging tool, but its utility can really be increased by using a logic pulser, such as the Circuitmate PR41 from Beckman Industrial Corporation (630 Puente Street, Brea, CA 92621). Both are perfect tools for people who don't want to spend a whole bunch of money on a set of basic instruments to help in designing and building digital electronic circuits. The PR41 lists for just $44.95.

Logic pulsers are invaluable for forcing digital IC's to change state. You can do the same thing with a clip lead and a resistor; but the hallmark of digital circuitry is controlled changes and, as we all know, you can't be very precise if you're debugging stuff with nothing more than a hunk of wire. Logic pulsers do their thing accurately—and safely. That's important since a heavy-handed approach usually produces nothing more than smoke.

The PR41 draws its power from the circuit under test. The coiled cord coming out of the back of the pulser ends in two clip-lead ends. All you have to do is to connect them to power and ground on your board, and the pulser is operational. Putting the unit to use involves nothing more than touching the tip to the input of the IC.

The circuitry in the pulser can operate at two different rates. Which one you choose will depend on what you're trying to do. The small slide switch allows you to select between pulse rates of 400 Hz and .5 Hz. The higher rate is useful if you want to clock part of your circuit and watch the results farther down the line. If you just want to force a logic translation, you're better off at the slow rate, since it will give you enough time to remove the tip from the IC before the second pulse is generated. You can see the number of pulses produced by watching the LED at the tip of the pulser.
RCA's Power Safe surge suppressors absorb voltage surges before your customers' electronics get damaged.

Now you can help your customers protect their expensive electronic equipment from sudden shock with two new surge suppressors from RCA.

The Power Safe (SK406) protects TVs, computers, microwaves and more by absorbing transient voltage surges resulting from nearby lightning strikes, load switching and other causes before the surge hits the equipment. Handsomely designed and easy to install, this handy six-outlet strip simply plugs into any grounded wall outlet.

The Power Safe Plus (SKF406) protects every way the Power Safe does, plus it filters out electronic noise interference. The suppressor's high-frequency bi-directional filter senses, absorbs, and dissipates noise interference before it can reach the equipment.

Together, they have the potential to become powerful profit builders for you.

To learn more about this shock-absorbing team, see your RCA Distributor. Or contact RCA Distributor and Special Products Division, Deptford, NJ 08096-2088.
The pulses being injected into the circuit have a risetime of 2 μs, last 15 μs, and then take about 30 μs to decay. The PR41 has push-pull output circuitry so it can source or sink up to 100 mA, which is more than enough to drive any IC input—whether it's already being driven by an IC output, or even tied to one end of the supply rail through a resistor. And since the pulses are so short, the chances of doing any damage to the IC being pulsed are low.

Being able to trigger in-circuit logic transitions is a great aid in circuit debugging but, unless you're looking at unclocked inputs, it still doesn't give you a true picture of circuit operations. The people at Beckman understood that when they designed the PR41. The unit can put out pulses in sync with an external clock. There are three pins on the pulser - ground, clock in, and clock out. The pin labeled EXT SYNC is an input that accepts a clock signal and then forces the unit to output pulses at the clock-signal's rate. The clock pulses are isolated and cleaned up by an internal Schmitt trigger and appear at the pin labeled SQ.

There are two points to keep in mind if you want to plan on using an external clock. If the clock you're feeding in has a frequency less than 400 Hz, the PR41 will put out pulses at the clock rate. If it sees a clock faster than 400 Hz, the output frequency isn't very easy to predict. The PR41 will lock to the input frequency and put out pulses at some indeterminate rate. The pulses will be synced to the incoming clock, but the maximum frequency will be 400 Hz. In other words, you'll be sure that every pulse the PR41 puts out coincides with an external clock pulse, but the output frequency won't be more than the pulser's maximum of 400 Hz.

The external clock input of the PR41 has an impedance of 1 megohm, so you can be confident that it will be invisible to just about any clock line you tap; there's very little chance of loading down your circuit. The pulser is extremely easy to use and, since it's built around CMOS circuitry, it can operate over a wide range of supply voltages. Even CMOS, however, has outside limits and you should be careful to stay within them or you'll damage the probe. The clock pulses produced by the PR41 swing very close to the supply voltage so you should make sure the input you're testing can safely handle that voltage. If it can't, you'll have to use a resistive voltage divider or some other arrangement to cut the pulses down to a safe level.

Experience the wonder... of fischertechnik kits

Learn about:

We make a variety of easy-to-build, educational kits, from the simple to the complex. For ages 6 and up. For learning that's fun.

Available at your Heath/Zenith Computers & Electronics Center. See your telephone white pages for the store nearest you. Or order from the Heathkit Catalog. To order by phone, call 1-800-253-0570.
### ELENCO PRODUCTS AT DISCOUNT PRICES!

#### 20 MHz DUAL TRACE OSCILLOSCOPE

- **Model:** MO-1251
- **Price:** $369

Top quality scopes at a very reasonable price. Contains all the desirable features. Elenco's 2 year guarantee assures you of continuous service. Two 1X, 10X probes, diagrams and manual included. Write for specifications.

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM-1500</td>
<td>$65</td>
<td>Multi Meter with Capacitance and Transistor Tester. Reads Volts, Ohms, Current.</td>
</tr>
<tr>
<td>M-7000</td>
<td>$135</td>
<td>True RMS 4½ Digit Multimeter. 0.05% DC Accuracy, 0.1% Resistance.</td>
</tr>
<tr>
<td>M-1180</td>
<td>$36.95</td>
<td>Auto Ranging plus Manual Ranging. 3 ½ Digit Meter. 28 Functions. Fully Protected.</td>
</tr>
</tbody>
</table>

---

#### 35 MHz DUAL TRACE OSCILLOSCOPE

- **Model:** MO-1252
- **Price:** $545

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GF-8016</td>
<td>$219</td>
<td>Function Generator with Freq. Counter. Sine, Square, Triangle, Pulse, Ramp. 2 to 2 MHz.</td>
</tr>
</tbody>
</table>

GF 8015 without Freq. Meter $169

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>XP-660</td>
<td>$149.50</td>
<td>Triple Power Supply. 0-20V @ 1A, 0-20V @ 1A, 0-5V @ 5A. Fully Regulated, Short Circuit Protected with 2 Limit Controls. 3 Separate Supplies.</td>
</tr>
</tbody>
</table>

---

#### 10 MHz OSCILLOSCOPE

- **Model:** S-3000
- **Price:** $190

Shown 9434

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-3000</td>
<td>$190</td>
<td>10 MHz DC or AC. Triggered Sweep. Calibrated Vert. &amp; Hor. Reads Volts &amp; Freq.</td>
</tr>
</tbody>
</table>

---

#### 50 MHz LOGIC PROBE

- **Price:** $23

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LP-700</td>
<td>$23</td>
<td>20 nsec with memory</td>
</tr>
</tbody>
</table>

---

#### LOGIC PULSER

- **Price:** $25

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LP-600</td>
<td>$25</td>
<td>2 use pulse @ 1A</td>
</tr>
</tbody>
</table>

---

#### DIGITAL LCR METER

- **Model:** LC-1800
- **Price:** $148

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LC-1800</td>
<td>$148</td>
<td>Measures: Inductors, Capacitors, Resistors. Inductors: 1H to 200H. Capacitor: 1µF to 200µF. Resistor: 0.1Ω to 20MΩ. Ranges: 6 Ind, 7 Cap, 7 Res.</td>
</tr>
</tbody>
</table>

---

C&S SALES, 8744 W. North Ter. Niles, IL 60648  
800-292-7711 (312) 459-9040  
15 DAY MONEY BACK GUARANTEE ASK FOR CATALOG  
2 Year Limited Guarantee. Add 5% for Postage ($10 max.), IL Res., 7% Tax  
CIRCLE 100 ON FREE INFORMATION CARD
KENWOOD

Hear it All!

R-5000
High performance receiver
THE high performance receiver is here from the leader in communications technology—the Kenwood R-5000. This all-band, all mode receiver has superior interference reduction circuits, and has been designed with the highest performance standards in mind. Listen to foreign music, news, and commentary. Tune in local police, fire, aircraft, weather, and other public service channels with the VC-20 VHF converter. All this excitement and more is yours with a Kenwood R-5000 receiver!

- Covers 100 kHz-30 MHz in 30 bands, with additional coverage from 108-174 MHz (with VC-20 converter installed).
- Superior dynamic range. Exclusive Kenwood DynaMix™ system ensures an honest 102 dB dynamic range. (14 MHz, 500 Hz bandwidth, 50 kHz spacing.)
- 100 memory channels. Store mode, frequency, antenna selection.
- Voice synthesizer option.
- Computer control option.
- Extremely stable, dual digital VFOs. Accurate to ±10 ppm over a wide temperature range.
- Kenwood's superb interference reduction. Optional filters further enhance selectivity. Dual noise blankers built-in.
- Direct keyboard frequency entry.
- Versatile programmable scanning, with center-stop tuning.
- Choice of either high or low impedance antenna connections.
- Kenwood non-volatile operating system. Lithium battery backs up memories; all functions remain intact even after lithium cell expires.
- Power supply built-in. Optional DC-2 allows DC operation.
- Selectable AGC, RF attenuator, record and headphone jacks, dual 24-hour clocks with timer, muting terminals, 120/220/240 VAC operation.

Optional Accessories:
- VC-20 VHF converter for 108-174 MHz operation • YK-88A 1.6 kHz AM filter
- YK-88S 2.4 kHz SSB filter • YK-88SN 1.8 kHz narrow SSB filter • YK-88C 500 Hz CW filter • YK-88CN 270 Hz narrow filter
- DCK-2 DC power cable • HS-5, HS-6, HS-7 headphones • MB-430 mobile bracket
- SP-430 external speaker • VS-1 voice synthesizer • IF-232C/IC-10 computer interface.

More information on the R-5000 and R-2000 is available from Authorized Kenwood Dealers.

KENWOOD

TRIO-KENWOOD COMMUNICATIONS
1111 West Walnut Street
Compton, California 90220

Specifications and prices are subject to change without notice or obligation.

CIRCLE 102 ON FREE INFORMATION CARD
BUILDING CRYSTAL SETS

I enjoyed Martin Clifford's article, "The Early Days of Radio," in the July 1986 Radio-Electronics. I have been building crystal sets as far back as I can remember. I would like to bring up a few things you missed, and make a suggestion or two.

First, as I remember, and according to the tradition that my father handed down to me, you could almost always get a better signal with a galena crystal and a cat's whisker than with a germanium diode (1N34). Also, the galena crystal and cat's whisker were never handled. Any film or oil from your skin would impede operation.

Second, all of the between-components wiring was done with "litz" wire, which you never touched the pure copper ends of. I doubt that many experimenters knew about the skin effect, but litz wire was part of the tradition.

Third, you needed 2000-ohm headphones. I have gotten results with lower-impedance headphones, but high-impedance headphones are a necessity for any degree of performance.

Fourth, you cannot overstress the importance of a good earth ground. The old cold-water pipe trick may suffice, but an eight-foot copper rod with a litz wire is really superior.

Then there are the little things. The wooden base, ideally, is made out of well-dried hardwood that is coated with several layers of varnish. The coil(s) are wound out of a medium-gauge pure copper wire with varnish insulation. Personally, I'm fond of oatmeal boxes as coil forms.

One thing that you made no mention of is the World War I crystal set. The heart of it was supposedly a razor blade and a piece of pencil lead. I have tried to duplicate that design with no luck but people tell me that it can be done. Perhaps you could offer some insight into that piece of lore.

Thanks again for the article.
MATTHEW KLEINMANN
Binghamton, NY

Capacitance, logic and more. For less.

Now, a fully-loaded DMM combines a capacitance meter, logic probe, and an hFE meter, all for the price of a DMM.

TTL Logic Probe: 20 MHz
Hi/lo/off indications
Detects 25nS pulse width
Capacitance: 5 ranges (2nF to 20μF)
hFE (NPN or PNP): 1 range (1000)
DMM: DCV-5 ranges (2V to 100V)
ACV-5 ranges (2V to 750V)
DCA-4 ranges (200μA to 10A)
ACA-3 ranges (20mA to 10A)
Ohms-7 ranges (200 Ohms to 2000 Megohms)
Continuity beeper
Diode check
Built-in bail
Anti-skid pads

See one now at your local Beckman Industrial distributor.

DM25L...$89.95

EOTC 98 ON FREE INFORMATION CARD

DECEMBER 1986

Volunteer Against Illiteracy.
The only degree you need is a degree of caring.
Today's world is the world of electronics. To be part of it, you need the right kind of training, the kind that can take you to a fast-growing career in business, aerospace, medicine, science, government, communications, and more.

**Specialized training.**
You learn best from a specialist, and that's CIE. We're the leader in teaching electronics through independent study, we teach only electronics and we've been doing it for over 50 years. You can put that experience to work for you just like more than 25,000 CIE students are currently doing all around the world.

**Practical training.**
You learn best with practical training, so CIE's Auto-Programmed® lessons are designed to take you step-by-step, principle-by-principle. You also get valuable hands-on experience at every stage with sophisticated electronics tools CIE-designed for teaching. Our 4K RAM Microprocessor Training Laboratory, for example, trains you to work with a broad range of computers in a way that working with a single, stock computer simply can't.

**Personalized training.**
You learn best with flexible training, so we let you choose from a broad range of courses. You start with what you know, a little or a lot, and you go wherever you want, as far as you want. With CIE, you can even earn your Associate in Applied Science Degree in Electronics Engineering Technology. Of course, you set your own pace, and, if you ever have questions or problems, our instructors are only a toll-free phone call away.

**The first step is yours.**
To find out more, mail in the coupon below. Or, if you prefer, call toll-free 1-800-321-2155 (in Ohio, 1-800-523-9109). We'll send a copy of CIE's school catalog and a complete package of enrollment information. For your convenience, we'll try to have a representative contact you to answer your questions.

---

YES! I want to get started. Send me my CIE school catalog including details about the Associate Degree Program. I am most interested in:

- [ ] computer repair
- [ ] television/high fidelity service
- [ ] telecommunication
- [ ] medical electronics
- [ ] robotics/automation
- [ ] broadcast engineering
- [ ] other

Print Name: __________________________
Address: ____________________________  Age: _______
City: __________________ State: ________ Zip: ______

Age _______ Area Code/Phone No. __________________________

Check box for G.I. Bulletin or Educational Benefits
- [ ] Veteran
- [ ] Active Duty

MAIL TODAY!

**OR CALL TOLL FREE**

**1-800-321-2155**

(In Ohio, 1-800-523-9109)
NEW PRODUCTS

DMM, the model 4800, measures DC/AC voltage, DC/AC current, resistance, frequency (Channel A, 10 Hz to 100 kHz; Channel B, 10 Hz to 1000 kHz), period, dbm, diode test, continuity test and temperature (with K-type thermocouple). Also included are comparator, data hold, peak hold, relative, and auto-ranging.

The large 3-digit LCD display indicates pushbutton-selected functions and low line voltage or overrange conditions. Both manual and auto ranging are provided. A relative measurement mode is available, which stores the applied input as a zero-reference point from which subsequent measurements will be displayed as deviations.

The comparative measurement mode permits input of high or low values as percentages, and a beeper sounds (and “GO” appears on the LCD) if the value being measured falls within the set limits. “Hi” or “Lo” will be displayed if the value is beyond the set limits. A relay contact is provided for the external comparator output. A “key lock” function prevents all switches except power-off from being actuated.

Accessories include: power cable, spare fuses, signal cable, alligator test leads, and comprehensive instruction manual. Optional accessories include various K-type thermocouples, bench “hold” probe, and 10-amp measurement probe.

The model 4800 is priced at $600.00.—Triplett Corporation, One Triplett Drive, Bluffton, OH 45817.

IN-CIRCUIT IC TESTER, the Chip Checker model TTL-1 is a full-mode in-circuit IC tester with the capability of detecting and displaying IC errors during actual operating conditions; it can do so automatically.

It is designed to test most 14, 16, 18, and 20-pin TTL IC’s, including low-power Schottky TTL. That includes logic gates, flip-flops, buffers, and interface elements. Newer and older logic families may also be tested.

Two front-panel-mounted switches are available for selecting the Vcc and GND pins on the IC under test. Lighted LED’s indicate errors or differences between the IC under test and a reference IC.

SERVICE MONITOR, the model COM-3, is designed to analyze and test transceivers in the 100-kHz to 1000-MHz range, in 1-kHz steps. It features a programmable microprocessor memory that stores and recalls on command up to 10 commonly used test setups. An easy-to-use keyboard offers programmable offset keys that simplify frequency entry for duplex or repeater radios, and incremental-step keys facilitate the testing of a receiver throughout its frequency range.

The model COM-3 is portable and has a built-in, rechargeable battery pack that makes it ideal for off-site testing; the COM-3 weighs less than 10 lbs. For additional portability, a durable Cordura travel case with zippered pockets and shoulder strap is available.

The model COM-3 is priced at $1995.00.—Ramsey Electronics Inc., 2575 Baird Road, Penfield, NY 14526.

CIRCLE 19 ON FREE INFORMATION CARD

CIRCLE 20 ON FREE INFORMATION CARD

CIRCLE 18 ON FREE INFORMATION CARD

MARINE PACK is a submersible housing designed for use with a Sony Handycam 8 mm camcorder.
100 MHz, Quad Input Oscilloscope

100 INSTANT REBATE

$1786 FINAL PRICE

Model 590A

- 1 mV/div sensitivity - Full Bandwidth
- 2% Vertical and Horizontal Sweep Accuracy
- Dual Independent Time Base
- Calibrated Delayed Sweep
- 20 kV Accelerating Voltage
- V Mode - Displays Four Signals Unrelated in Frequency
- And Much More!!!

$90 INSTANT REBATE

$1805 FINAL PRICE

Model 2520

- 20 MHz Real Time Bandwidth
- 20 MHz Storage Bandwidth
- 2 Megasamples/Second Sampling Rate
- 1 K Memory Per Channel
- Equivalent Time Sampling
- Pre-Trigger Capture
- And Much More!!!

80 INSTANT REBATE

$1384 FINAL PRICE

Model 570A

- 1 mV/div sensitivity - Full Bandwidth
- 2% Vertical and Horizontal Sweep Accuracy
- Dual Time Base/Calibrated Delayed Sweep
- V Mode - Displays Four Signals Unrelated in Frequency
- And Much More!!!

$60 INSTANT REBATE

$1207 FINAL PRICE

Model 1564

- 1 mV/div sensitivity
- -3% Vertical and Horizontal Sweep Accuracy
- Dual Time Base/Calibrated Delayed Sweep
- 12 kV Accelerating Voltage
- V Mode - Displays Three Signals Unrelated in Frequency
- And Much More!!!

40 INSTANT REBATE

$807 FINAL PRICE

Model 541

- 1 mV/div sensitivity
- 3% Vertical and Horizontal Sweep Accuracy
- Single Time Base
- 12 Calibrated Sweeps
- 6 kV Accelerating Voltage
- V Mode - Displays Two Signals Unrelated in Frequency
- And Much More!!!

$20 INSTANT REBATE

$747 FINAL PRICE

Model 1524

- 1 mV/div sensitivity
- 3% Vertical and Horizontal Sweep Accuracy
- Single Time Base
- 20 Calibrated Sweeps
- 6 kV Accelerating Voltage
- V Mode - Displays Two Signals Unrelated in Frequency
- And Much More!!!

B&K-Precision is offering these instant factory rebates on selected B&K-Precision Oscilloscopes to you through Participating Distributors.

HERE'S HOW IT WORKS!!!

Call 1-800-654-7256 for the name of your Participating B&K-PRECISION Distributor.

Select the B&K-PRECISION Oscilloscope that meets your needs from the Participating Distributor's stock.

The Participating Distributor will deduct the "INSTANT REBATE" for that model directly from the Invoice Price. You save instantly!

CIRCLE 77 ON FREE INFORMATION CARD

PLEASE NOTE: This offer is available only at Participating B&K-PRECISION Distributors. Only B&K-PRECISION Models 2520, 1590A, 1570A, 1564, 1541 and 1524 are eligible for INSTANT REBATES. Sorry, no substitutions are allowed. INSTANT REBATES apply to purchases from October 1, 1986 through November 30, 1986 only.

DYNASCAN CORPORATION
6450 West Cortland Street • Chicago, Illinois 60635 • 1-312/669-9387

International Sales: 6460 W. Cortland St., Chicago, Illinois 60635

Cable: Dynascan, Appleton, Oxford

Southwest and Central American Sales: Entra Exporters, Manila, Philippines
The Marine Pack features a piezoelectric underwater microphone for audio pickup, and a wide conversion lens. The unit weighs about 8 pounds, including ballast weight, and measures 11.80 inches x 10.25 x 10.45 inches.

The Marine Pack is priced at $995.95; with video light, $1400.95. (The Handycam camcorder is sold separately.)—Sony Corporation of America, Sony Park, Drive, Park Ridge, NJ 07656.

CELLULAR ANTENNA, the model CMR750, is designed to be mounted on a window inside a vehicle; no outside radial is needed. The design enables the antenna to operate with minimum signal loss or pattern distortion.

Installing the cellular antenna inside the vehicle lowers the possibility of theft and vandalism, and the antenna is protected from damage resulting from automatic car washes and harsh weather conditions. Although the model CMR750 is factory pre-tuned for the U.S. cellular band, a trimmer is provided for further adjustment. It comes complete with 12' of RG58X/M/U low-loss cable and all connectors.

The model CMR750 is priced at $72.95.—Alliance Research Corporation, 20120 Plummer Street, P.O. Box 4029, Chatsworth, CA 91313.

DMM, the model DM-1000, has 3½ digits and a rotary switch. Designed for the professional engineer and technician, as well as for hobbyists and students, its features include: pocket-size, overload protection, 10A DC current readings, 0.5" LCD, and 200-hour battery life. The model DM-1000 incorporates 6 functions in 17 ranges, including DCV, ACV, DCA, OHM, diode test, and battery test. Ranges include 200 mV, 2/20/200/1000 volts DC; 200/750 volts AC; 200 µA, 200mA, 10A DC; 200/2K/200K/2M ohms; diode test (0-2K ohms); battery test: 2 volts DC.

The model DM-1000 is priced at $39.95.—A. W. Sperry Instruments, 245 Marcus Boulevard, Hauppauge, NY 11788.
THYRISTOR TESTER, the model 20, is an easy-to-use instrument capable of measuring the basic DC parameters of thyristors and diodes. Important triggering characteristics are obtained without guesswork, confusion, or compromise. Forward and reverse blocking voltage measurements are safely made with the peak maximum current limited to the programmed condition. Two-terminal devices, such as rectifiers and diodes, may be tested as well.

The model 20 can be connected to a variety of devices—other test equipment, handlers, printers, or supply nor curve tracer is needed. The model 20 Thyristor Tester is priced at $1995.00. — Markenrich, 14946-A Shoemaker Avenue, Santa Fe Springs, CA 90670.

VACATION/HOME SENTRY, the model GD 1702 is a device that monitors internal house conditions and relays that information over the telephone.

The easy-to-assemble unit automatically detects low temperatures, and can also be used to detect water, and other problems through the addition of various sensors. If any of the sensors de-
A defense against cancer can be cooked up in your kitchen. There is evidence that diet and cancer are related. Follow these nine guidelines in your daily diet to reduce the risk of colorectal cancer:

1. Eat many fiber-rich foods, such as fruits and vegetables and whole-grain cereals.
2. Include dark green and deep yellow fruits and vegetables rich in vitamins A and C.
3. Include carrots, broccoli, and other vegetables rich in vitamin K and calcium.
4. Boil or steam in an electric pot, with or without water, and eat raw foods.
5. Cut down on salt; this reduces heart disease and cancer risk.
6. Avoid obesity.
7. Choose fresh over processed foods.

One tree can make 300,000 matches.
One match can burn 300,000 trees.

Two 9-volt batteries, which are tapped only when relaying information in response to a phone call. It is priced at $29.95—Heath Company, Benton Harbor, MI 49022.

DIP IC DISPENSERS, the MDD series, are designed for MOS and CMOS as well as standard devices. The dispensers offer flexibility and convenience. Each channel easily accepts any standard IC shipping tube, and can accommodate any standard IC with 2 to 24 pins on 0.300, 0.400, or 0.600 centers. Adjustable guides position each IC individually for easy extraction, and simple gravity feed assures reliable deposit of each IC into extraction position after the previous IC is removed.

The MDD design ensures effective static dissipation (a grounding lug is included) as well as reliable performance. One-, five-, and ten-channel versions are available.

Dispersers are priced at $22.88 (1); $87.37 (5); and $168.95 (10)—Dave Tech Inc., 2-05 Banta Place, Fair Lawn, NJ 07410.
AN INTRODUCTION TO BASIC PROGRAMMING TECHNIQUES. This book is based on the author's own experience in learning BASIC and also in helping others mostly beginners to programming. To understand the language included is a program library of programs that the author has actually written and run. Order your copy today Send $5.00 plus $2.65 for shipping in the U.S. to Electronic Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240.

SIMPLY SNAP THE WAT-50 MINIATURE FM TRANSMITTER on top of a 9v battery and hear every sound in an entire house up to 1 mile away. Adjusts from 70-130 MHZ with any FM radio. Complete kit $29.95 + $1.50 S & H. Free shipping on 2 or more COD add $4. Call or send VISA, MC, MO. DECO INDUSTRIES, Box 607, Bedford Hills, NY 10507. (914) 232-3878.

CIRCLE 127 ON FREE INFORMATION CARD

FREE TOOL AND INSTRUMENT CATALOG packed with over 5,000 quality products for testing, repairing and assembling electronic equipment. A full selection of test instruments plus precision hand tools, tools cases, soldering equipment and much more. Products are shown in full color with detailed descriptions, pricing and a 100% satisfaction guarantee. CONTACT EAST, P.O. Box 786, No. Andover, MA 01845. Call (800)-225-5370 or in MA (617)-682-2000.

CIRCLE 55 ON FREE INFORMATION CARD

OSCRAHM THE NEW VIDEO TAPE COPY PROTECTION SCHEME. When you rent or buy a recent movie release, stop the handling. ELEPHANT ELECTRONICS, Box 581-41865, 41865-L, Phoenix, AZ 85080. (602) 581-1973. MasterCard and Visa accepted.

CIRCLE 120 ON FREE INFORMATION CARD

SAFE-LEGAL-EFFECTIVE STUN GUN VIPER II. Instantly immobilizes an attacker up to 15 minutes. Penetrates through leather and thick clothing. Charges $50,000 from a single 9v NICad battery. Use by police around the country. 1 Year Guarantee. Viper II $39.95. With NICad battery and charger $49.95. Free belt clip with every Viper II. Catalog Free. United Imports & Mfg., 6846 NE 105th, Portland, OR 97220. (503) 782-5602.

CIRCLE 199 ON FREE INFORMATION CARD


CIRCLE 191 ON FREE INFORMATION CARD

60 dB SIGNAL ELIMINATOR— for removal of undesirable TV/FM/VHF signals. Can be tuned precisely to any signal within these ranges: Model 26 - Chs. 2-6 plus FM (54-108 MHz) Model 422 - Chs. 14(3) - 22(1) (120-174Mhz) Model 713 - Chs. 7-13 (174-216 MHz) Highly selective notch, adjustable strength. Single $30. Quantity discounts to 60%. STAR CIRCUITS, P.O. Box 8332 - Pembroke Pines, FL 33084

CIRCLE 94 ON FREE INFORMATION CARD


CIRCLE 65 ON FREE INFORMATION CARD


CIRCLE 81 ON FREE INFORMATION CARD
A CAREER START FOR THE 21ST CENTURY. Since 1905, National Technical Schools has helped people build successful careers. Enter the 21st Century through home study courses in Robotics, Computer Technology and Servicing, Microprocessors, Video Technology, Basic Electronics, Transportation Technology, Climate Control Technology or TV and Radio Servicing. For a FREE Catalog, call 1-800-BETTER. Or write NTS/INDEPENDENT TRAINING GROUP, 455 West M. L. King Jr. Blvd. L.A., CA 90037.

CIRCLE 181 ON FREE INFORMATION CARD

MODULAR PROBE FITS ALL SCOPES
- Save up to fifty percent on instant repair - no soldering - Satisfaction guaranteed - 250 MHz 10X Amplifier - Model M12X10...
- $62 with readout...
- $58 Free accessories catalog.
- For immediate service call: 800-368-5719 outside Calif. 213-853-2932 in Calif.
- TEST PROBES, INC., P.O. Box 2113, La Jolla, California 92038.

CIRCLE 123 ON FREE INFORMATION CARD

THE MODEL WTT-20 IS ONLY THE SIZE OF A DIME, yet transmits both sides of a telephone conversation to any FM radio with crystal clarity. Telephone line powered - never needs a battery! Up to ½ mile range. Adjustable from 70-130 MHz. Complete kit $29.95 + 1.50 S + H. Free Shipping on 2 or more.

CIRCLE 127 ON FREE INFORMATION CARD

"SODDER" WITH THE NEW BUTANE POWERED PORTASOL. No matter how you spell it, Portasol is the handiest soldering iron around. Seven inches long, variable power: 10 to 60 watts. 60 minutes use per refill. Only $29.95 + 2.00 P & H. Replacement tips: 1.2, 2.4 (standard). 3.2, 4.8mm, 7.50 + .50. Butane: 3.50 + .50. VA add 4% tax. Quantity discounts/dealers invited: Visa/MC orders: (703) 323-9000. Mail COD/Money-order to PORTASOL, 4358 Harvestor Farm Lane, Fairfax, VA 22032.

CIRCLE 190 ON FREE INFORMATION CARD

MODULAR PROBE FITS ALL SCOPES
- Save up to fifty percent on instant repair - no soldering - Satisfaction guaranteed - 250 MHz 10X Amplifier - Model M12X10...
- $62 with readout...
- $58 Free accessories catalog.
- For immediate service call: 800-368-5719 outside Calif. 213-853-2932 in Calif.
- TEST PROBES, INC., P.O. Box 2113, La Jolla, California 92038.

CIRCLE 123 ON FREE INFORMATION CARD

CABLE TV CONVERTERS AND DE-SCRAMBLERS. Large selection of top quality merchandise. Low prices. Quantity discounts. We ship COD. Most orders are shipped within 24 hrs. Send $2.00 for catalog.
- CABLETRONICS UNLIMITED, P.O. Box 266, Dept. R. S. Weymouth, MA 02190 (617) 849-5191

CIRCLE 188 ON FREE INFORMATION CARD

KEY TO THE FUTURE MICROLAB I by MASTERTECH. A Digital Electronics Course (with working laboratory). Forty lab experiments, comprehensive instructional manual, includes layout techniques, digital logic circuits, flip-flops, counters, shift registers, data handling, logic. Appendix includes logic IC's, manufacturers specification sheets. Completely assembled, no other equipment or parts necessary. Price $249.00. - $15.00 shipping/handling. MASTERTECH LABORATORIES INC., 302 Royal Trust Building, 612 View Street, Victoria, British Columbia, Canada, V8W 1J5.
- Telephone No. (604) 388-6631

CIRCLE 200 ON FREE INFORMATION CARD

TV STEREO ADAPTER KIT — For the price of a pre-recorded video tape, you and your family can enjoy dynamic stereo sound. Easily connects between your TV/VCR and your stereo system. Also includes a quality Stereo Simulator for non-stereo programming. Available in kit form $47.95 or assembled $67.95.
- DELPHONE INDUSTRIES INC., Box 150, Elmont NY 11003. NY Residence add Sales Tax. (718) 458-7367.

CIRCLE 56 ON FREE INFORMATION CARD

103 PROJECTS FOR ELECTRONICS EXPERIMENTERS.
- Soft cover; 308 pages of practical, proven plans for the electronics hobbyist...circuits, converters, amplifiers, synthesizers, optoelectronics, power supplies and more. Written and designed by Forrest M. Mims III. 12491 $11.50 plus $2.65 postage in USA. ELECTRONIC TECHNOLOGY TODAY INC., PO Box 240, Massapequa Park, NY 11762-0240.

CIRCLE 180 ON FREE INFORMATION CARD
Computers on the WORKBENCH

The personal computer does some surprising things in the electronics lab these days. Find out what and how right here.

ROBERT GROSSBLATT, CIRCUITS EDITOR

There are as many approaches to electronic design as there are designers. Each one has his own way of going from initial idea to final circuit. Of course, it takes a combination of both experience and creativity to produce working circuitry. But no matter how you arrive at a design, success often depends on the tools you use. Scopes, multimeters, function generators, capacitance meters—all those (and many more) are invaluable when you’re working on a circuit. The problem is that the more tools you have, the less space you have on your workbench.

One solution to the space problem is to use a multi-purpose test instrument. If you browse through the ads, you’ll find that many different test-instrument combinations are available. For example, many DMM’s now come with built-in frequency counters; and they can measure capacitance and transistor gain, too. Some top-of-the-line scopes even have built-in multimeters. Now the trend to combine various pieces of equipment has been carried over to personal computers as well. More and more companies are producing hardware add-ons for computers so they can be used as bench instruments.

Before we talk about what sort of computer-based instruments are available, it’s important to understand what advantages there are to using them. As a general rule, computer add-ons are much more expensive than traditional stand-alone instruments—but they have features that may simply be unavailable on traditional instruments.

For starters, since a computer is (or becomes) an integral part of the instrument, you get data storage and programmability for nothing. This means that the instrument can run...
in an unattended mode, take periodic readings, and store them on a disk. You can find that feature on top-of-the-line stand-alone instruments, but you'll pay a top-of-the-line price for them as well.

There's another bonus to using a personal computer as the brains of a test instrument: flexibility. Everyone who has ever used a traditional test instrument has had the experience of not being able to perform some essential test. The desired test could be anything from measuring capacitance on a multimeter to doing distortion analysis with a VU meter. Upgrading a standard instrument, if possible at all, is a hardware hassle; but with a computer-based instrument it may be just a matter of upgrading the software.

Another point is accuracy. As with standard instruments, you can get computer-based instruments with as much accuracy as you want. The number of significant figures is a function of the add-on hardware, not the computer. In fact, the front end of a stand-alone instrument may be very similar to that of a computer-based instrument. The differences between the two come further downstream: LCD display circuits vs. bus-interface circuits.

There's one BIG problem with computer-based instruments: Not all instruments work on all computers. Designing a computer peripheral is an expensive, time-consuming business. When you open the box and plug it into your computer, you're using a product that represents many man-hours of labor. As a result, the more sophisticated the instrument, the more computer-specific it's going to be.

The instruments we'll talk about here are IBM DMM's. If you are interested in a particular instrument, but own a non-supported computer, check with the manufacturer, a local user's group, or both, for information on a device that is compatible with your hardware. Don't run out and spend your money on anything until you're certain that it will work on your machine.

The IBM DMM?

A multimeter is probably the most standard instrument that you can have on a bench. No matter what you're working on, the chances are that you'll use your multimeter often. The Virtual Instrument Corporation (73 Redding Road, Georgetown, CT 06877) has introduced a computer-based instrument for the IBM that not only works as a multimeter, but gives you a full-featured function generator and universal counter/timer as well. Its specs are shown in Table 1.

As with any other computer instrument, the Virtual Cat is a two-part system. The hardware, shown surrounding the IBM PC in Fig. 1, takes the input signal, processes it, and converts it into data that can be passed to the second half of the system—the software controlling the computer. The hardware for the Virtual Cat consists of a card for the IBM and a box that's used to connect the probes. Since the unit plugs into an expansion slot, it gets its power from the computer. That reduces on-board parts, and results in production savings.

The noise circulating in a personal computer can be a problem for many boards, and it can be a major problem for the Virtual Cat. The reason is that there are several high-gain amplifiers on the board that are perfectly capable of amplifying noise as well as legitimate signal. The problem is solved, or at least considerably reduced, by housing the card in a metal shield. As you can see from the details in Table 1, the system's specifications are as good as the better stand-alone units.

As shown in Fig. 2, the software puts a sexy display upon the graphics screen that resembles a rack-mounted three-instrument set. That's a clever way to display the data, because it cuts the learning curve way down. Either a mouse or the keyboard can be used to move the cursor to any of the switches and change the settings. Doing so seems a bit strange at first, but after a while it becomes second nature.

You can use the Virtual Cat as a standard-instrument set, but the real strength of the product is its ability to be programmed. It's possible to write BASIC programs that control the operation of any of the three modules in the instrument. A simple program will cause the Virtual Cat to take measurements and record the information on a disk. Not only that, but the files can be loaded into a spreadsheet or database manager for later analysis. Each of the individual measurements will be time-and-date-stamped, so you can get an annotated listing of circuit behavior.

If you plan on using the programmable feature of the Virtual Cat, there is a high-level language package available that gives you much more control over the instrument than you have from BASIC. For most applications, however, the

---

**TABLE 1—VIRTUAL CAT SPECIFICATIONS**

<table>
<thead>
<tr>
<th>4½-digit autoranging multimeter</th>
<th>200 mV to 20 V in 4 ranges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volts (AC &amp; DC)</td>
<td>2 mA to 2 A in 4 ranges</td>
</tr>
<tr>
<td>Amperes (AC &amp; DC)</td>
<td>200 ohms to 20 Megohms in 6 ranges</td>
</tr>
<tr>
<td>Resistance</td>
<td>±0 to +48 dB</td>
</tr>
<tr>
<td>Decibels</td>
<td>±0.05%</td>
</tr>
<tr>
<td>Accuracy</td>
<td>600 V to ground</td>
</tr>
<tr>
<td>Isolation</td>
<td></td>
</tr>
</tbody>
</table>

**Counter, timer, frequency meter**

<table>
<thead>
<tr>
<th>Frequency</th>
<th>10 Hz to 100 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inputs: Channel A</td>
<td>10 Hz to 10 MHz</td>
</tr>
<tr>
<td>Channel B</td>
<td>10 Hz to 10 MHz</td>
</tr>
<tr>
<td>Period</td>
<td>0.5 µs to 10 s</td>
</tr>
<tr>
<td>Time interval</td>
<td>250 ns to 10 s</td>
</tr>
<tr>
<td>Maximum count</td>
<td>100 MHz</td>
</tr>
<tr>
<td>Resolution</td>
<td>100 ns</td>
</tr>
</tbody>
</table>

**Function generator**

<table>
<thead>
<tr>
<th>Waveforms</th>
<th>Sine, square, triangle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency range</td>
<td>0.1 Hz to 10 MHz</td>
</tr>
<tr>
<td>Resolution</td>
<td>±10%</td>
</tr>
<tr>
<td>Accuracy</td>
<td>±4%</td>
</tr>
<tr>
<td>Amplitude</td>
<td>0.5 to 20 V</td>
</tr>
<tr>
<td>Sweep range</td>
<td>0.1 to 1000 sweeps/sec</td>
</tr>
</tbody>
</table>

**Price**

| Basic unit | $1995 |

---

**FIG. 1**—THE VIRTUAL CAT puts a rack of test instruments inside an IBM PC

**FIG. 2**—SCREEN DISPLAY of the Virtual CAT: the hardware/software combination provides a function generator, a universal counter, and a digital multimeter.
**Computer scope**

If you’re in the market for a scope and you own a computer, you should seriously consider a computer scope. They’re more expensive than stand-alone units, but they give you lots of goodies for the money. RC Electronics (5386-D Hollister Ave., Santa Barbara, CA 93111) makes various devices that work in Apple and IBM’s, and Heathkit (Benton Harbor, MI 49022) makes two different models for the IBM. All units from both companies are hardware/software combinations that use the graphics capability of the computer to display a scope screen on the monitor.

The hardware component of the RC Computerscope is a plug-in card and a front panel. The Apple scope is a two-board set, but, as shown in Fig. 3, there is enough room on the larger IBM board to mount everything on a single card. The specs sheets reveal that there is a considerable performance difference between the two versions of the scope. The IBM scope is much more powerful, has a larger bandwidth, more input channels, and so on. The Apple scope comes in two versions; the difference between them is in the A/D converter used. The APD-D2 uses an 8-bit tracking A/D converter with a worst-case conversion time that provides a bandwidth of 100 kHz. In practice, bandwidth depends on the shape and amplitude of the signal. Some signals will cause the APD-D2 to fail apart at frequencies less than 100 kHz, but others will be measurable up to 1 MHz.

The APD-HR1 is based on a 14-bit A/D converter designed as a combination of tracking and flash converters to provide it with 14-bit accuracy up to a worst-case frequency of 500 kHz. As with the APD-D2, the upper frequency limit depends on the characteristics of the signal being measured.

**Table 2—RC COMPUTER SCOPE SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>APL-D2</th>
<th>APLHR-14</th>
<th>IBM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of channels</td>
<td>2</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>Vertical sensitivity</td>
<td>0.3-9</td>
<td>1-10</td>
<td>0.200-10</td>
</tr>
<tr>
<td>Vertical accuracy</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Vertical impedance</td>
<td>44</td>
<td>1000</td>
<td>20 k ohm</td>
</tr>
<tr>
<td>Frequency response</td>
<td>10 Hz</td>
<td>50 Hz</td>
<td>250 kHz</td>
</tr>
<tr>
<td>Maximum vertical input</td>
<td>±9</td>
<td>±9</td>
<td>±10</td>
</tr>
<tr>
<td>Timebase</td>
<td>2 x 10^-6</td>
<td>3.5</td>
<td>3.5 sec/</td>
</tr>
<tr>
<td>Sampling rate</td>
<td>3.5</td>
<td>0.5</td>
<td>3 MHz</td>
</tr>
<tr>
<td>Accuracy</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Price</td>
<td>$895</td>
<td>$1195</td>
<td>$2495</td>
</tr>
</tbody>
</table>

**Table 3—HEATH SCOPE SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>HEATH-14</th>
<th>HEATH-24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of channels</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Vertical sensitivity</td>
<td>5 mV</td>
<td>5 mV</td>
</tr>
<tr>
<td>Vertical accuracy</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>Vertical impedance</td>
<td>1 M ohm</td>
<td>1 M ohm</td>
</tr>
<tr>
<td>Frequency response</td>
<td>DC to 50 MHz</td>
<td>DC to 100 MHz</td>
</tr>
<tr>
<td>Maximum vertical input</td>
<td>125 V</td>
<td>250 V</td>
</tr>
<tr>
<td>Timebase</td>
<td>500 μs to 20 kHz</td>
<td>100 kHz</td>
</tr>
<tr>
<td>Sampling rate</td>
<td>100 kHz</td>
<td>100 kHz</td>
</tr>
<tr>
<td>Accuracy</td>
<td>6%</td>
<td>6%</td>
</tr>
<tr>
<td>Price</td>
<td>Kit $399.95</td>
<td>$575 499.95</td>
</tr>
</tbody>
</table>

**Table 4—SYSTEM ONE SPECIFICATION**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SYSTEM ONE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Generator</td>
<td>10 Hz to 204.775 kHz</td>
</tr>
<tr>
<td>Resolution</td>
<td>0.005%</td>
</tr>
<tr>
<td>Maximum output</td>
<td>30 dBm (600 ohms)</td>
</tr>
<tr>
<td>Accuracy</td>
<td>0.1 dB at 1 kHz</td>
</tr>
<tr>
<td>Flatness</td>
<td>0.05 dB (20 Hz to 20 kHz)</td>
</tr>
<tr>
<td>Maximum distortion</td>
<td>0.01%</td>
</tr>
<tr>
<td>Analyzer Module</td>
<td></td>
</tr>
<tr>
<td>Input range</td>
<td>0 to 240 V rms</td>
</tr>
<tr>
<td>Accuracy</td>
<td>0.1 dB at 1 kHz</td>
</tr>
<tr>
<td>Resolution</td>
<td>0.1%</td>
</tr>
<tr>
<td>Flatness</td>
<td>0.05 dB (20 Hz to 20 kHz)</td>
</tr>
<tr>
<td>Noise</td>
<td>-114 dBu</td>
</tr>
<tr>
<td>Distortion Module</td>
<td></td>
</tr>
<tr>
<td>Frequency Range</td>
<td>10 Hz to 100 kHz</td>
</tr>
<tr>
<td>THD Range</td>
<td>0 to 100%</td>
</tr>
<tr>
<td>Minimum input</td>
<td>10 mV</td>
</tr>
<tr>
<td>Accuracy</td>
<td>0.5 dB</td>
</tr>
<tr>
<td>Resolution</td>
<td>0.1%</td>
</tr>
<tr>
<td>Price</td>
<td>Basic unit, single channel, 3 modules</td>
</tr>
</tbody>
</table>

All versions of the RC scopes offer digital storage, programmability, and a minimum of two-channel, triggered operation. The APL-HR14 has an optional four-channel upgrade, and the IBM versions can handle as many as sixteen channels. All scope controls are set by command keys on the keyboard, and switching from one mode to another is very simple.

The resolution of the displayed signals depends on the computer. The IBM screen presents a much better image than the Apple screen, but any part of the signal...
can be examined in greater detail by expanding the scale. Sample screen and printer output is shown in Fig. 4.

Since the RC units are storage scopes, you can save their signals on disk and load them for analysis at your leisure. Once you use a storage scope it's really hard to go back to a non-storage type.

You just know that computer instrumentation is where things are going if Heath is getting into it. They have two scopes, both of which are available either in kit or assembled form. Both scopes convert an IBM-PC compatible computer to a 50-MHz storage oscilloscope; one, the 4850, will also talk to an older stand-alone scope and convert it for use as the display of a 50-MHz storage scope. Consequently, the 4850 (shown as this story's lead photo) has a slew of front-panel controls that determine how it works when you use it as a smart front end for a regular scope.

**FIG. 4—THE IBM VERSION OF RC's Computerscope provides both screen and hard-copy output.**

The 4850, and its less expensive counterpart, the 4802, are stand-alone boxes that output serial data to your computer on a standard RS-232 line. The specs for both units are shown in Table 3. The serial interface lets you forget about computer-generated noise, but it also puts an extra box on your workbench. The Heath scopes put their display on a standard IBM CGA (Color Graphics Adapter) card and are dual-trace triggered oscilloscopes. The current settings, as well as the keyboard command options, are always displayed on the screen, so it doesn't take long to get comfortable with changing parameters and operating the instrument.

Waveforms can be frozen, stored on disk, and then recalled for examination later. One nice feature of the Heath scopes is that you can display two stored waveforms on the screen and simultaneously view a live dual-trace representation of the input signal. Since the stored waveforms are shown using the currently-set time-base and vertical-sensitivity settings, a real comparison can be made with the live traces. You can use any print utilities, including the PrnSc (Print Screen) key, to get a hardcopy image of the displayed waveforms.

The scope's operating software is written in BASIC, and a compiled version of the program is what actually drives the system. The disk also contains the uncompiled version of the program, so that if you're into programming, you can customize the operation of the scope to fit any application you have in mind. And since the scopes deliver data via the RS-232 port, you can talk to the instrument via modem and do remote signal measurements. Heath supplies the necessary software on the disk that comes with the scope.

Stand-alone storage scopes are coming down in price, but even the most expensive ones don't have all the features you get on a computer-based scope. Both Heath instruments are reasonably priced when you add up all the goodies you get.

**Computerized audio testing**

Computer-based test instruments aren't limited to standard bench meters. Several companies make high-quality products designed for special markets. Audio Precision (P.O. Box 2209, Beaverton, OR 97075) is a small company that produces a set of instruments specifically designed for audio analysis. Their IBM system consists of a short-slot plug-in board as well as a set of external rack-mount boxes. The measuring hardware is external because of noise in the IBM. A DB-25 on the rear of the plug-in card allows the internal and external hardware to communicate. Specifications are shown in Table 4.

Although Audio Precision uses a DB-25 connector, communications between the two parts of the hardware are not done serially. As we mentioned earlier, when doing A/D conversion, the sampling rate must be at least twice the frequency of the signal being measured, depending on the accuracy you want. The lower limit is twice the measured frequency, but the upper limit is set by the designer, circuit costs, etc.

Audio Precision's System One was designed with no compromises in mind, and its performance specs are as good as, if not better than, many stand-alone instruments. The sampling rate is so high that it would require a rate of about 40 kilohertz on a standard RS-232 channel. As a result, the system uses a parallel interface. The rack (i.e., the external hardware) contains the notch and bandpass filters used for various kinds of analysis, as well as the generators for producing various test tones.

The System One is a computer-based instrument, so the rack and the device under test are controlled via software. To take a simple example: if after connecting the hardware you want to test to the rack, the rest of the test procedure is done from the computer's keyboard. Software is loaded and the instrument panel is selected from a menu that appears at the bottom of the screen. The output of the frequency generator can be set on the left, and the measured data will be shown in the center. The present analyzer settings are also displayed in the center panel. You can change frequency, phase, bandwidth, and so on with a few keystrokes, and immediately see the results of those changes on the computer's screen.

The real advantage of the System One is the fact that it's being run on a computer. Not only can any of the test results be graphed, but the software lets you define the coordinates, scaling, signal source, and other parameters. And, like the computer-based scopes, test results and setups can be saved in disk files.

**System One also allows unattended testing.** In addition, a test editor can be called from the menu to let you write test procedures in an English-like language. Once you're familiar with the syntax, you can link several tests together and have them run sequentially at specified times. Procedures can have conditional statements in them, so you can run unattended tests with as much nested conditional branching as you need. You can also specify limits in any test or procedure. And since a procedure can call in as many previously-saved test and limit files as you want, the System One is flexible enough to do even the most complicated sort of audio testing automatically.

The basic Audio Precision hardware does a wide range of audio testing, but its utility can be increased with optional extras. The extra hardware allows you to measure several kinds of THD distortion and wow and flutter; the addition of a switcher will let several devices be connected to the system at the same time.

**Sceptre III**

Even major semiconductor manufacturers are recognizing the power available on today's personal computers. Gould-AMI (3800 Homestead Road, Santa Clara, CA 95051) has a system available for the IBM that aids the design of gate arrays and other IC's. The Sceptre III is a graphics-oriented package that allows OEM's to design and debug gate arrays. When the design is complete, you send the disk to AMI where its data is used to build an actual IC.

**Conclusions**

The computer-based instruments we've discussed are only the tip of the iceberg. There are many others, and more are showing up every day. In general, they're more expensive than their stand-alone counterparts, but you get much for your money. And as for IC-design software, it's interesting to note that several semiconductor companies have software packages that run on VAX workstations. But few have awakened to the incredible power waiting inside the very same box used for blasting aliens with a joystick.
WHEN PERSONAL COMPUTERS STARTED TO SHOW UP IN THE late 1970's, the two most important qualifications for buying one were a healthy amount of both cash and curiosity. Even a basic machine cost a great deal of money, and there wasn't much software available. As a matter of fact, you could do little more than enter simple programs via front-panel switches, and read data on front-panel LED's. Not the most exciting way to spend a rainy evening.

Fortunately, the capability of the personal computer has increased dramatically in the ten or so years since it first appeared. As things stand now, the gap between the mainframe and the PC is narrowing rapidly. New silicon superstars such as the 68020 and the 80386 can address gigabytes of memory, run as fast as 25 Mhz, and do real multi-tasking. What that means is that, within a few years, about the only thing you'll need a mainframe for is operating NORAD—and who wants to do that in the living room?

As PC hardware gets more and more sophisticated, so does the software that runs on it. For example, the primitive graphics programs of a few years back have matured into sophisticated CAD packages with features specifically designed for particular applications—architecture, mechanical engineering, and, of course, electronics.

The number-crunching power of the typical PC has been used to eliminate the brain damage and tedium usually associated with a whole range of design activities. And nowhere is that more evident than in electronics design. As things stand now, a modest investment in software will not only save you countless hours of bench-time and breadboarding, but will also allow you to do waveform analysis and troubleshooting without ever touching a component.

There are many types of computers and many types of software; but there are also, unfortunately, no standards. A disk containing software for one computer is unusable on
TABLE I—PROGRAMS AND PRICES

<table>
<thead>
<tr>
<th></th>
<th>Apple II</th>
<th>Macintosh</th>
<th>IBM-PC</th>
<th>HP-150</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microcap</td>
<td>$475</td>
<td>—</td>
<td>$475</td>
<td>$475</td>
</tr>
<tr>
<td>Microcap II</td>
<td>—</td>
<td>$695</td>
<td>$695</td>
<td>$695</td>
</tr>
<tr>
<td>Micrologic</td>
<td>$450</td>
<td>—</td>
<td>$450</td>
<td>$450</td>
</tr>
<tr>
<td>DADISP (1)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Modeller</td>
<td>—</td>
<td>(2)</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Notes: 1. DADISP is available for a number of computers. Contact the manufacturer for details.
2. Contact the manufacturer for current licensing information.

1986-style design

In the past, the first thing one might do when you had an idea for a new circuit was to sit down with paper and pencil and start drawing circuits. Now you can use a computer for brainstorming: doing so gives you several advantages. For example, many general-purpose graphics programs will let you draw pictures on the screen, save them to disk, edit them, and print them. However, a few programs take things a step further. Micrologic and Microcap from Spectrum Software (1021 S. Wolfe Road, Department F, Sunnyvale, CA 94087) work together to allow you to draw a circuit on the screen and then analyze it by looking at the waveform generated at any node in the circuit. Although the look and the program flow of both Microcap and Micrologic are similar, Microcap deals with analog circuits, and Micrologic deals with digital circuits. If you’re familiar with one program, you’ll have no trouble using the other.

Software simulation of a circuit is an easy way to check a design without risking turning silicon into scrap. And, given the complexity of those programs, the learning curve is surprisingly short. Circuit data can be entered graphically or by generating a netlist that describes the components and how they’re connected.

A separate part of the program lets you define the characteristics of each of the components you’ll be using. Doing so allows you to specify things like transistor gain, op-amp slew rate, logic-element truth tables, and so on. Then, after you’ve defined the operating characteristics of your components, you can lay out the circuit using the graphics editor. The last step is to analyze the circuit.

Example output

Figure 1 is a voltage regulator that was drawn with Microcap. The symbols used in that drawing come from a standard library that is supplied with the program.

Adding components to the drawing is a simple matter of moving the cursor to the desired position and then telling the program that you want to add a part. You’ll be asked for the type of part, its orientation, and other parameters. As soon as the software knows exactly what you want, it will draw the component on the screen.

If you’re going to use a sub-section of a circuit more than once, you can save a great deal of time by building a circuit macro, analogous to a spreadsheet macro. The resistor network shown in Fig. 2, for example, could be converted to a macro and used in other drawings simply by loading it from disk.

Because a macro is a shorthand way of including a pre-drawn circuit in a new design, an additional step must be followed when the macro is defined. After the macro is complete, you must label the points in it that will connect to the circuit using it. It’s much easier to do than to describe. In Fig. 2, we labeled four points (A, B, C, and D) and saved the drawing to disk. Then we could add it to another drawing just as we would add any component.

To insert a macro, move the cursor to the point in the circuit where you want the macro to appear, and then use the same keystrokes as in adding any other component. The result can be inserted as many times as you want. Macros not only simplify circuit creation, but they also make it easier to understand the drawing.

Figure 3 shows the drawing of a simple RLC circuit that is driven by a pulsed voltage source. By doing a transient analysis on the circuit, Microcap processes the drawing and comes up with a netlist similar to the one shown in Table 2. Microcap shows you the parameters used for the analysis and lets you change them, if desired. Then Microcap does the circuit.
of detail. The timing diagrams (Fig. 5-b) are typical of what Micrologic can do for you.

### Circuit-design spreadsheet

The real usefulness of Microcap and Micrologic is their ability to analyze the drawings they produce. There are more powerful graphics-only programs, but, as far as electronics is concerned, being able to simulate real-world circuit operation is much more important than generating pretty artwork.

Spreadsheets let you manipulate financial data and play “what if” games. Micrologic and Microcap let you examine the operation of a circuit without ever touching a single piece of silicon. However, it takes much time and many keystrokes to analyze a circuit, change a few things, and then analyze it again. More than that, there’s just no way to do a side-by-side comparison of several versions of a circuit. However, within the past year or so, software has become available that gives you the flexibility of a spreadsheet for doing that type of circuit analysis.

For example, DADiSP (Data Acquisition and Digital Signal Processing) is a piece of software from DSP Systems (1 Kendall Square, Cambridge, MA 02139) that gives circuit designers the same power that Lotus 123 gives to accountants. It’s a scientifically oriented spreadsheet whose cells display graphs rather than numbers. DADiSP has more than 150 different scientific functions built in, so entering the formula for a particular waveform is relatively painless.

Let’s suppose that you’ve designed a circuit and have collected data by operating the circuit with a range of different input signals, time constants, and so on. Once you’ve entered your data in a file, it can be loaded into one of the spreadsheet cells and the program will display the data in graphic form. See Fig. 6. DADiSP will let you perform a number of different analyses, as well as manipulate any of the graphs displayed on the worksheet. Available functions range from simple signal arithmetic to complex calculations that use trig and calculus.

One strength of the program is its ability to refer to one window as a variable. For example, as shown in Fig. 7, you can see the result of a point-by-point multiplication of two signals (which are displayed in windows 1 and 2) by moving the cursor to a third window and entering the formula W2 * W1. Then you can integrate the output of the third window and display it in a fourth. That sort of analysis and

---

**FIG. 4**—THE UPPER WAVEFORM shows the output of the pulse source in Fig. 3; the lower waveform shows the waveform at the right edge of the coil (node 2).

**FIG. 5**—MICROLOGIC, the sister program of Microcap, can also do digital circuit analysis.
FIG. 6—A SPREADSHEET FOR ELECTRONICS DESIGNERS. DADiSP converts a circuit's operating parameters into graphic form and displays it in one of 64 cells. The software allows you to perform a wide variety of analyses and to manipulate the graph displayed in any of the cells. Mathematical operations ranging from simple arithmetic to complex calculations can be performed on the data.

FIG. 7—THE DADiSP SPREADSHEET lets you relate cells and derive results by combining those cells in various ways. Windows 1 and 2 show two independent signals; Window 3 shows their product; and Window 4 shows the integration of Window 3.

Editing can be done with any of the program's built-in functions and arguments. DADiSP is a 64-cell spreadsheet; the graphs contained in each cell can be interrelated. That means that changing the data in one cell will change the data in any related cells. Playing "what if" using those capabilities can enable you to line tune a complex analog circuit without physically changing a single component in the actual circuit.

One of the program's neatest features is its ability to graph the measured points and then interpolate the plot. DADiSP lets you look solely at a plot of your data, or at a curve that represents the best fit. After the program fits a curve to your data, you can activate a cursor that moves along the the curve and shows you the interpolated coordinates. For example, if you've plotted voltage versus time, DADiSP will give you interpolated values of voltage as you sweep the cursor across the time scale.

That type of interpolation can be a real time-saver when you do some kinds of analog circuit design. Imagine, for example, designing an oscillator or a filter circuit and calculating the values for the RC components. Doing the math isn't difficult, but attaining a specific frequency using standard-value parts can be exasperating. A good deal of that type of brain damage can be eliminated with DADiSP by plotting a graph of the circuit's time constant formula and then running the cursor along the result. As you move the cursor, the relevant RC values will show up at the bottom of the screen.

Other useful features include the ability to expand and compress the displays and automatically take care of scaling. Those features are important when you want to examine just a small part of a curve or look at an expanded time scale.

DADiSP isn't for everyone. It's an expensive piece of software, and it's only useful for some kinds of design and some kinds of designers. If you decide on component values by plugging things in and crossing your fingers, you won't get much use from the program. But for designers who do a lot of calculating and reading before ordering parts, DADiSP can be tremendously helpful.

DADiSP is like any other sophisticated analytical tool: the more it's used, the more useful it becomes. If your circuit designs are heavily math intensive, the software may be worth the investment in time and money you'll have to make. The program goes a long way toward helping you visualize the effects of varying circuit parameters and making sense out of real-world data.

Bose's Modeler

The number-crunching and graphics capabilities of computers are slowly being put to use to solve problems in just about every area of electronic design. Paper-
work and guesswork are being replaced by software and keystrokes. One field that is just starting to benefit from the use of the computer is acoustic design. Setting up a successful sound system in a large room has traditionally been the result of a combination of physical measurements, past experience, speaker dynamics, and a great deal of personal bias.

Before any attempt can be made to decide on the installation for a particular room, an enormous amount of data must be collected. Room dimensions and construction details, architectural features, reflectivity, and speaker characteristics are only a few of the specifications that must be known before design work can begin. Even then the math is time-consuming and must be redone if any of the data changes.

The Bose Corporation has recently introduced acoustic design software called Modeler that simplifies data entry and uses extensive graphics to display an acoustic model of the room. The designer uses the program’s graphics front end to create a set of planes that define the room, and then he specifies the physical material of each of the planes.

Next the computer builds a three-dimensional model of the room, taking account of the degree of sound absorbency and reflectivity of all surfaces. The model is displayed on-screen; it can be rotated around any of the three axes and redrawn to show the view from any angle. Figure 8-a shows a three-dimensional view of a room. You can see how the model was defined by building a series of planes. The location of any point in the room can be found because the plane dimensions and elevations were entered into the program while the room was being drawn on the screen.

The locations of the speaker clusters are entered by putting the cursor at the desired point and indicating which way they point. Since we’re dealing with a three-dimensional model, the speaker direction is specified by entering three figures to represent pitch, roll, and yaw. See Fig. 8-b. The speaker’s characteristics are contained in data files, so all that the designer must do is to tell the program what kind of speakers will be used.

After the speaker data has been entered, the computer has everything it needs to calculate and display any of the standard acoustic parameters at any point in the room. Those parameters include both direct and reflected components, time delay, relative loudness, and so on. If a change is made in any of the architectural features or speaker characteristics, the program will recalculate the parameters as necessary.

Being able to spot-check the acoustic parameters at any point in a room is nice, but the sexiest feature of the Bose software is its ability to draw an acoustic map of the room. It does that by calculating the sound-pressure level at every point in the room, then displaying the results using varying shades of gray to represent different acoustic levels.

The resulting gray-scale map gives the designer a graphic representation of the sound level anywhere in the room, which lets him spot areas that need reinforcement or muting, all without installing any hardware.

Modeler provides the acoustic designer with a diagnostic tool that is as powerful in its field as are the other software packages we discussed earlier in theirs. In this case the computer has given the designer capabilities that were unheard of as few as five years ago. The result is greater accuracy, lower design cost, and increased productivity.

Conclusions

The growth of sophisticated hardware and software for the personal computer has been unbelievably rapid since the days of the Altair and the IMSAI (the mid-1970’s). It’s a bit of a mind-bender to realize that some of the things routinely done on personal computers today weren’t possible even on mainframes ten years ago.

And there’s no end in sight. Even those of us that only like to fool around on the weekend can use computerized tools on a PC to reduce the donkey work of electronics design.

The software we’ve discussed here is only the tip of the iceberg. Many more products are available and just about every area of electronics, from designing IC’s to laying out printed-circuit boards, has benefited from the popularity of the personal computer. If you find yourself spending a great deal of time at the workbench, there’s a good chance that your work can be made much easier by using a computer.

And you don’t need a mainframe to enjoy the benefits that sophisticated design circuitry can produce. Besides, you can’t play Pacman on a mainframe.
THE BIG ONE FINALLY CAME THIS AUTHOR'S WAY: a job providing both financial reward and a fascinating challenge for his company, Vesta Technology. The project: To design a robot, including a control computer, an arm, and additional subsystems for motion control, navigation, and operator input/output. While designing the robot, we discovered much about the personal robot industry. For one, it appears to be dominated by expensive robots with limited capabilities. We felt that a new approach could make a home robot more affordable and more exciting.

Designing a robot requires expertise in a number of areas, including mechanics, electronics, and computer hardware and software. In order to augment Vesta's limited abilities in the field of mechanical engineering, we enlisted Stock Drive Products to aid our development effort. That company is the major supplier of mechanical components to the industrial robotics market. See the Sources box for their address.

The cost of a robot

"Stop for a moment and consider why personal robots are so expensive. One reason is that a considerable markup takes place at each point in the distribution chain. A manufacturer's purchasing department must have a secure supply of parts, so it may be willing to pay higher prices to attain that security. The hobbyist, however, has the advantage of being able to buy from less-expensive sources of parts. He can, for example, take advantage of surplus outlets, thereby eliminating middlemen; the result is a substantial savings over manufacturers' prices.

As for the controller, we designed a complete low-cost single-board computer that is highly compatible with the IBM-PC. Our approach emphasizes the use of flexible electronics that allow you to customize your robot with available mechanical parts.

By providing the electronic-control system and minimizing mechanical costs, we believe that building a personal robot can be both entertaining and affordable. In the upcoming series of articles, we will show you how you can adapt our designs to your problems.

The main components of our system are the single-board development system, a control/sensing board, and control software. Because the electronics systems are efficient and adaptable, you are free to interface them with whatever mechanical system meets your needs. The systems software that we have developed (and are still developing) is quite sophisticated, but the applications programming is left to you.

The bottom line is that we are not offering a kit for the type of ready-to-assemble robot that so many other companies offer, rather, we are suggesting that you can build the robot that you really want or need by integrating our control system with your mechanical design.

Overview

As we discuss the specifications of the R-E Robot, keep in mind that you can build your robot with other components, and in other configurations.

Our robot is powered by two 12-volt lead-acid batteries; it has a top speed of five miles per hour. Although we used utility batteries, we could have used auto or motorcycle batteries. Circuitry that indicates when power is low is included onboard, as is a 117-volt AC battery charger.

The robot's drive system consists of two independent 10.5-inch pneumatic tires that are connected to two toothed belt drives and to two 1/2-horsepower DC torque motors. A caster mounted at the rear provides lateral stability and ease of movement.

The robot is equipped with sensors for measuring temperature, light, and sound.
Microswitch collision detectors and sonar ranging, usable at distances as great as 20 feet, are also provided.

The robot lacks a traditional robot arm. Instead, it features a powerful gripper that rides a vertical track at the front of the unit. The arm, as shown in Fig. 1, somewhat resembles an industrial forklift. While some flexibility is sacrificed using this approach, some important advantages are gained. For one thing, the mechanical design is greatly simplified. That means that greater lifting capacity could be provided without greatly increasing cost. The gripper is capable of vertical travel from floor level to about table height.

In addition, the robot has options for an RF link, a speech synthesizer, and even a speech-recognition system.

The RPC

The hardware that makes it all possible is the RPC (Robotic Personal Computer). The heart of the RPC is a highly integrated Intel 80188 microprocessor; it significantly reduces costs by including—in the IC package—many support devices that are external to the 8088 (used in a true blue IBM-PC). The entire computer occupies a PC board that is less than eight inches on a side.

The interface between the RPC and the I/O unit is an adaptation of the IBM-PC bus. Signals from that bus are available at a 60-conductor IDC connector. That bus allows prototype circuits to be built without using special prototype cards.

Software

Complementing the hardware is a flexible programming environment that allows the programmer to choose his favorite and most productive language. The RPC may be programmed in two different ways.

One approach involves use of either of the onboard languages: BASIC and FORTH. Each language is a combination of operating system, development system, and high-level language. Each includes debugging support, inherent ROMability, and access to mass storage, and each supports interrupt programming, integrated procedures, and multitasking. An onboard EPROM programmer allows software to be written, tested, and burned into EPROM for dedicated use.

The other approach makes use of the RPC's IBM-PC compatibility. The RPC boots most operating systems designed for the PC, thereby allowing the programmer to choose his favorite language: Assembler, Fortran, Pascal, C, BASIC, and many others are all available. Programs in these languages can also be burned into ROM, if the compiler used generates ROMable code. Program code can also remain stored in battery-backed static RAM for power-on execution. In addition, programs and data can also be stored on floppy disks. The RPC can accommodate any mixture of as many as four 3.5- and 5.25-inch floppy-disk drives.

RCL

Although the robot's software is not yet as extensive as we would like, modules have been written to test each of the robot's capabilities. The next step is an extremely sophisticated Robotic Control
Language (RCL). The inclusion of RCL on-board is possible only because of the power of the RPC.

The onboard RCL puts our robot a step ahead of almost all other home robots. Most robots are controlled with obscure software commands. A typical motion function could be programmed as follows:

```plaintext
OUT (1);REM Turn on drive motors
DELAY 1000;REM For one second
OUT (1);REM Then turn off motors
```

RCL allows the operator to program the same function as:

```
10 FEET FORWARD
```

Choosing a language in which to implement RCL was not an easy task. Because RCL was to be interpreted, we had to implement it in a language that executes quickly. To ease development and to allow people to customize RCL for their own purposes, it had to be written in a high-level language. We also wanted to minimize the cost of the hardware required for developing the RCL interpreter.

After considering BASIC, C, FORTH, and Pascal, we decided that FORTH met our requirements best. It runs much faster than interpreted BASIC, but it allows interactive program development, testing, and debugging. In addition, that language promotes the writing of modular, structured programs (as do Pascal and C), but it does not require a disk-based development system.

Another benefit is that FORTH is extensible, which means that the code we write becomes a part of FORTH. Because most continued on page 94
This month we put our theories to work and build a functional descrambler.

WILLIAM SHEETS and RUDOLF F. GRAF

Part 6  
DURING THE PAST FEW months we've been looking at some of the principles behind television-signal encoding and decoding. Now it's time to put some of what we've learned to work. Beginning this month, we will look at three practical descrambler circuits that will decode single- and multitone, sync-pulse, and outband-signal encoded signals. Complete schematics, parts lists, and PC patterns will be provided; in addition, a kit of parts will be available.

But before we begin, take heed of this warning.

The decoding circuits that will be presented are for educational or experimental purposes only. It may be illegal to use the circuits to decode encrypted signals before obtaining prior permission from the programming supplier. It is up to the user to determine the conditions for legal use of these circuits and to obtain any permission required.

Sinewave scrambling

As discussed in the June 1986 issue of Radio-Electronics, in sinewave scrambling a 15.75-kHz sinewave is added to the video signal. If the sinewave is synchronized to the video signal, the sinewave's negative peaks occur during the video sync's positive peaks. The result is that the peak level of the sync is suppressed below that of the video. See Fig.

1. That suppression confuses the sync separator circuit in a television receiver and stops it from functioning properly. The picture that results is unwatchable: There is a dark vertical band and the video is color-distorted.

The audio may or may not be scrambled. Actually, it's not really scrambled; instead, it's stripped away from the main audio channel and placed on a hidden subcarrier. In sinewave scrambling, that subcarrier usually is located at 62.5 kHz.

Sinewave descrambling

Unscrambling a sinewave-encoded signal is relatively simple. It involves mixing the scrambled signal with a sinewave of the same amplitude and frequency as the scrambling sinewave, but shifted 180 degrees. The result is that the scrambling sinewave is canceled, leaving a standard video signal. A block diagram of an appropriate descrambler is shown in Fig. 2.

Leaving theory behind, let's look at a practical sinewave descrambler circuit. The bulk of the circuit is shown in Fig. 3. The input and output circuitry is shown in Fig. 4; that circuitry is mounted within a shielded "interface" box. We'll speak more about the box and why it is used when we look at how to install and align the decoder.

The first thing a sinewave descrambler must do is to extract the 15.75 kHz sinewave from the incoming signal. That can be done by filtering it directly from the video envelope after detection.

An IF and video-detector system is formed by Q1, IC1, and their associated circuitry. The output of the TV set's tuner is picked off and fed to that stage via the input/output circuitry. Resistor R1 is used to set the gain of the IF stage while C1 is a DC-blocking capacitor. Resistor R1 should be set so that the input to Q1 is on the order of 1 millivolt. That signal level is provided by most cable systems, but with the value shown for R1, the circuit can accommodate signal levels from 0.3μV to 5 mV.

Transistor Q1 is configured as a single-tuned bandpass amplifier with a gain of
FIG. 3—A COMPLETE SINEWAVE DESCRAMBLER. Easy to build, and relatively easy to align, this circuit completely removes the 15.75-kHz scrambling sine-wave.
The circuitry is mounted in a separate, shielded enclosure. This allows for greater flexibility in installing the circuit in a TV-set.

Descrambling audio

In sinewave scrambling, the programmer also has the option of encrypting the audio. For systems where the audio is scrambled, IC3, IC4, IC5, and their associated circuitry are used to recover the audio. If it is not needed, that part of the circuit may be omitted.

Part of the video signal at the output of IC1 is picked off and fed to IC3, an MC1358 TV-sound IF amplifier via a high-pass filter made up of C7, R7, and R8. That versatile LC provides 4.5-MHz detection, amplification, and limiting. The detector stage is tuned by the LC network located between pins 9 and 10. The inductor, 1.2, should be tuned for maximum signal at pin 12. While 62.5 kHz is the most common audio subcarrier frequency, with the values shown virtually all other possible subcarrier frequencies can be tuned by adjusting 1.2.

The pin-12 output is filtered to extract the audio subcarrier and that signal is fed to the input (pin 2) of IC4, an NE565 PLL. The VCO control voltage appears at pin 7. Assuming that the PLL is in a locked condition, that voltage will correspond to the program audio. For more detailed information on PLL operation, see Part 4 of this series in the September 1986 issue of Radio-Electronics.

Building a descrambler

Most of the circuitry is mounted on a single PC board. The foil pattern for that board is found in PC Service. The parts-placement diagram is shown in Fig. 5 and a photograph is shown in Fig. 6.

Other than R31, the volume control, the only components not located on the board are those that make up the interface circuit of Fig. 4. These parts should be mounted in a small shielded (metal) box. The circuit is simple and its placement within the box is not critical. Strictly speaking, the interface circuitry could have been located elsewhere.

The pin-7 signal is then filtered and coupled to an audio amplifier built around IC5. The output of the amplifier is fed to an external 8-ohm speaker. Volume is controlled via R31. A stabilizing network for the LM386, consisting of R32 and C33, is included to prevent the possibility of undesired high-frequency oscillation.

Parts List

All resistors 1/4-watt, 10% unless noted
R1, R10—100 ohms, trimmer potentiometer
R2, R8, R22, R24, R25—470 ohms
R3, R19—100 ohms
R4, R7—100 ohms
R5, R15, R33—47 ohms
R6—3300 ohms
R9, R12, R13, R20, R23—10,000 ohms
R11—220,000 ohms
R14, R16—5000 ohms, trimmer potentiometer
R15, R21—2200 ohms
R17, R27, R28, R29, R30—1000 ohms
R26—25,000 ohms, trimmer potentiometer
R31—10,000 ohms, trimmer potentiometer, audio tape
R32—10 ohms
R33—1,000 ohms

Capacitors
C1, C2, C5, C7, C13—C15, C21—C23, C26; C36—470 pF, ceramic disc
C9—15 pF, NPO or silver mica
C4—47 pF, NPO or silver mica
C6—56 pF, NPO or silver mica
C8, C9—0.001 µF, Mylar
C10—C12—1 µF, 20 volts, electrolytic
C16, C24, C27—C29, C35—0.01 µF, ceramic disc
C17, C30, C33—0.1 µF, Mylar
C18—68 pF, NPO or silver mica
C19—12 pF, NPO or silver mica
C20—220 pF, NPO or silver mica
C25, C31—10 µF, 20 volts, electrolytic
C32—470 µF, 20 volts, electrolytic
C34—470 pF, NPO or silver mica

Semiconductors
IC1—MC1330 video detector
IC2—LM1450 dual op-amp
IC3—MC1356 TV sound IF amplifier
IC4—NE565 PLL
IC5—LM386 audio amplifier
Q1—2N3563 NPN transistor
Q2—2N3566 NPN transistor
D1—MNP3404 PIN diode
D2—1n4002 rectifier diode

Other components
L1—0.3—0.5 µH, see text
L2—0.2—0.3 µH, see text
L3—5.8 µH choke
L4—10—33 µH (North Country Radio, L10-33 or equivalent), see text
J1—J3—phono jacks
SPKR1—8-ohm speaker
Miscellaneous: PC board, metal box for interface circuit, cabinet (optional), wire, solder, shielded cable, etc.

The following are available from North Country Radio, P.O. Box 83, Wykagyl Station, New Rochelle, NY 10804: Complete sinewave decoder kit, including PC board (metal box for interface circuit not included), item SW-1, $52.95 plus $2.50 shipping and handling; Pulse decoder kit, including PC board, item PD-1, $49.95 plus $2.50 shipping and handling; Outboard decoder kit, including PC board, item OB-1, $34.50 plus $2.50 shipping and handling. All three kits may be purchased for $129.95 plus $3.50 shipping and handling. The LX10-33 coil (L4 of the sinewave descrambler) is available for $4.00. NY state residents please include sales tax.
on the main board; but separating it from the main board allows for much more flexibility.

With our scheme, you can mount the interface box within the TV cabinet, physically close to the tuner and IF sections, but leave the remainder of the circuit outside for easier adjustments. Input and output signals are routed between the box and the board using shielded cables. With other schemes, either the whole circuit is mounted within the TV cabinet, making access difficult, or long signal runs are required, inevitably causing signal degradation.

Coils L1 and L2 are hand-wound. Coil L1 consists of 10 turns of number 22 enamelled wire wound on an 8-32 screw. Coil L2 consists of 6 to 7 turns of number 22 enamelled wire wound on an 8-32 screw. Once those coils are wound, remove the screws and replace them with ferrite slugs. You can salvage those slugs from an old TV set (from a coil in the IF circuit) or the front end of an old FM radio. Coil L4 is a custom part. It is designated as LX10-33 and is available only from the source given in the Parts List.

Aligning the circuit

It may be illegal to use or even align the circuit with the signal from an over-the-air or cable pay-TV programmer without obtaining prior permission. Do not use the circuit in that manner without first obtaining such permission.

In the meantime, it is possible to align the circuit "off-the-air." Doing that can give you greater insight into the way that signal descrambling works. Let's see what equipment is needed to perform such off-the-air alignment before looking at the procedure itself.

The circuit should be powered using a well-regulated, filtered +12-volt DC supply. Any excess ripple can interfere with circuit operation to the point where alignment is not possible.

You will also need an oscilloscope. It should have a bandwidth of at least 5 MHz and preferably 10 MHz, and a sensitivity of at least 100 mV/div. The scope should be equipped with a low-capacitance (less than 10 pF) probe.

You will need some way to simulate the 15.75-kHz scrambling sinewave. That can be done using an AF generator. Your VCR will suffice as a source of normal (descrambled) video. If one is available, a signal generator capable of outputting frequencies to about 70 MHz would be helpful, but it is not absolutely required and you can get away without one.

Connect J1 to J2 using a short length of shielded cable. Then connect power and apply a video signal to the signal-input jack (J3). Nothing should run hot. If it does, measure the resistance between the power supply and ground rails. If it is less than 100 ohms, you likely have a short somewhere. Correct any problems before proceeding.

Next, connect the oscilloscope probe to pin 4 of IC1. Adjust the settings of L1 and L2 for a maximum video signal display on the scope. Then adjust R1 for a video signal of about 250-mV p-p.

Move the scope probe to pin 12 of IC3. Adjust L4 for maximum audio signal as displayed on the scope.

Disconnect the video source. Set the signal generator to output either a 61.25- or 67.25-MHz signal with a 15.75-kHz sinewave from an AF generator. Apply the resulting signal to J3.

Connect a TV receiver to J4, the signal output jack. Normally, applying just the video carrier to the set will cause a uniform white raster. However, the sinewave should cause a rippling effect. If the circuit is working properly, you should be able to eliminate that ripple by adjusting R16, R10, and R14. If you can, it proves that the circuitry is capable of suppressing the scrambling sinewave.

That completes alignment. If you obtain permission to use the circuit with an over-the-air or cable signal, you will likely need to tweak up performance when the circuit is installed. However, those adjustments should be minor.

Installing the circuit is relatively simple. However, working inside a TV can be very dangerous unless you are sure what you are doing. We urge you to be cautious. Basically, the sinewave decoder interface box is installed between the TV's tuner and its IF section. Coaxial cable should be used, and you should provide a bypass switch to take the decoder out of the circuit. You may prefer to use a separate tuner as decoder's front end. Then the only connection required is to the TV's IF. Either way will work, but using a separate tuner may be more desirable.

Next time, we will look at gated-sync and outband-sync descrambling circuits that you can build yourself and experiment with.

FIG 6 — THE COMPLETED SINEWAVE DESCRAMBLER BOARD contains everything except the volume control and the circuitry shown in Fig. 4.

That completes the essential checkout procedures. If you have a signal generator, there is one final test you can perform. Once again, modulate a 61.25- or 67.25-MHz signal with a 15.75-kHz sinewave from an AF generator. Apply the resulting signal to J3.
Closed-Caption Decoder

Last month we looked at the theory and the circuitry behind the closed-caption decoder. Now let's build one.

Part 2

When we finished up last time, we discussed the basics of how closed captioning works, and we presented the complete schematic diagrams of our closed-caption decoder. Now you can warm up your soldering iron—we're ready to build the circuit.

Construction

Building the decoder is fairly easy because it has only a single IC and because all components, except the switches and power jack J1, mount on the PC board.

The NCI telecaption module, the heart of the decoder, mounts in the bottom of the case. The PC board mounts in the top. The close quarters in the case require that all components on the PC board be low-profile types with heights less than one inch. The only problem component is the 7805 regulator, which requires a relatively large heatsink. We solved the problem by installing a vertical-mount heatsink horizontally.

To begin construction, first inspect the PC board (whether you make your own or buy the kit) for plugged holes and broken or shorted traces. Fix any and all faults before proceeding.

Following the component-placement diagram in Fig. 7, install the three jumpers using 22-gauge bus wire. Keep the jumpers tight and flat against the surface of the board to prevent shorts. Next, insert 26 PC pins into the holes in the board where wires will connect: 15 along the right edge of the board (where the NCI module will connect), two for J1, two for S2, and seven for S1. Turn the board over carefully and rest it on the pins while you solder them in place.

Next install the nine fixed-value resistors. The holes for all the resistors are spaced so that the leads of each resistor can be bent right at the body. To ease troubleshooting, mount the resistors so that the color codes point the same way.

Install the capacitors, taking care to orient the polarized electrolytics and tantalum types correctly. Keep all the capacitors as close to the board as possible, bending their leads if necessary to match the hole spacing.

Install the diodes next, taking care both to orient them correctly and not to mistake the different types. In particular, be certain that the 6.2-volt Zener is inserted in the D3 position, and that the 8.2-volt Zener goes in the D11 spot. Use care in bending the leads of the diodes, particularly the glass types.

Now install the transistors. To avoid mixing up the two types, first insert and solder the five PNP devices Q5, Q6, Q9, Q13, and Q14. Then insert the nine NPN transistors in the remaining positions, and solder them in place. Keep the transistors close to the board—their cases should be no more than ¼ inch from its surface.

Press the four RCA jacks (J2, J4, J5, and J6) into the board and bend their tabs over to hold them in place. Check that they are all firmly and squarely seated, then solder them in place, using a fair amount of solder to obtain firm joints.

Insert the two trimmer resistors R50 and R35 into the board and solder them in place. Be certain that they are well mounted, so that repeated adjustments will not work them loose.

Press the RF modulator into the board and twist its lugs to hold it in place. Solder the lugs to the foil, using plenty of solder to make a secure joint. Not only do the lugs hold the relatively heavy modulator in place, but they are used as jumpers to extend the ground plane to two points near the center of the board. Poor mounting will cause problems. Insert the modulator's four leads into their holes, noting that they angle back from the edge of the board slightly. Pull the leads tight, then solder them.

Now install the 7805 regulator and its heatsink. The heatsink supplied with the kit has two pins extending from one end to facilitate vertical mounting. Since the heatsink will be mounted horizontally, remove the pins with a pair of pliers.

Insert the 7805 regulator into the board with its metal tab toward C1, and then bend it so that the hole in its tab lines up with the hole in the board. DO NOT solder its leads yet.

Pass the heatsink's mounting screw through the PC board and through several metal washers to hold the regulator slightly above the board. Apply a layer of heatsink compound to the back of the 7805 and attach the heatsink, tightening the screw firmly. Solder the regulator's leads now.

The last step in building the PC board is to mount power-on indicator LED2. It must extend from the edge of the PC board to meet its mounting hole in the front panel. The easiest way to determine its mounting position is to temporarily fit the
help the decoder to remain trouble-free in changing humidity conditions.

**Interconnections**

The connectors that couple our board to the NCI module are an unusual type with 0.1" spacing between adjacent pins. They are insulation-displacement types, so you need only press a strand of ribbon cable into each contact. We use three connectors of different sizes: four-, five-, and six-contact points. Each interconnecting cable has a connector only at the end that attaches to the NCI module; the other end is soldered to the PC board.

Cut three pieces of ribbon cable about six or seven inches long: one each with four-, five-, and six-conductor and separate the conductors about one inch at each end. Insert the unstripped wires into the "bays" of the appropriate connector and, holding them in place, pull the cable down across the terminals, but don't apply too much pressure. With the cable seated, use a small flat-blade screwdriver to push each wire into the notch of its terminal.

Strip about 1/2-inch of insulation from the other end of each conductor of all three ribbon cables. Twist the strands together and then solder the wires to the PC-board pins. Make sure that you solder those wires so that the connectors at the other end will be able to fit in the NCI module. Figure 8 shows how they should seat. The six-conductor cable should be split for an inch or so at the PC end between its second and third conductors in order to clear C15. Or you could push C15 so that it lies flat on the board. Don't break its ceramic coating or short any of the other connecting pins. After all of the wires are soldered in place, inspect your work and correct any errors.

Attach J1 and S2 to the rear panel, and insert the panel into the top half of the case. Install the PC board and secure it with four self-tapping screws. Make sure that the jacks line up with the holes in the panel.

Connect wires between J1's pins and the appropriate pins on the PC board. Then connect S2 to the channel-select pins, using segments of ribbon cable or other 20- to 24-gauge hookup wire. Keep the wires short and neat, but leave a small amount of slack to allow removal of the board or the panel.

Remove the anti-rotation lug from rotary switch S2 and mount the switch to the front panel, tightening its nut finger-tight. Fit the knob to the shaft and adjust the switch's position so that the knob's indicator lines up with the panel markings. Carefully remove the knob and tighten the nut. Then re-install the knob and make sure that the indicator still lines up.

Use bus wire to connect the five common terminals of S1-n together. Clip the terminals off just above the wire, and re-
move the off terminal completely. The terminals must be removed in order for the switch to clear the edge of the PC board. To prevent possible wiring errors, remove the two terminals corresponding to the off and the TV positions of S1-b.

Solder a six- to seven-inch length of seven-conductor ribbon cable to the pins near the front of the PC board. Connect the other end to the appropriate points of S1. Insert the front panel into the top of the case.

Drill a row of ¼-inch cooling holes along the bottom of the left half of the case. Those holes will let air get in to cool the heatsink; waste heat will pass by convection through the gaps among the rear-panel jacks.

Next mount the NCI module in the bottom half of the case. The module has four mounting lugs designed for attachment to a flat surface. To mount the module to the standoffs in the bottom of the case, bend the lugs so that they extend straight out from the module's shielding can; then make an additional horizontal bend about ¼ inch from the first bend. Press the module into place with the connectors on the opposite side of the cooling holes, and with the near edge against the slot for the rear panel. The module must be all the way back to provide room for the rotary switch in front. Secure the module in place using self-tapping screws and washers. Do not connect the module to the PC board yet.

**Testing and adjustment**

Turn the rotary switch to off and plug the wall transformer's output plug into the power jack. Then plug the transformer into an AC socket and turn S1 to off. LED1 should light up. Turn the knob through the other positions; the LED should remain lit.

Measure the voltage at the positive lead of CI. It should be no less than 12.5 and preferably no more than 16 volts. (That voltage will drop when the heavy load of the module is added.) Measure the 5-volt supply at either the +5 volt pin of S1-b or at module connector pin 5C4. It should be within 0.25 volt of 5 volts. Finally, measure the voltage at the cathode of D3; it should be between 5.8 and 6.2 volts. If all voltages are correct, turn the decoder off and attach the connectors to the NCI module. Turn the power back on.

---

**PARTS LIST**

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

- R1, R22, R23, R52, R53, R56, R60-1000 ohms
- R2-15000 ohms
- R3-27000 ohms
- R4-100000 ohms
- R5-222000 ohms
- R6-3900 ohms
- R7, R40-4700 ohms
- R8, R58-1800 ohms
- R9, R21-5600 ohms
- R10, R12, R17, R28-47000 ohms
- R13-254700 ohms
- R15-7500 ohms
- R16-15000 ohms
- R17-68000 ohms
- R18-222000 ohms
- R19-350000 ohms
- R21-33000 ohms
- R22, R34, R37-3300 ohms
- R23, R35-27000 ohms
- R26-3900 ohms
- R27-10000 ohms
- R29, R32, R36-120000 ohms
- R30-15000 ohms
- R33, R37-43300 ohms
- R34, R38-3300 ohms
- R35-27000 ohms
- R36-3900 ohms
- R37-10000 ohms
- R40-120000 ohms
- R41-1800 ohms
- R42, R39, R42-168000 ohms
- R50, R55-10000 ohms
- R51-100 ohms

**Capacitors**

- C1-1000 µF, 16 volts, electrolytic
- C2, C4, C6, C15, C24-0.1 µF, ceramic disk
- C3-1 µF, 35 volts, tantalum
- C5, C19, C20-10 µF, 16 volts, electrolytic
- C6, C21-22 µF, 16 volts, electrolytic
- C10-47 µF, 16 volts, electrolytic
- C11-39 µF, ceramic disk
- C12-2.2 µF, 16 volts, electrolytic
- C14-2200 pF, ceramic disk
- C15-560 µF, 16 volts, electrolytic
- C16-0.001 µF, ceramic disk
- C18-2200 pF, ceramic disk
- C20-22-100 µF, 16 volts, electrolytic
- C23-470 µF, 16 volts, electrolytic

**Semiconductors**

- IC1-UM1285-8, 7-volt regulator
- D1-1N4001, rectifier
- D2-not used
- D3-1N4735 6.2-volt, 1-watt Zener diode
- D4-10, D12, D13-1N914 switching diode
- D11-1N4738 8.2-volt, 1-watt Zener diode
- LED1-standard red
- Q1, Q2, Q4, Q6, Q9, Q11, Q12-2N2222A PNP
- C3, C5, C10, C13, C14-2N3906 NPN

**Other components**

- J1-1/4-inch miniature phone jack
- J2-J6-RCA phono jack
- S1-2P4T miniature rotary switch
- S2-SPST miniature slide switch

**Miscellaneous**

- Astec UP1285-8 video modulator, NCI Telecaptor Decoder Module, PC board, 12-volt 500-mA wall-mount transformer, case, panels, wire, screws, etc.

Note: A kit (no. K-6314) including PC board, case, and all parts except RF modulator and power transformer is available for $139 plus $7.55 shipping and handling from Dick Smith Electronics, Inc., P.O. Box 8021, Redwood City, CA 94062. The modulator (no. K-S04) is available for $9.95 and the power transformer (no. K-S05) is available for $6.95. Allow shipping of $5.00 plus 5% of order. California residents must add 6.5% sales tax. Orders outside the U.S. must include U.S. funds and add 20% of total for shipping.
As promised last month, we'll describe an all-electronic function-selector circuit that can be used to replace the rotary function selector, S1. The circuit is shown in Fig. 1.

The heart of the circuit is a 4822 8-stage ring counter. In a ring counter, one and only one output is high at any time. Each output of the 4822 drives an LED via an inverter. The first four outputs are also connected to the corresponding inputs on the main perfboard. When power is first applied, C2 and R3 reset the counter, so the B output (pin 2) is high. Therefore, the decoder comes up tuned to the most popular closed-caption channel, C1.

When S1 is pressed, a pulse is applied (via Schmitt trigger IC2-a) to the counter's clock input, that pulse advances the counter by one. The B output goes low and the 1 output (pin 1) goes high, so the C2 LED lights up, and caption channel C2 is selected. Successive presses of S1 cycle the 4822 through each of its states; a fifth press returns the decoder to the C1 mode, because the output 5 (pin 4) is coupled to the reset input via diode D1.

You can build this circuit on a piece of perfboard and attach R1 to the front panel with spacers and screws. Note that a separate SPST switch will then be required to switch the decoder's power on and off; in addition, power-on indicator LED1 (on the main board) can be omitted, since one of the function LED's will light up whenever the power is on.

To compensate, one or two of the resistors in the blanking and V level bias circuits will have to be changed. The resistors should be changed only if it is difficult to get clear captions and background.

If the background will not adjust properly, clip R47 from the board, leaving the lead stubs in place. Connect a 1K trimmer resistor to the stubs and, with the background trimmer set to the center of its travel, adjust the new resistor to obtain a dark background without streaks or distortion. Turn the decoder off, measure the value of the pot, and replace it with the closest standard resistor. If you're careful, you can solder the new resistor to the leads of the old one without having to remove the board from the case.

If it is the characters that will not adjust properly, perform the same procedure, but substitute a 2K trimmer resistor for R56. After everything is working correctly, disconnect the decoder, assemble the case, and reconnect it to your video system. Now you're ready to enjoy the new world of closed-caption programming.

To conclude, it's our sincere hope that all of the hearing-impaired persons who are aided by this project enjoy using it as much as the author enjoyed designing and developing it and we enjoyed publishing it. It was truly our pleasure.
DTMF Encoding and Decoding

Thanks to new low-cost DTMF encoders and decoders, the world of DTMF signalling now is available for use in your next project.

DALE NASSAR

DTMF (Dual-Tone Multi-Frequency) signalling was developed about two decades ago by Bell Labs as a faster (by a factor of about 10), more versatile, and more reliable telephone-dialing scheme than the old pulse or rotary-dialing technique. The DTMF method is often referred to as tone dialing or Touch-Tone (note that Touch-Tone is a trademark of AT&T) and is used with push-button telephones and other equipment.

A standard DTMF signal consists of a pair of audio tones chosen from a group of eight standard frequencies. Those frequencies are divided into two groups: a low-tone group of four frequencies and a high-tone group of four frequencies. A valid DTMF signal consists of the algebraic sum of one tone from the low group and one tone from the high group. There are therefore 16 (4 low × 4 high) possible DTMF signals that can be encoded with the eight frequencies. The four standard low frequencies are 697, 770, 852, and 941 Hz, and are referred to as row frequencies R1, R2, R3, and R4, respectively. The four standard high frequencies are 1209, 1336, 1477, and 1633 Hz, and are referred to as column frequencies C1, C2, C3, and C4, respectively. Any combination of DTMF tone can be generated using a 4 × 4 keypad switch matrix as shown in Fig. 1. The DTMF frequencies and the keypad layout of Fig. 1 are international standards. The frequencies produced by DTMF generators are allowed a ±1.5% deviation from the listed standards. Note that all of those tones are well within the telephone system's voice band.

The choice of the standard DTMF frequencies was by no means an arbitrary one. The designers of the DTMF system used a great deal of care in selecting the particular frequencies. Other tones that may appear on the telephone line such as dial tones and power-line noise must not fall in the DTMF frequency band. Further, the standard frequencies must have no harmonic interaction, thus the highest standard frequency (1633 Hz) is lower than the third harmonic of the lowest standard frequency (697 Hz).

Conventional telephones that use DTMF signalling are usually equipped with a standard 3 × 4 keypad matrix for representing the digits 0-9, and two spare symbols: * (star or asterisk), and # (pound or octothorpe), which can be used for various purposes. That 3 × 4 matrix represents all four row frequencies (R1-R4), and the three lowest column frequencies (C1-C3). Some special-purpose
telephones use the fourth column (C4) to represent four additional symbols (shown as A, B, C, and D in Fig. 1) in order to encode all of the sixteen possible DTMF signals.

If you have a tone-dial phone you can listen to a DTMF signal by simply picking up the telephone handset and pressing one of the buttons. For example, pressing the 8 key generates a 852-Hz tone (R3) and a 1336-Hz tone (C2) simultaneously. Those signals are processed and decoded by a DTMF receiver at the telephone company's central office.

The central office contains the switching equipment that provides local exchange telephone service for a given geographical area. That area is designated by the first three digits of the telephone number. After the connection is established between the called and the calling parties, the DTMF receiver (at the central office) is no longer active and the connected parties are free to use the keypad-generated signals for station-to-station (end-to-end) signalling.

Until very recently, the DTMF encoders used by the telephone companies exclusively used large and bulky transistorized LC-tuned oscillator circuits to generate the tones. Many such LC circuits are still in use. Such rugged circuits were used by the telephone company because they were extremely dependable. They were designed to withstand the worst of operating conditions. For the hobbyist, limited parts availability makes building that type of circuit almost impractical. Fortunately it is also unnecessary, as DTMF generators are available in IC form.

Further, until just a few years ago the experimenter had to settle for a not-so-reliable IC decoding (receiving) system. The decoding circuitry had to be built up using a number of simple IC's. For instance, a separate 567 phase-locked-loop tone-detector IC was required for each frequency used, for a total of eight. Additionally, each tone detector had to be tuned by critical external timing components. Because each DTMF signal received activated two detector outputs (one for each frequency received), a logic circuit had to be added to convert those outputs into a usable format. The net result was a complex circuit that was time-consuming to build and difficult to align. Also, performance was often unsatisfactory. True, performance could be improved with the addition of pre-filtering at the inputs of each tone detector. But the active-filter circuitry required for that made an already complex circuit even more so.

Fortunately, those days are gone forever. With the new DTMF IC's available today, a complete and extremely reliable DTMF-encoding and -decoding system can be breadboarded in less than 10 minutes. Also, the built-in features of those decoding IC's usually include pre-filtering, complex processing, signal validation, etc., making possible a high degree of efficiency and reliability. In addition, no external tuning components are required, keeping the parts count minimal. DTMF IC's are manufactured by Nation-
al, Silicon Systems, Mostek, Motorola, AMI, and Teltron.

Although the DTMF system was originally designed for telephone dialing, it is extremely useful as the basis for remote-control systems. In this article we'll describe some of the DTMF-encoding and -decoding IC's that are commercially available, and how they can be used in remote-control applications. After reading this article, you should have no trouble choosing and successfully using the DTMF IC's that best fit your needs.

**DTMF encoding**

The heart of a DTMF encoder is a DTMF tone-generator IC. Those IC's are extremely easy to use and are very low in cost. Some DTMF tone generators are available in quantities of less than $2.00. Some DTMF signals by dividing a crystal-generated reference frequency. The oscillator is on-board the IC; the crystal is simply connected across two terminals of the IC. The most-common crystal frequency is 3.579545 MHz; that's the TV color-burst frequency, so those crystals are readily available and low in cost. However, as we will see shortly, other frequency references may be used for special purposes.

A block diagram of a typical tone-encoder IC is shown in Fig. 2. The IC illustrated there is a Gould AM1 (3800 Homestead Rd., Santa Clara, CA 95051) S2559E. The desired DTMF signals are activated by a twelve-key (3 x 4) or sixteen-key (4 x 4) matrix keypad that is connected directly to the row- and column-input pins of the tone-generator IC. Two major types of keypad are used: one is the standard telephone pushbutton keypad. They are used with IC's that generate tones whenever the corresponding row and column pins are pulled high. As shown in Fig. 3-9, that keypad consists of a series of DPST momentary switches with a common line that simultaneously pulls the corresponding row and column outputs high when pressed. Note that some encoders are active low. For those, the keypad common line is connected to ground. Then, the appropriate row and common outputs are grounded when a key is pressed. The other, and simpler, keypad arrangement is shown in Fig. 3-6. Referred to as a calculator-type or X-Y keypad, it consists of SPST momentary switches and can be built easily. However, it can only be used with tone generators that use calculator-type scanning circuitry to detect switch closures. The S2559E contains such circuitry. Generally, the data sheet of a particular tone encoder will specify the type of keypad required.

A simple DTMF encoder is shown in Fig. 4. It mainly consists of a 16-key SPST keypad like the one shown in Fig. 3-9, and the S2559E tone-encoder IC. Power can be supplied by a small power supply or by a conventional 9-volt battery. Because the S2559E is a CMOS device, power consumption is low. Typically, the circuit shown will draw 5 mA during encoding and 7 µA when idle. Since the device is CMOS, be sure to observe all of the standard precautions when handling the IC.

**Encoder output**

The output of the encoder consists of two of the eight DTMF frequencies. Figure 5 shows an oscilloscope display of the row-3 signal (852 Hz) and Fig. 6 shows the column-2 signal (1336 Hz). The DTMF output is produced by adding the two signals together. The resulting signal.

---

**TABLE 1—PIN FUNCTIONS**

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIGNAL IN</td>
<td>DTMF input. Internally biased so that the input signal may be AC coupled. SIGNAL IN also permits DC coupling as long as the input voltage does not exceed the positive supply.</td>
</tr>
<tr>
<td>18/19</td>
<td>DTMF signal detection control. When switch 1 is at logic 1, the M-957 detects the 1.2 most commonly used DTMF signals (1 through 9). When switch 2 is at logic 1, the M-957 detects all 16 DTMF signals (1 through D).</td>
</tr>
<tr>
<td>A, B</td>
<td>Binary DTMF signal-sensitivity control inputs. A and B select the sensitivity of the SIGNAL IN input to a maximum of 5 mV.</td>
</tr>
<tr>
<td>D3, D2, D1, D0</td>
<td>Data outputs. When enabled by the OE input, the data outputs provide the code corresponding to the detected digit in the format programmed by the HEX pin. The data outputs remain valid after a tone pair has been detected and are cleared when a valid pause is time.</td>
</tr>
<tr>
<td>OE</td>
<td>Output enable. When OE is at logic 1, the data outputs are in the CMOS pullup state and represent the contents of the output register. When OE is driven to logic 0, the data outputs are forced to the high-impedance or &quot;third&quot; state.</td>
</tr>
<tr>
<td>HEX</td>
<td>Binary output format control. When HEX is at logic 1, the output of the M-957 is full 4-bit binary. When HEX is at logic 0, the output is binary-coded 2-of-8.</td>
</tr>
<tr>
<td>STROBE</td>
<td>Valid data indication. strobe goes to logic 1 after a valid tone pair is sensed and decoded at the data outputs. strobe remains at logic 1 until a valid pause occurs or the clear input is driven to logic 1, whichever is earlier.</td>
</tr>
<tr>
<td>CLEAR</td>
<td>strobe control. Driving CLEAR to logic 1 forces the strobe output to logic 0. When CLEAR is at logic 0, strobe is forced to logic 0 only when a valid pause is detected. Tie to VNA or VND when not used.</td>
</tr>
<tr>
<td>65</td>
<td>Early signal presence output. 65 indicates that a possible signal has been detected and is being validated.</td>
</tr>
<tr>
<td>XIN, XOUT</td>
<td>Crystal connections. When an auxiliary clock is used, XIN should be tied to logic 1.</td>
</tr>
<tr>
<td>OSC/CLK</td>
<td>Time base control. When OSC/CLK is at logic 1, the output of the M-957's internal oscillator is selected as the time base. When OSC/CLK is at logic 0 and XIN is at logic 1, the AUXCLK input is selected as the time base.</td>
</tr>
<tr>
<td>AUXCLK</td>
<td>Auxiliary clock input. When OSC/CLK is at logic 0 and XIN is at logic 1, the AUXCLK input is selected as the M-957's time base. The auxiliary input must be 3.58 MHz divided by 8 for the M-957 to operate to specifications. If unused, AUXCLK should be left open.</td>
</tr>
<tr>
<td>VNA, VND</td>
<td>Negative analog and digital power supply connections. Separated on the chip for greater system flexibility, VNA and VND should be at equal potentials.</td>
</tr>
<tr>
<td>VP</td>
<td>Positive power supply connection.</td>
</tr>
</tbody>
</table>
which would be generated by pressing the "8" key, is shown in Fig. 7. Note that the output of the S2559E is not a pure sine wave. Instead it is a digitally synthesized approximation, as shown in Fig. 8.

The S2559E also is capable of generating single-frequency tones. To place the IC in the single-frequency mode, pin 15, the mode-select pin (MSEL), is either tied high or left floating for DTMF operation, that pin is grounded. Once in the single-frequency mode, a single frequency is output by pressing two keys in the appropriate row or column. For instance, simultaneously pressing the 4 and 5 keys (in row 2) will result in a 770-Hz output. The single-frequency mode is used primarily for testing.

The S2559E, as well as most other encoder ICs, have mute and transmit pins (XMIT and XMT). In the S2559E, when no keys are pressed, the mute pin is low and the XMIT output is enabled and can source current to an external load. When a key is pressed, the XMIT output goes into a high-impedance state and the XMT output goes high. Those pins are used in telephone applications. For instance, the XMT pin is used to mute the telephone receiver during dialing so that the user does not hear the DTMF signals at full volume. The enterprising experimenter will doubtless find many other uses for those handy outputs.

To make the output of the encoder circuit audible, a speaker or some other transducer must be driven by the output signal. The S2559E output must be buffered to drive an 8-ohm speaker, but other high-impedance speakers can be driven by the IC directly. For example, the author has driven the earpiece from an old telephone headset by adding a 330-ohm resistor in series with the earpiece to prevent loading the encoder's output as well as to increase battery life.

We've been discussing the S2559E thus far, but there are three other members of that IC family. They are the S2559F, G, and H. Those four devices have replaced the earlier A, B, C, and D versions and feature extended operating voltage (2.5 to...
TABLE 2—DTMF TO BINARY DECODING

<table>
<thead>
<tr>
<th>Signal</th>
<th>Low-Frequency Component (Hz)</th>
<th>High-Frequency Component (Hz)</th>
<th>Hex Output Format</th>
<th>2-O'F-8 Output Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>697</td>
<td>1209</td>
<td>0010</td>
<td>0000</td>
</tr>
<tr>
<td>2</td>
<td>697</td>
<td>1336</td>
<td>0010</td>
<td>0001</td>
</tr>
<tr>
<td>3</td>
<td>697</td>
<td>1477</td>
<td>0100</td>
<td>0100</td>
</tr>
<tr>
<td>4</td>
<td>770</td>
<td>1209</td>
<td>0101</td>
<td>0101</td>
</tr>
<tr>
<td>5</td>
<td>770</td>
<td>1336</td>
<td>0110</td>
<td>0110</td>
</tr>
<tr>
<td>6</td>
<td>770</td>
<td>1477</td>
<td>1000</td>
<td>1001</td>
</tr>
<tr>
<td>7</td>
<td>852</td>
<td>1209</td>
<td>1010</td>
<td>1010</td>
</tr>
<tr>
<td>8</td>
<td>852</td>
<td>1336</td>
<td>1011</td>
<td>1011</td>
</tr>
<tr>
<td>9</td>
<td>941</td>
<td>1209</td>
<td>1100</td>
<td>1100</td>
</tr>
<tr>
<td>#</td>
<td>941</td>
<td>1336</td>
<td>1110</td>
<td>1110</td>
</tr>
<tr>
<td>A</td>
<td>697</td>
<td>1633</td>
<td>0011</td>
<td>0011</td>
</tr>
<tr>
<td>B</td>
<td>770</td>
<td>1633</td>
<td>0111</td>
<td>0111</td>
</tr>
<tr>
<td>C</td>
<td>852</td>
<td>1633</td>
<td>1111</td>
<td>1111</td>
</tr>
<tr>
<td>D</td>
<td>941</td>
<td>1633</td>
<td>1111</td>
<td>1111</td>
</tr>
</tbody>
</table>

Note: The M-957 detects signals A through D only when the x20 input is at logical 0.

DTMF decoding

DTMF decoding is considerably more complex than DTMF encoding. The most involved function of the decoder is to determine whether a received signal within the DTMF frequency band (697-1633 Hz) is a true DTMF signal or merely noise or speech. The detector must also be capable of detecting a DTMF signal that is combined with such noise. The DTMF detector should recognize any valid DTMF signal that is within ±2% of the standard value. The detector's job is made somewhat easier by the fact that a DTMF signal must have a minimum duration of 40 ms, and that each DTMF signal must be separated from others by at least 35 ms.

Somewhat surprisingly, most of the circuitry required to decode DTMF signals is now available in IC form. Therefore, despite its greater complexity, an entire 16-digit decoder can be built as easily and as simply as a 16-digit encoder.

DTMF decoders are often referred to by manufacturers as DTMF receivers. Those devices have only recently become commercially available at affordable prices. Some can be purchased for under $15.00 in single-unit quantities. Just a few years ago, when the first IC decoders became available, those devices cost about $100, and required external filters. The IC's on the market today are extremely sophisticated signal-processing devices with switched-capacitor filtering that use digital frequency-detection techniques. They can reliably detect DTMF signals with no need for pre-filtering.

The decoder that we'll use in our circuit is the M-957 from TelexTech (P.O. Box 657, 10801-120th Ave. N.E., Kirkland, WA 98033). That CMOS device can be powered by a DC power supply or batteries. There are two versions of the M-957: the M-957-01, which can accept voltages of 5 to 12, and the M-957-02, which is designed for 5-volt operation only.

A block diagram of the M-957 is shown in Fig. 9. The function of each pin is outlined in Table 1. The pre-processing stages of the M-957 filter out noise and split the received DTMF signal into its high and low-frequency group components, and limit each component to provide automatic gain control. The individual tones are then detected. The decoded output of the M-957-01 is a 4-bit binary code appearing at the D0-D3 output. The output code format can be selected via pin 2, hex. When that pin is
high (logic 1), the output format is 4-bit hexadecimal; when the pin is low (logic 0), the output format is binary-coded 2-of-8.

**Putting It together**

It takes very little in the way of external circuitry to put the M-957 to work. Adding just a single capacitor and a crystal, as shown in Fig. 10 yields a functional DTMF receiver/decorder.

Now that we have an encoder and a decoder, the next step is to verify that both work as intended. The easiest way to do that is to wire the output of the encoder (Fig. 4) to the input of the decoder. If you are using separate sources (batteries or DC power supplies) to power the circuits, be sure to tie their grounds together.

To monitor the output states of the encoder during testing you can build a simple monitor circuit like the one shown in Fig. 11. That circuit uses ½ of a 4049 hex Inverter as a buffer to drive five indicating LED's. Those five LED's show the states of the four data outputs as well as state of the strobe output. Table 2 shows the correspondence between the DTMF signal received and the state of the data outputs. The strobe output should be high, as indicated by a lighted LED, any time that a valid DTMF signal is received and decoded by the circuit.

Once you are sure that the decoder is operational it is time to think about adding to its usefulness and versatility. For one thing, the outputs could be further decoded to provide a 1-of-16 output. A circuit for doing that is shown in Fig. 12.

**ORDERING INFORMATION**

The following is available from High Technology Semiconductors, 2512 Chambers Road, Suite 204, Tusin, CA 92680, (714) 259-7733: Television M-957-N, $11.35, and STC-5088-N (which is pin-for-pin compatible with the AMI S2558E), $2.10; 3.58-MHz crystal, $1.25. Also available is a kit of parts, TRK-957-N, which consists of the M-957, STC-5088, 3.58-MHz crystal, a 22-pin DIP socket, and a 1-megohm resistor for $14.95. Please add $2.50 shipping to all orders. MasterCard, Visa, and COD orders accepted.

Built around a 74C154 4-to-16 decoder/multiplexer, it provides 16 separate output lines. Each of the 16 DTMF signals will enable only one of the circuit's normally high outputs. For instance, if a DTMF 9 is received, only the output pin 10 of IC1, will go low. That output will remain low as long as a valid DTMF 9 is being received by the circuit.

Another useful enhancement would be to add some type of latch function. That means that once the appropriate DTMF signal is received, the output would remain either high or low until the next time the same DTMF signal is received. Such operation approximates the on/off action of a toggle or pushbutton switch.

A circuit for adding latched outputs is shown in Fig. 13. It is built around half of a 74C73 dual flip-flop that is configured to act as an edge-triggered binary divider (divide-by-2). When the circuit is used as shown, no external debounce circuitry is required. The input is shown as a DTMF D₃, but it could be any of the DTMF signals. Two complementary latched outputs are available. Use whichever output is appropriate for your application. Tie all of the IC's unused inputs (IC1-B) to ground to prevent oscillation and unnecessary current drain.

Switch S₁ is used to clear both outputs to zero. That switch is not used for all applications and can be eliminated if desired. Conversely, the circuit can be set up for remote reset. That is done by eliminating the switch and two 2K resistors (R₁) and tying one of the momentary outputs of the 74C154 to the CLR pin of the 74C73.

For example, if pin 17 of the 74C154 is connected to pin 2 of the 74C73, the latch will be reset anytime a DTMF C is received. If no reset function is desired, the CLR pin must be tied high.

Up to sixteen devices may be independently controlled by the outputs of the circuit in Fig. 12. If the controlled device is digital and if it is voltage-compatible with the decoder output, direct connection to that device is possible. If heavy driving currents are required, that current can be supplied by transistor switches located at the decoder outputs. If the voltages are not directly compatible, matching can be done using optocouplers or power-driver IC's. Also solid-state relays may be used to interface the digital signals with high-voltage, high-current loads, such as 117-volt AC household appliances, or even industrial devices with larger power requirements.

**Going farther**

If a wireless data link is desired, any simple, single-channel radio or infrared communications link may be used. For example, a toy walkie-talkie set or a low-cost FM wireless-microphone/FM radio system may be used.

Many DTMF tone generators can be driven by logic-level signals. That allows direct control of DTMF signalling by a microprocessor or ROM circuit. The S2559F requires active high logic-levels at all of its row and column inputs. That means that an 8-bit signal or some type of external driving circuitry is required for digital control of the IC. Other DTMF devices are better suited to digital control. One such device is AMI's S2579 DTMF tone generator with binary input. That device is designed so that a 4-bit digital signal can be used to encode all 16 DTMF signals.

The DTMF IC's will function with crystal frequencies other than those specified for DTMF operation. However, the frequencies that will be generated or decoded will differ from the standard DTMF ones. If a higher crystal frequency is used, all tones will be correspondingly higher in frequency; if a lower crystal frequency is used, all tones will be lower in frequency. That effect can be useful for applications such as where a private communications code is desired.

In this article we've presented some of the basics of DTMF communications. We've also presented some possible applications of that technology. For the enterprising experimenter there are countless more. Now that the cost of the required encoding and decoding IC's is so low, the only limit to their use is your own imagination.
How to

Design OSCILLATOR Circuits

Digital clock circuits using TTL IC's.

Part 6: This time we'll discuss digital clocks.

We don't mean time-of-day clocks, but circuits that create pulse trains for synchronizing digital circuits. Digital clocks usually produce either a squarewave or a trapezoidal wave. In this article we'll discuss digital-clock circuits based on TTL IC's.

TTL basics

The TTL logic family was probably the first really successful family of integrated digital devices. Previous families (e.g., RTL and DTL) never really attained the widespread popularity enjoyed by TTL devices. One reason for TTL's popularity is that it uses standard input and output circuits, and standard logic levels.

A digital circuit is binary in nature; that is, it permits only two possible states. Those states, 1 and 0, can be represented by the digits of the binary (base 2) number system. Those two states are often called high and low (respectively).

Figure 1 shows the standard logic levels for TTL devices. The high condition is attained when the input or output voltage is greater than +2.4, but less than +5. The low condition is represented by any voltage between 0.0 and 0.8. Voltages above +5 (the groan zone) and below ground (the zap zone) must be avoided. In addition, an inappropriately connected capacitor or inductor can also feed too much (or incorrectly polarized) voltage to TTL devices.

The members of any logic family work together because inputs and outputs can be interconnected with only a conductor—no impedance-matching or other devices are necessary. Figure 2-a shows a standard TTL output, and Fig. 2-b shows a standard TTL input. The TTL input acts as a 1.6-mA current source, and the TTL output acts as a 16-mA current sink.

To interface TTL devices, all we must do is make sure that current-drive requirements are met. Those requirements are simple to calculate because of standardization. A single 1.6-mA input is said to have a “fan-in” of 1. A single 16-mA output has a fan-out of 10. In other words, a standard TTL output can drive 10 standard (fan-in-of-1) devices.

There are several sub-families of TTL devices. For example, low-power TTL devices are signified by an “L” in the part number (e.g., 74L00). L-type devices have lower drive capacities than regular TTL. There is also high-speed TTL, which contains an “H” in the part number (e.g., 74H00). There is also low-power Schottky. That is probably the most commonly used type of TTL IC; it contains “LS” in the part number (e.g., 74LS00).

The LS type of TTL device has Schottky diodes at its inputs; those diodes are somewhat sensitive to static electricity. Therefore, it is recommended that you handle LS-series TTL devices almost as gingerly as you would handle CMOS devices. The various sub-families have differing drive capacities; consult a data book for details.

Using TTL

Figure 3 shows a circuit that converts
the output of a transistor-based Colpitts oscillator circuit to TTL levels. As we saw in Part 5, which appeared in the November issue, the feedback level in a Colpitts oscillator is set by the capacitive voltage divider composed of C1 and C2. The oscillator’s frequency is set by XTAL1, a piezoelectric crystal. Variable capacitor C3 allows fine control of frequency.

The output stage is an LM311 comparator. A comparator is basically a differential amplifier with too much gain. In any differential amplifier, the output voltage is a function of the difference between the two input voltages. When the input voltages are equal, the difference is zero, so the output voltage will be zero. But when those voltages differ by even a few millivolts, the output voltage will be non-zero. The gain of a typical comparator is 10,000 to 100,000, so the output will satu-rate any time that the differential input voltage is non-zero.

In Fig. 3, the non-inverting input is grounded, so it sees a zero potential. Hence, whenever the signal applied to the inverting input (pin 3) exceeds zero volts, the output will go low.

The LM311 has what is called an “open-collector” output stage. That means that it requires a pull-up resistor (R4) in order to supply current. The 2K resistor shown can supply only about two mA of current at five volts, so the LM311’s output is not truly TTL-compatible.

Another way to accomplish the same trick is to use a TTL IC called a Schmitt trigger. The operation of the Schmitt trigger follows this simple rule: The output will snap high when the positive-going input signal crosses a certain threshold (1.7 volts), and it will snap low when the input signal crosses a lower threshold (0.9 volts) in a negative-going direction. If the transistor oscillator shown in Fig. 3 is used to drive a Schmitt trigger, as shown in Fig. 4, the sinusoidal output of the oscillator will produce a train of square waves at the output of the Schmitt trigger.

The output voltage will be zero. Hence, whenever the signal applied to the inverting input (pin 3) exceeds zero volts, the output will go low.

The LM311 has what is called an “open-collector” output stage. That means that it requires a pull-up resistor (R4) in order to supply current. The 2K resistor shown can supply only about two mA of current at five volts, so the LM311’s output is not truly TTL-compatible.

Another way to accomplish the same trick is to use a TTL IC called a Schmitt trigger. The operation of the Schmitt trigger follows this simple rule: The output will snap high when the positive-going input signal crosses a certain threshold (1.7 volts), and it will snap low when the input signal crosses a lower threshold (0.9 volts) in a negative-going direction. If the transistor oscillator shown in Fig. 3 is used to drive a Schmitt trigger, as shown in Fig. 4, the sinusoidal output of the oscillator will produce a train of square waves at the output of the Schmitt trigger.

Pure TTL clocks

Several TTL oscillators are shown in Figure 5. The circuits shown in Fig. 5-a and Fig. 5-b use NAND gates configured as inverters; the circuit in Fig. 5-c uses three standard inverters. The frequency at which the circuit in Fig. 5-a oscillates is determined by capacitor C1 and resistors R1 and R2. Potentiometer R1 allows you to vary the operating frequency over a small range. If only a single fixed frequency is needed for your application, replace R1 and R2 with a single fixed resistor.

One disadvantage of any RC oscillator is that its operating frequency is neither stable nor accurate. The effects of both problems can be reduced by using a piezoelectric crystal, as in Fig. 5-b and Fig. 5-c. Two of the NAND gates are used for the oscillator (IC1-a and IC1-b); the third functions as a buffer stage. Operating frequency is set by crystal XTAL1, and may be varied with capacitor C1.

The circuit shown in Fig. 5-c is similar to the one shown in Fig. 5-b, and is based on TTL inverters. Again, one stage (IC1-c) is used as an output buffer, and the oscillating stages are self-biased.

Special TTL oscillators

There are several all-in-one TTL oscillators on the market: Fig. 6 shows the diagram of a circuit based on the MC4024P dual voltage-controlled oscillator. Only one oscillator is used in that circuit. By the way, don’t confuse the MC4024P with the 4000-series CMOS device called the 4024.

The center frequency of oscillation can be controlled in two ways: with a capacitor or with a crystal. For non-critical applications, a capacitor is used; it will have a value of approximately 300pF (1Hz) picofarads. Potentiometer R1 gives you some control over the circuit’s frequency.

TTL clocks are easy to build and to operate, especially in applications where a great deal of frequency stability is unnecessary. In the next and final installment of this series we will examine clock circuits made from CMOS IC’s.
One of the most difficult tasks in building any construction project featured in Radio-Electronics is making the PC board using just the foil pattern provided with the article. Well, we're doing something about it.

We've moved all the foil patterns to this new section where they're printed by themselves, full sized, with nothing on the back side of the page. What that means for you is that the printed page can be used directly to produce PC boards!

Note: The patterns provided can be used directly only for direct positive photoprint methods.

BUILD THE SINEWAVE DESCRAMBLER using this PC pattern.

THE CLOSED CAPTION DECODER'S PC board is shown here.
ALL ABOUT INTERFACING
Everything You Need To Know In the First Of A Two-Part Article

V-20 VS 8088
A New Battle Is Shaping Up
ON THE COVER

If you’re going to be doing ANY interfacing, you’d better start by reading the story beginning on Page 9 of this issue. Admittedly, it’s a bit more involved than laying out photos and drawing the connecting lines! Most of the photos of assorted equipment around our office, were taken by Herb Friedman.

COMING NEXT MONTH

Naturally, we try to pack all the Information that we can into each issue. But in the January, 1987 issue, we’ve really outdone ourselves. You won’t want to miss the conclusion of our two-part article on interfacing, and we’ve got an important how-to on TVRO antenna pointing. We’re finishing up with a fine piece on a five-volt RS-232. Don’t miss it.
EDITORIAL

Let’s standardize the “standards.”

-Henry Ford has to be the father of mass production, and he built this scheme on totally-interchangeable parts. The carburetor of one car could easily be switched with the carburetor of another. And the need for standards extends well into electronics. Every young electronics devotee knows the standard for the resistor color code. You can see them counting on their fingers, as they recite, “Bad boys…”

But something began to go awry when it came to standardizing capacitor color codes. There were decimals to be considered, and multipliers, and the result was utter confusion.

Today, in the computer field, we have the so-called “RS-232” standard. But the manufacturers do not cleave to the standard, using their own variations for their own convenience. The result is a non-standard standard, and when you say “We’re using RS-232,” you find people asking just which “RS-232?”

It goes even beyond that. We have assorted operating systems, beginning with MS-DOS and CP/M and a host of other proprietary systems produced by various manufacturers, that prevent a software package that works on one, from working with another. The standard that seems to be emerging, is the IBM system, for almost every software manufacturer talks about “IBM compatibility.”

Even the simple blank disk cries for standardization. You now have a choice of “hard sectored disks,” or “soft sectored disks.”

Wouldn’t it be nice to be able to buy a computer without having to trace down the standards to make sure that they were indeed standard? Or that your projected computer purchase would operate all the disks you now have? Sure it would.


Byron G. Weis
Editor
LETTERS

Too Long
I submitted an article to your magazine, and got paid for it. Thank you. That was several months ago, and it still hasn't appeared in print. What's the delay?—S.T., Orlando, FL.

Have a heart! First of all, things just take time. For example, this column will actually appear in the December issue, but as I write these words, it's really August. The 17th, to be exact. And yes, if you look it up on a calendar, it's a Sunday. And right now, the magazine is all set through February. So maybe the next time we need a three-page one, and yours fits, you might get lucky.

Warranty
I'm confused about my computer warranty. It runs for a full year, unless I open the case! Now (a) how can I add a board or do some construction if I don't open the case, and (b) how are they going to know whether or not I did?—J.T., Fresno, CA.

You pays yer money and takes yer chere. Open it up, and you automatically void the warranty. And yes, they will know, for the manufacturers usually put a dab of paint on a cover-mounting screw, or paste on a small paper patch. Break the paint or paper and you kiss your warranty goodbye. We usually suggest waiting until the warranty expires before experimenting.

Budding Editor?
I'm fascinated with the publishing business and would (I think) like to get into it when I get older. What would you recommend?—A.L., Memphis, TN.

It's been extremely kind to me, and I'd suggest you start preparing the publishing business as well as yourself, by submitting articles on a freelance basis. This will help you learn to write, and will start getting your name around.

Expensive?
I've been pricing furniture (desks/tables) for my computer equipment. Now why is that stuff so expensive?—S.K., Reno, NV.

It doesn't have to be. Your local lumber yard can sell you a sheet of 4 x 8 plywood, finished one side and ¾-inch thick at a very low price. For another couple of bucks they'll cut 30-inches off one end and run another cut 30-inches down the length of the remainder. That will give you two handsome table tops, ready-to-finish and enough wood to make legs with!

COMPUTER PRODUCTS

For more details use the free information card inside the back cover

VOICE-RECOGNITION SYSTEM, the Voice Master, is a half-card expansion board with resident program that recognizes hundreds of words. It is designed for the IBM-PC, XT, AT and compatible.

SYNONYMOUS MODEM
The model 91 is designed to function point-to-point or in a multi- polled network. Multi-dropped operation is achieved by using a daisy-chained approach to system wiring, in which each model 91 regenerates each signal before passing it on in the link. That process of incorporating signal repeaters results in extremely-high data reliability, especially at long distances. At 19,200 baud, the model 91 will support link distances of one mile.

The opto-isolation feature assures that devices connected to the model 91 are electrically isolated from each other, thereby eliminating problems associated with potential differences between grounds.

The model 91 provides full duplex synchronous serial data communica-

From 150 to 19,200 baud using frequency modulation. Transmission of a self-clocking FM signal on a balanced opto-isolated current-loop allows transfer of clocking information as well as data. The model 91 can also be linked to establish a full-duplex bus network between host and a number of remote terminals. It is priced at $250.00—Telebyte Technology, Inc., 270 Pulaski Road, Greenlawn, NY 11740.
SOFTWARE REVIEW

That's right! A print shop in your computer.

Judging by its use, The Print Shop is probably the best-selling program. The program is used by schools, supermarkets, shops, even used-car dealers (and you know they're fussy about advertising).

For all its popularity, The Print Shop isn't a word processor, a spreadsheet, time-manager or CAD/CAM. It's a signmaker. Using pin-feed paper it makes 8½ x 11 inch signs, greeting cards from folded 8-1/2 x 11 inch paper, letterheads, and banners which can be used as advertising flyers, bookplates, report covers, award certificates, even abstract printed designs.

The program has an assortment of type styles in three formats (solid, outline and three-dimensional), borders, graphic characters and symbols, even abstract patterns. Each type style is its own size, each can be stretched to a proportional giant size. (The Commodore version has eight upper-case fonts, nine border styles, and 60 graphics. The IBM version has twelve type styles in upper and lower case, sixteen borders, and 119 graphics.)

The user can integrate any type style with any border and any graphic, or any print function can be left out so the paper can be run through for a second or third printing, or run through to add conventional text from a word processor when set to print greeting cards, all type, graphics and borders are reduced to the appropriate size and the printing is automatically rotated 180° so that everything comes out right side up when the paper is folded into a card.

Because the program was intended for children (if adults ever give them a chance to use it), it is menu-driven by cursor movement: the user steps the cursor to the desired mode and then hits return. Each menu, except for graphics selection, shows the available and selected border and type styles. (The IBM version also shows the available and selected graphics.)

Special screens let the user select a small, medium or large graphic, built-in or custom graphic layouts, and line and page type-setting. The screen shows the possible graphic locations depending on the user's size selection (the graphics cannot overlap), and the allowable characters per line for each type and size type. If you select giant size and the characters won't fit the available space the screen shows what will fit, along with left, center or right positioning normal, reverse or 3-D type on a per line basis, and automatic top-to-bottom centering, if desired.

The program is goof-proof, and you can step back through each function one at a time and change only what you want to change without losing all your work. For example, if after completing a sign you decide to change the border, say from stars to hearts, you step back through the composing, type selection, and graphics until you come to the border menu: You then change the border and step forward through graphics and type without affecting anything other than the border selection. You can even step back and change the position of a single line of type, or its outline, or even erase a line or characters (there is a built-in editor). What you can't do is mix type styles or graphics. The only variation on this rule is the IBM version, which permits the type to be upper or lower case on a per-line basis; that is, the line must be all upper case or all lower case.

The Print Shop has a graphics editor that lets you create your own graphics. In the Commodore version, the user-generated graphics can be saved to disk, but that's all that can be saved. In the IBM version the graphics and any sign, card, stationery or banner design can be saved to disk.

Each version supports a selection of printers, which is listed on the back of the box. If your printer isn't listed assume the program will not work.

The Print Shop is supplied on disk and requires at least one disk drive. It comes with a supply of heavyweight pinfeed paper and greeting card envelopes. Additional multi-color supplies and disk volumes of additional graphics characters are available. The Print Shop is heavily discounted: It sells for $19.95 to $59.95 depending on the version and the dealer—Broderbund Software, 17 Paul Drive, San Rafael, CA, 94903-2101.
Is there a direction change in the offing?

MARC STERN

The way to stay afloat in the microcomputer world is IBM emulation, as it is accepted by big business, professionals, and home users.

Many manufacturers, having first tried to go their own ways, found that crowds weren't flocking to their doors for solutions. The crowds were still heading toward IBM. Those firms that were able to switch have survived, while those that haven't are no longer active in the microcomputer market.

The ultimate in emulation would be a microprocessor that not only emulates, but surpasses that used in the IBM Personal Computer series.

Such a microprocessor is the Nippon Electric Co.'s (NEC) V20/30 series. It not only emulates the 40 pin Intel 8086/8088 series, used in the IBM PC and close compatibles, but it better's that series by using less power (300 mW versus 1.7 W) and operates about 20 percent faster than the IBM version.

The only way you can differentiate between the two is the NEC stamp on the microprocessor chip, and the "V" designation.

The V20/30 series has an added mode, 8080 emulation. This gives CP/M users an out because CP/M was written to work in a Z80/8080 environment. With an emulator the V-20 will function effectively as an 8080. So those CP/M programs which may have been threatened with obsolescence by the 8086/8088 series and PC/MS-DOS will gain a new life and users will be able to retain their investment in software.

A closer look

The V20 and V30 are equivalent to the 8088 and 8086, respectively. Like the 8088, the V20 is an 8/16 microprocessor. It has an 8-bit data bus, but a 16-bit internal architecture. The marketing departments of various microcomputer manufacturers like to call this type of microprocessor a 16-bit device, but, it really isn't.

The true 16-bit device is the 8086. It has a 16-bit architecture, and also a 16-bit data bus. It is faster than the 8088 in realtime number crunching. The V30 is the
functional equivalent to this device.

Both microprocessors are available in 5 and 8 MHz versions and they are CMOS devices. While both microprocessor series are functionally equivalent, the V20/30 series uses 600 percent less power to handle the same jobs. For a system that is struggling at the razor edge of its power supply the lower demands of the NEC device can make a difference.

Not only are the V20/30 chips power miser in their active mode, they offer a standby mode where their power consumption drops from 300 mW to 30 mW which means these devices can be used in standard desktop machines, and they can be used in briefcase or lap-top microcomputers.

The advantages seem to be with the V20/30, because the V20/30 series is much newer than the 8086/8088 family. Because it was designed recently, NEC has taken advantage of Very Large-Scale Integration and gate array technology, as well as advances in CMOS technology to produce this capable chip. The 8086/8088 series was designed in the mid-1970s and its age is beginning to show.

Another result of the age difference is the V20/30's dual internal bus (See Fig. 1), which compares with the single internal bus of the 8086/8088 family. This can effectively increase the speed specifications of the V20/V30 because destination and source data can move along the data bus at the same time in two directions.

Data are taken into the registers in preparation for processing and the data are sent to the temporary storage registers and shifters. At this point, the data goes to the arithmetic-logic unit (ALU) for processing and then to either bus, depending on whether the information is source or destination. Data can pass from the registers back to the second bus.

Moving in parallel, the microprocessor is freed of wait states generated by having to wait alternate cycles on the data bus for 16-bit source data and then destination data. Picture a single freeway lane trying to accommodate traffic in both directions during rush hour. This applies to the execution time of the 8086/8088 family. We're talking about a difference of microseconds and the user won't notice the difference in speedup unless the application crunches a lot of numbers and must constantly fetch and latch the numeric data.

Another change in the architecture of the V20/V30 is the substitution of hardware address calculations for the software (microcode) and hardware address calculation of the 8086/8088 series. The V20/30 series includes a hardware section which performs address calculations from 2.6 to 6 times faster than the 8086/8088. Where it takes the 8086/8088 from five to 12 clock cycles to perform address calculations, the V20/V30 performs them in two. Address calculation, then, is also transparent to applications, which means that a developer only has to be concerned with a standard set of addresses for a particular device, rather than having to worry about both hardware and software addressing.

Another performance enhancement that is unique to the V20/V30 is its prefetch pointer. (See Fig. 2)

Working with the instruction pointer, the prefetch pointer speeds things by moving to the next instruction and points to it as the microprocessor works through a program. A movable pointer, the prefetch jumps to the next instruction no matter how far it is from the instruction pointer. This enhances performance because the next instruction is always available for the micro.

The V20/V30 begins with performance advantages that the 8086/8088 series doesn't have. These advantages wouldn't make much difference if the V20/V30 wasn't compatible with the 8086/8088 family, which it is.

When it was developed, this series was modeled on and implemented the instruction set of the 80186/80188, a more powerful and later version of the 8086/8088 family. The differences were in the level of integration of such functions as the timer and interrupt controller, which are on-chip functions on the 80186/80188 series. The instruction set is enhanced with new instructions which add power and flexibility, but without sacrificing compatibility. There's no loss of compatibility as the complete instruction set of the 8086/8088 series is supported, as well as the additional code.

Speed improvement

While the specifications indicate a potential speed increase, it doesn't work out that way in practice. The V20/V30 series gives a user about a 20 percent increase in performance. Independent testing has confirmed this. The increase in speed is noticeable in processor-intensive applications where the microprocessor must constantly issue fetch commands for new instructions. The same testing has confirmed that input-output intensive applications, such as word-processing or telecommunications won't benefit much from the new microprocessor because the system is constantly waiting for keyboard or communications port input.

You might be wondering why the speed differential exists. The microprocessor is busy doing other things—adding, subtracting, looping—while it is handling specific data addressing and calculation. Because it is, its resources are being spread through the system and they can't all be brought to bear for the ultimate speed increase.

Clock speed also seems to enter the picture. Running

![FIG. 2: THE PREFETCH POINTER speeds up processing in the V20/V30 series by moving directly to the next instruction to be executed by the microprocessor. This speeds things up because the micro always has the next instruction ready for its instruction pointer, which doesn't have to move around as much.](image-url)
a standard IBM Personal Computer or close compatible at its standard 4.7 MHz imposes timing and performance constraints on its 8088 processor. Reports circulated in the IBM user community for years of hyper-speed functionality brought about simply by changing the clock chip from 4.7 MHz to 8 MHz, at which the 8088 is easily capable of operating.

Although the V20 is a capable performer, when you run standard IBM applications or languages that are meant to operate at 4.7 MHz, you're imposing the same fetters on microprocessor performance that you have on the IBM's 8088 and performance of the system will be degraded, even though you are using the V20/V30. The 20 percent speed increase seems reasonable in light of this input.

Some users have complained about the speed shortfall and have questioned the capability of the V20/V30. But, those users have come to expect too much. It's one of the oldest marketing plays in the microcomputer world, the specifications game, where the specifications are fantastic, but the performance doesn't match.

The solution, if you're considering the V20/V30, is knowledge. If you realize that the speeds won't be superfast, but will be modestly improved, then you'll get what you expect from the $25 to $30 V20/V30 chip.

Even a 20 percent performance increase is welcomed in some applications.

Finally, temperature and power usage are also important considerations and this is an area where the V20/V30 shines. It generates a lot less heat and uses manifestly less power than the 8088 and because it does it proves a blessing for a system overtaxed by the number of add-in cards and devices that may be on the motherboard because there's less heat and power consumption for the system box to contend with.
ALL ABOUT INTERFACING
PART I

All you need to know about microcomputer interfacing

Jeff Holtzman

Connecting peripheral devices such as printers, modems, and plotters to personal computers can be confusing. Many books dealing with the subject concentrate on connecting specific computers to specific peripherals.

We cannot guarantee that by absorbing the information presented here you will be able to connect any computer to any peripheral device. Designers and manufacturers in the microcomputer world do their best to avoid any efforts at following standards.

What you will learn are the basic principles of both parallel and serial interfaces, with hints on how to get two pieces of equipment talking to each other. As Count Basie used to say, let's try it "just one more once."

Serial versus parallel

Most microcomputers move data to and from peripheral devices in eight-bit bytes. There are two methods of moving a byte from one location to another: we can send all eight bits at once, or we can send one bit at a time. The one-bit-at-a-time approach is called serial data transmission, and the all-at-once approach is called parallel data transmission. Neither is better; each has advantages and disadvantages that must be weighed for each application.

If we send one bit at a time, we can get by with as few as two lines (signal and ground). If we only need one way communication, or three lines, if we need communications to and from a peripheral device: We'll talk about that later. But now consider that for parallel transmission, we're going to need eight separate signal lines, plus a ground, and another one or two for synchronizing things so data won't be lost.

One advantage of parallel transmission is, since all bits are sent at once, transmission may occur at a higher speed than serial transmission. Also, the parallel circuitry is simpler and less expensive than serial circuitry. But the connecting cables are more expensive than serial cables, and there is less standardization of parallel connectors than serial connectors.

In another example, disk drives have (special) parallel interfaces that let them to take advantage of the speed advantage of the parallel approach. Some laboratory equipment and some low cost personal computers communicate with disk drives over (special) serial interfaces, but that is the exception.

Plotters and graphics printers usually operate with parallel interfaces. The time to send—serially—the large amounts of data they require would be excessive.

Parallel transmission

The minimum parallel interface consists of ten signal lines and a ground. Frequently each active (non-ground) line of a parallel interface is twisted together with—or run close by—a ground line. That provides immunity to electrical interference, and is one reason parallel cables often have so many leads.

Of the active lines, eight are for data, one is a strobe line, which indicates to the receiving device that it should take the data present on the data lines, one is a busy signal, which goes high to indicate that the receiving device is busy, and not to transmit any more data until it goes low, and the final signal is called ACK, which is (usually) a short, negative-going pulse from the receiving device that indicates the data has been accepted properly. A simple parallel interface might be wired as shown in Fig. 1. Note that the twisted-pair grounds are not shown. Note also that the busy and ACK lines come from the peripheral device, and that the strobe line goes to it.

The normal sequence for sending a byte of data over such an interface is as follows. Refer to the timing diagram in Fig. 2. The character in that figure is the letter "U," which has an ASCII value of 55.

The computer monitors the busy line, waiting for the peripheral device to OK sending data. After the busy line goes low, the computer places its data on the eight data lines and pulses the strobe line. That informs the peripheral device to grab the data. After it has taken the data, it pulses the ACK line, and turns the busy

---

FIG. 1—EACH ACTIVE SIGNAL may have a ground, implemented as a twisted pair, as a shield, or as a nearby wire in a multi-conductor ribbon cable.
line on, if necessary, while processing that byte of data. When it finishes doing that, the busy line goes low, and the process may be repeated. If you are interested in how fast a parallel device can accept data, try connecting an oscilloscope to the slowest line of your computer.

The highest bit, bit 8, is low ASCII encoded data requires seven bits, so the eighth bit may be ignored or used for other purposes. Some word processing programs use the eighth bit to mark end of words, and in data communications, the eighth bit is often used to indicate the parity of a character.

Parity indicates how many of the lower seven bits of a character are "on" (high). Our "U" has four "on" bits, and four is an even number. If our transmitting device were set up for even parity, all eight of the "U" would be low, since the character already has four bits. If our transmitter were set up for odd parity, all eight of the "U" would be high, in order to make a total of 5 "on" bits. A transmitted "V" (ASCII 56, decimal 96) would cause the opposite parity values.

Parity is used for error checking. When a device using parity checking receives a character with incorrect parity, it signals the driving software that an error has occurred, which might then cause a request for the data to be re-transmitted. The most common circuitry allows parity to be set for odd, even, mark, space, or no parity. We have discussed the first two; mark and space simply force bit 8 high or low, respectively, and no parity simply ignores bit 8. Unless you have a specific reason not to do so, choose the latter when setting up your equipment. Otherwise only seven bits of each byte will carry useful data.

The transmission process outlined could be applied to any parallel interface: one linking a computer and a printer, a computer and a laboratory instrument, a computer and another computer, etc. However, a typical parallel printer interface will have a number of additional signal lines, as shown in Fig. 3.

The PAPER END signal indicates when the printer is out of paper. The SELECT line is generally high when the printer is "on-line"—that is, ready to receive data, and low when the ON-LINE switch has been pressed by the operator. The READY signal is a reset line that will cause the printer to start a new well-defined (by each particular printer manufacturer!) state. Finally, the ERROR line goes high when the printer is off-line, when it is out of paper or ribbon, or if some sort of transmission error has occurred.

It is important to understand that not every printer will have all of those signals, and some printers may have additional signals (such as a low-current +5-volt source for powering peripheral devices such as a serial to parallel interface). It is also important to understand that little—indeed—microcomputer software makes much use of any of the warning signals shown in Fig. 3. Usually, a printer suffering from a paper-out condition will cause the computer to lock up because the printer sends both the Busy and Paper End signals low, but software usually pays attention only to the Busy line. So your word-processing program might know that the printer is "busy" but not the reason for it.

A serial interface transmits bits of data one after the other. But not at random. When data is transmitted over a line conforming to the RS-232 standard, there are timing restrictions on when individual bytes of data may be sent. However, each bit of a particular byte must be transmitted with strict attention to timing. Baud Rate refers to the speed at which transmission occurs, but not in a glib way.

**Baud rate**

First, let's define Baud Rate as the number of bits that may be transmitted per second. A Baud Rate of 300 means that 300 bits may be transmitted per second. That doesn't mean that 300 bits will necessarily be transmitted every second, though that's possible.

The term baud rate refers to the spacing between each bit of a single character, not the speed at which complete characters are transmitted. The way to find the time between each bit is to take the inverse of the Baud Rate:

\[
TC \text{ (sec)} = 1 / \text{Baud Rate}
\]

To find the time it takes to transmit a complete character, multiply TC by the number of bits per character.
In a 300 baud system, the amount of time from the start of one bit to the start of the next is 1/300, or 3.33 msec. To determine the amount of time a character takes, multiply the number of bits per character by 3.33. How many bits does a character have? In the microcomputer world of the 1980s, the correct answer is usually eight. There are exceptions.

An 8-bit character is going to be 10 or 11 bits long! Every character has a start bit, and one or more stop bits. Most equipment operates with one stop bit; older equipment used two stop bits to give slow machines a little bit (no pun intended) of "recovery" time.

Transmission of a character begins with a start bit. The data bits follow (usually eight, but not always), and then one or two stop bits. Figure 4 shows the transmission of the "U" character with 1 start bit, 1 stop bit and 8 data bits. Note the time "t" between each bit; that is the value 1/Baud rate.

If our 8-bit character has one start and one stop bit, that is a total of 10 bits. So the time to transmit one character at 300 baud is 10 * 3.33 = 33.3 msec.

How many characters can be transmitted in one second, if it takes 33.3 msec to transmit one character? Using a little algebra, we see that

\[
\text{1 character} \times \frac{\text{Xchars}}{\text{s}} = \frac{0.0333 \text{sec}}{1.0 \text{sec}}
\]

So \( X = \frac{1}{0.0333} = 30 \text{ chars/sec}. \) We could have arrived at the same answer without the algebra—but doing it the hard way taught us something. Divide the baud rate by the number of bits per character. In our case, and in most cases you're likely to encounter, just divide the baud rate by ten.

\[
300/10 = 30 \text{ chars/sec}
\]

What is the character/second rate of a 110-baud transmission?

If you come up with 11, you jumped the gun. You can't really answer the question without knowing the number of bits per character. We picked 110 baud because the old Teletype machines used that as their baud rate. And they used two stop bits—so the TTY has 11 bits/char, and 110/11 = 10 chars/sec.

Here's another trick question: If characters are coming over a transmission line at 300 baud, does that mean that 30 characters come through every second? It doesn't, and that brings us to our next topic.

**Transmission Rate**

Transmission rate may be defined as the number of characters flowing over a communications line per unit of time. The most important thing to realize is that there is no relationship between baud rate and transmission rate! You might have a computer dumping data at 300 Baud and another at 9600 Baud, and the latter might have a lower transmission rate than the former. How could that happen?

The 300 baud machine might be dumping 30 characters every second, the 9600 baud machine might only send a character once every 30 minutes. Remember a transmission rate of 300 Baud guarantees only that there will be a delay of 3.33 msec between each bit of a character.

That example illustrates the point. Higher baud rates aren't necessarily better. You could attach circuitry (such as a "printer buffer") to a 110-baud Teletype machine that would enable your computer to dump characters at 9600 baud. The TTY will be unable to print at the rate of 9600 characters/second, so as soon as the buffer memory inside your interface filled up, your effective transmission rate would fall from the baud rate to nearly the actual printing speed of the TTY.

Adding a high-speed interface to a slow piece of equipment may still be an advantage. If the buffer memory could hold a fairly large number of characters, your computer might dump an entire document at high speed and go on to do something else while the buffer outputs data at a rate the printer can handle.

If you attach a buffer memory to your printer (or MODEM, for that matter), make sure you get a buffer with enough memory to make it cost effective. If you mostly print double-space documents under about 25 pages, a 64K buffer should suffice. But with documents much longer than that, or with graphics dumps, you'll run up against the same problem. Once the buffer's memory is filled, transmission rate will...
decrease drastically.
A practical RS-232 interface would appear as in Fig. 5. There are two data lines, a ground, and, like the parallel interface shown in Fig. 1, a busy line. There is no strobe line, as the start bit informs the receiving device that more is on the way. Neither is there an ace. The busy line may perform the same function as in a parallel interface, as shown in Fig. 4, but there are other ways of indicating a busy condition.

**Controlling transmission rate**

Often we are unable to allow a computer to spew forth data at a transmission rate equal (or close to) the maximum value allowed by the baud rate—30 chars/sec, in the 300-baud system discussed here. The hardware on the receiving end must have a way of telling the transmitter "Hey—wait! I can’t accept any more data right now!"

There are two ways of doing that: With hardware and with software. With software we require two communication lines: One allowing data to flow from the transmitter to the receiver, and another allowing data to flow from the receiver to the transmitter. What happens is that the transmitter sends data as fast as it can, while monitoring the line from the receiver for a special "wait" character that tells the transmitter not to send any more data. After receiving the "wait" character, the transmitter stops until it receives a "continue" character from the receiver. There are several such "protocols" in common use; you may have heard of ETX/Ack or X-OffX-On. The first member of each pair simply represents the "wait" character, and the other, the "continue" character.

With hardware, a busy condition can be shown simply by the polarity of a signal line (high or low); the opposite polarity represents the "continue" condition. For example, low represents "Busy," high represents "continue."

Note that neither the hardware nor the software method is better than the other; each was developed to solve different problems. The software protocols for use with MODEMs and remotely operated printers where single-line communication links are a part of the system. A seismographic sensing unit might be located in a remote location, would be linked to a printer in a geological survey office by MODEM. A signal in addition to the transmit data and receive data lines that would distinguish between "wait" and "continue" conditions is hard to implement. Modern printers let you choose between software and hardware solutions, or both.

Historically, MODEMs were serial-in serial-out devices, as shown in Fig. 6a. There we see two computers connected through MODEMs, via telephone lines. Each computer has a device labeled "P/S Converter," and each MODEM has a device labeled "S/P Converter." That is the same device, and is called a UART (Universal Asynchronous Receiver Transmitter). Another device inside the MODEM (called on FSK, for Frequency Shift Keying encoder) converts the parallel binary data into audio tones that can be transmitted over telephone lines.

It is becoming common for MODEMs to be built right in the computer; some MODEMs are built on plug-in cards. Such MODEMs give cost advantages, as shown in Fig. 6b: external packaging can be eliminated, as can the power supply, two UARTs, and associated circuitry. But a stand-alone MODEM can be used with any computer, printer or other device with appropriate interfaces, whereas plug-in cards are limited to one specific machine.

**To be continued in next month’s issue**
Computer Digest Volume 3
January 1986 — December 1986

Abbreviations: (C) Construction; (D) Department; (E) Editorial; (L) Letter; (ER) Equipment Review; (SR) Software Review

A
All About Interfacing (Holtzman) Printers (Friedman) Oct 9 Mar 8

B
Best Friend...884.96 (SR) Apr 5
General-Purpose Interface (Stem) June 12

C
CB Scanner, Computer (C) (Mackie) Changing Face of Computing (E) Oct 3
C'mon. You Guys (E) Jul 3
Computer
Aid Design of Loudspeaker Endlosures (Rahal & Raleigh) Jan 10, Feb 7
Cable (Friedman) Sep 7
CB Scanner (C) (Mackie) May 15
Power Supply Component Selection (Curtisman) May 15
Products (D) Jul 8, Aug 4, Sep 8, Oct 4, Nov 4, Dec 4

Construction
Computer CB Scanner (Mackie) Grades-12 (Stem) Sep 7
Modern: No Frills (Kotler) Nov 9
Remote Power Console for your Commodore-64 (Swedden) May 11
CrossTalk: Is There a Universal Software? (SR) Jun 5

D
Disc Drives: Hard (Stem)
Optical (Stem) Jan 5 Sep 18

E
Changing Face of Computing C'mon, You Guys! Jul 3
I'd Give a Man a Fish... RAL241 Aug 3
Systems Sep 3
So You Go! Who Are You Fooling? Mar 3
Wonderful idea: #1275 Apr 3
You've Got To Sacrifice Mar 3

F
555 Design Program (Holtzman) Jan 8
Frequency Counter for your C-64 (Heald) Mar 12

G
GPIB, General-Purpose Interface Bus (Stem) Jun 12

H
Graphics
Backtrack Monitor Program (Peterson) Oct 8
Sarat 32 (C) (DeNoly) Feb 9, Mar 13, Apr 12

I
Hard Disk Drives (Stem) Jan 8
How to Back Up a Protected Disk Oct 5
If I Give a Man a Fish... (E) Jun 3
Interfacing, All About (Holtzman) Dec 9

L
LAN — Local Area Networking (Stone) Jun 8
Letter(s) (D) Jan 3, Feb 3, Mar 4, Apr 4, May 4, Jun 4, Jul 4, Aug 4, Sep 4, Oct 4, Nov 4, Dec 4
Little Black Book (SR) Nov 7
Local Area Networking — LAN (Stone) Jan 10, Feb 7
Loudspeaker Enclosures, Computer-Aided Design (Rahal & Raleigh) May 11

M
Media Master Plus (SR) Nov 5
bible-Jim (SR) Oct 6
Modern
Move On (Friedman) Jul 7
No Frills (C) (Kotler) Nov 9
MonoBox, So You're Going to Buy a (Friedman) Feb 8

O
Olddata YOU-Chip (Kotler) Oct 12
Optical Disks (Stem) Sep 15

P
PcPun Radio (Stem) Apr 10
pjet: Write (SR) Jul 8
Printers
All About (Friedman) Oct 12
CrossTalk Utopia Online (Kotler) Aug 5

R
Program (see SOFTWARE) Oct 12
Protocol Conver (HR) Jul 11
Remote Power Controller for your Commodore-64 (C) (Swedden) May 11
Resetting Printers (Friedman) Aug 6

S
Schmitt Trigger Design (O'Connor) Nov 8
Single Transistor Switching Circuit Design (Holtzman) Aug 15
So You're Going to Buy a Monitor (Friedman) Feb 4

Software
Program
Computerized Power Supply Component Selection (Curtisman) May 15
GPIB (Holtzman) Jan 8
Single Transistor Switching Circuit Design (Holtzman) Oct 8
TVRO Antenna Pointer (Smith) Oct 10

Review
Jan 4, Mar 7, Apr 6, May 5, June 5, Sep 6, Nov 5, Dec 5

T
Tape (Sandree) (Stem) Nov 5
Telepath (SR) Aug 16
Told Ya So! (E) (Wells) Sep 3
Touchscreen Technology (Stem) Jul 15
TVRO Antenna Pointer Program (Smith) Oct 10
Typewriter — $49.50 (SR) Jan 8

U
Universal Software?, Is There (SR) Jun 8
Using a TI-99 Keyboard on a Sinclair ZX-81 (Grossblatt) May 7

V
V-20 vs 8088 (Stem) Dec 6

W
When Lightning Strikes (Friedman) Jun 10
Who are you Fooling (E) May 3
Wonderful idea: #1275 (E) Apr 3
Word Finder — An Electronic Thesaurus (SR) May 5

Y
You've Got To Sacrifice (E) Mar 3
Hacking Videocipher

PARDON ME IF I'M REPEATING OLD news, but most of the major satellite signals are being broadcast in scrambled form. That scrambling has caused significant problems in the TVRO industry. For example, sales are off by more than half, and everyone from OEM to dealer is hurting. Some people are hurting badly enough that they are attempting to do something about scrambling—they're trying to beat it.

Black-box solutions abound already, and there is an active underground (and middleground) in which descrambling devices and information are being distributed. However, until quite recently, most claims about successful descrambling were fanciful flights of creative copywriting. But no more.

Oak and M/A-Com

Two unrelated scrambling systems are being used in the U.S. and Canada this year. One is the product of Oak Industries, they call their system the ORION (Oak Restricted Information and Operation Network). Two versions of their decoders are available, one is for cable-systems operators and one is for the home market. The home-style decoder for that system is called the ORION P; the P stands for Personal.

In the U.S., we have the M/A-Com Videocipher system, which has been widely adopted by cable programmers such as HBO, CNN, and more than a dozen others. (Even The Disney Channel is scrambling now.) There are also two versions of Videocipher, the VC-2, which is for the cable people, and the VC-2000, which is for home use.

Descrambling both Oak's and M/A-Com's video signals was child's play. In fact, at least one home-style receiver manufactured by Arunta Engineering (3111 E. Thomas Rd., Phoenix, AZ 85016) decodes that type of video straight out of the box. It may be coincidental, but Arunta's receiver was designed and marketed before Videocipher took off. But the fact is that it does produce perfect pictures from both types of signals.

The audio has been a greater challenge. The first breakthrough comes from the Canadian firm Westar Technologies (2 Bloor Street West, Suite 100, Toronto, Ontario, Canada M4W 3E2). Westar has introduced an IC, shown in Fig. 1, that contains complete descrambling circuitry for the Oak system—both video and audio—on a 40-pin carrier.

In mid-August that IC costs about $250, and the ORION P decoders are selling for approximately the same price. So, for $500 or so, you can have access to everything scrambled by the Oak system.

Needless to say, there are several legal problems here, because neither U.S. nor Canadian authorities condone descrambling signals that are intended only for authorized use.

The next breakthrough is imminent, if it has not been attained by the time this column reaches print. It involves the Videocipher system, which until now has been invincible to hacking attempts.

The Oak system converts audio to digital form and then hides it in the video signal. The M/A-Com system uses a similar technology, but it also encrypts the audio according to a Governmental security standard called DES (Digital Encryption Standard). To recover the Videocipher audio, one must first extract the digital data and then decrypt it according to a key.

The M/A-Com system might have been invincible were it not for design "features" of the Videocipher system. What really compromises the system is that a master decoding key is transmitted along with the encoded audio.

Interested in TVRO?

For nearly two years Bob Cooper has provided a no-charge kit of printed materials that describes the challenges of and opportunities in selling TVRO systems today. With the present intense interest in scrambling systems, Coop's CSD has made available a new no-charge service.

The SCRAMBLE FAX hotline is a 24-hour-per-day telephone service that provides accurate, detailed, and hard-to-find facts concerning the changeover to scrambling in the satellite communications industry. Information describing satellite receivers tested for scrambling compatibility, sources for authorized decoders, wholesale rates of scrambling equipment and services—all are provided on the SCRAMBLE FAX hotline. There is no charge for that service, other than your long-distance telephone expenses. Simply dial (305) 771-0575 for a concise and timely three-minute capsule report that covers the latest in scrambling news.
Therefore the key to unlock scrambling the system is actually there in the data stream. The key itself is also encrypted, but it is nonetheless present.

Finding a way to decode that key is a considerable challenge, and it has attracted some of the most talented engineers, software hackers, and cryptanalysts in the world. Like Mount Everest, it is there; and, for the same reason that some climb the mountain, others are slowly revealing the secrets of Videocipher. There has been significant progress to date; much more will have been accomplished by the time you read this report.

For example, it was determined at an early stage that integrated circuit U7 in the Videocipher unit holds some of the decrypting keys. Getting inside that IC to recover the data hidden there was a trick, since removing it from the circuit killed it. To get inside, researchers used a microscopic drill to enter the IC and reach a special location where the silicon chip is bonded to the carrier. A small drop of mercury was then placed in the microscopic hole to allow an electrical connection to that point. Signals within the IC could then be analyzed. All of that was accomplished while the chip was fired up and operating! Needless to say, several of the IC's were destroyed during that process.

Data was extracted and delivered to software analysts who were assigned the task of descrambling the programming secrets. Once the program is deciphered, the next trick is to write a new program that gets around M/A-Com's program.

The upshot of this is that we expect to see Videocipher clones soon. And since the hackers also expect that some of their clones will ultimately end up at M/A-Com, a clever "auto-cloning" technique is being studied; it will allow the clone IC's to "refresh" their decoding keys by continually analyzing the data stream fed via satellite that we now know is present.

Legalities

It is not illegal to take Videocipher apart to learn how it works. However, distributing hardware that does so, or even information describing how to do so may be illegal.

Many of those working on cracking Videocipher have no commercial interest in selling or profiting in any way from cracking Videocipher; when the task is accomplished they will simply back out and leave any possible commercial exploitation and distribution to others. Rest assured that such exploitation will take place.

Needless to say, the people at Oak and M/A-Com are unhappy about any unauthorized descrambling. So lawsuits are probable. Even those who provide detailed decoder/hacking information in print run the risk of being sued. As in many other facets of American life, the lawyers will make lots of bucks while the public struggles to understand the how's and why's of what is happening, and tries to figure out how to react to the underground distribution of information and hardware.

---

**SCRAMBLE-FAX**

**SCRAMBLE-FAX**

from Bob Cooper

If satellite scrambling is important to you, here is a single source of timely, confidential information of great value: SCRAMBLE-FAX. Bob Cooper is routinely gathering all of the important scrambling information (who, what, when, where and how) and compiling it in printed form in an important newsletter called SCRAMBLE-FAX™. Sources for pirate decoders, reports on attempts to 'beat the system', full lists of who is scrambling, how and when.

Each issue of SCRAMBLE-FAX is timely and new, but, each issue is a detailed encyclopedia of scrambling information and totally complete.

REPORTS on M/A-Com efforts to shut down pirate units, exporting of bootleg descramblers outside the USA, complete listings of all (37+) channels now scrambling and those planning to scramble. The activities of DESug, the DES Users Group, and their progress on 'beating' the Videocipher 'code', modifying receivers to accept Videocipher and much much more.

DIAL 305/771-0575 anytime for a complete update on the status of scrambling. 'Hotline' recorded reports are provided by Bob Cooper as an instant update to SCRAMBLE-FAX and carry fast-breaking news items of interest to the scrambling scene. But have your notebook and pen handy; each 'Hotline' report contains many telephone numbers and addresses you will want to retain.

---

**SCRAMBLE-FAX**

by Bob Cooper

305/771-0505 or for free 'Hotline' service, 305/771-0575. To order by mail, send check/money order or enclose VISA/Mastercharge number and expiration date: CSD Magazine, P.O. Box 100858, Ft Lauderdale, FL 33310
Experimental robot vision

LAST TIME WE PRESENTED THE CONSTRUCTION DETAILS OF A SIMPLE PHOTOCELL-BASED VISION SENSOR. TO CONCLUDE THE PRESENTATION, THIS TIME WE'LL SHOW YOU HOW TO CONNECT IT TO A MICROCOMPUTER, AND THEN WE'LL DISCUSS A FEW SOFTWARE ALGORITHMS THAT DEMONSTRATE HOW TO USE IT.


IT WOULD BE INCONVENIENT AND EXPENSIVE TO CONNECT A SINGLE ADC TO EACH OF THE NINE SENSORS IN OUR VISION UNIT. Fortunately, HOWEVER, NATIONAL SEMICONDUCTOR HAS AN IC (THE ADC0816) THAT INCLUDES NOT ONLY AN ADC, BUT ALSO A 16-CHANNEL ANALOG MULTIPLEXER THAT ALLOWS US TO MONITOR ALL NINE PHOTOCELLS AND SEVEN OTHER ANALOG INPUTS, IF DESIRED) WITHOUT MULTIPLYING COSTS NINE TIMES.

FIGURE 1 SHOWS THE CIRCUIT DETAILS OF THE SENSOR INTERFACE. IN ADDITION TO THE SIXTEEN ANALOG INPUTS, THE ADC0816 HAS FOUR ADDRESS INPUTS THAT ALLOW YOU TO SELECT WHICH OF THE SIXTEEN INPUTS YOU WANT TO READ. FURTHER, THE CIRCUIT HAS SEVERAL CONTROL LINES THAT ARE USED TO SELECT VARIOUS OPERATIONS. WE'LL
discuss each of the control lines below.

If your computer has a built-in eight-bit parallel interface, you can probably use the circuit directly as shown. Otherwise, you’ll have to add some external circuitry. One way of connecting the ADC0816 to an 8-bit computer system is as follows.

The computer’s data bus (or eight-bit I/O bus) is connected directly to the IC’s 3-state data outputs (pins 24–31). You could add the computer’s read signal with a decoded port address and apply that signal to the output enable input (pin 21) in order to read a value from the ADC0816.

Selecting a channel is done by setting up the four address lines of the ADC0816 and then strobing the address into the ALE input (pin 32) via another decoded output and through the computer’s write line. The ADC’s address lines can be connected directly to the low-order address lines of the control computer.

Last, the start input (pin 16) is used to start the conversion process. You could drive that input with another decoded output port and-ed with the computer’s write line.

Because the ADC works much slower than your computer, you cannot simply select a channel, send a “start” command, and then read the data. The ADC must sample the input and then convert it to digital form. The ADC0816 can take as long as 116 µs to complete the conversion. To alert the computer when the conversion is done, the IC has a special end-of-conversion output (pin 13) that goes high when a digital representation of the analog input may be read. You can monitor pin 13 by and-ing a decoded I/O port address with your computer’s read line. Alternatively, you may want to connect pin 13 to an interrupt input; doing so would allow your computer to do other things while the ADC is working.

Figure 2 outlines the basic algorithm for scanning the nine-element sensor. First we select analog channel one. Then the start signal is activated. Then the computer goes into a loop and monitors the end-of-conversion output. When that signal goes high, the output buffer is read, and its value is stored in a nine-byte table for analysis later. The program loops to select the next channel (i.e., the next sensor element) and executes the same sequence of operations. When all sensors have been read, the algorithm is finished.

After reading in the data, it must be analyzed. It would simplify analysis if each sensor returned a value of 1 for light areas and a value of 0 for dark areas. Then the table

Copies of articles from this publication are now available from the UMI Article Clearinghouse.

For more information about the Clearinghouse, please fill out and mail back the coupon below.
of bytes could be compared with a set of previously-stored templates. The program would interpret the object as being the one with the closest match.

However, things don't work quite so simply in the real world. In fact, the circuit shown here is so sensitive that, instead of getting two distinct values that represent light and dark, you'll be getting readings with 256 distinct values. Areas of your target that appear to be the same will actually register tremendous differences.

In order to eliminate most of that "clutter," an auto-sensitization adjustment must be made. What we must do is trick the circuit into being less sensitive. One way of doing so is with a threshold adjustment. Looking back at the circuit in Fig. 1, notice the resistive voltage divider connected to pin 19 (VREF) of the ADC. All converted values are compared to the value at that pin. By varying the reference, you can adjust the sensitivity of the circuit.

You could use a DAC (Digital-to-Analog Converter) to perform the auto-focus. Connect the digital inputs of the DAC to a separate output port, and the analog output of the DAC to the reference input of the ADC. Then, by placing a black and white cross (or some other shape) under the sensor, have the computer read the ADC. If the sensors under the black areas don't read similarly, have the computer change the reference voltage via the DAC converter. Adjust the reference until the output reads the way you want it to.

Also, you could calibrate the sensor manually using a potentiometer and some sort of program that outputs the values to the screen. The value of the automatic circuit, though, is that the computer can calibrate itself at any time.

I have found the sensor to be great at picking out brightly colored symbols on a dark block. In addition, the sensor reads well at a distance of one inch above the target object. As discussed last time, use a flash from an old camera to illuminate the area evenly. And be sure that the duration of the flash is at least 200 μs to compensate for the conversion time.
ANTIQUE
RADIOS

Reader letters, filament checker

DURING THE LAST TWO YEARS I HAVE made many references to reader correspondence. It is gratifying to know that so many are interested in the history of radio, which is probably the most important scientific discovery of all time. At least it's the most fascinating, especially to readers of this column.

Writing this column has taught me a lot. Much of my knowledge comes out of the research I must do to generate the column, but more comes from information contained in readers' letters. I have heard from some very knowledgeable readers who have firsthand information on radio history. In fact, many have personal recollections of the developing days of radio. First broadcasts, homemade equipment, and early receivers are still fresh in the minds of many readers of this column.

While many letters share information, many others contain questions. Many of the latter cause me to do considerable research. Often readers ask about sets of which only a few were manufactured, and which have long been forgotten. Sometimes it's hard to believe that a reader actually has one. Of course, I'd like to show photos of all those forgotten radios, but there simply isn't room to do so.

Letters

Now let's get to the letters. Maybe we can all learn something from the problems experienced by these readers. Or perhaps readers can help each other.

Daniel Neveus (11836 Alamo, Baton Rouge, LA 70818) needs the glass dial cover for a Zenith Model 65556 radio. Dan mentioned that he could get the set repaired for $300.00, and that it is similar to the Zenith pictured in the June 1985 column. Dan, if you're referring to the Zenith console with the veneer problem, that's not the only thing wrong with it. There is also the matter of a burnt-out power transformer. You can have the whole thing for $300.00. Actually, if you didn't live so far from me, you could get the whole set for $300.00. If anyone in Dan's area can help, drop him a line.

Many antique-radio restorers find their sets complete except for one small but hard-to-locate part. Usually it's an accessory like an escutcheon, a knob, a cabinet, or a piece of curved glass. Often, if you have patience, you can fabricate a missing part from commonly available materials. For example, you can turn (or carve) a piece of dowel rod to simulate a knob. Other materials that come in handy include veneer, masonite, and stiff, clear plastic such as toys are packaged in. The plastic can be used to replace missing glass. Sometimes it's even worthwhile to buy an item just for the packaging.

Cliff Priddle, (P. O. Box 725, North Bend, OR 97459) is interested in crystal sets. He would like to obtain old parts. Cliff, my old tube sets keep me so busy I haven't had time to get into crystal sets. However, one company advises me that they can supply crystal-radio parts and information. Send an SASE to MIDCO (P.O. Box 2288, Hollywood, FL 33022). (Also check the Classified Advertisements in the back of the magazine.—Editor)

Here's an interesting letter from an antique collector who hasn't located a suitable set yet, or for those who would like to add to their collection. Victor Jackman (230 April Court, North Hunting, PA 15642) has a fine collectable to sell. It was made by International Radio Inc., of Ann Arbor, MI and has serial No. 2914. I have some information on International Radio, but their sets are listed by model number. If anyone wants more information about this collectable, drop Vic a line.

Another interesting collectable is an Ultradyne Model 1-2. It's a TRF with tubes, circuit, and cabinet. More information can be obtained by contacting Herb Henry (331 Elliot Road, Ft. Walton Beach, FL 32542.)

I have searched my files but am unable to help Eugene K. Warner (522 Weiman Street, Ridgecrest, CA 93555.) He has a small radio with no tubes. Also, no tube diagram or manufacturer's name or model number. It appears to use both a line-cord resistor and a ballast tube. The only clues are on the dial, which contains the image of a four-engine prop transport airplane and the name Clipper. The radio may be from the thirties.

I wish I could share the set of color photos sent in by Allie C. Lingo of Pierks, Arkansas. They show a classic southwestern tester and some equally classic radios.

While discussing photos, I have to mention the photo of a World War I military receiver sent in by Charles W. Dold of New Smyrna Beach, FL. Mr. Dold responded to my promise to discuss WW I equipment in a future issue. However, my visits to military mu-
BUILD YOUR OWN ANTIQUE-RADIO TUBE-FILAMENT CHECKER

This month, I am going to show you how to build a simple but useful piece of test equipment. That is a tube filament tester. I have always found such a device very valuable in troubleshooting old radios.

While the much-altered filament tester shown in Fig. 1 is about 40 years old, I didn't invent it. Commercial versions were available for years before I built mine. Besides testing tube filaments, you can also use it to test light bulbs, home and auto fuses, etc.

Even if you already own an emission-type tube tester, there is an advantage to having a simple filament checker: it's much easier to use because you don't have to set nine switches, three dials, and several pushbuttons, nor to mention tube warm-up time. Besides, many late-model tube testers don't have sockets for the antique tubes we are interested in.

As shown in Fig. 2, the filament checker has sockets that are pre-wired to accept the most popular types of tubes, and a pair of test leads that allow you to check any tube with non-standard filament connections of a non-standard base. The box has special clamps to hold that type of tube in place while you connect the test leads.

The circuit works like this. The battery, lamp and the tube under test are all connected in series through the on/off switch. When you close the switch, the lamp will light if the filament is good. Otherwise it's bad.

The box shown in the photo measures 9" x 12" x 4". The two plastic boxes affixed to the sides of the checker can serve as "in" and "out" boxes when you're testing a batch of tubes. Place tested-good tubes in the out box, and simply discard any bad tubes.

You can use any low-voltage low-current light bulb for LMP, such as a number 49 or 49, or even a number 14, which is rated at 2.47 volts at 300 mA. The toggle switch isn't really necessary. I just like to have a switch on all electrical equipment to make sure that it is off when I'm not using it.

Fluke 70 Series Analog/Digital multimeters are like money in the bank. Buy one, and you're guaranteed to save both time and money.

Money, because you get longer battery life and longer warranty coverage — 3 years vs. 1 year or less on others.

And time, because 70 Series meters are easier to operate and have more automatic measurement features.

So before buying any meter, look beyond the sticker price. And take a closer look at the new low-priced $79 Fluke 73, the $99 Fluke 75, and the deluxe $199 Fluke 77. In the long run, they'll cost less, and give higher performance, too.

And that, you can bank on.

For a free brochure, and your nearest distributor, call toll-free 1-800-227-3800, ext. 229.

FROM THE WORLD LEADER IN DIGITAL MULTIMETERS.

Our guaranteed savings plan.

Fluke 70 Series Analog/Digital multimeters are like money in the bank. Buy one, and you're guaranteed to save both time and money.

Money, because you get longer battery life and longer warranty coverage — 3 years vs. 1 year or less on others.

And time, because 70 Series meters are easier to operate and have more automatic measurement features.

So before buying any meter, look beyond the sticker price. And take a closer look at the new low-priced $79 Fluke 73, the $99 Fluke 75, and the deluxe $199 Fluke 77. In the long run, they'll cost less, and give higher performance, too.

And that, you can bank on.

For a free brochure, and your nearest distributor, call toll-free 1-800-227-3800, ext. 229.

FROM THE WORLD LEADER IN DIGITAL MULTIMETERS.

Our guaranteed savings plan.

Fluke 70 Series Analog/Digital multimeters are like money in the bank. Buy one, and you're guaranteed to save both time and money.

Money, because you get longer battery life and longer warranty coverage — 3 years vs. 1 year or less on others.

And time, because 70 Series meters are easier to operate and have more automatic measurement features.

So before buying any meter, look beyond the sticker price. And take a closer look at the new low-priced $79 Fluke 73, the $99 Fluke 75, and the deluxe $199 Fluke 77. In the long run, they'll cost less, and give higher performance, too.

And that, you can bank on.

For a free brochure, and your nearest distributor, call toll-free 1-800-227-3800, ext. 229.

FROM THE WORLD LEADER IN DIGITAL MULTIMETERS.

Our guaranteed savings plan.

Fluke 70 Series Analog/Digital multimeters are like money in the bank. Buy one, and you're guaranteed to save both time and money.

Money, because you get longer battery life and longer warranty coverage — 3 years vs. 1 year or less on others.

And time, because 70 Series meters are easier to operate and have more automatic measurement features.

So before buying any meter, look beyond the sticker price. And take a closer look at the new low-priced $79 Fluke 73, the $99 Fluke 75, and the deluxe $199 Fluke 77. In the long run, they'll cost less, and give higher performance, too.

And that, you can bank on.

For a free brochure, and your nearest distributor, call toll-free 1-800-227-3800, ext. 229.

FROM THE WORLD LEADER IN DIGITAL MULTIMETERS.

Our guaranteed savings plan.

Fluke 70 Series Analog/Digital multimeters are like money in the bank. Buy one, and you're guaranteed to save both time and money.

Money, because you get longer battery life and longer warranty coverage — 3 years vs. 1 year or less on others.

And time, because 70 Series meters are easier to operate and have more automatic measurement features.

So before buying any meter, look beyond the sticker price. And take a closer look at the new low-priced $79 Fluke 73, the $99 Fluke 75, and the deluxe $199 Fluke 77. In the long run, they'll cost less, and give higher performance, too.

And that, you can bank on.

For a free brochure, and your nearest distributor, call toll-free 1-800-227-3800, ext. 229.

FROM THE WORLD LEADER IN DIGITAL MULTIMETERS.

Our guaranteed savings plan.

Fluke 70 Series Analog/Digital multimeters are like money in the bank. Buy one, and you're guaranteed to save both time and money.

Money, because you get longer battery life and longer warranty coverage — 3 years vs. 1 year or less on others.

And time, because 70 Series meters are easier to operate and have more automatic measurement features.

So before buying any meter, look beyond the sticker price. And take a closer look at the new low-priced $79 Fluke 73, the $99 Fluke 75, and the deluxe $199 Fluke 77. In the long run, they'll cost less, and give higher performance, too.

And that, you can bank on.

For a free brochure, and your nearest distributor, call toll-free 1-800-227-3800, ext. 229.

FROM THE WORLD LEADER IN DIGITAL MULTIMETERS.

Our guaranteed savings plan.

Fluke 70 Series Analog/Digital multimeters are like money in the bank. Buy one, and you're guaranteed to save both time and money.

Money, because you get longer battery life and longer warranty coverage — 3 years vs. 1 year or less on others.

And time, because 70 Series meters are easier to operate and have more automatic measurement features.

So before buying any meter, look beyond the sticker price. And take a closer look at the new low-priced $79 Fluke 73, the $99 Fluke 75, and the deluxe $199 Fluke 77. In the long run, they'll cost less, and give higher performance, too.

And that, you can bank on.

For a free brochure, and your nearest distributor, call toll-free 1-800-227-3800, ext. 229.

FROM THE WORLD LEADER IN DIGITAL MULTIMETERS.
A remote-control system

IF YOU'RE A REGULAR READER OF THIS column, there's one thing you should realize by now—I'm a firm believer in a systematic approach to design. A sure road to brain damage is trying to design something without analyzing the problem first. The subject we're going to start discussing this month—remote control—is one that requires a systematic approach. There's just no way of doing a successful design without planning the whole system out on paper beforehand.

A remote-control system is more complex than many of the other circuits we've looked at in this column. The degree of complexity is, of course, directly related to how much you want the circuit to do for you. But even if you only want your remote controller to switch your TV on and off from your armchair, the first step is to list the overall specifications of your control system. Our system's specifications are as follows:

1. The transmitter will be battery powered.
2. The transmission medium will be infrared light.
3. The circuit will be able to control at least 10 devices.
4. Standard parts will be used wherever possible.
5. The receiver will be as noise-immune as possible.

If you think about those specifications for a moment, you'll see that the remote-control system is really a combination of two different circuits, each of which has several subsections. The two main sections are the transmitter, shown in Fig. 1-a, and the receiver, shown in Fig. 1-b. Each of the main sections is a complete circuit in itself, and each must be designed separately before the whole thing can be assembled. But before we can even start thinking about putting the electronics together, we must get an overview of the system's operation.

Keyboard and encoder circuits are nothing new. We've designed them several times in past columns. Basically, we're looking for something that will translate a keypress into a unique binary code and place that code on a data bus.
After the code has been generated, we must modulate it before we send it on to the transmitter. The modulator (and the corresponding demodulator in the receiver) are both new circuits in this column.

The modulator must take the data from the keyboard and convert it to whatever is needed by our transmission circuitry. There are many schemes for accomplishing that. For example, the data can be encoded as FSK (Frequency-Shift Keying), AM (Amplitude Modulation), or DTMF (Dual Tone Multi-Frequency). We all know the latter from its use in Touch-Tone dialing.

After the data has been converted by the modulator, it is passed on to the transmitter. For a transmission medium we could use anything from a pair of twisted wires to ultrasonic sound, but we’ll use infrared light. When we begin that part of the design, you’ll see that it’s very easy to change from one transmission medium to another. I’m using infrared because ultrasonic waves make my teeth hurt.

At the receiving end, the signal is detected, conditioned, and then passed on to the demodulator where it is converted back to its original binary form. Then the decoder turns on the selected output.

Now that we have an overall idea of how the circuit works, let’s get started by looking at the transmitter’s keyboard encoder.

From keypress to code

Figure 2 shows the schematic of the keyboard encoder we’ll use for our remote-control system. The 4514 is a 4- to 16-line decoder with normally low outputs. When a 4-bit binary word is presented at its A-D inputs, the corresponding decoded 16 outputs go high. Pin 1 is an active-high input enable (te), and pin 23 is an active-low output enable (OE) control. In normal operation, pin 1 must be high and pin 23 must be low. The 4520 is a dual synchronous 4-bit binary counter. We’ve used it so often that you should be able to recite its pinout in your sleep.

The operation of the keyboard circuit is straightforward. One of the 4520’s counters is fed with a clock that causes the counter to cycle through its full 4-bit count (0 to 15) repetitively. The binary inputs of the 4514 are tied to the 4520’s outputs, thereby causing its 16 outputs to go high one at a time in turn. Because OE (pin 23) is tied to ground, the 4514’s outputs are always enabled. The output enable (pin 1), however, is connected to the common terminal of switches S1–S16 through an inverter. As long as no key is pressed, resistor R1 holds that point low, so the output of the inverter is high, so the 4514 continues to cycle through its various states.

When a key is pressed, however, the outputs continue to cycle until the output corresponding to that key goes high. When that happens, the inverter’s input goes high, so its output goes low. That causes the 4514 and the 4520. Therefore, the binary output of the 4520 is frozen on the data bus.

There is one special feature of the circuit that’s not immediately apparent. You’ll notice that nothing is done to debounce the switches. If you trace through the operation of the circuit carefully, you’ll see that it’s not necessary—the circuit is inherently bounce-free. If we happen to produce a bounce when the switch is closed, all that happens is that the inputs stay enabled and the 4514 continues to cycle through another full count. But by using the output of the inverter to strobe data into the following stage (which is what we’ll do next time), we can ignore the additional pulses.

To see how the circuit works, breadboard it and feed it a clock of some sort—say 555 circuit will do just fine for test purposes. If you slow the clock down to a few Hertz, you’ll be able to watch the circuit operate. Slowing the clock and watching the outputs will do more to help you understand how the circuit works than ten pages of written explanations.

The next thing we must do is take the 4-bit binary code from the keyboard and encode it for transmission. But that is a subject for next time. In case you’re interested, we’ll be using the S2579 DTMF Generator from American Microsystems Inc.
Oughta be ain’t is!

The first thing thing to do with any set that looks totally dead is to start measuring DC voltages. When you find one that looks incorrect, try to find a logical reason for it: look at nearby components that may be bad (open or shorted) and at other sections of the circuit that could affect the one with problems.

An incorrect or missing DC voltage is often the best clue we have to a bad stage. Always check DC signals first: No volts, no work! However, you can’t use DC levels as your only source of troubleshooting information; some parts can stop an audio or video signal cold without having much effect on the DC voltages. If you find no odd-looking DC levels, you’ll have to try another technique—signal tracing, for example.

If you’ve got decent service literature, most likely it has scope photos illustrating the shape and amplitude of signals at various points in the circuit. Try feeding a test signal (that approximates what you see in the literature) into the input of the circuit, and see if the output looks anything at all like what it should.

For example, take a look at the horizontal output stage in Fig. 1. You might try feeding a 10-volt p-p sinewave into D1. Then look at the collector of Q1. If you don’t see something that resembles the 170-volt p-p signal shown in the schematic, Q1 may be bad. On the other hand, if the test signal gets through, that part of the circuit probably works correctly, so you can go on and test other stages.

By following that process in a logical manner, you’ll eliminate possible sources of trouble one by one and eventually arrive at the real source of trouble.

Of course there are special things to look out for: coupling capacitors, for example. If one develops an open, it can stop the signal dead in its tracks, but the DC voltages will often be affected little, if at all. And that’s when we’ve got to resort to signal tracing.

Always be careful with little things like coupling capacitors that look good. Don’t assume that those capacitors never go bad. I used to have a bad habit of doing just that. That is, until the day I found one that had developed an open!

So never get into the bad habit of assuming any part is good without thoroughly checking it; always test everything. I used to make assumptions until one day I had a lot of trouble figuring out what was wrong with several different sets. So always keep that most valuable asset of a service technician: the completely open mind! In other words, suspect everything in a circuit until you find out who the real culprit is! And don’t be too sure then!

Here’s an example of how making assumptions can lead you astray. I had a set that was completely dead: no video, no audio, not even any noise. There was one big solder joint on a terminal right in the middle of the chassis. It had a large blob of solder on it, and it looked like a perfectly good joint. I thrashed around in that circuit until I finally got a hold of myself, started signal-tracing, and, behold, the signal came right up to that “perfect” solder joint where it stopped!

I melted the joint, and the moment my iron touched it, it went up in a little puff of smoke! It wasn’t solder at all, but a big blob
of what is called “liquid solder.” Obviously there wasn’t much continuity in that joint. Hardened acetate cement doesn’t conduct electricity very well. So I soldered that joint in the usual way, and the set began working right away.

The moral is that, if you never take anything for granted, you’ll have fewer servicing headaches. Never assume that a solder joint is good. Check the dad-burned thing with an ohmmeter just to make sure. You’ll find many pitfalls of that sort; don’t let ‘em throw you. When tracing a signal that suddenly stops, check everything in the immediate vicinity and you’ll often find something that will surprise you.

**Shop bookkeeping**

One thing we seldom talk about is how to keep track of the amount of work that has been done for each customer, and which parts went into his set. One way to keep track of things is by keeping the parts we’ve pulled out for replacement in a separate pile for each customer. That way, when the job is over, we can just go through the pile and charge the customer accordingly. That makes bookkeeping (one of our favorite tasks!) much easier. And if you’re your own bookkeeper, as most of us are, it’s well worth spending a little time getting and staying organized; you could lose a lot of money if you’re not careful.

Another thing that can help, when making out the bill, is to write down each part you installed, and its function (for example, 0.01 μF, “2nd IF screen-bypass capacitor”). Keep a copy of the bill, and the next time the customer comes in, you’ll quickly be able to see what you’ve already done to that set. And you’ll want to know the date of installation for parts that are covered by warranty—yours or the manufacturer’s.

And be sure to write clearly! If you can’t read your own writing, get someone else to do it for you! That way, if you get a callback on a job, you’ll have some idea of where to begin troubleshooting. If you can pull the original bill, you’ll be able to tell just which parts you installed, and, more importantly, which you didn’t.

That’s about all for now. I got a card from an old friend, Bill Eslick, 2607 E. 12th Street, Wichita, KS 67214. He wants to buy old issues of Radio-Electronics, Radio-Craft, etc. Drop Bill a line if you have any back issues for sale.

**SERVICE QUESTIONS**

**BLOOMIN’ PROBLEMS**

I’ve got a problem in my own set! It’s blooming with visible retrace lines, and the contrast control won’t darken the screen. The brightness increases until the HV shuts off. I’ve checked all voltages, and they seem normal. The PC board is so delicate that I don’t want to do a lot of desoldering without a good idea of where to begin. I hope you can help.—R. D. W., Bergen, NJ.

So do I! I think you’ll find a leaky transistor somewhere. Check all DC voltages carefully and see if one is a good bit off. If so, that will change the bias on the CRT, and make it draw more current until the set shuts off. Start by measuring the CRT grid and cathode voltages very carefully, and then trace the circuit back until you come to the stage that controls it. There you will find the trouble.

**RED-HOT 6KD6 TUBE**

I’ve got a Philco CT7340AWA. It uses a 6KD6 horizontal output tube. The problem is that the 6KD6 plate gets red hot and there is no HV. The sound also gets distorted. Any ideas?—M. R., Flushing, NY.

Several, and all boil down to one thing; you have lost the grid drive on the 6KD6 tube. That drive normally generates a high negative voltage to bias the tube. If you lose grid drive, the tube will draw a very high current, perhaps as much as 400-500 mA. That’s normal. The fact that the tube will take that much current shows that it is still good, but don’t allow high current to flow through the tube for too long, or it might be damaged.

Normal bias on the 6KD6 should be at least —60 volts. Check your schematic for the exact value, because sometimes it’s even more. You may also want to check the horizontal oscillator.
MARKET CENTER

FOR SALE

TUBES New, unused. Send self-addressed, stamped envelope for list. FALA ELECTRONICS, Box 1376-2, Milwaukee, WI 53201.

A SINGER’S DREAM!

REMOVES VOCALS FROM RECORDS!

Now you can sing with the world’s best bands! The Thompson Vocal Eliminator can remove most or all of a lead vocal from a standard stereo record and leave the background! Writie or call for a free brochure and demo record.

LJ Sound, Dept. R-1, P.O. Box 338, Stony Mountain, GA 30088. (404) 483-1258

MARKET CENTER

WHOLESALE car-radio computer telephone audio video subsystems, components catalog (Thur) 897-0509 D&W, 68-12 110th St., Flushing, NY 11375.

WORLDS best channel 3 notch filter $19.95! (Dealer inquiries invited) CROSLEY (A). Box 840, Champaign, IL 61820.

SPECTACULAR strobe light chasers, strobeoscopic devices. Helium-Neon Laser Components, scientific items, more! Free catalog. ALLEGRO ELECTRONICS, P.O. Box 1402, Dept. R-E, Hope, AR 72843.

HIGH gain descramblers, CRT automatic dimmer. SCR tester, plus other unusual electronic devices. Send $3.00 for Info. RB ELECTRONICS ENGINEERING, PO Box 645, Kalamazoo, MI 49003.

CLONE kits, modern, hard drive kits, disk drives, diodes and printers, memory, and ICs. Distributor pricing to end users and dealers. For catalog call 1-800-833-2600, In Ohio call (513) 531-3836. Free shipping.

CABLE-TV converters and equipment. Plans and parts. Build or Buy. Free information. CAD ELECTRONICS, PO Box 1402, Dear. Re., Hope, AR 71810.


WARNING (cable equip. buyers): Let the Dalek in! Don’t buy used equipment when you can buy new for less. N-1200 $75.00, vari sync add $10.00, 10-568.00, case of 20 $48.00 channel 2 or 3. 5B-3000 with auto switch $75.00, 10 assy $65.00, case of 20 $55.00. Vari sync plan and parts list $10.00. Remotes, converters, video accessories, 90 day guarantee. Free catalog. Call or write today. MC, Visa, COD. (402) 331-4557. M. D. ELECTRONICS, 5076 S. 108th W., Omaha, NE 68137.

CABLE television converter, descrambler, and microwave television antenna equipment accessories video cable. FREE. CABLE DISTRIBUTORS UNLIMITED, 116 Main Road, Washington, NY 11782.

ELECTRONIC project components, PCB supplies, test instruments. Oscilloscopes $12.00, multimeters $7.95, power supplies $26.95, Receivers 10-10 $29.95. Send $3.00 for Info. RB ELECTRONICS, 4388 Crystal Peak Dr., Las Vegas, NV 89117.

LOTTO Buster. Analyzes all 6 digit lottery games, $25.00. IBM and compatibles. LOTTO BUSTER, 912 North Hamilton, Bay City, MI 48706.

Is it true...Jeeps for $44 through the government? Call for facts 1-312-742-1142, ext. 4673.

LINEAR parts, tubes, transformers—NRF454 $16.00, DOR545 $12.00, NRF477 $11.00, NRF478 $18.00. Catalog RFPC, Box 700, San Marcos, CA 92069 (619) 744-0728.

TV tunable notch filters, free brochure. D.K. VIDEO, Box 847, Manchester, LG 03103. (305) 752-8202.

TEST equipment, reconditioned. For sale. $1.25 for catalog. WALTER-S, 5687 N. Heviak, San Pablo, CA 94806 (415) 724-0587.

LASERS, components and accessories. Free catalog, M. J. HEAL COMPANY, 6612 Mallard Ct., OH, 43241.

FREE AC adapter (limited offer) with Assortment #103—Toko coils 144L-120K, 520HN-300023, BKAN-K5552AX(2); PCB transformers 2N3940(2), BF085 (Sub), ICs 7812, 74123, MC1330AP1; Diodes ND194, ND233. Only $25.00. Coils only $8.00. Send Free Shipping. MC/Visa/CO. D. set. $1-000-021-5252 Ext. 426 (orders). JIM RHODES, INC., 1025 Ransome Lane, Kingsport, TN 37660.

TUBES: name brands, new, 80% off list. KINBY, 295 West Carmel Drive, Carmel, IN 46032.

INDIVIDUAL Photofact folders $1 to #1400. $3.00 postpaid. LOEB, 414 Chestnut Lane, East Meadow, NY 11554.


CB MODIFICATIONS

Increase channel range. Privacy! We specialize in frequency expanders, speech processors, FM converters, PLL & slider traps, now-in-books, plans kits. Expert mail-in repairs & conversions. 16-page catalog $2. Our 11th year!

CIBC INTERNATIONAL, P.O. Box 31500R, PHOENIX, AZ 85016


SCIENTIFC Atlanta non-addressable converters. 8500 series (original units), remote control, $250.00-$275.00. Tacorn and Zenith descramblers available, guaranteed. N.A.S., (215) 631-3552.

CB’S-EERS Monitor your CB’s modulation through headphones. "Audio Tracker". $19.95, details $1.00, LEM-TRONIX, Box 5261, Long Beach, CA 90805. (213) 531-3552.

TUBES: "oldest". "latest", parts, components, schematics, FAQ for list. STEINMETZ, 7511 Woodrow Ave., R.E., Hammond, IN 46324.


WIREWRAP labels, identify IC’s, pins, Easier, anti-oxidation. All OP’s, 8-40 pin. Cont. Registry, 382 labels $6.00, PAUL’S LABELS, 7230 Embassy, Miramar, FL 33023.

BUY BONDS

RADIO/ELECTRONICS
SCIENTIFIC ATLANTA UNITS

LOWEST PRICES ANYWHERE!

CABLE-TV

BONANZA!

WE'LL MATCH OR BEAT ANYONE'S ADVERTISED RETAIL OR WHOLESALE PRICES!

<table>
<thead>
<tr>
<th>ITEM</th>
<th>SINGLE UNIT PRICE</th>
<th>DEALER 10-UNIT PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCA 36 CHANNEL CONVERTER (CH. 3 OUTPUT ONLY)</td>
<td>29.95</td>
<td>18.00</td>
</tr>
<tr>
<td>PIONEER WIRELESS CONVERTER (OUR BEST BUY)</td>
<td>88.95</td>
<td>72.00</td>
</tr>
<tr>
<td>JERROLD 450 WIRELESS CONVERTER (CH. 3 OUTPUT ONLY)</td>
<td>105.95</td>
<td>90.00</td>
</tr>
<tr>
<td>SB ADD-ON UNIT</td>
<td>109.95</td>
<td>58.00</td>
</tr>
<tr>
<td>BRAND NEW — UNIT FOR SCIENTIFIC ATLANTA</td>
<td>109.95</td>
<td>58.00</td>
</tr>
<tr>
<td>MINICODE (N-12)</td>
<td>119.95</td>
<td>62.00</td>
</tr>
<tr>
<td>MINICODE (N-12) VARI/SYNC</td>
<td>119.95</td>
<td>62.00</td>
</tr>
<tr>
<td>MINICODE VARI/SYNC W/AUTO ON-OFF</td>
<td>179.95</td>
<td>115.00</td>
</tr>
<tr>
<td>M-35 B (CH. 3 OUTPUT ONLY)</td>
<td>139.95</td>
<td>70.00</td>
</tr>
<tr>
<td>M-35 B W/AUTO ON-OFF (CALL FOR AVAILABILITY)</td>
<td>199.95</td>
<td>125.00</td>
</tr>
<tr>
<td>MLD-1200-3 (CALL IF CH. 2 OUTPUT)</td>
<td>109.95</td>
<td>58.00</td>
</tr>
<tr>
<td>INTERFERENCE FILTERS — CH. 3</td>
<td>24.95</td>
<td>14.00</td>
</tr>
<tr>
<td>JERROLD 400 OR 450 REMOTE CONTROLLER</td>
<td>29.95</td>
<td>18.00</td>
</tr>
<tr>
<td>ZENITH SSABI CABLE READY (DEALER PRICE BASED ON 5 UNITS)</td>
<td>225.00</td>
<td>185.00</td>
</tr>
</tbody>
</table>

SPECIFY CHANNEL 2 or 3 OUTPUT

California Penal Code #593-D forbids us from shipping any cable descrambling unit to anyone residing in the state of California. Prices subject to change without notice.

PLEASE PRINT

Name: ____________________________
Address: ____________________________
City: ____________________________
State: ____________________________
Zip: ____________________________
Phone Number: ____________________________

☐ Cashier's Check  ☐ Money Order  ☐ COD  ☐ Visa  ☐ MasterCard

Acct #: ____________________________
Exp. Date: ____________________________
Signature: ____________________________

FOR OUR RECORDS

DECLARATION OF AUTHORIZED USE — I, the undersigned, do hereby declare under penalty of perjury that all products purchased now and in the future, will only be used on cable TV systems with proper authorization from local officials or cable company officials in accordance with all applicable federal and state laws.

Dated: ____________________________
Signed: ____________________________

Pacific Cable Company, Inc.
7325½ RESEDA BLVD., DEPT. R-12 • RESEDA, CA 91335
(818) 716-5914 • No Collect Calls • (818) 716-5140

IMPORTANT: WHEN CALLING FOR INFORMATION
Please have the make and model # of the equipment used in your area. Thank You
THE NEW 65/9028 TV ANSI VIDEO TERMINAL BOARD!
FROM LINING ENTERPRISES

A second generation, low cost, high performance, mini sized, single board for making your own RS232 Video Terminal. Use as a computer console or with a MODEM for hook up to any of the telecommunication computer services.

FEATURES:
- Uses the new SMC 9028 Video Controller Chip coupled with a 6502 CPU.
- RS-232 at 16 Baud Rates from 50 to 18,200.
- On board printer port.
- 24 X 40 format (50-60 Hz).
- For 15,750 Hz (Horizontal) monitors.
- 3 Terminal Modes: M-19, ADMS and ANSI (3.64-1979).
- Wide and thin line graphics.
- While characters on black background or reversed.
- Character Attributes: Intensity, Inverted.
- Low Power: 5VDC @ 7A = 12VDC @ 20mA.
- Min size: 6.5 X 6.5 inches.
- Comprehensive matrix/servos.
- 5 X 8 Dot Matrix characters (32 code).
- Answer back capability.
- Battery backed up status memory.
- For ASCII parallel keyboard.

**MICRO SIZE!**

**$99.95 (Full Kit)**

**SOURCE DISKETTE:**
PC/XT FORMAT
5% IN. $15

DIGITAL RESEARCH COMPUTERS
(OF TEXAS)

Call or write for a free catalog on Z-80 or 6809 Single Board Computers, SS-50 Boards, and other S-100 product.

DIGITAL RESEARCH COMPUTERS
P.O. Box 384450
DUNCANVILLE TX 75118
(214) 225-2309

**BUSINESS OPPORTUNITIES**


YOUR own radio station!! AM, FM, TV, Cable. Licensing, Turnkey operation. BROADCASTING: Box 150-F2, Paradise, CA 95969.

$100-$300/week. Become a licensed technician. No quotas. Securely licensed, rush stamped envelopes. NATIONAL MAILING: Box 17585-F2, Las Vegas, NV 89129.

DEALERS wanted! DMM's, solderless breadboards, soldering tools. Individuals welcome. CENERITY INTERNATIONAL COMPANY, Box 29762, Dallas, TX 75229.

**EDUCATION & INSTRUCTION**

LEARN to be a television studio technician. After only 14 months earn your degree and a great career in video, financial aid and national placement assistance. Dallas (214) 263-2933 or Long Beach (213) 595-1660. VIDEO TECHNICAL INSTITUTE.

**HIGH VOLTAGE TRIPLERS/MULTIPLIERS**

<table>
<thead>
<tr>
<th>ECG/GE</th>
<th>SK</th>
<th>500A</th>
<th>SK571 &amp; SK794</th>
<th>8.75</th>
<th>6.95</th>
</tr>
</thead>
<tbody>
<tr>
<td>523</td>
<td>SK571 &amp; SK794</td>
<td>8.85</td>
<td>7.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>526A</td>
<td>SK570 &amp; SK794</td>
<td>8.85</td>
<td>7.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>528</td>
<td>SK908</td>
<td>10.70</td>
<td>8.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>529</td>
<td>SK572 &amp; SK797</td>
<td>9.99</td>
<td>7.95</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**OUTPUT TRANSISTORS**

| 165     | SK5115 & SK5118 | 2.25 | 1.95 |
| 246     | SK571 & SK794 | 2.75 | 2.35 |
| 285     | SK572 & SK797 | 2.25 | 1.95 |
| 251P     | SK574 & SK799 | 2.25 | 1.95 |

**MICROPROCESSOR**

| 125     | 1000/250A | 2.25 | 1.95 |
| 506     | CANON/HY-VOLT PAST-RECOVERY | 2.25 | 1.95 |

**SS ADDITIONAL SAVINGS**

<table>
<thead>
<tr>
<th>10</th>
<th>50</th>
<th>100</th>
<th>min</th>
<th>max</th>
<th>10</th>
<th>50</th>
<th>100</th>
<th>min</th>
<th>max</th>
</tr>
</thead>
<tbody>
<tr>
<td>102A</td>
<td>.35</td>
<td>.55</td>
<td>29</td>
<td>59</td>
<td>171</td>
<td>.35</td>
<td>.55</td>
<td>29</td>
<td>59</td>
</tr>
<tr>
<td>123A</td>
<td>.35</td>
<td>.55</td>
<td>29</td>
<td>59</td>
<td>186</td>
<td>.35</td>
<td>.55</td>
<td>29</td>
<td>59</td>
</tr>
<tr>
<td>126A</td>
<td>.35</td>
<td>.55</td>
<td>29</td>
<td>59</td>
<td>198</td>
<td>.35</td>
<td>.55</td>
<td>29</td>
<td>59</td>
</tr>
<tr>
<td>130A</td>
<td>.35</td>
<td>.55</td>
<td>29</td>
<td>59</td>
<td>208</td>
<td>.35</td>
<td>.55</td>
<td>29</td>
<td>59</td>
</tr>
<tr>
<td>150A</td>
<td>.35</td>
<td>.55</td>
<td>29</td>
<td>59</td>
<td>254</td>
<td>.35</td>
<td>.55</td>
<td>29</td>
<td>59</td>
</tr>
<tr>
<td>162A</td>
<td>.35</td>
<td>.55</td>
<td>29</td>
<td>59</td>
<td>275</td>
<td>.35</td>
<td>.55</td>
<td>29</td>
<td>59</td>
</tr>
</tbody>
</table>

**DIGITRON ELECTRONICS**

110 HILLSIDE AVENUE, SPRINGFIELD, NEW JERSEY 07081

Truck Free! 1-800-524-4828. IN (213) 595-1660. TEL: 595-1660. TRUCK FREE.

**DIGITRON ELECTRONICS**

110 HILLSIDE AVENUE, SPRINGFIELD, NEW JERSEY 07081

Truck Free! 1-800-524-4828. IN (213) 595-1660. TEL: 595-1660. TRUCK FREE.

**DIGITRON ELECTRONICS**

110 HILLSIDE AVENUE, SPRINGFIELD, NEW JERSEY 07081

Truck Free! 1-800-524-4828. IN (213) 595-1660. TEL: 595-1660. TRUCK FREE.

**DIGITRON ELECTRONICS**

110 HILLSIDE AVENUE, SPRINGFIELD, NEW JERSEY 07081

Truck Free! 1-800-524-4828. IN (213) 595-1660. TEL: 595-1660. TRUCK FREE.

**DIGITRON ELECTRONICS**

110 HILLSIDE AVENUE, SPRINGFIELD, NEW JERSEY 07081

Truck Free! 1-800-524-4828. IN (213) 595-1660. TEL: 595-1660. TRUCK FREE.

**DIGITRON ELECTRONICS**

110 HILLSIDE AVENUE, SPRINGFIELD, NEW JERSEY 07081

Truck Free! 1-800-524-4828. IN (213) 595-1660. TEL: 595-1660. TRUCK FREE.

**DIGITRON ELECTRONICS**

110 HILLSIDE AVENUE, SPRINGFIELD, NEW JERSEY 07081

Truck Free! 1-800-524-4828. IN (213) 595-1660. TEL: 595-1660. TRUCK FREE.

**DIGITRON ELECTRONICS**

110 HILLSIDE AVENUE, SPRINGFIELD, NEW JERSEY 07081

Truck Free! 1-800-524-4828. IN (213) 595-1660. TEL: 595-1660. TRUCK FREE.

**DIGITRON ELECTRONICS**

110 HILLSIDE AVENUE, SPRINGFIELD, NEW JERSEY 07081

Truck Free! 1-800-524-4828. IN (213) 595-1660. TEL: 595-1660. TRUCK FREE.

**DIGITRON ELECTRONICS**

110 HILLSIDE AVENUE, SPRINGFIELD, NEW JERSEY 07081

Truck Free! 1-800-524-4828. IN (213) 595-1660. TEL: 595-1660. TRUCK FREE.
Quality products — low prices — no gimmicks — seed for free brochure and 800 number to S.S.E., P.O. Box 9853, Osaka, FL 32678.

OAK Orion "turn-on" modifications. "Chipit" or "remote winding" deck. Nac-Sav, Box 5261, Long Beach, CA 90805, (213) 631-3552.

Pay TV and Satellite Descrambling All New 8th Edition

Now 100 pages of working schematics and theory for all major cable and satellite systems, including Orion, Video Cypher Fantasy and Echow. New sections on how illegal descramblers are detected. Scientific Atlantia, Tri-Media, Pilotessa, Pico, Star-Lok IV and E-Mac. Fastest, latest info on Orion peace chips and the breaking of Video Cypher. The most complete source of descrambling info available. $14.50 plus $1.50 postage and handling.

Shojiki Electronics Corp., 1327 R
Niagara St., Niagara Falls, NY 14303.
COD’s 716-284-2153

ATTENTION satellite dealers. See everything with your video cypher 20010E demonstrator on all the transponders (secret modification voids manufacturers warranty). Send $24.00 for V.G. kit. Send $10.00 for full set of schematics of the model 1 model 2000E, receiver TV Sharp 127 E. Mission, Fairpark, CA 92828. (619) 723-1302.

DESCRAMBLER unencrypted videocipher H satellite TV signals with Defector. Two video only. Simple low cost circuit using only three transistors. C.P. board, instructions $5.00. P.P. VALLEY MICRO-WAVE ELECTRONICS, P.O. Box 150, Nova Scotia, Canada BO-510. (902) 467-3577

Quality Microwave TV Antenna Multi-Channel 1 to 2.7 GHz 40 dB Gain True Parabolan 20 mph Dish. U.G. Limited Tuning Corp. System $5.00 (Shop not inst.) DREAM CHASER SYSTEMS P.O. Box 2764-10, Phoenix, AZ 85040

LIFETIME 50 T-500 (Beach Road, Nyack, NY) $450.00 AMPLIFIERS 50 T-100 (beach road, Nyack, NY) $300.00 Master Control Mike COD’s City, Philadelphia.

PLANS AND KITS

CATALOG: Mobile Broadcasting 1750 meters, Ham CB; transmitters, amplifiers, antennas, scramblers, buggling devices: mel PanAXIS, Box 130-F12, Panama, Iowa, 50469.

CRYSTAL radio, cars, plans, parts, kits, catalog $1.00. MDCO, 660 North Ohio Highway, Holleywood, CA 32302.

BUILD this five digit panel meter and square wave generator including an ohms, capacitance and frequency meter. Detailed instructions $5.00. BAG-800 ELECTRONICS, 179 May, Fairfield, CT 06430.

CABLE TV converters: Jerrold Products include "New Jerrold Tri-Mode," SB-3, Hamlin, Oak VN-12, M-35-8, Zenith, Magnavox, Scientific Atlanta, and more. (Quantity discounts) 60 day warranty. Service converters sold here. For fast service C.O.D. orders accepted. Send SASE (60 cents postage) or call for Info (312) 637-4408. Midwest Electronics, Inc., HIGGS ELECTRONICS, CHICAGO, IL 60639.


SHERRIF SUBSCIRIBER ELECTRONICS, 7223 Stony Island, Chicago, IL 60649.


DESCRAMBLE the latest video cassette copy protection scheme. Simple Line Zapper circuit takes the jitter out of your picture. Complete plans and theory only $9.95 plus $1.50 postage and handling.

ELEPHANT ELECTRONICS, INC., Box 41865-J, Phoenix, AZ 85040. (602) 997-6606.

Hi-Fi speaker systems, kits and speaker components from the world's finest manufacturers. For beginners and audiophiles. Free literature. A &S SPEAKERS, Box 74X28, Denver, CO 80207. (303) 395-6609.

VOICE decoders! Telephone bug FM bug! Other kits! Catalog $1.00 (Refundable) XANDO, Box 25647, Dept 605, Temple, AZ 85282.

EXPERIMENT with fiber optics! Send your voice over a beam of light via an optical fiber. Complete kit ($39.95) includes microphone, speaker, fiber, PCB's and all parts. Easily assembled. Complete plans package only $33. Send to: FIBER SCIENCES, Box 5355, Chatsworth, CA 91319-3555. CA residents add 5.5%.

ROBOTICS catalog for hobbyists, 20% off sale $2.00 (refundable) ALPHAN ROBOTICS, INC., Box 21081, St. Paul, MN 55121.

SURROUND sound decoder plans. Extracts hidden sound from satellite sound systems. Effective sound localization is built-in along with volume and tone controls and line level output. Easy to build. Complete plans send $8.95 to SYNCTIC, 524 San Antonio Avenue, Suite 201, San Antonio, CA 94500.

JERROLD in mode 1419, $55. Complete kit includes PC board, parts and schematic for interface in SB or DTC type units $15.00.

ARUS ELECTRONICS, PO Box 662, Chappaqua, NY 10514.

BODMINS bass incredibly! Build your own graphic equalizer! Studio quality! Plans $5.00.

BRUCE EDWARDS, 103268 Lawson Rd., Jackson ville, FL 32216.

BRAIN waves control and read inexpensively with computer. System plans $19.95. ROSE, 9900 Coast Sea Opening, MD 20742.

DESIGN your own custom circuits on your Commodore PET. Just enter specifications and the computer does the rest. Send for free Information! WEASEL GRAPHICS PROGRAM, Dept. REI 1, 606 Thomasville, Pocahontas, AR 72455.

KITSI Stereo scratch filter, frequency counter, radar detector and more. Semi-assembled and tested. Write for free literature! SERENA INDUSTRIES, 1180-A Ashler Ave., Sunnyvale, CA 94086.

ZENITH cable anti-flash kits. Dealers only. 100% guaranteed. Works where other fail. UES, Box 1311, Elgin, IL 60120 (012) 697-0600.

PROGRAMMABLE chime light circuit, useful as a brake light system P.C.B., plans $25.00, J.G.M. LABS, PO Box 62, Enola, IL 60519.

FREE microprogramming, memory chips, etc. Free electronics magazine subscription. Send to: ELECTRONICS, 2401 N.E. Cornell Blvd., 133 Hillborough St., Orlando, FL 32812.

DESCRAMBLING, new secret manual! Build your own descramblers for cable and subscription TV. Instructions, schematics for SAVI, QK-2, Satellite News, $6.55. Satellite Non-Satellite. Complete instructions, thorough explanation of digital audio encoding, $9.50. (HQ Cinema, Showtime, etc.) For immediate delivery, $1.00, DESIRE ELECTRONICS, Box 35002R, Bethesda, MD 20814.

COMPUTER plans/kit 6802 micro kit $35.00, 280 micro $40.00, EPROM programmer $20.00, plans $10.00. Build your own micro! MICRO MOD, 141BW, Coll. Chander, IL 62524.

SURVEILLANCE transmitters. Dozen proven schematics, plans kits $10.00. SEAL, PO Box 15253, Plantation, FL 33318.

DECEMBER 1985
of FORTH is written in FORTH, the internal routines are available to the programmer, and we can use parts of the FORTH interpreter in the RCL interpreter. The end result is an interactive RCL that can be modified by the user, and that can be used without a disk drive. We will be looking at RCL in depth in a future installment.

Operator interface

Most applications of robots are limited not by the ability of the hardware to perform a given task, but by the amount of time it takes to “teach” the robot. RCL significantly improves productivity.

Several methods of operator interface were considered. One was the “teach pendant” approach wherein motion sequences are learned and stored for recall and execution at a later time. However, after both utility and expense were considered, all other methods of interface were abandoned in favor of using a serial terminal. The reason is that almost everyone who considers building a robot has a terminal or a personal computer that can emulate a terminal. And if a more sophisticated method of control is desired, the required modifications are easy to perform. However, modifications of that sort are left to the ingenuity of the reader.

It is important to be able to operate the robot from a remote location. What we need is a way to transport our commands from the control terminal to the robot. That is done using an RF link. The link interfaces to the terminal via the terminal's serial port.

Table 1 shows how our robot stacks up against several of the leaders in the personal-robot market: the RB-JX from RB Robots (14618 W. Sixth St., Golden, CO 80401) and the Heath (Benton Harbor, MI 49022) HERO 2000.
Sound-Generator IC

0.95
3 Independent Analog Outputs

Adds Sound Effects to Your Computer

This chip is a great way to "dress-up" your program. Only your imagination will limit the type of sound effects and music you can produce. The three analog audio outputs are programmable. Two general-purpose 8-bit I/O ports and single 5 VDC supply operation make it easy to interface with most microprocessors. 40-pin DIP.

ICs, Resistors, Switches,276-066...

LEDs Light Up the Season!

(9) Super-Bright Red LED. #275-066

(10) Blinks Green LED. #275-030

(11) Flashing Lamp. Yellow, red, green, ideal for model trains. #273-070

(12) Xenon Strobe Tube. #273-145

DC Fan and Trans

(3) 3" Brushless DC Fan. Low-noise. 0.5rpm or

(4) UL-Recognized Heavy-Duty Transformers.

IC Chime, Siren and Buzzers

(5) Electronic Chime. Delivers 80 dB "ding
dong" at 12 VDC. #273-071

(6) 3-Sound Sirens. 3 distinctive sounds. Deliv-
ers 80 dB at 3 VDC. #273-072

(7) Two-Tone Piezo Buzzer. 100 dB minimum.

(8) High-Speed data transfer with

(9) High-Speed data transfer with

Mini Relays and Switches

(10) DTMF Receiver in A Single IC

12.95

For Many Remote Control Applications

High-performance, easy to use. Features single analog input and 8 built-in switched-capacitor filters. Selectable hardware or binary coded 2 output format. 18-pin DIP.

High-speed data transfer with

Auxiliary parts...276-178

10-Piece Electronic Tool Kit

14.95

Complete Home/Shop Set-Up

Includes 30-piece UL listed 12V DC brushless iron and steel, scissors, soldering iron, needle nose pliers, diagonal cutters, three screwdrivers and heatsink. #79-280

Scientific Calculator

29.95

Never Needs Batteries!

EC-4016. Solving-style. Extra-large keys and LCD display. 16 useful functions. 10-digit mantissa, 2-digit exponent. #65-382

Solar Energy Project Set

9.95

Discover the future promise of solar technology today! Complete complete with solar cell connected to a DC motor, color wheel, power meter, and books with interesting projects. #277-120

Radio Shack

A DIVISION OF TANDY CORPORATION

Best stock in parlishing Radio Shack items and circuits

www.americanradiohistory.com
Open up the world of Closed Captions!

Many TV programs carry specially encoded signals to provide captions that allow hearing-impaired people to follow dialogue & narrations. Educators find captions improve reading skills.

The DSE SuperText TC is a low-cost alternative to the more expensive NCI telecaptor. Using the same decoding technology (under license from NCI), the SuperText TC adds a superior performance display to one that displays both black and white text, and 6-line operation. Captions are displayed at the top of the screen, in the black box background, and are easy to read. Captions are encoded using a variety of fonts, and the display can be customized to suit individual preferences. The SuperText TC connects to any television or VCR and can be used with any decoder, including the NCI decoder. It can also be used with other captioning systems, such as those used in schools and hospitals.

Benefits:
- Easy installation
- No additional hardware required
- Compatible with all VCRs and televisions
- Low cost

Features:
- Easy to use
- No programming required
- Connects to any television or VCR

Get the Audio Quality You Deserve!

Features:
- High-fidelity sound reproduction
- Easy-to-read captions
- Adjustable caption size
- Customizable display settings

Enjoy your Home Electronics in Total Comfort

Features:
- Build-in battery backup
- Easy-to-read captions
- Adjustable caption size
- Customizable display settings

DSE's RDF rates outstanding technical reviews!

Features:
- 12V operation
- Built-in battery backup
- Easy-to-read captions
- Adjustable caption size
- Customizable display settings

Return with us now to those thrilling days of yesteryear

Features:
- Authentic antique radios
- Fully operational
- Educational value

Radio Direction Finder Kit

Features:
- 12V operation
- Built-in battery backup
- Easy-to-read captions
- Adjustable caption size
- Customizable display settings

Check us out!

Dick Smith Electronics for Service, Value & Innovation!

GET THE AUDIO QUALITY YOU DESERVE!

Get the Audio Quality You Deserve! Features:
- Sound reproduction
- Easy-to-read captions
- Adjustable caption size
- Customizable display settings

Radio Direction Finder Kit

Features:
- 12V operation
- Built-in battery backup
- Easy-to-read captions
- Adjustable caption size
- Customizable display settings

Return with us now to those thrilling days of yesteryear

Features:
- Authentic antique radios
- Fully operational
- Educational value

Radio Direction Finder Kit

Features:
- 12V operation
- Built-in battery backup
- Easy-to-read captions
- Adjustable caption size
- Customizable display settings

Check us out!

Dick Smith Electronics for Service, Value & Innovation!

GET THE AUDIO QUALITY YOU DESERVE!

Get the Audio Quality You Deserve! Features:
- Sound reproduction
- Easy-to-read captions
- Adjustable caption size
- Customizable display settings

Radio Direction Finder Kit

Features:
- 12V operation
- Built-in battery backup
- Easy-to-read captions
- Adjustable caption size
- Customizable display settings

Return with us now to those thrilling days of yesteryear

Features:
- Authentic antique radios
- Fully operational
- Educational value

Radio Direction Finder Kit

Features:
- 12V operation
- Built-in battery backup
- Easy-to-read captions
- Adjustable caption size
- Customizable display settings

Check us out!

Dick Smith Electronics for Service, Value & Innovation!
Get Better GRAPHICS for your PC Compatible

This sensitive chip adds an expansion slot to provide high quality true and full spectrum color graphics for IBM PC XT, PC AT, and compatibles. You can switch between monochrome and enhanced color displays without removing this PC's cover. Look at these super-bright, 264-character display with 16 color support for 640x320 graphics...

Enhanced Graphics: $259
Adaptar Card

ATTENTION BULK BUYERS!
Schools, Colleges, Manufacturers—Call 415-368-8844 for special quantity pricing!

DEALER INQUIRIES WELCOME!
MULTIPURPOSE MELODY GENERATOR

SPECIFICATIONS:
- Orders over $100: 50% off
- Orders under $100: 25% off
- Power Supply: DC 12V, 100mA
- Can be used as a doortone, musical chime for electronic devices.

TA-500 A/C 48616
- Jingle Bell
- Sleepy night
- Rudolph, the red-nosed reindeer
- O come, all ye faithfull

TA-500 B/C 48206
- London Bridge is falling down
- Are you sleeping
- Twas Symphonie
- Weep me

CORDERLESS SOLDERING IRON RECHARGEABLE

Model No.
- $65.00
- Type: 65W
- Battery: NiCad
- Weight: 1 lb

TALKING CLOCK

Model No.
- PARAD 881
- Display: Moon
- Time: 12/24
- Temperature: Yes

100W DYNAMIC CLASS "A" MAIN POWER AMPLIFIER

Model No.
- TAA-1000
- Description: 100W Amplifier

STEREO SIMULATOR

Model No.
- TAA-3000
- Description: 3000W Power Amplifier

COLOR LIGHT CONTROLLER

Model No.
- TY-238
- Description: 7 colors

HIGH QUALITY MULTIPURPOSE PRE-AmPLIFIER

Model No.
- TAA-479
- Description: 479W Power Amplifier

120W MOSFET POWER AMPLIFIER

Model No.
- TAA-479
- Description: 479W Power Amplifier

TERMS: Minimum order: $20.00, Charge card order: $25.00, No COD's. Check & Money order, phone order. Orders under $10.00, handling fee of $2.50, handling fee of $2.00, handling fee of $1.50, handling fee of $1.00, handling fee of $0.50. All merchandise subject to change without notice. All merchandise subject to change without notice. All merchandise subject to change without notice. All merchandise subject to change without notice. All merchandise subject to change without notice. All merchandise subject to change without notice.
### 20MB HARD DISK SYSTEM ONLY $389.95!

<table>
<thead>
<tr>
<th>Description</th>
<th>Order by</th>
<th>Contacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Reliability Tooling</td>
<td>AUGUST 23</td>
<td>82-95-99</td>
</tr>
<tr>
<td>High Reliability Tooling</td>
<td>AUGUST 23</td>
<td>5-10</td>
</tr>
<tr>
<td>Component Descriptions</td>
<td>I/O Pin</td>
<td>69-99</td>
</tr>
<tr>
<td>Component Descriptions</td>
<td>ID Pin</td>
<td>99-99</td>
</tr>
<tr>
<td>Component Descriptions</td>
<td>ID Pin</td>
<td>1-178</td>
</tr>
<tr>
<td>Component Descriptions</td>
<td>ID Pin</td>
<td>1-2.9</td>
</tr>
</tbody>
</table>

### Diodes/Opto/Transistors

<table>
<thead>
<tr>
<th>Description</th>
<th>Order by</th>
<th>Contacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diode Power</td>
<td>625-99</td>
<td></td>
</tr>
<tr>
<td>Transistor NPN</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Transistor PNP</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Opto Couplers</td>
<td>3-13</td>
<td></td>
</tr>
<tr>
<td>Opto Couplers</td>
<td>3-13</td>
<td></td>
</tr>
<tr>
<td>Opto Couplers</td>
<td>3-13</td>
<td></td>
</tr>
</tbody>
</table>

### LED Displays

<table>
<thead>
<tr>
<th>Description</th>
<th>Order by</th>
<th>Contacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED Displays</td>
<td>352</td>
<td>352</td>
</tr>
<tr>
<td>LED Displays</td>
<td>352</td>
<td>352</td>
</tr>
<tr>
<td>LED Displays</td>
<td>352</td>
<td>352</td>
</tr>
</tbody>
</table>

### Switches

<table>
<thead>
<tr>
<th>Description</th>
<th>Order by</th>
<th>Contacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switches</td>
<td>69</td>
<td>69</td>
</tr>
<tr>
<td>Switches</td>
<td>69</td>
<td>69</td>
</tr>
<tr>
<td>Switches</td>
<td>69</td>
<td>69</td>
</tr>
</tbody>
</table>

### Hard to Find Snapable Headers

<table>
<thead>
<tr>
<th>Description</th>
<th>Order by</th>
<th>Contacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snapable Headers</td>
<td>5-100</td>
<td>5-100</td>
</tr>
<tr>
<td>Snapable Headers</td>
<td>5-100</td>
<td>5-100</td>
</tr>
<tr>
<td>Snapable Headers</td>
<td>5-100</td>
<td>5-100</td>
</tr>
</tbody>
</table>

### Snubbing Notchers

<table>
<thead>
<tr>
<th>Description</th>
<th>Order by</th>
<th>Contacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snubbing Notchers</td>
<td>5-100</td>
<td>5-100</td>
</tr>
<tr>
<td>Snubbing Notchers</td>
<td>5-100</td>
<td>5-100</td>
</tr>
<tr>
<td>Snubbing Notchers</td>
<td>5-100</td>
<td>5-100</td>
</tr>
</tbody>
</table>

###naire

<table>
<thead>
<tr>
<th>Description</th>
<th>Order by</th>
<th>Contacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drivers</td>
<td>5-100</td>
<td>5-100</td>
</tr>
<tr>
<td>Drivers</td>
<td>5-100</td>
<td>5-100</td>
</tr>
<tr>
<td>Drivers</td>
<td>5-100</td>
<td>5-100</td>
</tr>
</tbody>
</table>

### RIBBON CABLE

<table>
<thead>
<tr>
<th>Description</th>
<th>Order by</th>
<th>Contacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ribbon Cable</td>
<td>5-100</td>
<td>5-100</td>
</tr>
<tr>
<td>Ribbon Cable</td>
<td>5-100</td>
<td>5-100</td>
</tr>
<tr>
<td>Ribbon Cable</td>
<td>5-100</td>
<td>5-100</td>
</tr>
</tbody>
</table>

### ELECTROCARDIOGRAMS

<table>
<thead>
<tr>
<th>Description</th>
<th>Order by</th>
<th>Contacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrocardiograms</td>
<td>5-100</td>
<td>5-100</td>
</tr>
<tr>
<td>Electrocardiograms</td>
<td>5-100</td>
<td>5-100</td>
</tr>
<tr>
<td>Electrocardiograms</td>
<td>5-100</td>
<td>5-100</td>
</tr>
</tbody>
</table>

### MICRODEVICES

<table>
<thead>
<tr>
<th>Description</th>
<th>Order by</th>
<th>Contacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microdevices</td>
<td>5-100</td>
<td>5-100</td>
</tr>
<tr>
<td>Microdevices</td>
<td>5-100</td>
<td>5-100</td>
</tr>
<tr>
<td>Microdevices</td>
<td>5-100</td>
<td>5-100</td>
</tr>
</tbody>
</table>

---

**CALL FOR VOLUME QUOTES**

© COPYRIGHT 1986 DJR MICRODEVICES

**CIRCLE 176 ON FREE INFORMATION CARD**
20MB HARD DISK SYSTEM ONLY $389.95!

DISK DRIVES FOR APPLE COMPUTERS

AP-150 $99.95
- 5" DISK DRIVE
- 100% APPLE COMPATIBLE
- SIX MONTH WARRANTY

BAL-500 $100.95
- 5" DISK DRIVE
- TEAC MECHANISM
- 100% APPLE COMPATIBLE
- FULL ONE YEAR WARRANTY

AP-135 $129.95
- FULL HYDRAULIC MECHANISM
- DIRECT REPLACEMENT FOR APPLE DISK II
- SIX MONTH WARRANTY

MAC535 $249.95
- 3.5" ADD-ON DISK DRIVE
- 100% COMPATIBLE
- DOUBLED SIDED DOCK STORAGE
- HIGH RELIABILITY DRIVE
- HAS AUTO SELECT Mechanism
- FULL ONE YEAR WARRANTY

IC TEST Card $99.95
- DICHTONE MORE COMMON ICs
- WHAT PASS OR failing
- ONE YEAR WARRANTY
- TESTS 1000 SERIES CMOS
- 74HC SERIES CMOS
- 74HCT SERIES CMOS

DISK DRIVE ACCESSORIES

FOD CONTROLLER CARD $45.95
- Interface Adaptor cable $19.95
- Adapts standard drive interfaces for use with Apple II

KB-1000 $79.95
- CASE WITH KEYBOARD FOR APPLE TYPE MOTHERBOARD
- USER DEFINED FUNCTION KEYS
- NUMERIC KEYPAD WITH CURSOR CONTROL
- CASE LOCK - AUTO REPEAT

KEYBOARD $49.95
- REPLACEMENT FOR APPLE II KEYBOARD
- CASE LOCK KEY - AUTO REPEAT
- ONE DEC/EXP OF BASIC OR 16K CMOS

APPLE COMPATIBLE INTERFACE CARDS

EPROM PROGRAMMER $38.95
- DIP RAPID OR BURN ANY
- STANDARD EPA SERIES EPROM
- CONNECTS 2 PRINTERS TO ONE DISK
- ALL UNESCHWEE
- HIGH RELIABILITY SWITCH MOUNTED
- DYE CONTACTS
- BURST METAL ENCLOSURE

MODEL RP525

3-WAY SWITCH BOXES

- 5" DISK OR PARALLEL
- CONNECTS 2 PRINTERS TO ONE DISK
- ALL UNESCHWEE
- DYE CONTACTS
- BURST METAL ENCLOSURE

MODEL RP525

PRINT SIGNALS

- DIP RAPID OR BURN ANY
- STANDARD EPA SERIES EPROM
- DOUBLE SIDED DOCK STORAGE
- HIGH RELIABILITY DRIVE
- HAS AUTO SELECT Mechanism
- FULL ONE YEAR WARRANTY

SP120P PARALLEL $139.95
- 8K EPROM UPGRADABLE TO 16K
- 16K EPROMS UPGRADABLE TO 32K
- LED INDICATOR SHOWS VOLUME OF DATA IN BUFFER

SP120S 8232 SERIAL $159.95
- 8K EPROM UPGRADABLE TO 16K
- 16K EPROMS UPGRADABLE TO 32K
- LED BARGRAPH DISPLAYS AMOUNT OF DATA IN BUFFER

SP110P PARALLEL $249.95
- 64K EPROMS UPGRADABLE TO 128K
- 128K EPROMS UPGRADABLE TO 256K
- LED BARGRAPH DISPLAYS AMOUNT OF DATA IN BUFFER

PRINT SIGNALS

- DIP RAPID OR BURN ANY
- STANDARD EPA SERIES EPROM
- FULL ONE YEAR WARRANTY

APPLE DISKETTES DEALS

51/4" SOFT SECTOR DRIVE WITH HUB RINGS

NASHUA DISKETTES $99.95
- 69C Elizabeth $99.95
- 60SS 96.95

3000 MODMEM $48.95
- FOR APPLE OR IBM
- INCLUDES ASCI PRO-2Z SOFTWARE

JOYSTICK $7.95
- FOR ATARI 400, 800, 2600, VIC 20 & APPLE II

DISKFILE

- HOLDS 70K DISKETTES
- 3.5" DISK FILE HOLDS 40 $89.95

TEST EQUIPMENT FROM JDR INSTRUMENTS

DIGITAL MULTIMETER PEN DPM-1000

- AUTO RANGING, POLARITY AND DECIMAL

- LARGE 3.5 DIGIT
- DATA HOLD SWITCH
- FREEZE READING
- FAST, JUDGABLE CONTINUITY TEST
- VOLUME DIAL SWEEP
- LED INDICATOR
- OVERLOAD PROTECTION

20MHZ DUAL TRACE OSCILLOSCOPE $369.00

35MHZ DUAL TRACE OSCILLOSCOPE $359.00

CALL FOR VOLUME QUOTES

CIRCLE 178 ON FREE INFORMATION CARD

DECEMBER 1985

BUILD STEVE GIARCA'S INTELLIGENT EPROM PROGRAMMER

AS SHOWN IN BIRD OCT. 88

- STAND-ALONE OR RS-232 SERIAL OPERATION
- MENU SELECTABLE EPROM TYPES
- NO CONFIGURATION JUMPER
- PROGRAMS ALL 8C 27XX EPROMS
- FROM 2716 TO 2764
- READ-COPY OR VERIFY EPROM
- UPGRADE-DOWNLOAD INTEL HEX FILES
- PROGRAMMER DRIVER USER MODIFIABLE

ONLY $199

KIT INCLUDES PCB AND ALL COMPONENTS EXCEPT CASE AND POWER SUPPLY

51/4" FLOPPY DISK DRIVES

TRAC FD-556 8K 16/90 FOR 5 1/4" $139.95
TRAC FD-570 8K 80/160 FOR 5 1/2" $149.95
TEARDROP FD-SHOW 16/90 FOR 5 1/2" $169.95
TANDON TM-100 2 - 60/120 FOR 5 1/4" $179.95
TANDON TM-116 3 - 120/240 FOR 5 1/4" $199.95
MI-382 60 - 100 FOR IBM $279.95
ULTRA GT-142 150 - 100 FOR IBM $299.95

8" FLOPPY DISK DRIVES

FD-1005-550/80/64-100 FOR IBM $159.95
FD-2006-550/80/120 FOR IBM $159.95

DISK DRIVE ENCLOSURES

TEAC FD-95 $249.95
TANDON TM-100-2 $299.95

DISK DRIVE ENCLOSES

CAP-APPLE $14.95
APPLE TYPE CADDY WITH OUT POWER SUPPLY

CAP-1FH5 $14.95
FULL HY-8" 16-51 KB CABINET W/PWR SUPPLY

CAP-25V $49.95
DUAL LUMINATE 8" CABINET W/POWER SUPPLY

CAP-210 $34.95
DUAL LUMINATE 8" CABINET W/POWER SUPPLY

CAP-215 $219.95
DUAL FULL HT 8" CABINET W/JACKS, SUPPLY

CAP-25V $19.95

CAP-1FH $19.95

35MHZ DUAL TRACE OSCILLOSCOPE MODEL 350 $549.00

FOR MORE INFORMATION ON THE OSCILLOSCOPES, CALL US FOR FREE PRODUCT GRIFTS.
IBM COMPATIBLE INTERFACE CARDS

MULTI I/O FLOPPY CARD

- Perfect for the 80/85 XT/AT
- 4 Drive Floppy Disk Controller
- 15732 Serial Port, Option 2nd Port
- Parallel Printer Port
- Async RS-232 Port
- Clock, Cal NDAR
- Hardware Clock Utilities
- RAMDisk, Spooler
- Optional Serial Port $15.95

MULTIFUNCTION CARD

- All the features of AST's 8 Pack Plus at Half the Price
- Clock/Calendar
- 2 Serial Ports
- 2 Async Ports
- Game Port
- Printer Port $39.95

COLOR GRAPHICS ADAPTOR

- Fully compatible with IBM Color Card
- 4 Video Interfaces
- IBM COMPATIBLE COLOR GRAPHICS
- IBM COMPATIBLE MONOCHROME
- IBM COMPATIBLE MONOCHROME MONITOR
- LUMIEN TEXT INTERFACE

MONOCHROME GRAPHICS CARD

- Fully compatible with IBM Monochrome Monitor & Hercules Graphics
- 2 Dots Mode 90 X 25
- Graphics Mode 320 X 200
- Parallel Printer Interface
- Optional Serial Port $19.95

MONOCHROME ADAPTOR

- Alternative Funtion Value from JDR
- 55128 IBM Compatible
- 55128 IBM Compatible
- Please Note: This Card will not run Lotus Graphics and Does Not Include a Parallel Port

FLOPPY DISK DRIVE ADAPTOR

- Interfaces up to 4 Standard FDD or IBM PC or Compatibles
- Includes Cable for Two Internal Drives
- Standard AB37 for External Drives
- Username Disk Drive Adapters When Used With Optional 26128

IBM COMPATIBLE KEYBOARDS

- DSKM-2000
- IBM-5151

POWER SUPPLY

- 1200 BAUD MODEMS
- SMARTTEAM
- MODEL 1200B* 1200 BAUD MODEMS
- SMARTTEAM 1200 BAUD MODEMS
- 1200 BAUD MODEMS
- SMARTTEAM 1200 BAUD MODEMS
- 1200 BAUD MODEMS

DISK DRIVES

- TANDON TM50-2
- 150 WATT MODEL

IBM STYLIZED COMPUTER CASE

- An attractive steel case with a hinged lid fits the popular XT compatible motherboards
- Switch cutout on side for PC XT style power supply
- Cutout for expansion slots
- All hardware included

IBM COMPATIBLE MOTHERBOARD

- PRO-BIOS
- IBM COMPATIBLE
- IBM COMPATIBLE
- IBM COMPATIBLE
- IBM COMPATIBLE
- IBM COMPATIBLE

IBM PRINTED CABLE

- DB9 TO CENTRONICS
- SHIELDED CABLE $3.95

IBM STYLE COMPUTER CASE

- IBM COMPATIBLE TT MONITOR
- IBM COMPATIBLE TT MONITOR
- IBM COMPATIBLE TT MONITOR
- IBM COMPATIBLE TT MONITOR
- IBM COMPATIBLE TT MONITOR

CRT MONITORS FOR ALL APPLICATIONS

- LUXOR
- SAKATA
- CENTER SYSTEMS

BUILD YOUR OWN 256K XT COMPATIBLE SYSTEM

- XT MOTHERBOARD
- IBM-1151
- IBM-5151

IBM COMPATIBLE TT INPUT

- IBM COMPATIBLE TT INPUT
- IBM COMPATIBLE TT INPUT
- IBM COMPATIBLE TT INPUT
- IBM COMPATIBLE TT INPUT

IBM TV MICRODEVICES

- JDR Microdevices
- IBM COMPATIBLE
- IBM COMPATIBLE
- IBM COMPATIBLE
- IBM COMPATIBLE
- IBM COMPATIBLE

1200 BAUD MODEMS

- SMARTTEAM
- MODEL 1200B
- 1200 BAUD MODEMS
- SMARTTEAM 1200 BAUD MODEMS
- 1200 BAUD MODEMS

IBM PRINTED CABLE

- DB9 TO CENTRONICS
- SHIELDED CABLE $3.95
NEW PRODUCTS!

TTX 14" RGB Color Monitor for IBM PC, XT and Compatible Computers

- Full Signal (800 x 600 x 16-colors) or 640 x 480 x 256-colors resolution.
- 80 Hz refresh rate.
- High contrast and brightness.
- Price: $299.95

ZUCKERBOARD

- Expansion Memory Half-Card for the Tandy 1000 and Compatible Computers.
- Includes 256K RAM and Manual.
- Price: $299.95

Options for TAN-EM52K/512X

- 3.5 Micro Floppy Disk Drive for Tandy 1000, 65100A, IBM PC, XT, AT and
  Compatible Computers.
- Price: $39.95

NEW! 64K/256K NEW! Printer Buffer

- Universal
- Price: $299.95

IBM-Compatible ACCESSORIES

83-Key Keyboard

- Price: $29.95

Build an IBM PC/XT Compatible!

- IBM-64K (2) 44 $9.95
- IBM-53 45 $14.95
- IBM-56C $29.95
- IBM-56P $69.95
- IBM-56S 270 $109.95
- IBM-56MB $129.95
- IBM-56MR $129.95

Regular List: $899.95

IBM+Special Ship 3 Box Order $499.95

Additional Add-Ons Available!

- IBM-KB $29.95
- IBM-ENH 83-Key Keyboard $9.95
- IBM-ENM Enhanced Keyboard $69.95
- IBM-EGS Enhanced Graphics Screen $129.95
- IBM-206MK $499.95

Uniformations

64K/256K NEW! Printer Buffer

- Price: $299.95

IBM Compatible DISK DRIVES

- Price: $299.95

IBM Compat. DISK DRIVES

- Price: $299.95

Was $20 Minimum Order • U.S. Funds Only

Shipping: Add 6% plus $1.50 Insurance California Residents: Add 6%, 6% or 7% Sales Tax

Spec. Sheets — 50c each

Prices Subject to Change

Send $1.00 Postage for a FREE 1987 JAMECO CATALOG

©1986 Jameco Electronics

NEW PRODUCTS!

TTX 14" RGB Color Monitor for IBM PC, XT and Compatible Computers

- Full Signal (800 x 600 x 16-colors) or 640 x 480 x 256-colors resolution.
- 80 Hz refresh rate.
- High contrast and brightness.
- Price: $299.95

ZUCKERBOARD

- Expansion Memory Half-Card for the Tandy 1000 and Compatible Computers.
- Includes 256K RAM and Manual.
- Price: $299.95

Options for TAN-EM52K/512X

- 3.5 Micro Floppy Disk Drive for Tandy 1000, 65100A, IBM PC, XT, AT and
  Compatible Computers.
- Price: $39.95

NEW! 64K/256K NEW! Printer Buffer

- Universal
- Price: $299.95

IBM-Compatible ACCESSORIES

83-Key Keyboard

- Price: $29.95

Build an IBM PC/XT Compatible!

- IBM-64K (2) 44 $9.95
- IBM-53 45 $14.95
- IBM-56C $29.95
- IBM-56P $69.95
- IBM-56S 270 $109.95
- IBM-56MB $129.95
- IBM-56MR $129.95

Regular List: $899.95

IBM+Special Ship 3 Box Order $499.95

Additional Add-Ons Available!

- IBM-KB $29.95
- IBM-ENH 83-Key Keyboard $9.95
- IBM-ENM Enhanced Keyboard $69.95
- IBM-EGS Enhanced Graphics Screen $129.95
- IBM-206MK $499.95

Uniformations

64K/256K NEW! Printer Buffer

- Price: $299.95

IBM Compatible DISK DRIVES

- Price: $299.95

IBM Compat. DISK DRIVES

- Price: $299.95

Was $20 Minimum Order • U.S. Funds Only

Shipping: Add 6% plus $1.50 Insurance California Residents: Add 6%, 6% or 7% Sales Tax

Spec. Sheets — 50c each

Prices Subject to Change

Send $1.00 Postage for a FREE 1987 JAMECO CATALOG

©1986 Jameco Electronics
We stock the exact parts, PC board and AC adaptor for Radio Electronics February 1984 article on building your own Cable TV Descrambler.

#701 PARTS PACKAGE $29.95
Includes all the original resistors, capacitors, diodes, transistors, integrated circuits, coils, IF transformers (toko BKAN-K5552AXX).

#702 PC BOARD $12.95
Original etched & drilled silk-screened PC board used in the article.

#704 AC ADAPTOR $12.95
Original (14 volts DC @ 285ma) ac adaptor used in the article.

SPECIALS
BOTH #701 & #702 NOW $39
ALL THREE #701, #702 & #704 NOW $49
Add $2.50 shipping and handling — $4.50 for Canadian orders
We also offer quantity Discounts on 5 or more units

FREE Reprint of Radio Electronics article (February 1984) on Building Your Own CABLE TV DESCRAMBLER with any purchase of above.

60-CHANNEL CABLE CONVERTER WITH INFRARED REMOTE CONTROL
SC-60R CONVERTER $69.95
Thousands of these converters sold nationally for $69.95
We offer you this same type of converter for only $69.95
All converters are NEW, with Full manufacturer’s WARRANTY.
FEATURES:
- Full 60 Channel Capability
- Cordless Infrared remote control
- Ultra-Stable Synthesized tuning
- Microprocessor controlled PLL
- Works on all TV models, channel 3 output
- Standard/HRC Switch for compatibility with all Cable Systems
- Will work with all types of external descramblers
Add $3.50 Shipping and Handling $4.50 on Canadian Orders

ORDER TOLL FREE
1-800-227-8529
inside MA 617-695-8699 VISA, MASTERCARD or C.O.D.

J & W ELECTRONICS, INC.
P.O. BOX 800R • MANSFIELD, MA 02048
NEW RAMSEY 1200 VOM MULTITESTER

Check transistors, diodes and LEDs with this professional-quality meter. One instrument includes: diode tester, 20k ohm meter testing, 3½ million scale, polarity check, 20 measuring ranges, safety probes, high impact plastic case.

Was $399.95 NOW ONLY $249.95

MINI KITS—EASY TO ASSEMBLE, FUN TO USE BEGINNERS & PROS WILL HAVE A GREAT TIME WITH THESE KITS

FM MINI MIKE

A super Hi-Fi performance FM mini mike that really plays. Transmits a strong signal up to 200 miles with amazing clarity. Great for home use, parties, television, etc.

FM Wireless Mike Kit

Transmits up to 300 yds to any FM broadcast or receive using any type of mike. Runs on 1 AA battery. Kit includes a new high quality 44-channel FM radio receiver. This is the same unit used by CB's.

Whisper Light Kit

An interesting six-wide light make-up kit withConsults kit to 300 yds to turn on 1 AA battery. Complete kit, $1.95

Universal Test Kit

Provides the basic parts and PC board used for service of all amplifiers, televisions, recorders, etc. Complete kit includes a variety of parts for most Hi-Fi needs.

UT-5 kit $6.95

30 Watt 2 mtr PWR AMP

Satellite Class G power and features 8 times power gain. 1 watt or 8 out, 2 watt or 15 out, a watt or 30 out. Maximum output of 35 W into 750W. Complete with all parts, leads and T/R relay.

Re: 30 watt per amp relay TV-2-T-3 RF remote T-4 relay kit $22.95

ACCESSORIES FOR RAMSEY COUNTERS

Teloscope whip antenna—BNC plug $1.95

High power antenna, high gain $9.95

Low profile double balun, high speed $18.95

Direct Probe, general purpose use $13.95

Tilt bar, for CT-76, 90, 125 $3.95

CIRCLE 70 ON FREE INFORMATION CARD

RAMSEY ELECTRONICS, INC.
2575 Baird Rd.
Penfield, N.Y. 14526

December 1980

Phone Orders

Call 716-586-3950

Telex 46673S Ramsey CI

PHONE ORDERS CALL

716-586-3950

RAMSEY 20 MHz Dual Trace Oscilloscope

A handy and accurate scope for service as well as production use. Features include: high bandwidth range, high sensitivity, automatically adjustable triggering function, delayed triggered sweeping, hold-off and all trigger, 3 dynode sweep, TV input, magnification. AC or DC operation. HMF noise reduction.

3500 Dual Trace Oscilloscope $499.95

NEW

35 MHz Dual Trace Oscilloscope

A handy and accurate scope for service as well as production use. Features include: high bandwidth range, high sensitivity, automatically adjustable triggering function, delayed triggered sweeping, hold-off and all trigger, 3 dynode sweep, TV input, magnification. AC or DC operation. HMF noise reduction.

3500 Dual Trace Oscilloscope $499.95

MINI-100 FREQUENCY COUNTER

Features and capabilities of counters costing less than 30¢ include: high sensitivity, low pump up time, etc. Accuracy, 2000 hours battery life.

LOW PASS FILTER

Low pass filter, audio use. $14.95

DIGITAL MULTITESTER

Compact reliability and accuracy. This digital multimeter easily fits in your pocket. It can be used as a tester, a voltage meter, and trigger sensitive circuits.

CT-70 7 DIGIT 525 MHz COUNTER

Lab quality at a break through price. Features include: high selectability, wide range, high sensitivity, low current drain, high sensitivity, low current drain, high sensitivity, low current drain.

$199.95

ADAPTER

$5.95

OM-700 DIGITAL MULTIMETER

Professional accuracy at a snap through price. Features include: 7 digit digital display, high sensitivity, low current drain, high sensitivity, low current drain.

$199.95

MO-700 10 digit 600 MHz COUNTER

$199.95

PS-2 AUDIO MULTIPLIER

The PS-2 is handy for high sensitivity audio troubleshooting, frequency multiplications, etc. Features include: high sensitivity, low current drain, high sensitivity, low current drain.

$99.95

PS-10-B PREAMP

$99.95

RAMSEY ELECTRONICS, INC.
2575 Baird Rd.
Penfield, N.Y. 14526

CIRCLE 70 ON FREE INFORMATION CARD

Www.americanradiohistory.com
What’s New at
AMERICAN DESIGN COMPONENTS?

W e have warehouse 60,000
items at American
Design Components — expen-
sive, often hard-to-find
components for sale at
a fraction of their original cost.
You’ll find every part you
need — either brand new,
or removed from equipment
(RFE) in excellent condition.
But quantities are limited.
Order from this ad, or visit
our retail showroom and find
exactly what you need from
the thousands of items on
display.

Open Mon. - Sat. 9-5

THERE’S NO RISK.
With our 90 day warranty, any purchase can be returned for
any reason for full credit or refund.

ADAM COMPUTER KIT (less printer & w/o cabinet)
Build it yourself from subassembly kits. No
wiring necessary (just plugs together).
Finished unit comes complete with key-
board, 1 cassette digital disk drive, 2 com-
ponents, standard cabinet, and one cassette.
Also includes duplexing drive, built-in
Power Supply. Item #741C $99.00 (complete).

ADAM PRINTER

Complete, easy top cover, platen, precision
feed, parallel ribbon case, 13 lines per inch.
Competitive price. Item #8939 $69.50.

ADAM ACCESSORIES

Data Drive $641 $9.95
DID Power Supply $641 $14.95
ASCI keybord $643 $19.95
A80 Cassette $788 $19.95

COMMODORE SPECIALS!

6 K KEY MECHANICAL KEYBOARD

Gray keys with black letters.
Item #939e $5.95 New

AMERICAN DESIGN COMPONENTS, 62 JOSEPH STREET, MOONACHIE, N.J. 07074

YES! Please send me the following items:

Item No. Price

Shipping & handling, add UPS, unless otherwise specified. Add $3 plus 10% for cash only. Sales tax, N.J., weekend orders, please add 6% of total.

ORDER TOTAL

For all phone orders, call TOLL-FREE 800-524-0809. In New Jersey, 201-939-2710.

“Source” of the electro-mechanical components for the hobbyist.

- 4096 MB — Compatible with ST/ST 5 1/4” FULL HEIGHT DISK DRIVE
- IBM FORMAT COMPATIBLE
- 3 1/2” DISK DRIVE
- TABOR TC-500
- 2, 3, 4, 5 drives
- 5% more tracks
- 100% backwards compatible
- Colorful disk, easy to use
- IBM PC/XT

- DUAL 3 1/2” DISK DRIVE EXPANSION MODULE

Stacked mounting, replaces bid-
ctional 50 disk drawer. Can hold
2, 3, 4, 5 disks. 500K bytes
Storage, 300MBS, 5 bed, motorized, ax
minute. $169.00

- 5 1/4” DISK DRIVE 1/6” HT: 96 T.P.I.

"That’s ADAM COMPUTER KIT!
controllors, power supply, all
memory boards, and one cassette. Can be used with PDP-11, built-in
Power Supply. Item #741D $99.00 (complete).

HI POWER COMPUTER
POWER SUPPLY

- 12 VDC
- 15 VAC-0.5W
- 27 VAC, 12 VDC
- 4 Watt
- Polarity protected. Can be
mounted for either or both.
Dimensions: 3” x 4” x 4” deep
Mfr - Power Systems PS1500
Item #8543 $19.95 New

DIGITAL OPTOMETER

- 3% digit. 3” High display.
- Mountable on panel.
- Accuracy: 0.5%.
- Nominal range: 2 VDC
- Case size: 1” x 1” x 1/2” deep
Mfr - Heidolph Instruments #6345
Item #8219 $22.50 New

STEEPING MOTORS

for ROBOTICS

Precision stepper with
connections on 20 to 50
steps. Speeds up to
8,000 steps.

Fig. 1 - 2

Fig. 2 - 3

BIPOLAR

- 12V @ 30A
- 12V @ 4A
- 115VAC-0.5W
- 24V @ 1.5A
- 4 Watt
- Polarity protected. Can be
mounted for either or both.
Dimensions: 3” x 4” x 4” deep
Mfr - Power Systems PS1500
Item #8543 $19.95 New

PUMPS - COMPRESSORS - BLOWERS - MOTORS - POTENTIOMETERS - COUNTERS - TIMERS - RELAYS - VOLTAGE REGULATORS - POWER SUPPLIES

- A0AM CASSETTES

(A3x3 ordered)

- 48 KEY KEYBOARD

- 6V @ 9.9 AH
- 12V @ 450 ma
- 1 2V @ 1.05 AH
- 12V @ 600 ma

- GEL-CELL BATTERIES

(Rechargeable)

For use with
- Model cars
- Trains, boats, etc.
- Cars
- Trucks, etc.

- AMERICAN DESIGN COMPONENTS

62 JOSEPH STREET, MOONACHIE, N.J. 07074

YES! Please send me the following items:

Item No. Price

Shipping & handling, add UPS, unless otherwise specified. Add $3 plus 10% for cash only. Sales tax, N.J., weekend orders, please add 6% of total.

ORDER TOTAL

For all phone orders, call TOLL-FREE 800-524-0809. In New Jersey, 201-939-2710.
**THE NAME YOU CAN TRUST IN ELECTRONIC TEST EQUIPMENT**

**TENMA Combination Function Generator and Frequency Counter**
- Six digit display
- Output range: 2Hz-2MHz
- Seven ranges
- Counter range: 1Hz-10MHz
- 5-15V TTL and CMOS output
- Wave forms: sine, triangle, square, pulse, and ramp
- For detailed specifications call for a complete Tenma catalog

#72-380
$219.90 (ea.)

**TENMA 120MHz Frequency Counter**
- Eight digit LED display
- Measurement range: 1Hz-120MHz
- 10MHz and 100MHz input sensitivity
- Counter range: 1kHz-10MHz
- Carry case included
- For detailed specifications call for a complete Tenma catalog

#72-375
$189.95 (ea.)

**TENMA 30A Power Supply**
- Output voltage: 1-15VDC
- Displays voltage, current and power simultaneously
- Output current: 30A, 24A
- Continuous fan cooled

#72-035
$227.80 (ea.)

**TENMA Digital LCR Meter**
- Measures inductance, capacitance and resistance
- ESR: 100-200MHz
- Display: 4½ digit
- Carrying case included
- For detailed specifications call for a complete Tenma catalog

#72-370
$149.95 (ea.)

**TENMA Clamp-On/DMM**
- Measures AC current via clamp
- High quality built-in DMM measures DC volts, AC volts, resistance, AC current and peak hold
- Data hold, audible continuity buzzer
- For detailed specifications call for a complete Tenma catalog

#72-395
$84.90 (ea.)

**TENMA 20MHz Dual Trace Oscilloscope**
- Two high quality 10:1 probes included
- For detailed specifications call for a complete Tenma catalog

#72-320
$389.95 (ea.)

**MCM ELECTRONICS**
A PREMIER Company
SOURCE NO. RE-27

**CALL TOLL FREE 1-800-543-4330**
In Ohio 1-800-762-4315 • In Alaska and Hawaii 1-800-858-1849
CIRCLE 87 ON FREE INFORMATION CARD

**Be Sure To Call For Your FREE Catalog! Over 6,000 Items!**

We also have... a full line of test equipment, computer accessories, television parts, flybacks, tubes, lamps, capacitors, resistors, cartridges, styli, wire, CATV equipment, the largest selection of original Japanese semiconductors in the country and more.

**Terms:**
- 10% minimum order $1.00 charge for orders under $10
- 20% minimum charge on orders under $50
- Electronic parts shipped UPS G.O.B.
- Entire order shipped within 24 hours
- Orders over $100 shipped UPS G.O.B.
- 2% discount on orders over $100
- Orders shipped within 24 hours
- VISA - MasterCard - American Express
- 30-day return privilege
- Free shipping and handling charges exceed $3.75, the balance due will be sent COD.
## Dynamic RAMs

<table>
<thead>
<tr>
<th>RAM</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>4164-150NS</td>
<td>$ .95</td>
</tr>
<tr>
<td>41256-150NS</td>
<td>$2.55</td>
</tr>
</tbody>
</table>

## Integrated Circuits

<table>
<thead>
<tr>
<th>Code</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>65C02</td>
<td>$8.95</td>
</tr>
<tr>
<td>AD0816CCN</td>
<td>6.95</td>
</tr>
<tr>
<td>F01767-02</td>
<td>7.95</td>
</tr>
<tr>
<td>WD2143M-02</td>
<td>4.95</td>
</tr>
<tr>
<td>PAL21I0NC</td>
<td>2.95</td>
</tr>
</tbody>
</table>

## EPROMs

<table>
<thead>
<tr>
<th>EPROM</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2721-450NS</td>
<td>$2.95</td>
</tr>
<tr>
<td>2732A-450NS</td>
<td>2.25</td>
</tr>
<tr>
<td>2764-450NS</td>
<td>3.00</td>
</tr>
<tr>
<td>2764-250NS</td>
<td>3.75</td>
</tr>
<tr>
<td>27256-300NS</td>
<td>8.75</td>
</tr>
</tbody>
</table>

## Drives

<table>
<thead>
<tr>
<th>Drive</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teac 55B</td>
<td>$85.00</td>
</tr>
<tr>
<td>Fujitsu MZ551A</td>
<td>79.00</td>
</tr>
<tr>
<td>MIT 4653 Quad/OS 96 TP1</td>
<td>69.95</td>
</tr>
<tr>
<td>Seagate 20MB 1/2 HD</td>
<td>298.00</td>
</tr>
<tr>
<td>Quantum 40MG Full HL</td>
<td>795.00</td>
</tr>
</tbody>
</table>

### PC/AT Compatible System Board

**$749.00**

*1 Megabyte Installed*

### PC/XT Compatible System Board

**$129.00**

*Turbo/640KB w/o Bios & Ram*

### PC/XT System Kit

**$795.00**

*Turbo/640KB*

### Hard Disk Drive

**$895.00**

*PC At Compatible 70MB — 25mssec Access*

### TOLL FREE

800/621-0854 ext. 245

**800/646-4949**

### ADVERTISING INDEX

**RADIO-ELECTRONICS** does not assume any responsibility for errors that may appear in the Index below.

<table>
<thead>
<tr>
<th>Free Information Number</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>“2001”</td>
<td>CV3</td>
</tr>
<tr>
<td>81</td>
<td>106</td>
</tr>
<tr>
<td>A.T.S. Satellite</td>
<td>37</td>
</tr>
<tr>
<td>108</td>
<td>187</td>
</tr>
<tr>
<td>ASCII Sales</td>
<td>84</td>
</tr>
<tr>
<td>76</td>
<td>191</td>
</tr>
<tr>
<td>AP Products, Brand of MI</td>
<td>84</td>
</tr>
<tr>
<td>107</td>
<td>191</td>
</tr>
<tr>
<td>All Electronics</td>
<td>84</td>
</tr>
<tr>
<td>— Amazing Devices</td>
<td></td>
</tr>
<tr>
<td>— American Design Components</td>
<td></td>
</tr>
<tr>
<td>77</td>
<td>191</td>
</tr>
<tr>
<td>R &amp; K Precision</td>
<td>84</td>
</tr>
<tr>
<td>98</td>
<td>191</td>
</tr>
<tr>
<td>Beckman Industrial</td>
<td>84</td>
</tr>
<tr>
<td>85</td>
<td>191</td>
</tr>
<tr>
<td>Blue Star Industries</td>
<td>84</td>
</tr>
<tr>
<td>109</td>
<td>191</td>
</tr>
<tr>
<td>C &amp; S Sales</td>
<td>84</td>
</tr>
<tr>
<td>60</td>
<td>191</td>
</tr>
<tr>
<td>CIR</td>
<td>84</td>
</tr>
<tr>
<td>186</td>
<td>191</td>
</tr>
<tr>
<td>Calibrator</td>
<td>84</td>
</tr>
<tr>
<td>188</td>
<td>191</td>
</tr>
<tr>
<td>Carg Laboratories</td>
<td>84</td>
</tr>
<tr>
<td>189</td>
<td>191</td>
</tr>
<tr>
<td>Cameo Enterprises</td>
<td>84</td>
</tr>
<tr>
<td>127</td>
<td>191</td>
</tr>
<tr>
<td>Dico Industries</td>
<td>84</td>
</tr>
<tr>
<td>96</td>
<td>191</td>
</tr>
<tr>
<td>Hel-Phone Industries</td>
<td>84</td>
</tr>
<tr>
<td>95</td>
<td>191</td>
</tr>
<tr>
<td>Dick Smith Electronics</td>
<td>84</td>
</tr>
<tr>
<td>82</td>
<td>191</td>
</tr>
<tr>
<td>(I)</td>
<td>105</td>
</tr>
<tr>
<td>— Digital Research Computers</td>
<td>92</td>
</tr>
<tr>
<td>57</td>
<td>191</td>
</tr>
<tr>
<td>Digitaltron</td>
<td>84</td>
</tr>
<tr>
<td>194</td>
<td>191</td>
</tr>
<tr>
<td>ESI</td>
<td>84</td>
</tr>
<tr>
<td>— Electronic Technology Today</td>
<td>43,44</td>
</tr>
<tr>
<td>120</td>
<td>191</td>
</tr>
<tr>
<td>Elephant Electronics</td>
<td>84</td>
</tr>
<tr>
<td>181</td>
<td>191</td>
</tr>
<tr>
<td>Erionix</td>
<td>84</td>
</tr>
<tr>
<td>100</td>
<td>191</td>
</tr>
<tr>
<td>Firestick II</td>
<td>84</td>
</tr>
<tr>
<td>122</td>
<td>191</td>
</tr>
<tr>
<td>FlexTech Technik</td>
<td>84</td>
</tr>
<tr>
<td>123</td>
<td>191</td>
</tr>
<tr>
<td>Plume Manufacturing</td>
<td>84</td>
</tr>
<tr>
<td>114</td>
<td>191</td>
</tr>
<tr>
<td>Jorden</td>
<td>84</td>
</tr>
<tr>
<td>102</td>
<td>191</td>
</tr>
<tr>
<td>Jan Cycles</td>
<td>84</td>
</tr>
<tr>
<td>103</td>
<td>191</td>
</tr>
<tr>
<td>Joseph Electronics</td>
<td>84</td>
</tr>
<tr>
<td>97</td>
<td>191</td>
</tr>
<tr>
<td>MCH Electronics</td>
<td>84</td>
</tr>
<tr>
<td>98</td>
<td>191</td>
</tr>
<tr>
<td>Mark V. Electronics</td>
<td>84</td>
</tr>
<tr>
<td>200</td>
<td>191</td>
</tr>
<tr>
<td>MasterTech Laboratories</td>
<td>84</td>
</tr>
<tr>
<td>201</td>
<td>191</td>
</tr>
<tr>
<td>Microprocessor Unted.</td>
<td>84</td>
</tr>
<tr>
<td>202</td>
<td>191</td>
</tr>
<tr>
<td>NRI</td>
<td>84</td>
</tr>
<tr>
<td>203</td>
<td>191</td>
</tr>
<tr>
<td>NTS</td>
<td>84</td>
</tr>
<tr>
<td>204</td>
<td>191</td>
</tr>
<tr>
<td>Optron</td>
<td>84</td>
</tr>
<tr>
<td>110</td>
<td>191</td>
</tr>
<tr>
<td>OrCAD Systems</td>
<td>84</td>
</tr>
<tr>
<td>205</td>
<td>191</td>
</tr>
<tr>
<td>Pacfic Cable</td>
<td>84</td>
</tr>
<tr>
<td>101</td>
<td>191</td>
</tr>
<tr>
<td>Pensona Electronics</td>
<td>84</td>
</tr>
</tbody>
</table>

**Portal: 44**

**IAG Electronics: 5**

**KCA D & S: 29**

**Radio Shack: 95**

**Rand: 109**

**Regency: 11**

**RE Reprint Bookstore: 13**

**Sarasota Electronics: 112**

**Silicon Valley Surplus: 94**

**Star Circuits: 143**

**Steven Mail Order Electronics: 87**

**Tektronix: CV2**

**Test Probes: 44**

**Time-Warner: 32**

**United Electronic Supply: 10**

**United Imports: 43**

**Web B. Allen: 27**

---

Gernsback Publications, Inc., 500-B Di-County Blvd., Farmingdale, NY 11735

(516) 293-3000

President: Larry Steckler

Vice President: Cathy Steckler

For Advertising ONLY 516-293-3000

Larry Steckler

Publisher

Arlene Feldman

Advertising Director

Sheila Weinman

Advertising Associate

Lisa Steckler

Credit Manager

Christina Estrada

Advertising Assistant

SALES OFFICES

**EAST/SOUTHEAST**

Stanley Levitan

Eastern Sales Manager

Radio-Electronics

259-23 57th Avenue

Little Neck, NY 11362

718-428-6037, 516-293-3000

**MIDWEST/TEXAS/ARKANSAS/OKLA.**

Ralph Bergen

Midwest Sales Manager

Radio-Electronics

540 Frontage Road — Suite 339

Northfield, IL 60093

312-446-1444

**PACIFIC COAST/MOUNTAIN STATES**

Marvin Green

Pacific Sales Manager

Radio-Electronics

1733 Morrison St. — Suite 207

Sherman Oaks, CA 91403

818-388-2981
An electronics revolution is in the making, but you don't have to wait until 2001 to find out how it will change your life in the 21st century. Radio-Electronics will forecast the coming changes and how they will affect you in the May 1987 issue!

Created by a special editorial task force—two years in preparation—this unique issue, 2001, takes you into the research laboratories of Westinghouse, Texas Instruments, Ford and Bell Labs where the future is being invented today!

You'll get an advance look at what's coming in artificial intelligence... new cars and highways (cleaner, quieter and more efficient)... futuristic energy sources like magneto-hydrodynamic and particle-beam generators... personal communications systems that will give you instant access to anyone anywhere... super computers and teaching breakthroughs that will multiply your capacity to learn!

Arthur Clarke introduces 2001. Isaac Asimov explores the marvels of robotics. But it is not science fiction. Rather it is emerging technology with a solid foundation in current research and development.

And its impact will be enormous. It will change the way you work... the way you think... the way you live!

2001 is the kind of special publishing event that can only happen once in any magazine's lifetime and it will happen to Radio-Electronics in May, 1987.

With extra features and extra pages, 2001 will bear a premium cover cost, but you can reserve your copy now at less than the regular cover cost by mailing any one of the subscription orders in this issue.

2001 is coming in May. Make sure now that you don't miss it!
BP Video Processor gives you precision picture control.

You’ll get 5 units in one! The BP Video Processor functions as a Stabilizer to end video guard distortion... as an Enhancer to provide peak sharpness... as an RF Converter to feed signals from video cameras, computer or VCR in your TV... as a Video Fader for professional fade-in and fade-out effects... and as a Dual Output Distribution Amplifier to send TV signals to other sets.

Model V-1880

$79.95

Preserve your memories on videotape

The video-cine converts your slides and home movies to VCR tape with any video camera. This easy-to-use model features precision optics and rear projection. Macro lens attachment available for cameras without close-up capability.

Model V-1701

Micro Lens Attachment

Model V-14

$34.95

$14.95

Increase the life of your VCR head and tape with BP VHS or Beta Tape Rewinders.

Don’t risk worn-down heads and tape damage by rewinding on your VCR. BP Tape Rewinders feature counter, soft button action, controlled speed and automatic shut-off.

Model V-7779

Model V-7780

$49.95

$49.95

A small investment... buys BIG VIDEO PERFORMANCE!

Get the most out of your video and stereo equipment

Add Stereo to your Video

The mini speaker with maxi sound. 3" long throw woofer, 1" soft dome tweeter, 2" extended midrange speaker. Max power 50 watts.

Model HF-9

$29.95

per pair

FM Antenna fine-tunes your fm/stereo reception.

You’ll get clear, crisp, undistorted sound from this high quality, directional FM antenna. Mounts instantly indoors, comes complete with coaxial cable and transformer.

Model FM-9700

$34.95

Model V-1895

$149.95

Get true-to-life color... and reduce noise... with Audio Video Color Processor.

This versatile color processor corrects off color tape, eliminates single color dominance and restores sharpness in detail. Plus, it stabilizes copy guarded tapes and filters audio noise.

Model V-7790

Model V-7780

$49.95

$49.95

Send for FREE catalog of hundreds of items. Money orders, checks accepted. C.O.D.’s require 25% deposit.

Fordham

260 Motor Parkway, Hauppauge, NY 11788

Toll Free 800-645-9518

In NY State 800-832-1446

www.americanradiohistory.com