Radio-Electronics®

FMX: IS IT GOOD FOR FM RADIO?

OCTOBER 1989

TECHNOLOGY - VIDEO - STEREO - COMPUTERS - SERVICE

BUILD R-E'S FAX-MATE

Save the cost of a second phone line!

BUILD A REMOTE-CONTROLLED A/B SWITCH

For the ultimate couch potato: Never leave your easy chair again!

BUILD A SHORTWAVE CONVERTER

Convert any AM radio to a one-band shortwave receiver

AUTOMATED TEST EQUIPMENT

A roundup of available techniques and features

BUILD A SPECTRUM MONITOR

Convert your oscilloscope into a spectrum analyzer

COMPUTERDIGEST

How to put the 68705 microcontroller to work

10

0 71896 48783 1

$2.25 U.S.
$2.75 CAN

A GERNSBACK PUBLICATION

October 1989

Radio-Electronics®

Vol. 60 No. 10

BUILD THIS

TECHNOLOGY

COMPUTERS

PAGE 83

PAGE 52

DEPARTMENTS

AND MORE

ON THE COVER

While facsimile seems destined to become a ubiquitous fixture in offices, the growth of home and home-office fax is slowed considerably by the requirement of a second dedicated phone line. The convenience of fax often isn't worth the expense of installing the line, along with the monthly charges.

But our Fax-Mate lets you use a fax machine on the same line as your regular phone! The caller simply dials your number, and when the Fax-Mate answers, he presses the # key. His call is automatically switched to the fax machine. Yes, the Fax-Mate works with a modem, too!

COMING NEXT MONTH

THE NOVEMBER ISSUE GOES ON SALE OCTOBER 3.

BUILD R-E'S VIDEO CONTROL SYSTEM
Add wipes, fades, and other special effects to your home video movies.

BUILD THE DECA BOX
A resistance decade box with the addition of capacitance selection.

INTERFACE A DIGITAL COMPASS TO YOUR COMPUTER
Now your robot can keep track of the direction in which it's heading.

CIRCUIT COOKBOOK
Practical circuits that let you put CMOS bilateral switches to work.

SERVICING CD PLAYERS
A look at the basic operating principles of CD players, and the equipment needed to service them.

RADIO-ELECTRONICS, (ISSN 0033-7862) October 1989. Published monthly by Gernsback Publications, Inc., 500-B Bi-County Boulevard, Farmingdale, NY 11735 Second-Class Postage paid at Farmingdale, NY and additional mailing offices. Second-Class mail registration No. 9242 authorized at Toronto, Canada. One-year subscription rate U.S.A. and possessions $17.97, Canada $23.97, all other countries $26.97. All subscription orders payable in U.S.A. funds only, via international postal money order or check drawn on a U.S.A. bank. Single copies $2.25. © 1989 by Gernsback Publications, Inc. All rights reserved. Printed in U.S.A.

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

Radio-Electronics

Hugo Gernsback (1884-1967) founder
M. Harvey Gernsback, editor-in-chief, emeritus

Larry Steckler, EHF, CET, editor-in-chief and publisher

EDITORIAL DEPARTMENT
Art Kleiman, editorial director
Brian C. Fenton, editor
Marc Spiwak, associate editor
Daniel Goodman, technical editor
Jonathan A. Gordon, assistant technical editor
Teri Scaduto, assistant editor
Jeffrey K. Holtzman, computer editor
Robert A. Young, assistant editor
Byron G. Wels, editorial associate
Jack Darr, CET, service editor
Robert Grossblatt, circuits editor
Larry Klein, audio editor
David Lachenbruch, contributing editor
Don Lancaster, contributing editor
Richard D. Fitch, contributing editor
Kathy Campbell, editorial assistant
Andre Duzant, technical illustrator
Injae Lee, assistant illustrator

PRODUCTION DEPARTMENT
Ruby M. Yee, production director
Robert A. W. Lowndes, editorial production
Karen Tucker, advertising production
Marcella Amoroso, production traffic

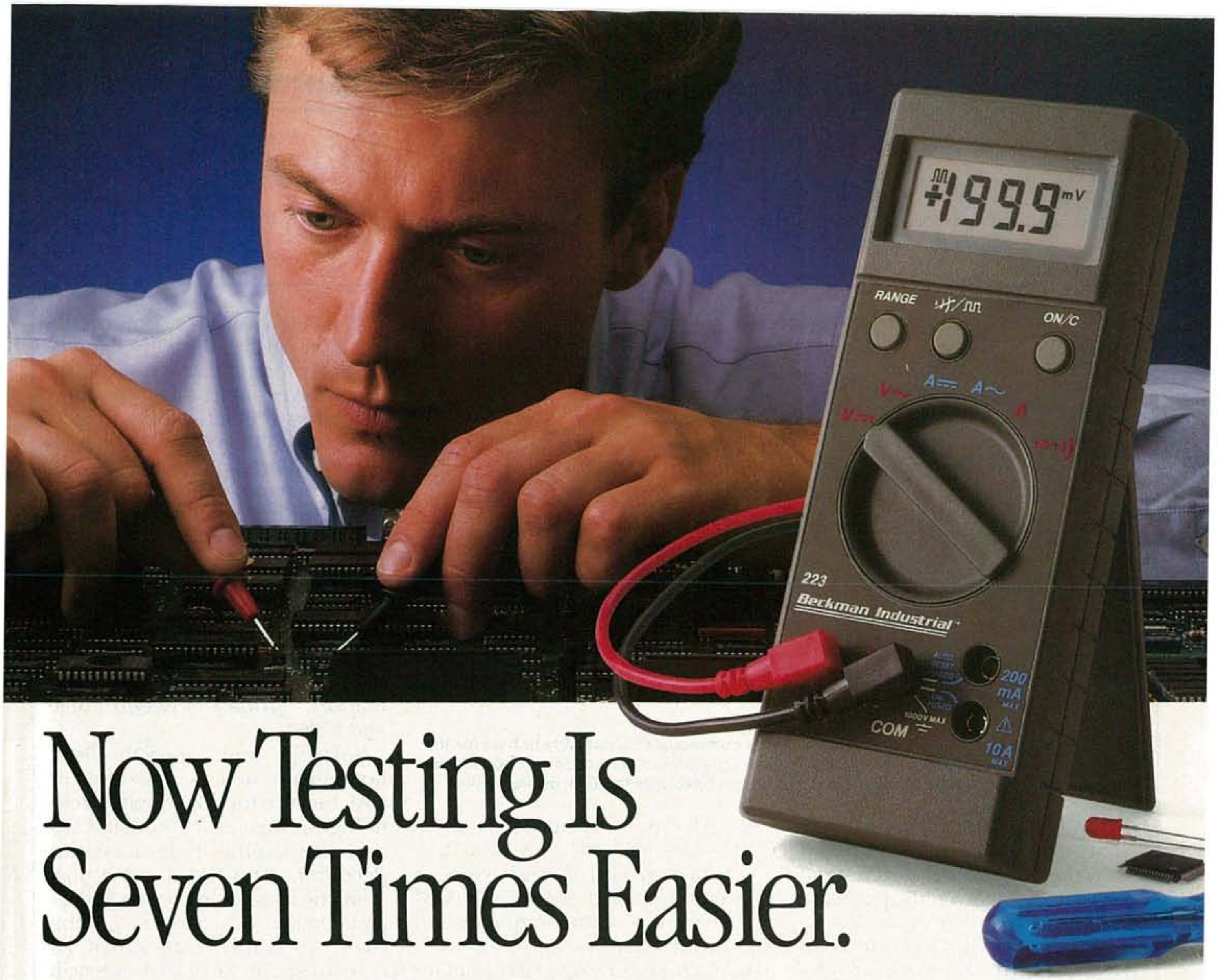
CIRCULATION DEPARTMENT
Jacqueline P. Cheeseboro, circulation director
Wendy Alanko, circulation analyst
Theresa Lombardo, circulation assistant

Typography by Mates Graphics
Cover photo by John D. McManus

Radio-Electronics is indexed in *Applied Science & Technology Index* and *Readers Guide to Periodical Literature*.
Microfilm & Microfiche editions are available. Contact circulation department for details.

Advertising Sales Offices listed on page 108.

MPA The Audit Bureau EIA



Now Testing Is Seven Times Easier.

1. End Blown Fuses.
The new 200 Series multimeter is protected from excess voltage or surges with a self-resetting fuse.

2. Keep Your Eyes On Your Work.
Quickly probe a circuit board listening for audible tone changes that pinpoint the problem without glancing at the LCD.

3. Detect Intermittents.
Hear a distinctive crackling sound when an intermittent occurs.

4. Find Dead Capacitors.
Capacitor voltage build-up or bleed-off is heard loud and clear with the 200 Series' Audible Readout.

5. Find Logic Stuck-Ats.
Using standard leads, a fast Logic Pulse Detector lets you easily detect pulses down to 50ns.

6. Adjust Voltage Levels.
When adjusting audio or video response, an audible tone that changes pitch as measured signals increase or decrease permits faster and easier adjustments.

7. Stop Third Hand Problem.
Tilt stand and Skyhook,™ auto-ranging, and Audible Readout allow you to spend less time fiddling with your meter.

FEATURES	222	223
Audible Readout		•
Logic Pulse Detector		•
Fast Auto-Ranging	•	•
Self-Resetting Fuse	•	•
Auto-off Battery Saver	•	•
DC Voltage Accuracy	0.5%	0.25%
Warranty	2 years	2 years
Price	$129.00	$149.00

The 200 Series. Multimeters that take the work out of work. Call or write for complete information.
1-800-227-9781 Inside California.
1-800-854-2708 Outside California.

30 DAY MONEY BACK GUARANTEE

Beckman Industrial™
An Affiliate of Emerson Electric Co.

Instrumentation Products Division
3883 Ruffin Road, San Diego, CA 92123-1898
(619) 495-3200 • FAX (619) 268-0172 • TLX 249031

CIRCLE 98 ON FREE INFORMATION CARD

What's News

Copy-protected DAT

DAT CASSETTES, LIKE THIS ONE, may become commonplace, possibly in time for the Christmas-shopping season. That's if the new copy-protection scheme proposed by Philips is approved by the RIAA and can be incorporated into the DAT decks by then.

N.V. Philips has devised a copy-protection method, dubbed *Solocopy*, for *D*igital *A*udio *T*ape (DAT) decks that could pave the way for a pre-Christmas market introduction of the long-delayed product. Although the technology—which provides CD-or-better quality in a cassette-tape format—has been available for three years, pressures from the *R*ecording *I*ndustry *A*ssociation of *A*merica (RIAA) have kept the actual product out of the consumer's reach. Worried about loss of revenues due to potential DAT piracy and CD-to-DAT remastering, the RIAA has been trying to get federal anti-copying legislation passed.

While no hard details have been released, Philips' Solocopy is said to make use of the unique ID and subcode data that is on each CD title. When copying a CD selection onto a digital-audio tape, Solocopy would search out that data and store it in non-volatile memory. The next attempt to copy that selection would be unsuccessful, as Solocopy recognizes the data and stops the recording. As for digital tape-to-tape copying, it is said that Solocopy "slips a bit," so that duplicates of prerecorded DAT materials will play only on the deck on which they were copied.

For a product that has yet to hit the shelves—and one that manufacturers predict will be as big a consumer hit as CD's—DAT has already acquired a checkered past. Two years ago, CBS Labs tried to market a notch-filter protection method that was rejected by audiophiles and the National Bureau of Standards due to its detrimental effect on audio quality. DAT decks, which are widely sold in Japan for about $1000, have been available to Americans only via the "gray market," priced between $1000 and $2000.

Solocopy could open the door not only for the U.S. marketing of DAT, but also for other digital technologies, such as recordable CD's and the *D*igital *V*ideo*C*assette *R*ecorders (DVCR's) that are now being developed in Europe and Japan. On June 9, at a meeting of the *I*nternational *F*ederation of *P*honogram and Videogram *P*roducers (IFPI), representatives previewed Solocopy and agreed to accept it—*if* the RIAA gives its approval. Once that hurdle is passed, both the RIAA and the IFPI would probably abandon attempts to impose royalty fees on blank tapes, DAT decks, or both. The final step would be some hardware modifications to existing DAT decks.

Low-energy digital IC's

A method for producing low-energy digital integrated circuits that can be used in solar-powered equipment has been developed by researchers at Uppsala University in Sweden. The technique is based on the *ME*tal *S*emiconductor *F*ield-*E*ffect *T*ransistor (MESFET), which uses n- and p-type transistors (both with Schottky gates) and power rectifiers.

The MESFET, which also was developed in the Department of Electronics at Uppsala University, is related to *C*omplementary *ME*tal *S*emiconductor (CMES) technology. What sets CMES circuits apart is that metal can be placed directly on the transistors without an insulating film, resulting in less-than-average power consumption and lower sensitivity to radiation. Projected applications for the low-energy digital IC's are in battery-powered portable equipment and in systems such as satellites that are powered by solar cells.

Smallest laser

A team of scientists from Bellcore and AT&T Bell Laboratories have created the world's smallest surface-emitting laser. Two million of them can fit in the area the size of a fingernail. The new device requires one hundred times less space than conventional semiconductor lasers, making them useful for a variety of applications, including high speed communications. **R-E**

VIDEO NEWS

DAVID LACHENBRUCH,
CONTRIBUTING EDITOR

• **VHS-C fights back.** Although most Americans prefer full-sized VHS camcorders, the two smaller formats are making some inroads into video photography. This year has seen 8mm pull out into a strong lead over VHS-C, despite the latter's claim to "compatibility" with VHS (through the use of an adaptor to play the smaller VHS-C cassette). The VHS-C group has now mapped out a strategy to regain lost ground, which involves a major promotion campaign and two technological developments.

Four manufacturers have demonstrated VHS decks that will record or play a VHS-C cassette without an adaptor. Those should be available in 1990 but, unfortunately, they will be quite expensive, at least at the start. Tape manufacturers, meanwhile, have increased the recording time of VHS-C from 20 to 30 minutes in the standard mode and from 60 to 90 minutes in the extended-play mode. Since Super VHS-C cassettes have also been extended, there has been talk of offering pre-recorded movies in the compact super format. The standard 8mm cassette can record for two hours in the fastest mode, and four hours in LP mode. If VHS-C's popularity continues to slip in 1990, you can expect to see defections to 8mm by major VHS manufacturers by fall or winter.

• **Widescreen TV.** Most of the proposed high-definition TV systems specify pictures with an aspect ratio of 16:9, the equivalent of Cinemascope and similar motion-picture systems. Consumer surveys have shown an overwhelming preference for the wide aspect ratio as opposed to today's TV screen proportions of 4:3. Worldwide, major picture-tube manufacturers are preparing to produce tubes in the new widescreen proportions. In Europe, even before true HDTV begins, direct satellite broadcasting is expected to be available in the widescreen format. There is even speculation that the two largest European television manufacturers—Philips and Thomson—will introduce widescreen TV sets in 1990.

In the United States, at least one manufacturer is exploring the idea of offering a widescreen TV set—as a top-of-the-line "home theater." Although there will be no widescreen broadcasting available in the United States next year, there *will* be a program source: movies on tape or videodisc. Some films are now available in the "letterbox" format, with black bands along the top and bottom, so they may be viewed in their original proportions. One manufacturer is discussing the idea of including a "widescreen" button on the TV set's remote control to enlarge the letterbox movie to the full dimensions of the 16:9 screen. Thus the widescreen TV would be a kind of special "movie-edition" TV.

What do you do with your widescreen TV when a regular 4:3 television picture is being shown? Philips has already provided the answer in a slightly different context: *P*icture-*O*utside-*P*icture, or POP. That system would provide three smaller pictures from other channels at the side of the main picture, to permit viewing of four pictures at one time. Another manufacturer has proposed, with tongue in cheek, a "wood-grain" chip that will disguise the extra screen width as part of the cabinet when not in use.

• **New kind of projection.** Just as liquid-crystal displays, or LCD's, made tiny television sets possible, they are also giving birth to new types of giant-screen sets, with pictures up to 100 inches in diagonal measurement. The Summer Consumer Electronics Show saw LCD projection systems by Sharp, Toshiba, JVC, and Sanyo, but only Sharp's carried a delivery date (this fall) and a suggested list price ($5,000). All of the systems use three LCD panels as light valves, with an external light source. They have one focusable lens, instead of the three separate lenses used in CRT projectors, and are able to project pictures of various sizes. The projectors are relatively small, about the size of an old-fashioned "magic lantern" slide projector or a large VCR. Pictures shown on the larger screen models are still rather coarse, but represent a marked improvement over earlier versions. The Eastman Kodak projector produced in Japan by Seiko (**Radio-Electronics**, January 1989) was the first LCD TV projector to go on the market, less than a year ago. **R-E**

READY-TO-USE PROFESSIONAL INSTRUMENTS NOW FROM HEATH

Backed by the expertise that makes our instruments famous

- An engineering department that insists on honest value in every product.
- Rigorous quality assurance inspection.
- Full one year warranty.
- Outstanding manuals with complete specifications, operating instructions, schematics and more.
- Technical assistance hotline: (616) 982-3315.
- Our own factory service department.

A DMM THAT'S GOT IT ALL

This powerful handheld does more than any DMM we've seen. It lets you measure frequency to 20 MHz, works as a logic probe to 20 MHz, tests transistor beta, measures capacitance plus does everything you'd expect a DMM to do. Even measures resistance to 2000 MΩ!

SM-2372 .... $99.95

Specifications: At 23 ±5° C, DC Volts: ±0.5% of reading ±1 digit, 200 mV -1000 V. Input impedance 10 MΩ. Overload protection: 200 mV range, 500 VDC/350 VAC 15 seconds. Other ranges, 1200 VDC/850 VAC, 60 seconds. AC Volts: 200 mV–750 V. Accuracy ±1.0 % of reading ± 4 digits except 1.5% on 750 V range. DC Amps: 200 µA-10 A. ±1% of reading ±1 digit except 2.0 % on 10 A range. AC Amps: 200 µA-10 A. Accuracy ±1.2% of reading ± 4 digits except ±2% on 10 A. Resistance:200 Ω-2000 MΩ. Overload Protection, 200 mV range, 500 VDC/350 VAC for 15 seconds; Other ranges, 1200 VDC/850 VAC for 60 seconds. Capacitance: 2 nF-20 µF. Frequency: 2 KHz-20 MHz. Logic: TTL to 20 MHz. Other: Diode test, continuity beeper, beta.

ONE OF OUR BEST SELLERS

Here's a 3-1/2 digit DMM that will give you excellent and reliable service. Full DMM functions include current to 10 A, capacitance and transistor beta. A lined carrying case keeps your DMM safe from the bumps and scrapes of everyday use. Kit version also available.

SM-2320 .... $77.95

Specifications: DC Volts: 200 mV-1000 V ±0.5% of reading ±1 digit. Overload protection: 1000 VDC/750 VAC except 500/350 on 200 mV. Input 10 MΩ. AC Volts: 200 mV-750 V ±1.25% of reading ±4 digits, 40 Hz-10 kHz. Overload: 1000 VDC/750 VAC except 500/350 on 200 mV. Input 10 MΩ. DC Amps: 200 µA-10 A, ±1% of reading ±1 digit except ±2%/±3 digits on 10 A. AC current: 20 mA-10 A ±1.5% ±3 digits except ±2.5%/±4 digits on 10 A. Resistance: 200 Ω-20 MΩ. Overload protection, 500 VDC/VAC. Capacitance: 2 nF-20 µF. Other: diode check, continuity beeper, beta.

HALF PRICE SPECIAL!

ONLY $12.47

Order any product from this ad and get our popular shirt pocket miniature DMM SM-2300-A for only **$12.47** — half our regular price.

Specifications: Autoranging 3-1/2 digit DMM. DC volts: 2000 mv to 450 V, ±1.3% ±4 counts. Approx. 11 MΩ input resistance. Max input, 450 VDC. AC volts: 2000 mV to 450 V, ±2.3% ±8 counts, 50 to 400 Hz. Approx. 11 MΩ input resistance. Max input, 450 V. Resistance: 2000 Ω to 2 MΩ ±2% ±4 counts.

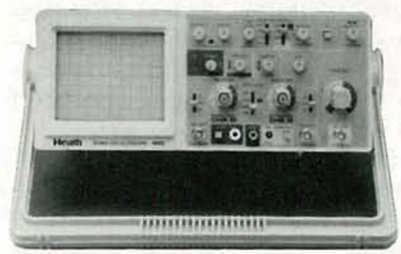
A POWER SUPPLY FOR EVERY WORKBENCH

Here's an excellent value in an all-around bench power supply. Dual meters let you continuously monitor voltage and current, and 0-30 volt 3-amp output fills most common power supply needs. Use the constant current mode to charge rechargeable batteries, limit power to circuits under test and operate devices that are current dependent.

SP-2762 .... $199.95

Specifications: Output voltage: 0-30 VDC continuously variable. Coarse and fine controls. Output load: 0-3 A continuous. Output impedance: Typically less 0.2 Ω to 10 KHz. Ripple: To 10 kHz, less than 5 mV p-p (0.5 mV rms typical). Load regulation: ±0.25% ±3 mV, 1-100% of rated current. Line regulation: ±0.25% ±2 mV for ±10% line variation. Current limiting: 0-3 A, variable. Power: 120 VAC/240 VAC, ±10%, 50-60 Hz, 180 watts.

DELUXE SCOPES ARE A PLEASURE TO USE



These oscilloscopes offer the measurement capability you need, plus luxury features that make them fun to own. TV triggers, 1 mV/div sensitivity, differential and X-Y measurements, plus beam finder, component tester, graticule illumination, and other features many manufacturers omit. Enjoy a top-quality 25 or 40 Mhz scope backed by a reliable name, full warranty and complete specifications.

25 MHz: SO-4552 .... $399.95
40 MHz: SO-4554 .... $599.95

Specifications: Vertical: 1 mV/div-5 V/div. Bandwidth loss at 1 mV/div. Accuracy ±3% at 1 KHz, ±5% at 1 mV/div. Overshoot: less than 5%. Max input: 400 V. Modes: CHA, CHB, dual, add. Horizontal: .2 s - .1 µs/div, plus X10 magnifier. Trigger: CHA, CHB, line, ext. Auto, norm, TV-V, TV-H, +/-. Power: 90-132/198-264 VAC, 50/60 Hz, 45 W. Weight: 16.7 lbs.

To order CALL TOLL FREE 1-800-253-0570

Use order code 217-320

for credit card orders, 24 hrs a day

For your free HEATHKIT catalog call 1-800-44-HEATH

We guarantee every specification we publish on every product we sell.

Heath Instruments
PO Box 8589
Benton Harbor, MI 49022

ASK R-E

WRITE TO:

ASK R-E
Radio-Electronics
500-B Bi-County Blvd.
Farmingdale, NY 11735

I NEED VALUES

I'm sending you a schematic of a circuit that turns on a cassette recorder when the telephone rings so that you can tape your calls. I don't have the values for all the parts, so can you indicate what they should be?—J. Sherwood, Wilkes Barre, Pennsylvania

After looking over the schematic, the best guess is that they're just small-signal transistors such as a 2N3906 (PNP) or a 2N2222 (NPN). As far as the passive components go, your drawing isn't clear enough to be able to tell exactly what's connected to what.

Since the ultimate idea behind your letter is probably to have a circuit that does what yours is supposed to do, it's a lot easier to give you a different one.

The schematic in Fig. 1 is a good way to do the job you have in mind. The parts layout isn't critical; you can build it on a piece of perfboard and probably make it small enough to fit inside your phone or cassette recorder.

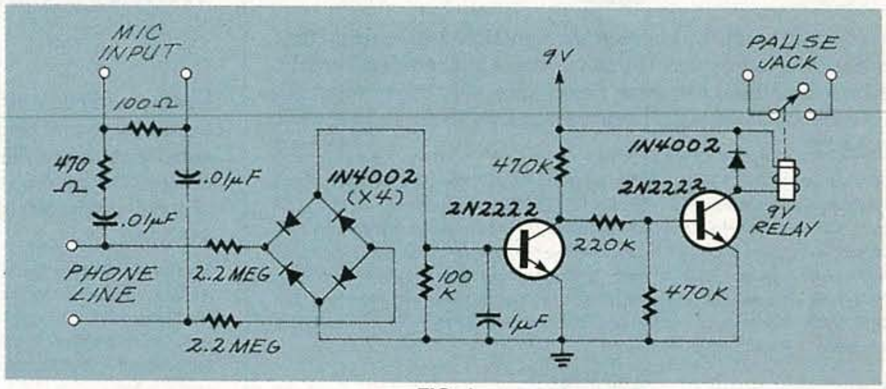


FIG. 1

The key to the circuit's operation is that, when the phone is taken off the hook, the DC voltage on the line drops from about 50 volts to 5 volts. When the low voltage appears at the base of Q1, it causes a high to be present at the collector. That turns on Q2, sending its collector low, consequently energizing the relay. When you hang up the phone, the line voltage will go high again and cause the relay to open.

Notice that the circuit is powered by a 9-volt battery. Since there's only significant draw when the relay is activated, the battery should last for a long time. You could work out a way to power the circuit directly off the phone line, but the battery drain is so small that it's easier to save the parts and set it up as shown. And considering what's happened to the telephone system ever since divestiture, it's probably a good idea to avoid taking more from the phone lines than necessary.

COLOR REMOVER

I have a computer that generates composite video and, while I like to have some things show up in color, other things are better in black-and-white. I want to build some sort of black box that takes my computer's color composite output video and removes the colorburst signal so I can use it on my monochrome monitor.—R. Bergsman, Merion, Pennsylvania

You'll get no argument here that some things, such as word processing, are better in monochrome while other things, like blasting aliens, are much more satisfying in color. Your request, however, is a little bit puzzling.

Color-killer circuits, which are what you're asking for, are needed when you want to put monochrome data on a color monitor. If the burst isn't removed, the picture will frequently show color fringing and a few other side effects that tend to make the display confusing and hard to watch. The problem, however, only comes about when you're using a color monitor—the situation is completely different when the video is being fed into a monochrome monitor.

The colorburst signal is used as the reference for the generation of colors on each line of video. Composite color monitors (and color TV's) have circuits that detect colorburst and use that information to control the display of color. The important point here is that the burst is only the reference signal for the color, not the color signal itself.

Without going into a lot of the gory details, the part of each line of video that actually carries picture information is made up of two basic elements, luminance

Now you can meet the challenges of today's electronics quickly and easily. This professional level learning series is as innovative as the circuitry it explains and as fascinating as the experiments you build and explore! And it's for anyone who has an interest in electronics... from the hobbyist to the professional.

Thousands Have Already Experienced the Excitement!

Today's high-tech world demands an entirely new and innovative approach to understanding electronics. That's why McGraw-Hill has developed this unique "hands-on" learning method that brings to life the dynamics of the new electronics. It's a unique combination of interactive materials that gets you involved as you build and experiment with today's latest electronic circuitry.

Just how well this innovative learning approach meets the challenge of the new electronics is confirmed by those who have already completed the Series... "You have put me right into the middle of an extraordinary learning experience. With each lab exercise I have gained a new understanding of the intricacies of today's electronics." Or ... "For me, the Series was just the answer. I felt confident within my specialty, but my grasp of other areas of electronics was slipping away. Your Series helped me upgrade my knowledge of the latest electronics concepts." Or this from a company director of training... "We manufacture sophisticated electronic products, with a lot of people in sales, assembly and purchasing. McGraw-Hill has answered a real need in helping our employees see the total picture. They now communicate with customers and each other more effectively."

Your Involvement in the New Electronics Begins Immediately.

You master one subject at a time with 15 McGraw-Hill *Concept Modules*, sent to you one every 4 to 6 weeks. You waste no time on extraneous materials or outdated history. It's an entertaining, lively, nontraditional approach to the most modern of subject matter.

Your very first module takes you right to the heart of basic circuit concepts and gets you ready to use integrated circuits to build a digital oscillator. Then, you'll verify the operation of different electronic circuits using a light emitting diode (LED).

And each successive module brings you up to speed quickly, clarifying the latest advances in today's electronics ... from digital logic and microprocessors to data communications, robotics, lasers, fiber optics, and more.

With your first module, you'll build this solderless breadboarding system. As you add additional boards, you create increasingly complex circuits easily and quickly, bringing today's electronics concepts to life.

Unique Combination of Interactive Instruction Materials Makes Learning Easy.

Laboratory experiments, vividly illustrated text and interactive cassette tapes all blend together to give you a clear, simplified understanding of contemporary electronics.

With each module, you receive a McGraw-Hill *Action-Audio Cassette* that brings to life the facts and makes you feel as if you're participating in a lively dialogue with experts.

Your ability to quickly make this knowledge your own is further aided by strikingly *illustrated* texts that use diagrams, explanations, illustrations, and schematics to drive home and reinforce the meaning of each important point. Carefully indexed binders conveniently house all this material, as well as the instructions that will guide you through your "hands-on" lab experiments.

Throughout your Series, *laboratory experiments* reinforce every significant concept. With this essential "hands-on" experience using actual electronic components, you master principles that apply all the way up to tomorrow's VLSI (Very Large Scale Integrated) circuitry.

Discover, Explore, Experience for Yourself—15-Day Trial.

In all ways, the Contemporary Electronics Series is an exciting learning experience that offers you the quickest and least expensive method available to master today's electronics... and the only one with "hands-on" experience.

To order your first module for a 15-day trial examination, simply complete the card and send today! If the card is missing, write to us for ordering information.

McGraw-Hill Continuing Education Center

4401 Connecticut Avenue
Washington, D.C. 20008

and chroma. The former is what determines how bright the picture will be and the latter controls what colors will be seen. It's the chroma that's referenced to colorburst—the luminance is something else altogether.

Building a circuit to remove colorburst before the video is fed to a monochrome monitor is exactly like putting a 30-kHz notch filter on your stereo. It might get rid of the signal but, since you can't hear it anyway, why bother? Your monochrome monitor doesn't have any circuitry to detect burst so, as far as it's concerned, it's not there in the first place. You can watch color-TV transmissions on a black-and-white TV where the burst is being fed to it anyway. You might see some improvement in the picture if you removed chroma from the signal but it would be, if anything, such a marginal change that it's just not worth going to the effort of putting the circuit together.

One last thing: You didn't mention what kind of computer you have, but there aren't many that put out real NTSC video. Some, such as the Apple and Commodore, get very close to it but "close" isn't always good enough. If you have a scope, you can compare some real NTSC signals with the output of your computer and see the difference yourself. You'll be surprised.

NEON WOES

I'm building a small project for school and I would like to use neon lights as indicators instead of LED's. The problem is that my circuit is powered by a nine-volt battery and I can't figure out how to light the neon with that voltage. Do you have some easy way to do that?—A. Blumenthal, Lexington, KY.

If you're talking about the kind of neon lights that you see in store windows, you should switch to LED's. If, however, you want to light small neon bulbs, the circuit in Fig. 2 should do the job. Just make sure you use good-quality neon bulbs, because cheap ones usually need more voltage than Fig. 2 can provide.

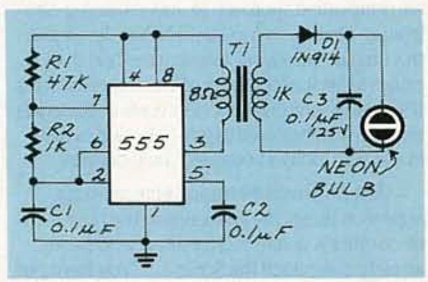


FIG. 2

Neon bulbs need about 90-volts AC, and the only way to get that from a DC supply is to build an oscillator. The circuit uses a 555 running at about 300 Hz. The output voltage of the 555 is stepped up using a typical audio output transformer and rectified by D1 to feed pulsing DC to the neon bulb.

Be careful when you build it, because there's enough voltage on the neon side of the transformer to give you a nasty shock. If the bulb flickers, try dropping the frequency of the 555 or leave it alone and try a different bulb.

7805 TURN ON

I've built a circuit that's powered from a 7805 regulator. I'm looking for some way to turn the regulator on and off using external logic from another device. I've got buffered outputs available, but I'm not sure exactly how to go about it.—G. Olson, New York, NY.

The 78XX family of regulators are convenient ways to control circuit voltage but, being three-terminal devices, there's no handy dandy pin available to turn them on and off. Fortunately, controlling one of them with external logic only involves the addition of a few parts to the board.

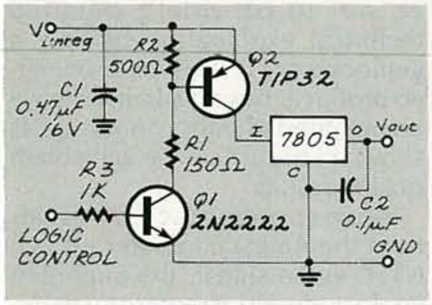


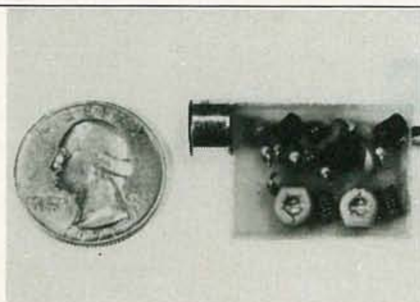
FIG. 3

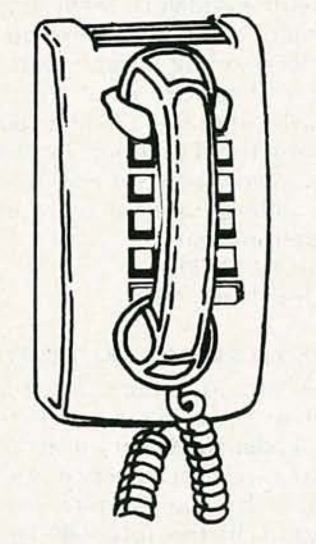
The basic idea is shown in Fig. 3. Both Q1 and Q2 are set up as switches and their operation is controlled by the logic level present at the base of Q1. When a high is presented to the base of Q1, the resulting low at its collector pulls enough current through R1 to turn on Q2. Using two transistors is a good idea since Q1 not only does the needed inversion to properly control Q2, but it acts as a buffer to help isolate the controlling logic circuit from the power supply.

The only thing critical in the circuit is the value of R1, because it has to pass enough current to turn on Q2. Since it's in the circuit as a current limiter, it's not too difficult to calculate the needed value. You'll need about 50 mA to turn on Q2 so the value of R1 can be gotten from Ohm's Law as follows:

$$R1 = V_{UNREG}/50\ mA$$

You can see from the schematic that all the regulator current has to pass through Q2; so make sure that you pick a part that can handle however much current your circuit is going to draw. It would be smart to heat-sink Q2 as well since it's definitely always better to be safe than sorry. **R-E**





LETTERS

RADALERT TAKES OFF

You made a real contribution when you published the "Radalert" articles in the June and July 1988 issues of **Radio-Electronics**. I was glad to see a follow-up article in the June, 1989 issue. I bought a set and would like to relate some casual experiences, because here—finally—is a practical, portable instrument that gives you actual numbers, which can be used for meaningful comparisons. I hope more people will report, especially users near some of the nuclear reactors. In time, maybe we can find out whether there is real danger or just unquantified alarmist reporting.

I took my Radalert on some airplane trips. As the plane flies up to cruising altitude, the count per minute goes up from about 12, which is background, to 380! The reason is that much more cosmic radiation reaches you because there is 10 pounds less air per square inch to shield you. But perhaps someone can explain why airline personnel, exposed to that level of radiation for many hours every week, are not known to be more susceptible to cancer than the population that works at ground level. A count of 380/min. must not be very harmful.

I left the Radalert in the carry-on luggage, turned on, as it went through the x-ray machines. In some it got a count of 5000, in others, 2500 or so. Maybe another reader can explain the reason for those differences.

Now, in defense of reporters who make radiation sound scary, I would like to offer an explanation: The human race has evolved to have senses that warn of danger—for sound, temperature, touch, smell, and sight. No living creature has a sense for radiation. You can't smell or hear it. There was no reason to develop such a sense until artificial radiation was created in this century. So that new danger, which one cannot sense, understandably concerns people.

With a Radalert, however, more people can begin to develop some understanding. I hope more readers will report what they find. (Maybe there is a Concorde flyer among them to report from 40,000 feet.) Eventually we will get a better feeling for what is around us, radiation-wise.

WALTER LINDE
Dobbs Ferry, NY

WIEN-BRIDGE OSCILLATORS

I'd like to remark on a mistake that seems to be slowly penetrating **Radio-Electronics** articles. The most recent occurrence was in an article by Ray Marston on oscillators in the July 1989 issue. A particular type of oscillator is called a *Wien*-bridge oscillator, not a *Wein* bridge. I believe that it was named after a Mr. Wien, although that is also the name of the town of Vienna.

Wein means "wine" in German, and I've never seen a Wine-bridge oscillator yet—except for several times in **Radio-Electronics**!

ROBERT NUNNIKHOVEN
Suresnes, France

COMPUTER-AIDED VIDEO PRODUCTION

In response to the letter from Eileen Tuuri of Magni Systems in the June issue of **Radio-Electronics**: The purpose of our article, "Computer-Aided Video" (March 1989), was to show the reader how to set up a video post-production system based on the Amiga computer, *not* to provide a detailed technical explanation of how a genlock works. If a would-be video producer buys the hardware we recommended, and connects it as shown in the article, he will obtain quality results.

When encoding the RGB signals from the Amiga computer into an NTSC video signal, the Supergen genlock *does not* require an external video signal. With no external signal, the genlock acts as an RGB-to-NTSC encoder, and the dissolve sliders have no effect on the output. Only when an external signal is connected does the genlock depend on that signal's synch pulses to synchronize the computer to the external video source. In that mode, the quality of the output signal is limited to the quality of the input signal. With a Panasonic AG1950 VCR as the source, the output of the Supergen will meet NTSC specifications.

With no external signal connected to the genlock (i.e., "source VCR not operating"), the Supergen works fine as an encoder. If the source-video signal is reasonably close to NTSC, the genlock also works fine. Our problem was that the Supergen does not reject non-NTSC signals. Those include the "snow" that is produced when the tuner of the source VCR is selected but not tuned to a station. The scrambled signal produced by gated-sync-encoded channels is also problematic. The Supergen could not detect that they were not NTSC signals, so it tried to synchronize the computer with them.

The Supergen genlock is considered by most Amiga video users and software manufacturers to be the industry standard. Many video-related software products take advantage of the programmability of the Supergen.

It may be the intention of Magni Systems to make the 4004 Genlockable Video Graphics Encoder the "Premier Genlock for the Amiga 2000." That effort, however, will not succeed by making misleading statements about competitors' products or by falsely accusing authors of misleading their readers.

WALTER M. SCOTT III
KAREN D. MORTON
S&M Video Productions

TECH-NICAL EXPERTISE

In response to John Sawka's letter in the June issue of **Radio-Electronics**, a technician is a skilled worker, a person with two years of intense college study and two years of on-the-job training—and all that had better be supported by a technical credential such as CET certification. A tech is a person who has paid his dues—a lot more than three years of calculus—and still gets paid peanuts.

I would love to pair off with Mr. Sawka in a complex problem, using a 2230 TEK oscilloscope. Just try to catch a 100-ns glitch with calculus and figure where it came from! We all put in our 40 hours a week.

JEFF D. BROWN
Bio-Medical Technician
Fresno, CA

OK. That's all on the subject. Obviously engineers and technicians serve very important functions; neither is inherently better or more important than the other. We encourage engineers and technicians to get along together—after all, we can't get along separately.—Editor

CAPACITANCE-METER ERRORS

In the capacitance-meter article in the July 1989 issue of **Radio-Electronics**, Fig. 3 shows pin 7 of IC3 (the 555 astable) connected to R13 or R14 via switch S3-b, with both potentiometers grounded. Figure 1 in the sidebar on page 40 shows pin 7 connected to the collector of an internal NPN transistor. Also, pin 7 of IC1 and IC2 (the 555 monostables) is tied to +5V. Even if a 555 astable could function with pin 7 grounded, your schematic shows pin 2 tied to pin 4. Checking on a breadboard shows that there's *no way* for a 555 to function with pins 4 and/or 7 grounded.

RICHARD P. MARQUISS
Wheaton, MD

You're right. The bottom terminals of R13 and R14 (connected to switch S3-b in Fig. 3 on page 39), and pin 4 of IC3 should be tied to +5V, not ground. However, pin 6 is correctly connected to C6. Although wrong in the schematic, the PC board and Parts-Placement diagram are correct.

We also found several errors in the sidebar on pages 40–41 that you didn't notice. The two "PRESENT/ABSENT" labels in the upper left-hand corner of Fig. 1 in the *sidebar are reversed. Also, the label on R4 between pins 7 and 8 is missing. Next, in the right-hand column of the sidebar text on page 41, the total period of a 555 astable should read:*

$$T_A = T_{AC} + T_{AD}$$
$$= 0.693 \times [R4 + (2 \times R5)] \times C1.$$

Finally, Fig. 3 in the sidebar is unclear. The upper waveform is V_{TRIG} (the trigger pulse), the middle one is V_{C1} (the voltage across C1), and the bottom one is V_{OUT} (the 555 monostable pulse output). The downward transition of V_{TRIG} starts V_{OUT}. However, the intention was to show that V_{TRIG} can end as soon as V_{OUT} starts, which is before V_{C1} begins its discharge segment and V_{OUT} ends.—Editor

ALTERED STATES

I found your article "Alpha/Theta Meditation Goggles" (**Radio-Electronics**, April 1989) to be well written and interesting. However, as a teacher of Transcendental Meditation (TM) and a Ph.D. candidate in the electroencephalo topography of higher states of consciousness, I wish to correct a common misunderstanding about the technique that surfaced in your article. The writer referred to "months and sometimes years of painstaking practice" of yoga and TM to reach the "state that produces a preponderance of alpha brain waves."

Since the TM technique was introduced by Maharishi Mahesh Yogi in 1958, more than 3 million people have learned it. Its widespread popularity sometimes results in it being confused with other forms of meditation. The point I wish to emphasize is that TM is a simple, effortless, and natural state that does not involve external stimuli. There is no concentration, forcing, or straining with TM. It is easy to learn and begins to produce beneficial results from the first session.

During the practice of TM, one experiences the most settled state of mental awareness, often called Transcendental Consciousness (TC), that is the source of the mind's unlimited creativity and intelligence. Researchers have found that TC is actually a fourth major state of consciousness—distinct from waking, dreaming, and sleeping—with its own unique physiological correlates. During TM, respiration slows, oxygen consumption and heart rate go down, and frontal alpha is exhibited. Deep rest is gained and stresses are released during the pleasant, 20-minute, twice-daily TM sessions. Creativity and dynamism are infused into the awareness.

It is that deep rest and the experience of TC that produce the results—not the alpha, which is only a natural by-product. The increasing mental clarity, intelligence, ability to focus sharply while maintaining a broad comprehension, deep rest, release of stress, better mental and physical health, and greater joy in life are some of the benefits that scientists have documented. The diligent practice of transcendental meditation often results in much more than a simple state of relaxation.

E. TED NEVELS
Livingston Manor, NY

R-E

EQUIPMENT REPORTS

Circuitmate DM27 Digital Multimeter

Bring along an entire electronics test lab on your next field repair!

CIRCLE 40 ON FREE INFORMATION CARD

FIELD REPAIRS USED TO MEAN LUGGING an awful lot of heavy equipment with you to the site. With the complexity of some of the equipment that needs to be serviced these days, you may have to lug along even more equipment. But modern semiconductor technology has downsized more than just Walkman-type radios; it has also squeezed an entire electronics test lab into a remarkably small package. Introducing the Circuitmate *DM27* 3½-digit multimeter: It's a high-quality instrument from Beckman Industrial Corp., (Instrumentation Products Division, 3883 Ruffin Rd., San Diego, CA 92123-1898).

Features

For starters, the *DM27* can measure AC and DC voltages, current, and resistance. Then there are such features as an audible continuity check and a diode tester that are found on many DMM's. The *DM27* is also a capacitance tester, and it can measure the hFE, or *gain* of a transistor. And at last we come to a couple of features that you'll seldom see on any DMM; a 20-MHz frequency counter and a 20-MHz logic probe.

The *DM27* is housed inside a durable plastic case measuring 6.3×3.0×1.4 inches, and also has a built-in stand for easy viewing of the display. The unit weighs 11 ounces, including the battery. Supplied with the meter are a rugged set of test leads, a 9-volt battery, a spare fuse, an operator's manual, and a one-year limited warranty. The face of the meter contains the usual function/range switch, in addition to a separate on/off switch. That convenience allows you to turn the meter on and off while leaving it set on a particular function. The meter also has an AC/DC switch and a trigger-level switch for the frequency counter.

Besides the volt/ohm input terminals, the *DM27* has two input terminals for measuring current; one for measurements up to 200 mA, and another for up to 10 amps. There are two 4-pin test sockets for measuring transistor hFE; one socket is for NPN transistors and the other is for PNP. The 4-pin sockets, labeled E-B-C-E from left to right, allow easy insertion of any transistor configuration. A separate test socket is provided for testing capacitors.

Specifications

For measuring voltages, the *DM27* has DC ranges of 20mV, 2 V, 20 V, 200 V, and 1000 V, and AC ranges of 200 mV, 2 V, 20 V, 200 V, and 750 V—all with 0.8% accuracy. The unit is overload-protected from 500 VDC/350 VAC for 15 seconds in the 200-mV range, and from 1200 VDC/850 VAC for 60 seconds in all other ranges. It can measure up to 10 amps, AC or DC. In the DC mode the ranges are 200 μA, 20 mA, 200 mA, and 10 A. And in the AC mode the ranges are 20 mA, 200 mA, and 10 A.

For measuring resistors, the unit has seven ranges, from 200-ohms to 2000 megohms. The continuity beeper sounds in the 200-ohm range when less than 100 ohms is measured. For capacitors, the unit has 2000-pF, 0.02-μF, 0.2-μF, 2-μF, and 20-μF ranges. When used a frequency counter, the *DM27* has 2-kHz, 20-kHz, 200-kHz, 2-MHz, 20-MHz ranges. In the logic-probe mode, the display will show an up-arrow when it reads a logic-high, and a down-arrow for a logic-low. Then unit can also detect pulses with a minimum width of 25 nS.

When testing diodes, the meter will show the forward voltage drop of the diode if it is forward-biased. If the test leads are reversed, the meter will show the reverse leakage current of the diode. When testing transistors, if the leads of a transistor are properly inserted (E, B, and C) in the right socket (NPN or PNP), the meter will display the transistor's hFE.

Among the accessories available for the *DM27* are a carrying case, a high-voltage DC probe, an RF probe, a temperature probe, etc. At $129.95, the *DM-27* is a great piece of test equipment for any electronics enthusiast, as it eliminates the need for several other test instruments. It's one tool that you'll always want to have nearby. **R-E**

B + K Model 1201SR Television Frequency Converter/Modulator

Convert any video generator to all-channel operation.

CIRCLE 41 ON FREE INFORMATION CARD

TESTING CABLE TV EQUIPMENT HAS JUST been made easier with the introduction of the model *1201SR* Television Frequency Converter/Modulator from B + K Precision (6470 West Cortland Street, Chicago, IL 60635). With the *1201SR* you can generate modulated carriers on VHF, UHF, and CATV channels.

As its name implies, the *1201SR* performs two main functions. It can output a carrier that is modulated by a video input, or it can convert an already-modulated Channel-3 input to another TV or cable frequency. The *1201SR* makes it easy to test cable distribution networks over their entire frequency range. It also allows you to test tuners, and to verify the correct channel assignments of cable-ready TV's and VCR's.

The *1201SR* is packaged in a black high-impact plastic case that measures roughly 3½ × 9 × 10½ inches. The front panel is neatly arranged with a row of function selectors, a group of input/output jacks, channel-selection switches, and two LED displays that show the band and channel of operation.

The row of 6 function-selector pushbuttons contains a power switch and an EXT VIDEO switch that lets you choose whether the output will be modulated by a Channel-3 or external-video input. In other words, it switches the *1201SR* between its converter and modulator functions. The remaining 4 pushbutton switches are used for band selection.

The *1201SR* has four bands of operation. In the standard broadcast band, it can output signals on Channels 2 through 13 VHF and Channel 14 through Channel 18 UHF. In the standard CATV band, it can output on Channels 0 through 70. The *1201SR* also outputs on Channels 0 through 70 on HRC and ICC systems. (HRC or *H*armonically *R*elated *C*arrier cable systems have channels whose frequencies are all harmonics of 6 MHz. ICC or *I*ncrementally *C*orrelated *C*arrier systems are essentially the same as standard CATV, with the exception of channels 5 and 6 which are offset by 2 MHz.)

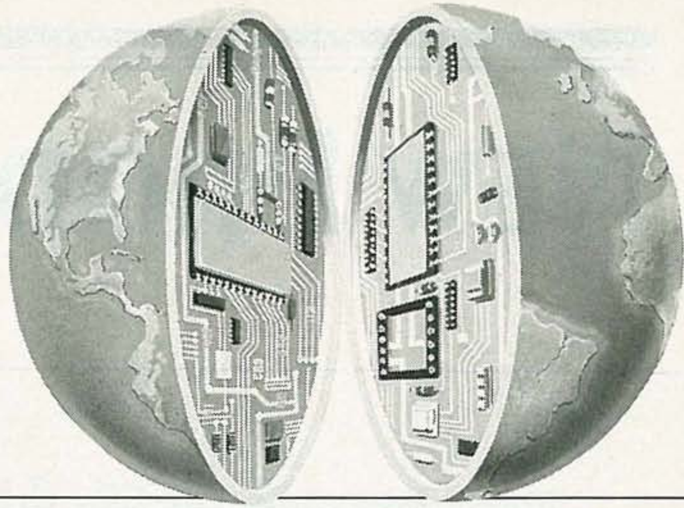
If you have special needs and require outputs on different frequencies, the unit may be factory-programmed for any frequencies in the 55–500-MHz band. (A change of an EPROM is all that's required.)

BNC jacks are provided for a video input, and two BNC jacks are provided for channel-3 inputs (one of which attenuates the signal by 20 dB). The output jack is also a BNC connector. The remainder of the front panel contains channel-selection switches and LED displays that show the band and channel of operation.

The *1201SR* can convert any video generator to all-channel operation, and let you check TV and VCR tuners on every channel.

The unit is supplied with an adequate instruction manual, which includes a schematic, parts list, and alignment instructions. Various cables and adapters are available as accessories. The *1201SR* carries a suggested retail price of $796. **R-E**

WITH CIE, THE WORLD OF ELECTRONICS CAN BE YOUR WORLD, TOO.



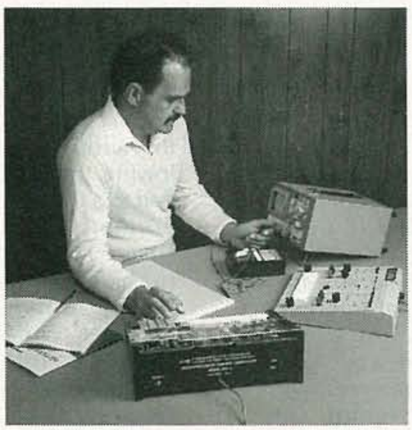
Look at the world as it was 20 years ago and as it is today. Now, try to name another field that's grown faster in those 20 years than electronics. Everywhere you look, you'll find electronics in action. In industry, aerospace, business, medicine, science, government, communications—you name it. And as high technology grows, electronics will grow. Which means few other fields, if any, offer more career opportunities, more job security, more room for advancement—if you have the right skills.

SPECIALISTS NEED SPECIALIZED TRAINING.

It stands to reason that you learn anything best from a specialist, and CIE is the largest independent home study school specializing exclusively in electronics, with a record that speaks for itself. According to a recent survey, 92% of CIE graduates are employed in electronics or a closely related field. When you're investing your time and money, you deserve results like that.

INDEPENDENT STUDY BACKED BY PERSONAL ATTENTION.

We believe in independent study because it puts you in a classroom of one. So you can study where and when you want. At your pace, no somebody else's. And with over 50 years of experience, we've developed proven programs to give you the support such study demands. Programs that give you the theory you need backed with practical experience using some of the most sophisticated electronics tools available anywhere, including our Microprocessor Training Laboratory with 4K of random access memory. Of course, if you ever have a question or problem, our instructors are only a phone call away.



START WHERE YOU WANT, GO AS FAR AS YOU WANT.

CIE's broad range of entry, intermediate, and advanced level courses in a variety of career areas gives you many options. Start with the Career Course that best suits your talents and interests and go as far as you want—all the way, if you wish, to your Associate in Applied Science Degree in Electronics Engineering Technology. But wherever you start, the time to start is **now**. Simply use the coupon below to send for your FREE CIE catalog and complete package of career information. Or phone us, toll-free, at **1-800-321-2155** (in Ohio, 1-800-523-9109). Don't wait, ask for your free catalog now. After all, there's a whole world of electronics out there waiting for you.

CIE

Cleveland Institute of Electronics, Inc.
1776 East 17th Street, Cleveland, Ohio 44114

Member NHSC
Accredited Member National Home Study Council

CIE **Cleveland Institute of Electronics, Inc.**
1776 East 17th Street, Cleveland, Ohio 44114

ARE-145

YES... I want to learn from the specialists in electronics—CIE. Please send me my FREE CIE school catalog, including details about CIE's Associate Degree program, plus my FREE package of home study information.

Name (print): ____________________

Address: ____________________

City: ____________ State: _____ Zip: _______

Age: _______ Area Code/Phone No.: _____ / ____________

Check box for G.I. Bill bulletin on educational benefits:
☐ Veteran ☐ Active Duty

MAIL TODAY!

NEW PRODUCTS

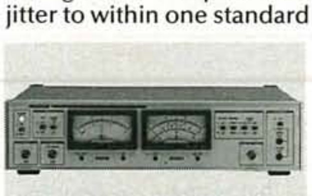
CIRCLE 10 ON FREE INFORMATION CARD

PORTABLE TEST RECEIVER. Incorporating circuitry derived from *AVCOM's* well-known *COM-2* and *COM-3* satellite receivers, the *PTR-25* Ku- and C-band portable test receiver achieves high-quality video and threshold performance. The battery-operated satellite receiver has a built-in 4½-inch black-and-white TV, which offers excellent picture definition and "sparklie" resolution—and uses less power than comparable color units. The *PTR-25's* full range of outputs provide signals for large TV monitors, video recorders, and audio amplifiers. A special sampled IF output is generated, which allows the 70-MHz IF signal—including terrestrial interference, if there is any to be observed on any AVCOM spectrum analyzer.

Signal strength can be monitored on a large, easy-to-read front-panel meter, or by an audible indicator. As the signal nears maximum strength, the pitch of the audible tone rises, allowing the dish to be peaked to a fraction of a dB. The portable instrument measures 14½ × 5½ × 13½ inches, and weighs 17 pounds. It runs on 100–130-volts AC, or built-in rechargeable batteries.

The *PTR-25* portable test receiver has a suggested list price of $1,935.—**AVCOM**, 500 Southlake Boulevard, Richmond, VA 23236.

CD JITTER METER. Designed to improve the accuracy, reliability, and speed of CD-player alignment and repairs, *Leader Instrument's LJM-1851* CD jitter meter displays objective values—rather than the subjective human interpretation required when viewing the EFM (*E*ight-to-*F*ourteen *M*odulation) eye pattern on an oscilloscope. The instrument performs simultaneous measurements of jitter (3T) and HF levels (3T or 11T) for the EFM signals used in CD players.



CIRCLE 11 ON FREE INFORMATION CARD

The meter's sigma-measuring mode computes the jitter to within one standard deviation to produce a near-steady-state reading of jitter-facilitating, accurate quantitative measurements. The EFM-signal level is indicated as a peak-to-peak value for the 3T- or 11T-bit component and is selected by pushbutton. Besides its usefulness in servicing CD players, the jitter meter can be used in research and development to evaluate the effects of temperature and vibration.

The *LMJ-1851* CD jitter meter has a suggested list price of $1,495.00.—**Leader Instruments Corporation**, 380 Oser Avenue, Hauppauge, NY 11788; Tel. 516-231-6900 (in NY) or 1-800-645-5104.

PORTABLE 2-WAY RADIOS. *Midland's* line of 4-channel, crystal-controlled, 2-way portable FM radios is specifically designed to provide reasonably priced signaling and voice-scrambling capabilities. The line includes models in four frequency ranges. The model *70-040* covers the 30–50-MHz range; the model *70-064*, 66–88-MHZ; the model *70-144*, 136–174-MHz; and the model *70-244* (pictured), 406–470-MHz. Each of the rugged portables has a slightly extended die-cast chassis with stainless-steel covers, to provide room for a variety of options in addition to CTCSS. Options in-

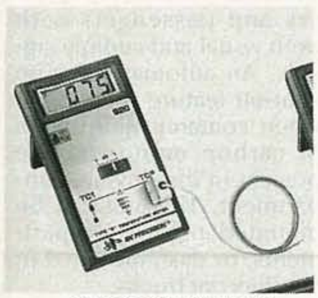
CIRCLE 12 ON FREE INFORMATION CARD

clude a DTMF encoder and decoder, a DTMF encoder and 2-tone sequential decoder, or a voice-inversion scrambler.

The "signaling" portables measure about 6½ × 2½ × 1½ inches, including the standard 600-mAh twist-off battery pack, which provides approximately 9½ hours at 2 watts or 6 hours at 5 watts. (An optional 1000-mAh battery brings the time up to 14 hours at 2 watts or 10 hours at 5 watts.) Other options and accessories include a DTMF keypad front, a speaker/microphone, a belt-clip back-plate, and an assortment of carrying cases and battery chargers. The models *70-040*, *70-064*, *70-144*, and *70-244* have suggested retail prices of $440.00, $435.00, $425.00, and $550.00, respectively.—**Midland LMR**, 1690 North Topping, Kansas City, MO 64120.

DIGITAL TEMPERATURE METERS. *B&K-PRECISION's* series of three hand-held digital temperature meters includes the *920* dual-input and the *910* single-input models, which span −58°F to +1999°F, and the compact model *900*, which spans −58°F to +302°F. Each of the meters features a 3½-digit LCD display, and is powered by a standard 9-volt battery.

The model *920* (pictured) has two K-type thermocouple sensor probes, with selectable probe-1 or probe-2 temperature readings. The user can choose Centigrade or Fahrenheit measurement. The model *910* has a single K-type thermocouple



CIRCLE 13 ON FREE INFORMATION CARD

probe, and offers the added feature of selectable 1° or 0.1° resolution. Both are designed for industrial and laboratory applications, and the model *920* meets the needs of many applications for monitoring two temperatures, such as ambient and internal, as well.

The model *900*, which measures just 5.6 · 1.8 × 1.1 inches, is designed for HVAC, building-maintenance, and general-purpose applications. It features selectable internal or external operation; the internal mode uses a probe with a semiconductor-type sensor. The unit automatically turns on when the self-contained probe is extended, and turns off when it is retracted. In the external mode, the meter accepts an external K-type thermocouple probe for 0°F to 1500°F measurements.

The models *900, 910,* and *920* digital temperature meters have suggested list prices of $55.00, $80.00, and $110.00, respectively.—**B&K-PRECISION**, Maxtec International Corporation, 6470 West Cortland Street, Chicago, IL 60635.

COUNTERFEIT-MONEY DETECTOR. Any business that deals in cash is vulnerable to counterfeit-currency scams, which cost merchants throughout the United States millions of dollars every year. One solution to the problem is the

Vistatector counterfeit-currency detector, which provides an easy and accurate means of checking bills. Using a simple two-step test, it detects the magnetic particles that are embedded in certain areas on the front of all legitimate U.S. paper currency.

The slim, pen-like detector is used by placing the bill on a soft padded surface (a paper note pad will do, or the optional *Vistatector Security Pad* can be used) and quickly rubbing the head of the unit back and forth across portions of the bill while pressing a thumb button that activates the unit. The portrait is checked first, and then the Federal Reserve seal is tested. Lights at the top of the unit and an audible tone indicate whether a bill is genuine or a fake. The *Vistatector* can also detect counterfeits in many foreign currencies and travelers checks.

CIRCLE 14 ON FREE INFORMATION CARD

The *Vistatector* counterfeit-currency detector has a suggested retail price of $99.95; the security pad costs $19.95.—**Vistatech Enterprises, Ltd.**, Security Products Division, 935 Broadway, New York, NY 10020.

DIGITIZING SCOPES. *Hewlett-Packard's HP 54500* family of high-performance digitizing oscilloscopes includes the two-channel model *HP 54502A* (pictured) and the four-channel models *HP 54501A* and *HP 54503A*. All three oscilloscopes include features such as autoscale for single-keystroke instrument setup; 16 automatic pulse-parameter measurements; advanced logic-triggering capability, including TV triggering, supplied at no extra cost; an *HP-IB* (IEEE-488) interface for programmable data acquisition and control; and pushbutton hardcopy output to Hewlett-Packard graphics printers. Each oscilloscope also includes a simplified user interface, measurement statistics, measurement-limit testing, and dual-timebase windowing.

CIRCLE 15 ON FREE INFORMATION CARD

The *HP 54501A* has a 100-MHz repetitive bandwidth and a 1.0-MHz single-shot bandwidth. The *HP 54502A* has a repetitive bandwidth of 400 MHz and a 100-MHz single-shot bandwidth. The *HP 54503A* has a 500-MHz repetitive bandwidth and a single-shot bandwidth of 2.0 MHz.

The respective list prices for the models *HP 54501A*, *HP 54502A*, and *HP 54503A* digitizing oscilloscopes are $3.465.00, $4,950.00, and $6,450.00.—**Hewlett-Packard**, Company Inquiries, Pruneridge Avenue, Cupertino, CA 95014; Tel. 1-800-752-0900.

VIDEO-TRANSFER SYSTEM. *Ambico's Model V-0651* All-in-One video-transfer system provides an easy means of transferring photos, films, and slides to video tape for convenient viewing as a continuous video on a TV set. Music and narration are easy to add during the transfer process.

A special internal mirror is controlled via the unit's TRANSFER/SELECT switch. With the switch in the PHOTO position, the mirror flips out of the way to allow direct videotaping of any photo up to 4 × 6 inches. In the MOVIES/SLIDES position, the

CIRCLE 16 ON FREE INFORMATION CARD

mirror flips open to reflect images projected onto the built-in mini-screen by a movie or slide projector, allowing any camcorder to record those images.

The *V-0651* All-in-One video-transfer system has a suggested retail price of $99.95.—**Ambico Inc.**, 50 Maple St., Norwood, NJ 07648.

REWRITABLE OPTICAL DISKS. The fully erasable, rewritable optical disks from *Maxell* are 5¼-inch disks that can store up to 644 MB of data on both sides—"equivalent to ... about 1,000 conventional, magnetic floppy disks," according to Maxell. Because these magneto-optic disks can rewrite both image and coded data, they can function as storage media for various large-scale external systems such as electronic files, file savers, and backup files for disk systems.

CIRCLE 17 ON FREE INFORMATION CARD

The *Model OC112G-2*, available since early spring, uses a glass substrate. The *Model OC112P-2*, which uses a plastic, polycarbonate substrate, is scheduled for commercial release in early July. Both configurations offer high-density recording with high-resolution magneto-optical recording film, which is composed of a rare-earth transition-metal alloy. The 644-MB capacity is achieved using Constant Angular Velocity (CAV), and high signal-to-noise ratio and reliability are achieved through the use of a multilayer structured film.

In single quantities, the *OC112G-2* glass-based optical disk costs $400.00; the *OC112P-2* polycarbonate model costs $250.00.—**Maxell Corporation of America**, 22-08 Route 208, Fairlawn, NJ 07410.

CARBON MONOXIDE DETECTOR. Carbon monoxide is a leading cause of death by poisoning in America, and carbon-monoxide poi-

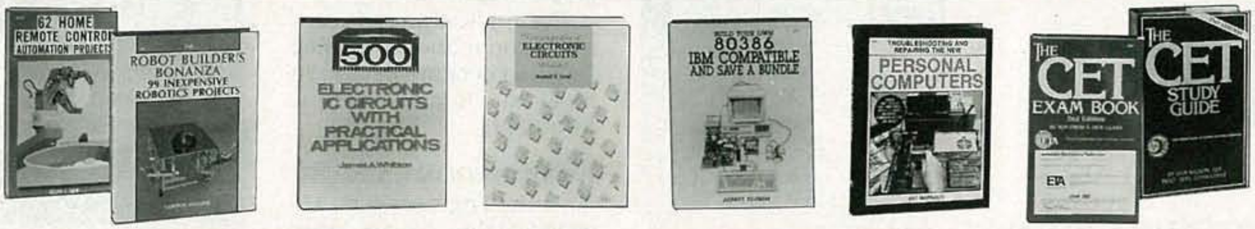
CIRCLE 18 ON FREE INFORMATION CARD

soning can also cause such driving impairments as dizziness, visual disturbances, and loss of consciousness. *Snooper Detectors' Carbon Monoxide Detection System* addresses that danger by warning motor-vehicle occupants of dangerous levels of carbon monoxide.

The system, which meets U.S. recreational-vehicle standards and features commercial-grade, solid-state electronics, alerts drivers and passengers with both visual and audible signals. An automatic engine shut-off feature is activated when contamination levels of carbon monoxide are present in the driving compartment. The unit can be mounted in glove compartments, or dash-mounted in commercial trucks.

The *Carbon Monoxide Detection System* has a suggested retail price of $49.95.—**Snooper Detectors**, 11632 Chairman Drive, Dallas, TX 75243. **RE**

19 Reasons Why TAB Is Your Source for Electronics Books



■ ***Buy Both and Save (#5350C) — Yours for only $24.45!***
62 Home Remote Control and Automation Projects
by D. Horn. *280 pp., 222 illus.*
The Robot Builder's Bonanza: 99 Inexpensive Robotics Projects *by G. McComb.* *352 pp., 283 illus.*

■ **500 Electronic IC Circuits with Practical Applications**
by J. Whitson. Scores of practical uses for IC circuits.
352 pp., 600+ illus., **#2920H, $29.95**

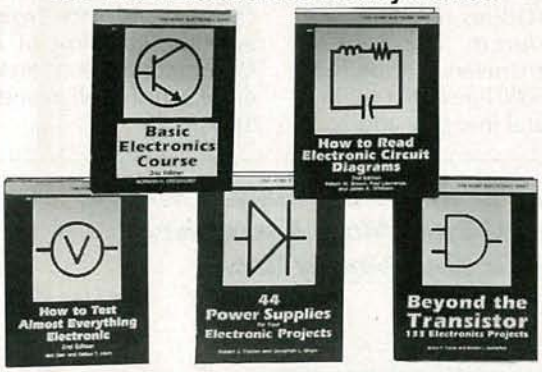
■ **Encyclopedia of Electronic Circuits—Vol. 2**
by R. Graf. 700+ circuits. *744 pp., 728 illus.* **#3138P, $29.95**

■ **Build Your Own 80386 and Save a Bundle**
by A. Pilgrim. Get power and efficiency at a down-to-earth price!
232 pp., 84 illus. **#3131H, $24.95**

■ **Troubleshooting and Repairing the New Computers**
by A. Margolis. Save hundreds of dollars in repair costs!
*416 pp., 350 illus.***#2809H, $27.95**

■ ***Save $10 on the Set (#5300C)— Yours for $33.90!***
Pass the Associate and Journeyman Exams with Flying Colors!
The CET Exam Book—2nd Ed. *by D. Glass and R. Crow.*
The CET Study Guide—2nd Ed. *by S. Wilson.*

The TAB Electronics Hobby Series — Save Over $25 on the set (#5282C)— yours for just $75!



■ **Basic Electronics Course—2nd Ed.** *by N. Crowhurst.* Master the funndamentals and prepare for the future! *400 pp., 347 illus.,* **#2613H, $24.95**

■ **How to Read Electronic Circuit Diagrams—2nd Ed.**
by R. Brown, P. Lawrence, and J. Whitson. Become proficient in the "language" of modern circuitry! *224 pp., 213 illus.,* **#2880H, $20.95**

■ **How to Test Almost Everything Electronic—2nd Ed.**
by J. Darr and D. Horn. An outstanding bestseller, over 35,000 copies sold!
180 pp., 138 illus., **#2925H, $16.95**

■**44 Power Supplies for Your Electronics Projects**
by R. Traister and J. Mayo. Find the simple or advanced circuits you need for all your project designs! *220 pp., 208 illus.,* **#2922H, $24.95**

■ **Beyond the Transistor: 133 Electronics Projects**
by R. Turner and B. Rutherford. Make the most of semiconductors—no experience necessary! *240 pp., 173 illus.,* **#2887H, $16.95**

■ **Troubleshooting and Repairing VCRs**
by G. McComb. Save money making your own VCR repairs! *336 pp., 200 illus.*
#2960H, $26.95

■ **Build Your Own Universal Interface**
by B. Chubb. Use your computer to control almost anything! *285 pp., 224 illus.*
#3122H, $27.95

■ **The Master Handbook of IC Circuits—2nd Ed.**
by D. Horn. Build 979 different circuits using 200+ popular ICs! *544 pp., 960 illus.*
#3185H, $34.95

■ **Customize Your Home Entertainment System**
by S. Sokolowski. Build audio and video enhancements with 22 inexpensive projects! *288 pp., 100 illus.* **#3234H, $24.95**

■ **The 8088 Project Book** *by R. Grossblatt.*
Design and construct an 8088 computer and 17 hardware and software enhancements! *256 pp., 125 illus.* **#3171H, $27.95**

■ **The Laser Cookbook**
by G. McComb. 88 inexpensive, fun-filled and useful projects!
401 pp., 361 illus. **#3090H, $25.95**

TO ORDER, Call Toll Free: 1-800-822-8158

(in PA and AK call direct 1-717-794-2191) or mail coupon to:
TAB BOOKS Inc., Blue Ridge Summit, PA 17294-0840

Please send me the book(s) below.

No.________ Price________ No.________ Price________

No.________ Price________ No.________ Price________

PA, NY, and ME residents add applicable sales tax (in Canada add $5.00 shipping & handling.)

☐ Check or money order enclosed (made payable to TAB BOOKS Inc.)

Charge my ☐ VISA ☐ MasterCard ☐ American Express

Acct. No.________ Exp.________

Signature________

Name________

Address________

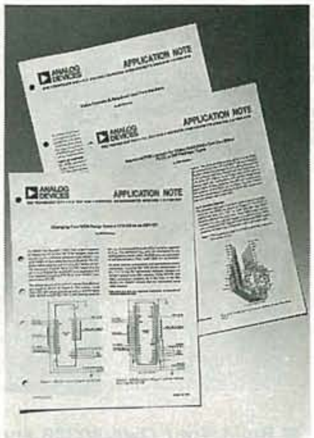
City________

State/Zip________

SATISFACTION GUARANTEED—If you are not completely satisfied, return the books for a complete refund.

RE89

NEW LIT



CIRCLE 19 ON FREE INFORMATION CARD

APPLICATION NOTES. Three new application notes from *Analog Devices* describe the company's *ADV Series* of video RAM-DAC IC's. The 4-page "Video Formats and Required Load Terminations," the 2-page "Improved PCB Layouts for Video RAD-DAC's Can Use Either PLCC or DIP Package Types," and the 1-page "Changing Your VGA Design from a 171/176 to an ADV471" all include waveforms, diagrams, and tables relating to the use of those DAC's.

The monolithic devices can be used in compliance with various international standards that specify video levels used in television and video monitors. The first note describes and compares some of the more common standards and details the required load terminations for the video RAM-DAC's. The second note describes PC-board layout schemes for the video RAM-DAC portion of a VGA-compatible graphics card. The third application note explains how an *ADV471* is used in a VGA graphics system.

The application notes are free upon request.—**Analog Devices Literature Center**, 70 Shawmut Road, Canton, MA 02021.

CIRCLE 20 ON FREE INFORMATION CARD

WORK-STATION CATALOG. *Advance Engineering's* 32-page catalog covers their entire line of assembly benches, electronic laboratory and test stations, and integrated work systems. The brochure logically presents every consideration in planning a single work station or a complete work system, using Advance's expertise in custom design, plant layout, and industrial engineering. Three basic lines of work stations and benches are offered: The Benchmaster, Universal, and Challenge 3000 lines all combine structural integrity and aesthetics with a flexible modular design. The catalog also includes a full line of seating, featuring pneumatic height adjustment, individual adjustment of seat and backrest, and extra-wide 5-prong bases with braking casters.

There is no charge for the catalog.—**Advance Engineering Inc.**, Division of Zero Corporation, 6900 Beck Avenue, North Hollywood, CA 91605. **R-E**

EXPAND YOUR CAREER HORIZONS...

The CIE Microprocessor Trainer helps you to learn how circuits with microprocessors function in computers.

START WITH CIE.

Microprocessor Technology. Satellite Communications. Robotics. Wherever you want to go in electronics... start first with CIE.

Why CIE? Because we're the leader in teaching electronics through independent study. Consider this. We teach over 25,000 students from all over the United States and in over 70 foreign countries. And we've been doing it for over 50 years, helping thousands of men and women get started in electronics careers.

We offer flexible training to meet your needs. You can start at the beginner level or, if you already know something about electronics, you may want to start at a higher level. But wherever you start, you can go as far as you like. You can even earn your Associate in Applied Science Degree in Electronics.

Let us get you started today. Just call toll-free **1-800-321-2155** (in Ohio, 1-800-362-2105) or mail in the handy reply coupon or card below to: Cleveland Institute of Electronics, 1776 East 17th Street, Cleveland, Ohio 44114.

CIRCLE 60 ON FREE INFORMATION CARD

CIE World Headquarters — ARE-144

Cleveland Institute of Electronics, Inc.
1776 East 17th Street • Cleveland, Ohio 44114

☐ Please send your independent study catalog.
For your convenience, CIE will try to have a representative contact you — there is no obligation.

Print Name ______________________________

Address ______________________________ Apt. ________

City ____________________ State __________ Zip __________

Age __________ Area Code/Phone No. ______________________

Check box for G.I. Bill bulletin on Educational Benefits
☐ Veteran ☐ Active Duty **MAIL TODAY!**

Just call toll-free **1-800-321-2155** (in Ohio, 1-800-362-2105)

CIRCLE 109 ON FREE INFORMATION CARD

FAX MATE

The Fax-Mate allows both fax and voice communication on a single phone line...it works with a modem, too!

DAVID F. PLANT

THE USE OF FAX MACHINES IS CATCHING ON by storm, and, as fax-machine prices continue to drop down toward the five-hundred-dollar mark, their sales will continue to skyrocket. However, the one continuing problem with using a standard auto-answer fax machine, is that it requires a separate phone line because it answers on the first ring and the modem tones make voice communication impossible. Unfortunately, the monthly cost of a second phone line may be higher than the lease cost of fax equipment! Computer-modem users have been fighting the same problem for years.

Historically, the solution has been to prearrange a fax transmission with a quick phone call, and then call back after the fax machine is connected. While that does work (if someone is there) it's inconvenient for everyone. The solution is to allow the same phone line to receive both voice and digital data, and that's where the Fax-Mate comes in. It will prevent your fax machine from answering a phone call before you get a chance to, allowing you to use one phone line for both of them—but, of course, only one of the two at any given time.

Theory of operation

Voice calls are the majority of telephone contacts; and with a single line, they are usually the most important. That means that the telephone should be answered first. A fax machine will also try to answer first when plugged in, so it must be isolated until needed. The Fax-Mate acts as a switch between the incoming line and the fax machine. It:

1) Separates the fax machine from the phone line

2) Rings-up the fax machine when commanded

3) Connects the equipment to the incoming line

4) Senses the end of the message and resets

Referring to the block diagram in Fig. 1, the incoming telephone line is split into two paths. The top path is the data line that switches the fax equipment on and off, and the lower path continually monitors and waits for a control signal.

Fax-Mate is a registered trademark of Benchmark Research, Inc.

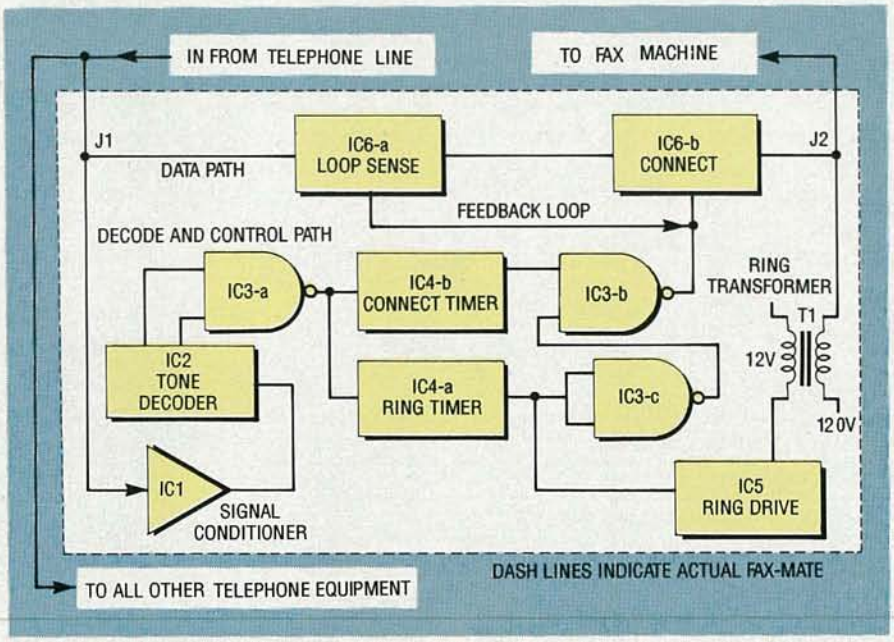


FIG. 1—BLOCK DIAGRAM for the Fax-Mate. The upper path is for data, and the lower one is the decode and control path.

Starting with the lower path, the phone line enters an op-amp. The op-amp, IC1, converts the balanced phone input to a single-ended signal that drives the tone decoder, IC2. It also serves as a buffer to prevent any incoming high-voltage ringing signal from entering the tone decoder.

When the decoder detects a *Touch Tone* representing the "#" key, its BCD output causes NAND-gate IC3-a to go low. The # key was chosen because it is not used in ordinary dialing and is present on most phones. The low from the NAND gate triggers IC4, a dual 556 timer. The 566 has two distinct functions, and both are triggered at the same time by the tone decoder's NAND gate. Optoisolator IC5 is driven by IC4-a for 1½ seconds. Transformer T1 is actually a 120-to-12-volt AC step-down transformer used in reverse; what's normally the primary is now the secondary, and vice-versa. Therefore, the *secondary* of T1 is driven by IC5, and a stepped-up 100 volts AC at the *primary* of T1 provides a ring signal to the fax machine through jack J2. IC3-c also receives an input from the ring timer (IC4-a) and, wired as an inverter, serves to inhibit the connect line during the ring cycle.

The other section of the 556, IC4-b, runs for 15 seconds and drives part of the connect IC (IC6-b) through IC3-b, which will not let the connect signal pass through until the ringing phase is completed. At this point the fax (or modem) has fired up and is sending out a handshake tone. It will do that 6 or 8 times, along with an ASCII message telling its baud rate. The fifteen seconds that the connect driver is turned on allows the handshake time that is necessary to establish contact. The connect IC (IC6) does two things: IC6-b connects the equipment for the initial link-up and, when that occurs, the loop-current detector (IC6-a) continues to keep the connect section powered. The hookup is broken when the fax machine hangs up and the loop-current detector turns off the connect section. The system is then reset and waits for the next message.

Circuitry

When working with the phone line, it is very important not to put any foreign signals on the line, and equally important not to load the line except when equipment is connected to communicate. Looking at the schematic in Fig. 2, the upper path is the data path and the lower path monitors the incoming line waiting for a # *Touch-Tone*. As designed, the Fax-Mate will not respond to any other voice or data signal. IC1 is the phone-line monitor buffer, and it conditions incoming tones for the decoder, IC2. C1 and C2 prevent the nominal 48-volts DC on the phone line from overloading the op-amp, and resistors R1 and R2 limit the current on an incoming ringing voltage. The ratio of R3/R2 sets the gain of IC1 to unity, and voltage-divider R6/R7 biases IC1 midway between its supply voltage and ground. That allows the op-amp to operate from a single supply.

The tone decoder, IC2, is manufac-

All resistors are ¼-watt, 5%, unless otherwise indicated
R1–R3, R5—330,000 ohms
R4, R12—1000 ohms
R6, R7—27,000 ohms
R8—1 megohm
R9—270,000 ohms
R10—27,000 ohms
R11—100 ohms
R13, R14—2200 ohms
R15—27 ohms
R16—330 ohms
Capacitors
C1, C2—0.001 µF, ceramic disk
C3, C6, C9—47 µF, 16 volts, electrolytic
C4, C5, C7, C8, C10, C13—0.1 µF, ceramic disk
C11—0.47 µF, 250 volts
C12—1000 µF, 16 volts, electrolytic
Semiconductors
IC1—LM741 op-amp IC2—SSI 204CP or Sierra 11204 *Touch Tone* decoder
IC3—74LS00 quad NOR gate
IC4—LM556 dual timer
IC5—MOC3010 triac driver
IC6—Theta-J TS117 telcom switch and loop sense
IC7—7805 regulator IC
D1—1N4001 silicon diode
BR1—50-volt bridge rectifier
LED1—red light-emitting diode
LED2—green light-emitting diode
Other components
XTAL1—3.58 MHz crystal
J1, J2—RJ-11 modular phone jack
J3—⅛th-inch miniature phone jack
T1—12-volt transformer (see text)
S1—DPDT switch
Miscellaneous: 1 8–12-volt AC 300-mA wall adapter, modular phone cable, project case, solder, etc.
Note: A kit containing a PC board and all parts *except* T1, LED1, LED2, S1, the wall adapter, the phone cable, and a project case is available from Benchmark Research, Inc., 2727 W. Manor Pl., Seattle, WA 98199 (206) 283-4700, for $52.50 plus $2.50 shipping and handling. WA residents must add 8% state sales tax.

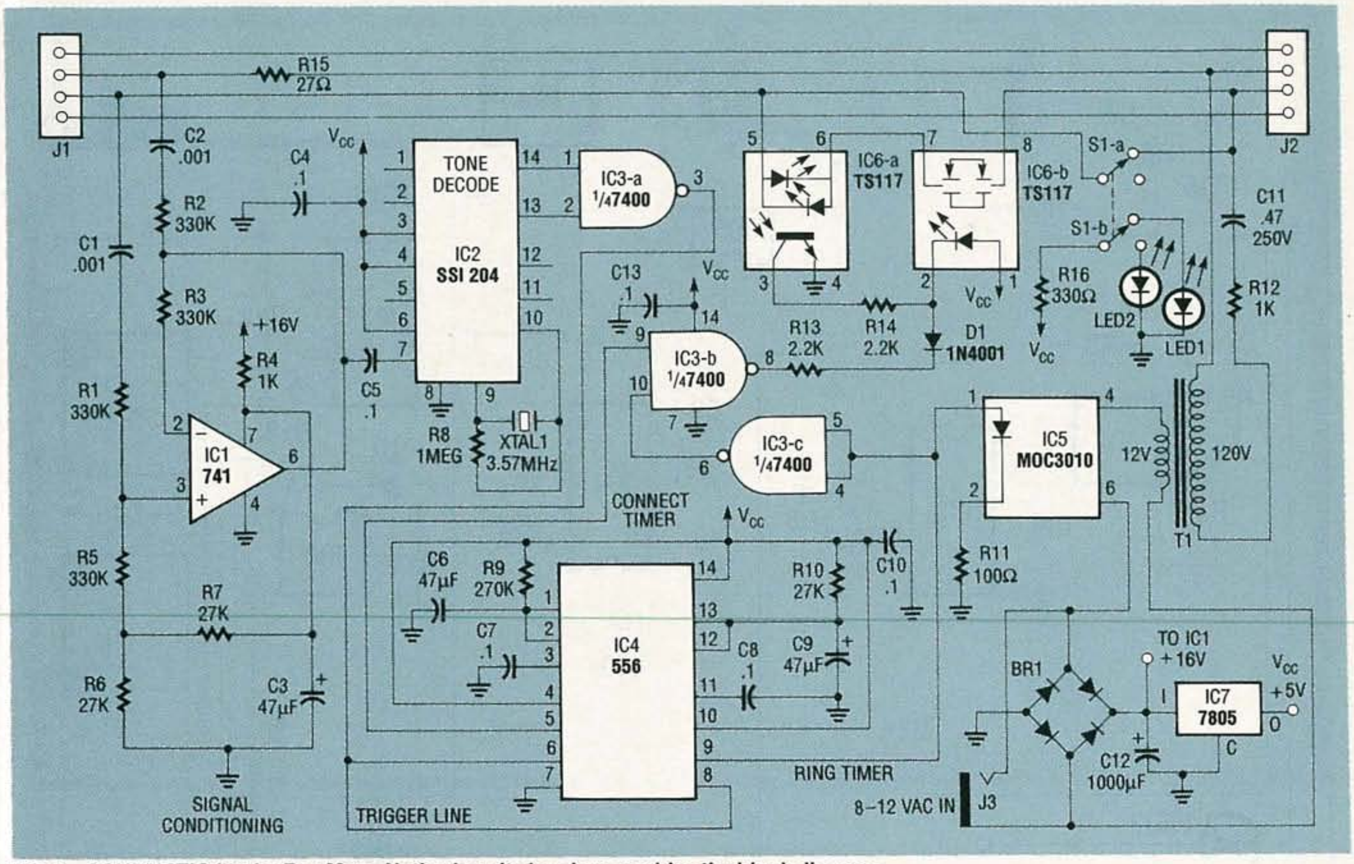


FIG. 2—SCHEMATIC for the Fax-Mate. Notice how it closely resembles the block diagram.

tured by both SSI and Sierra Semiconductor under part numbers 204CP and 11204, respectively. Both work equally well, require no tuning, and show great immunity to false triggering. Furthermore, all they require is an external crystal and a 1-megohm resistor, and they can drive either CMOS or TTL. The output is three-state 4-bit hexadecimal. The decoder can read 16 tone sets, but a typical telephone has only twelve keys. The other keys are for phone-system internal use, as well as certain industrial controls.

The decoder puts a high on pins 13 and 14 when the # tone is decoded; the two high pins drive NAND-gate IC3-a low, which triggers the 556 timer, IC4-a. That section of the timer drives IC5 for 1½ seconds to generate the ring signal required to activate the fax or modem. The M0C3010 (IC5) is one of a series of triac drivers designed to be optically coupled to 5-volt logic, but is used here to drive the 12-volt secondary of the ring transformer, T1. IC5's drive is current-limited by R11, and the 1½-second high signal from IC4-a also goes to IC3-c which is wired as an inverter.

At the same time, IC4-b (the 15-second timer) is triggered and sends its high signal to another NAND gate, IC3-b. That gate also receives the low input from the inverter, IC3-c, and will not let the connect stage conduct until ringing has finished. IC3-b drives the data-connect circuitry through R13 and D1, preventing current from flowing backward when the data line is self-running.

In Fig. 2, one side of the telephone line enters J1 and passes through R15 to the fax jack, J2. Resistor R15 balances that side of the line against the small resistance that IC6 inserts into the lower loop. (By the way, the Fax-Mate is not dependent upon phone-line polarity, but the PC layout does adhere to tip-and-ring standards in and out of the project.)

Incoming data passes through ½ of IC6, the current-sensing portion of a TS117 optoisolator. As shown, the telephone-loop current is fed through a bidirectional LED configuration that controls a phototransistor output. That output latches the connect section of the optoisolator, IC6-b.

The project draws 25 mA in its quiescent state from the 5-volt output of IC7, a 7805 regulator IC. From a 12-volt AC supply, the filtered input to the 7805 is 16 volts, yielding a device dissipation of 275 milliwatts.

Switch S1-a connects the data equipment straight through the Fax-Mate for outgoing calls. S1-b is used to switch between two LED's (a red and a green), as a reminder to put the project back into receive. Nothing serious will happen if the device is left in the send mode, except that the fax machine will answer before you do.

Construction

With the exception of T1 and the front-panel components, everything mounts on the printed-circuit board, for which a foil pattern is provided in PC Service. Perfboard construction is also adequate. There is also a kit that is available that includes a drilled and plated PC board and all parts that mount on it. However, you will have to supply your own transformer, front-panel LED's, switch, and cabinet (see Parts List).

The PC board measures 2¾ × 4¾ inches, and that, alongside Radio Shack's 12-volt transformer (part no. 273-1385) measures 4¼ inches across. The required internal height is 1¼ inches. The cabinet shown in the photographs is a Pac-Tek model CM 5-125, but any enclosure of the right size will do.

It is helpful to attach leads to the

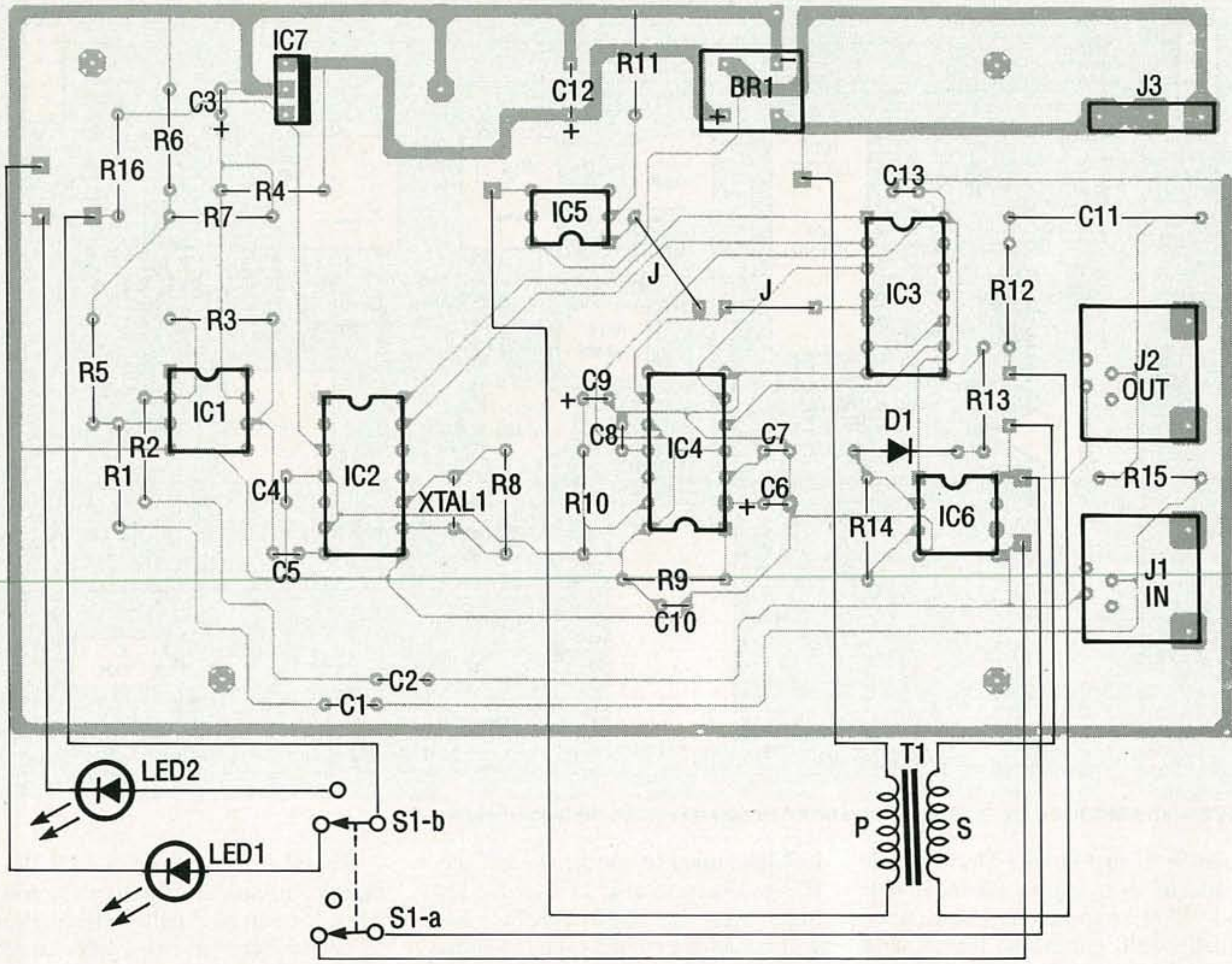


FIG. 3—PARTS-PLACEMENT DIAGRAM. A similar layout can be used if you choose to use perfboard instead of a PC board.

transformer before mounting it, because they will be difficult to attach once T1 is mounted. Also, as in the prototype, T1's pins may be bent sideways to mount the transformer directly to the case. Just be sure that the wiring does not touch the underside of the PC board.

A Parts-Placement diagram is shown in Fig. 3. Some builders prefer to use sockets for the IC's, but they are not necessary for this project. The PC board is laid out for a closed-circuit jack for J3; the third pin is not used, but it adds mechanical strength to the power jack mounted on the PC board, and it costs just a few cents more. The modular jacks, J1 and J2, have protrusions that fit through holes in the circuit board; the protrusions can then be flattened out with a hot soldering iron to secure the jacks in place. (Be sure to clean and re-tin the iron's tip after melting the plastic.)

The prototype uses a red LED for a transmit indicator and a green LED for receive. That tells you which position the switch was left in—in other words, green is for go. Also, because the two jacks are identical, they should be labeled "Tel In" and "fax Out."

One last thing: the Fax-Mate requires an AC power source of 8–12 volts. Many **R-E** advertisers offer such wall adapters.

Installation and test

Installation of the Fax-Mate consists of unplugging the fax (or modem) from the incoming phone line and connecting the unit to the Fax-Mate's J2. The Fax-Mate then requires one modular cable to connect it to the incoming telephone line.

As a first test, with the Fax-Mate installed, punch in any variety of digits; nothing should happen. Then enter the # sign; you should hear the fax fire up and transmit the handshake signal. The signal, a steady tone followed with an ASCII burst, will repeat for about 30 seconds. The machine will then automatically reset. The second test is equally simple. Have a friend who also has a fax machine send you a fax. Explain to him that once your phone is answered, either by yourself, family, answering service, or answering machine, he should push the # sign and press the send button on his fax machine. The sender (or the originator) will hear the receive tones. The receiver (you, the host) will continue contact until the sending fax finishes. Your fax (or modem) will then hang up and the Fax-Mate will reset and wait for the next incoming call.

Once your Fax-Mate is operating properly, leave it connected to your fax machine and make sure that it is set on "receive." That way you will avoid the inconvenience of having your fax machine answer the phone before you get a chance to. Use the "send" mode only when you wish to send a fax to someone else. **R-E**

BUILD THIS

REMOTE A/B SWITCH

With our IR remote control, you can switch cables between your VCR, TV, and outdoor antenna with the same ease as switching channels.

ROBERT A. HEIL

DON'T YOU WISH THAT YOU COULD SWITCH the cables between the outside antenna, VCR, and TV without the hassles of bending over the TV, reaching behind the VCR, and fumbling in dim light to disconnect one cable while connecting others? It doesn't take long before that type of inconvenience forces you to buy a manually operated A/B switch. And for awhile that seems to clear things up. But after going through all that trouble, you still have to get up from your cozy chair to throw the A/B switch by hand. If only you could do the whole thing remotely.

Well that's just what we've done. Our A/B switch operates by an infrared (IR) light beam just like your TV remote control, and that makes it possible to switch TV cables without ever having to leave the comfort of your own chair.

And that's not all! By using a power relay instead of a high-frequency relay, our unit becomes a remote-control power switch for small appliances and lamps. A third module containing a standard relay can be used to remotely turn on and off just about anything else.

A/B switch setup

Here are four tried-and-true setups using our IR remote A/B switch.

- Figure 1 shows a setup in which the incoming television signal is first put through a splitter that outputs two identical signals attenuated between 2–4 dB. (Even though the attenuation is undesirable, it can't be helped.) One signal is fed into the cable box, where it's re-modulated to a TV carrier frequency (usually channel 3), and then routed to the VCR that must be tuned to the same channel. The output of the VCR is then fed to the B input. The other splitter output is fed directly into the A input.

Selecting the B position allows you to watch cable on channel 3. To record a cable program while watching another channel is no problem if your TV is cable-ready. Begin recording your program, then flip the A/B switch to position A. Use your TV remote control to select the desired channels on your TV tuner. If your TV set is not cable-ready, then that setup won't work; but don't despair, maybe the setup in Fig. 2 can help you.

- Figure 2 shows the A/B switch between the cable box and the VCR. If you have an older TV and a remote-controlled cable-ready VCR, you can use the VCR to tune in the unscrambled cable channels. Position A restores full operation to your VCR tuner including multiple programming features, assuming it's cable-ready. In that setup, the TV must be tuned to Channel 3 at all times.
- Figure 3 shows a setup that allows you to watch unscrambled cable channels (or a tape playback) on the second TV that's cable-ready, while viewing scrambled cable or a VCR tape on the main TV set. If a family member decides to play a tape or record a program, you can retreat to the second TV and watch something else.
- Figure 4 uses two A/B switches. You can watch either the VCR or cable box on channel 3, or unscrambled channels using your cable-ready TV tuner. If you add an IR remote extender as described and featured in the May, 1989 issue of **Radio-Electronics**, the second TV can be anywhere in the house.

As you can see, A/B switches can be used in many ways to contour a system to your liking. If the input

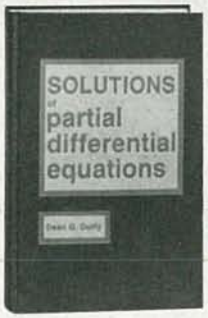
Take any 3 BOOKS for only $4.95

values to $168.40

when you join the

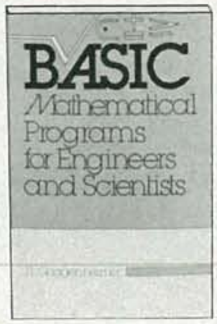
ELECTRONICS ENGINEERS & DESIGNERS BOOK CLUB®

ENGINEERING MATH



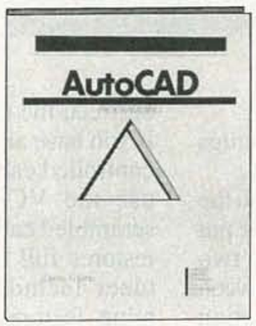
2612 **$25.95**
Step-by-step methods for solving real-world partial and differential equations. 102 illus., 560 pp.

2988 **$39.50**
Keep up with current strategies—learn how to use CIM system to tie your manufacturing operation together. 470 pp. *Counts as 2.*



8225P **$29.95**
Tested programs for most mathematical computing needs. 233 pp.

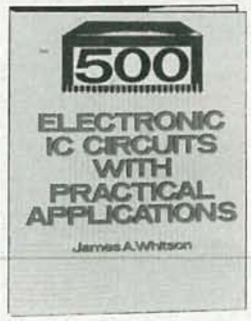
9776 **$36.95**
A convenient guide to the power and practicality of discrete mathematics for computer science and math applications. 448 pp.



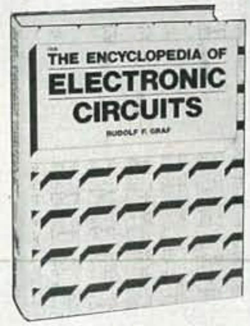
3093 **$39.95**
A tutorial and resource for extending the capability of AutoCAD Version 2.0. 288 pp. *Counts as 2.*

3147 **$32.95**
Implement PCs and streamline your process control schemes. 304 pp. *Counts as 2.*

ELECTRONIC CIRCUITS



2920 **$29.95**
600 diagrams, schematics, and tables showing IC circuits. 352 pp.



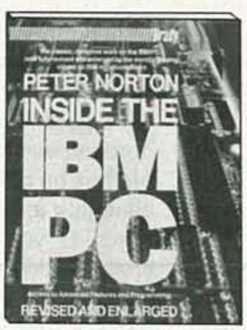
1938 **$60.00**
Over 1,300 useful and versatile electronic circuit designs. 768 pp. *Counts as 2.*

9825 **$49.95**
A comprehensive manual for soldering and cleaning printed circuit boards. 430 pp.

2727 **$24.95**
Perform complex calculations with simple analog circuits. 200 pp.

COMPUTER SCIENCE

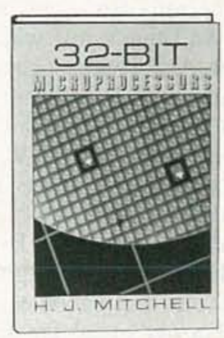
3131 **$24.95**
Assemble your own powerful microcomputer system . . . it's easy and inexpensive. 224 pp.



9762P **$21.95**
The classic definitive work on the IBM PC—fully revised and enlarged. 387 pp.

9152 **$39.95**
One of the first in-depth reviews of optical data processing available! 385 pp. *Counts as 2.*

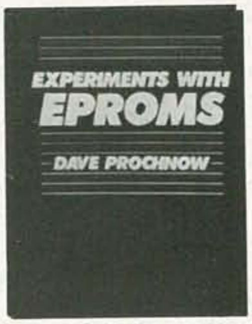
9808 **$34.95**
For both micro and mainframe users, second edition of the all-time best selling guide. 449 pp.



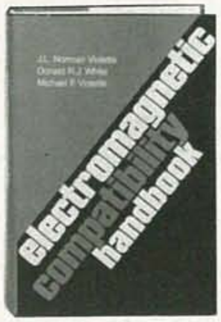
9829 **$45.00**
An inclusive overview for electronics engineers and computer scientists. 248 pp.

STATE-OF-THE-ART

9773 **$44.95**
Examines the significant advances in communications technology. 406 pp.



2962 **$24.95**
Complete schematic diagrams, parts lists, and photos for building a variety of projects. 296 pp.

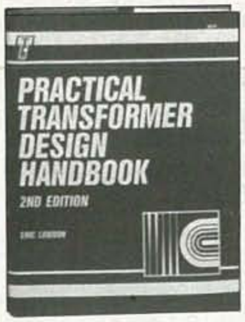


9781 **$68.95**
Designed to help deal effectively with today's fast-paced EMC technology. 707 pp.

3094 **$42.95**
A new resource for those who design, develop, and install power systems. 400 pp.
Counts as 2.

3089 **$26.95**
A nonmathematical introduction to the design, fabrications, and application. 272 pp.

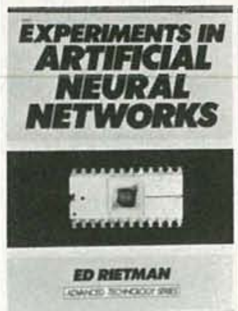
ELECTRONIC COMPONENTS



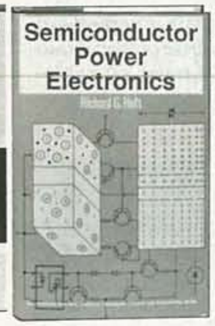
3212 **$34.95**

2672 **$49.50**

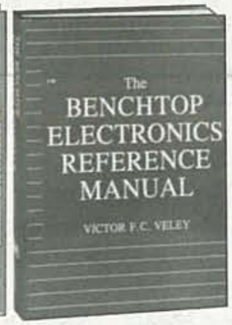
3002 **$49.50**



3037 **$24.95**



9820 **$46.95**



2785 **$39.95**

3212 A no-nonsense guide on design, building, and applications of small iron-core transformers. 350 pp. *Counts as 2.*

2672 Linear integrated circuits—specifications, prices & data. 614 pp.

3002 Fast, accurate information guaranteed to simplify your search for the right IC. 624 pp.

3037 Build your own neural networking breadboards—systems that can store and retrieve information like the brain! 160 pp.

9820 Covers transistor and thryistor circuits for power electronics systems. 324 pp.

2785 Easy-to-use reference to 160 electronic principles: ac/dc, solid-state, oscillators, amplifiers and radio communications. 620 pp. *Counts as 2.*

How the Club Works

YOUR BENEFITS: You get 3 books for $4.95 plus shipping & handling when you join. You keep on saving with discounts up to 50% as a member.

YOUR PROFESSIONAL BOOKSTORE BY MAIL: Every 3-4 weeks, you will receive the EE&D Book Club News describing the Main Selection and Alternates, as well as bonus offers and special sales, with scores of titles to choose from.

AUTOMATIC ORDER: If you want the Main selection, do nothing and it will be sent to you automatically. If you prefer another selection, or no selection at all, simply indicate your choice on the reply form provided. As a member, you agree to purchase at least 3 books within the next 2 years and may resign at any time thereafter.

BONUS BOOKS: Starting immediately you will be eligible for our *Bonus Book Plan* with savings of up to 80% off publishers' prices.

IRONCLAD NO-RISK GUARANTEE: If not satisfied with your books, return them within 10 days without obligation!

EXCEPTIONAL QUALITY: All books are quality publishers' editions especially selected by our Editorial Board.

All books are hardcover unless number is followed by a "P" for paperback. (Publishers' Prices shown)

ELECTRONICS ENGINEERS & DESIGNERS BOOK CLUB®

Blue Ridge Summit, PA 17294-0860

YES! Please accept my membership in the *Electronics Engineers & Designers Book Club®* and send me the volumes I have listed below, billing me only $4.95 plus shipping and handling charges. I understand that the books are sent on a 10-Day Free Examination basis. If dissatisfied in any way, I may return the books within 10 days and incur no further obligation. Otherwise, I agree to pay the enclosed invoice promptly and to receive regular club bulletins as described in "How the Club Works." To complete my membership obligation I need only purchase 3 additional books at regular members' prices during the next 2 years, and may resign at any time thereafter.

NAME ____________________

ADDRESS ____________________

CITY ____________________

STATE ______ ZIP ____________ PHONE ____________

SIGNATURE ____________________

Valid for new members only. Foreign applicants will receive special ordering instructions. Canada *must* remit in U.S. funds. This order is subject to acceptance by the *Electronics Engineers & Designers Book Club®*
DRE1089

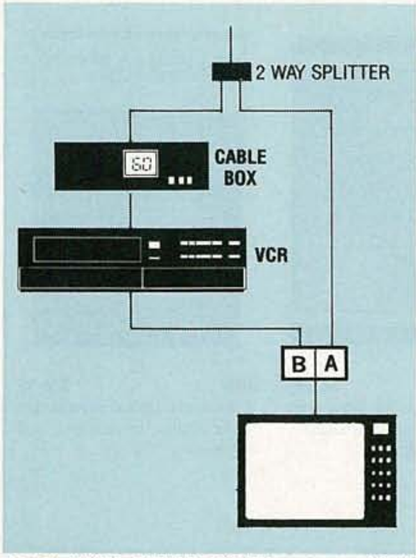


FIG. 1—YOU CAN RECORD a scrambled show while watching an unscrambled one with this setup. Your TV must be cable-ready to do so.

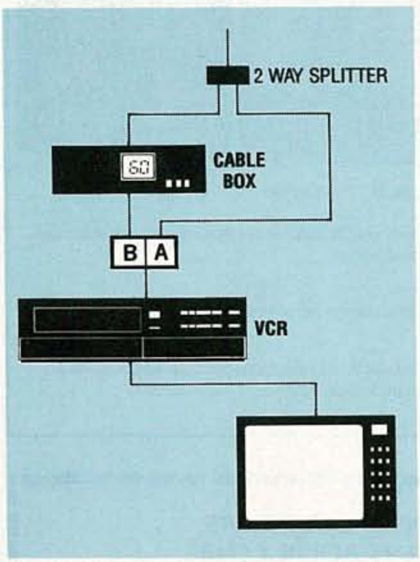


FIG. 2—THOSE WITH OLDER TV SETS and a cable-ready VCR prefer this setup.

signal loses too much strength due to signal splitters, just add a 10-dB signal booster (such as Radio Shack's 15-1118) between the input of the first splitter and the cable trunk line. Besides all the elaborate setups you can create, an A/B switch can also be used to keep an emergency antenna hooked up in case of a cable blackout in your area.

IR transmitter

The IR transmitter is a transistor oscillator that pulses an IR diode at 850 Hz. The IR output is quite strong, even when working off 3 volts. Figure 5-*a* shows the IR transmitter circuit. When S1 is depressed, Q4 and Q5 begin oscillating at a frequency determined by R16 and C11; changing C11 to a smaller value increases the frequency. Diode LED4 is an infrared light-emitting diode, while LED3 is a red 2-mA mini light-emitting diode that's connected across LED4 so you can visually monitor the output.

IR receiver

Figure 5-*b* shows the receiver circuitry. The infrared signal from the IR transmitter passes through a front-end magnifying lens and falls on Q1, a light-sensing phototransistor, where the IR radiation is converted into electrical pulses. The pulses are coupled through C1 and R1 to IC1's inverting input. The biasing of Q1 is set to keep it from saturating too quickly from ambient room light.

Op-amp IC1's gain is set to ×1000 by the R2-R3 feedback network. The reference voltage at IC1's non-inverting input is set at one half the supply voltage by R5 and R6; that forces the output, pin 6, to one half the supply voltage. Op-amp IC1 is usually powered from a bipolar supply; however, a single-ended supply can be used—as we did—if a midpoint ground is created. The output signal can then vary above and below that (bias) artificial ground.

The output pulses are then passed through R7 and decoupled by C2 before entering pin 3 of IC2, a tone decoder. Here, IC2 compares the pulse's frequency with an internal voltage-controlled oscillator that's set to a specific frequency by potentiometer R17, and C3. The frequency-lock range is set by C5. The delay period, the time between when the pulses are received and when pin 8 of IC2 goes low, is set by C4. Pull-up resistor R9 is needed because pin 8 is an open-collector output. Capacitor C7 shapes up that output, which is then passed to IC4-a where the signal is inverted from low to high.

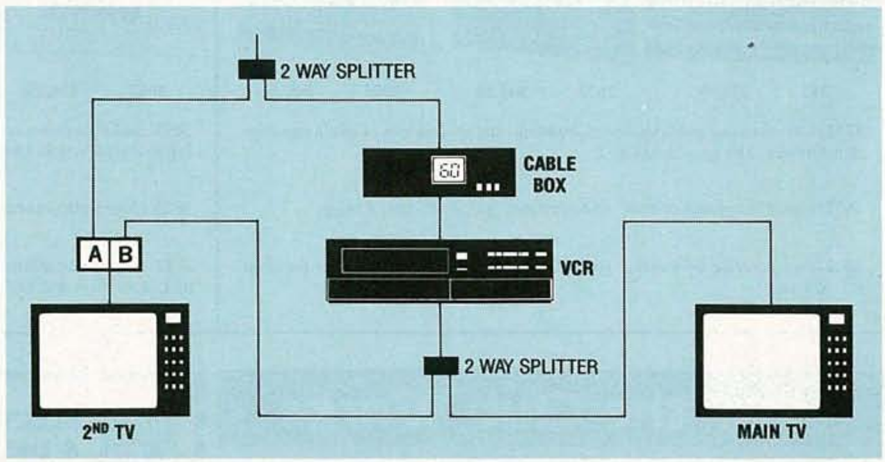


FIG. 3—USE THE A/B SWITCH TO CONNECT A SECOND TV with an option to watch either unscrambled cable via the A input, or scramble cable or a VCR tape via the B input.

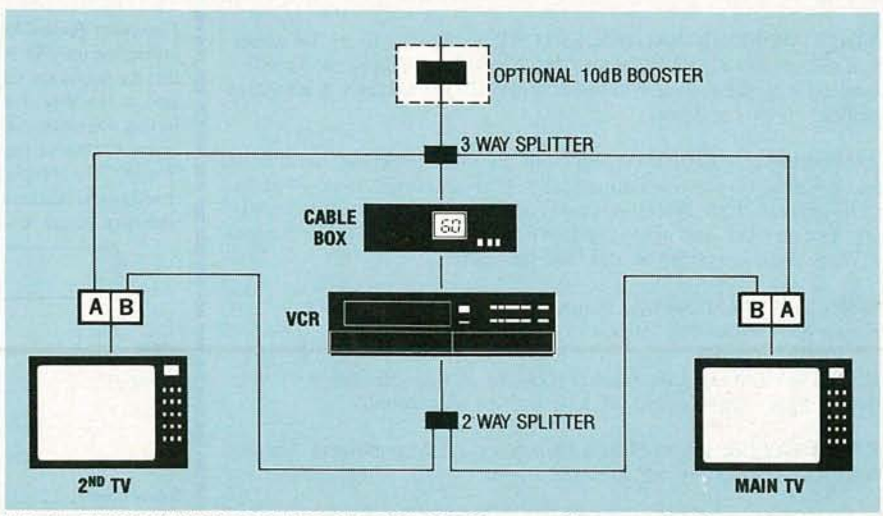


FIG. 4—THIS SETUP USES TWO A/B SWITCHES to provide more viewing options.

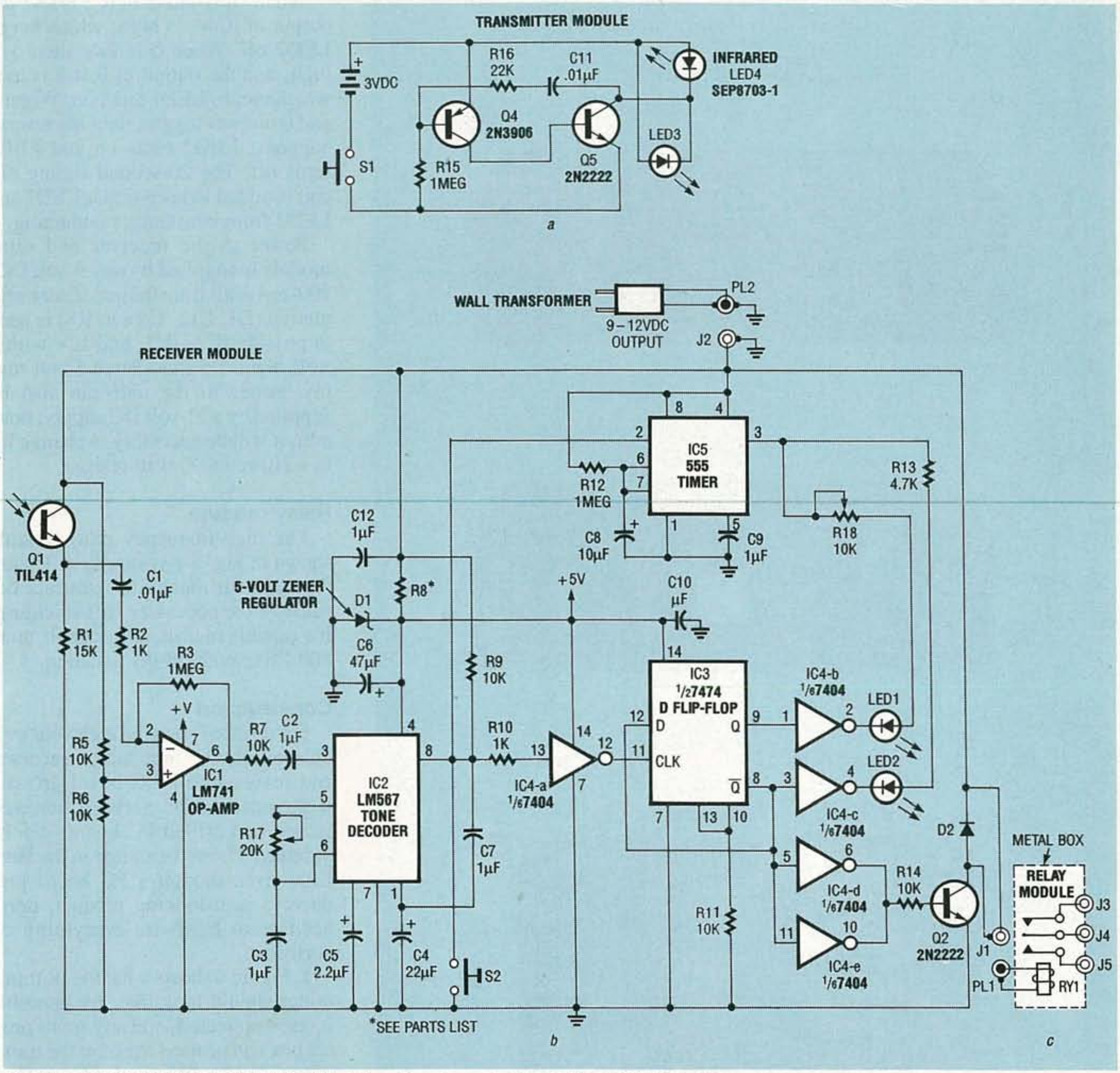


FIG. 5—THE INFRARED TRANSMITTER *(a)* can't get much simpler than this: two transistors with RC feedback. The infrared receiver *(b)* uses a number of optional components. For example, IC5 is used to turn the A/B indicator LEDs off after about 15 seconds. The relay module *(c)* is simple in design, although a bit complicated to construct.

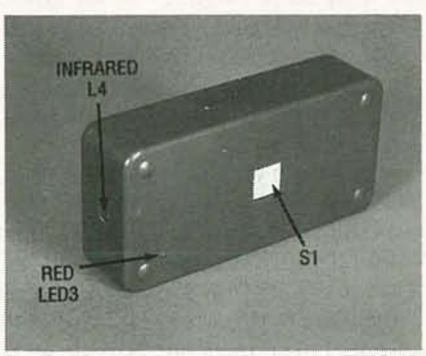


FIG. 6—YOU CAN ASSEMBLE THIS IR transmitter even smaller than the author's model. This project case is about the same size as a regular remote control.

The Q and $\overline{Q}$ outputs of D flip-flop IC3 toggle on the rising edge of the output from IC4-a. The two inverters IC4-d and IC4-e are connected in parallel to double the available driving current to Q2. When IC3's $\overline{Q}$ output goes high, inverters IC4-d and -e go low, and that turns on Q2. The bottom side of relay RY1 is grounded by Q2, which energizes the relay coil, so the contacts throw to the opposite position. Diode D3 protects the collector of Q2 by suppressing negative voltage spikes that occur when the relay coil is de-energized.

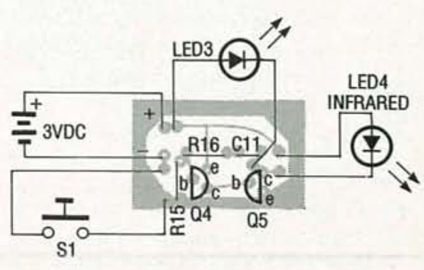


FIG. 7—THE IR-TRANSMITTER PC board should take you about 5 minutes to stuff. Instead of using LED3 as an indicator, try a low-voltage buzzer.

When IR-light pulses of the correct frequency are received, pin 8 of IC2

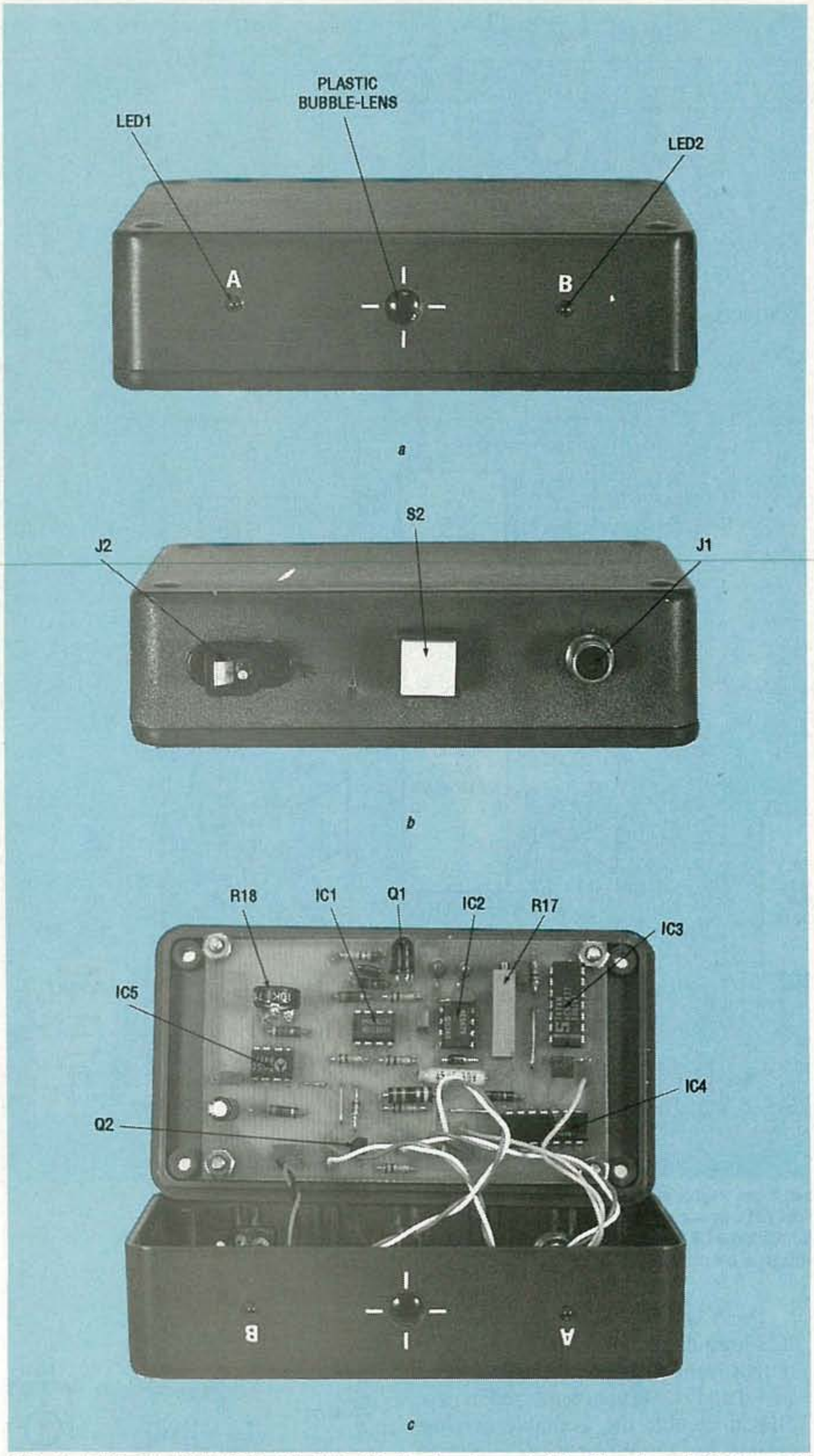


FIG. 8—THE AUTHOR HAS JAZZED UP the front panel *(a)* with rub-on-lettering and decals. The rear panel *(b)* shows J1, the DC current path for energizing the relay's coil, S2, which manually toggles the A/B switch, and J2, the DC-input jack. The opened IR receiver *(c)* reveals the author's handy work.

goes low; that forces pin 2 of IC5 low, which starts the timer. Pin 3 goes high for about 20 seconds, supplying voltage to LED1 and LED2. The timing cycle is set by R12 and C8. Resistor R13 limits the current through LED2. Potentiometer R18 is used to match the current through LED1 to that of LED2, so that both LED's glow with equal brightness.

When the $\overline{Q}$ output of IC3 is low, the output of IC4-c is high, which keeps LED2 off. When $\overline{Q}$ is low, then Q is high, and the output of IC4-b is low, which means LED1 turns on. When Q and $\overline{Q}$ outputs toggle, then the reverse happens, LED2 turns on and LED1 turns off. The 20-second timing circuit is added to keep either LED1 and LED2 from constantly conducting.

Power to the receiver and relay module is supplied by any 9-volt DC, 200-mA wall transformer. Zener regulation (D1, C12, C6 and R8) is used to provide IC2, IC3, and IC4 with a well-regulated and filtered 5-volt supply. Power to the unit can also be supplied by a 12-volt DC supply; however, it will be necessary to change R8 to a 110-ohm, ½-watt resistor.

Relay module

The high-frequency relay module shown in Fig. 5-*c* is simple in design, though a bit touchy to construct because of the necessary RFI shielding. It's capable of switching signals up to 800 MHz with 68-dB isolation.

Construction

For those of you who etch your own PC boards, the transmitter, receiver, and relay-module PC-board artwork is provided in PC Service; however, etched and drilled PC boards can be purchased from the source in the Parts List. Even though a PC board produces a neat-looking product, don't hesitate to hardwire everything on perfboard.

1. Figure 6 shows what the IR transmitter should look like. Its assembly is uncomplicated, and any small project box can be used to house the transmitter. Drill a hole in the box's front just large enough for IR LED4 to peek through; then mount the circuit board, shown in Fig. 7, and position LED4 in the whole you just drilled. The flat side of LED4 is connected to C11. The optional indicator LED5 is located in the corner, and can be fixed securely in place with a small drop of *Krazy Glue*.

2. Figure 8 shows what the IR receiver should look like. The PC board should be mounted on ¼-inch standoffs. If you don't have standoffs, then use three nuts on top of each other. The large hole for the lens of Q1 in the front of the project box is made with a 5⁄16 drill bit. Bevel the inside of the hole to give the lens more mounting surface.

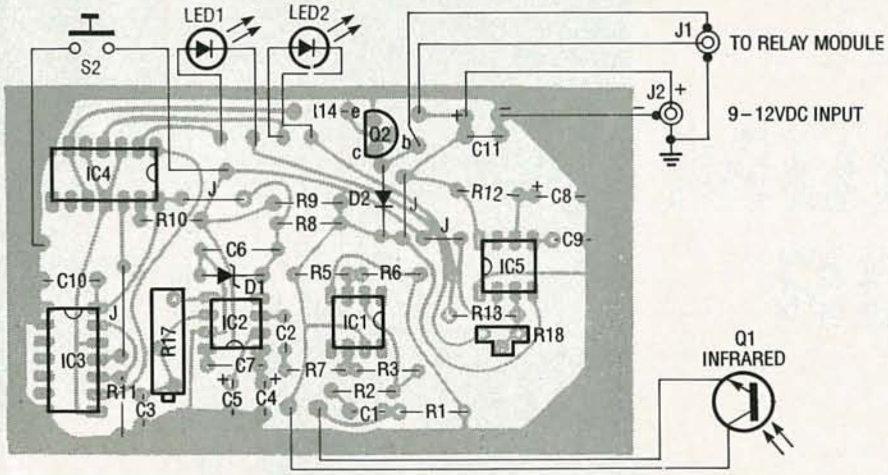


FIG. 9—STUFFING THE IR-RECEIVER PC BOARD should present no special problems.

PARTS LIST

All resistors are ¼-watt, 5%, unless otherwise noted.
R1—15,000 ohms
R2, R10—1000 ohms
R3, R12, R15—1 megohm
R5, R6, R7, R9, R11, R14—10,000 ohms
R8—68 ohms, ½-watt for 9-volts DC
R8—110 ohm ½-watt for 12-volt DC
R13—4700 ohms
R16—22,000 ohms
R17—20,000-ohms, 20-turn trimmer potentiometer
R18—10,000-ohms, 1-turn trimmer potentiometer

Capacitors
C1, C11—.01 µF, (CK05 type) molded ceramic
C2, C3, C7, C9, C10, C12—1 µF, (CK05 type) molded ceramic
C4—22 µF, 16 volts, tantalum
C5—2.2 µF, 35 volts, tantalum
C6—47 µF, 35 volts, electrolytic
C8—10 µF, 35 volts, electrolytic

Semiconductors
LED1, LED2—Mini red LED's
LED3—micro red LED
LED4—SEP8703-1 Infrared LED
D1—5.1-volt DC, 1-watt Zener
D2—IN914 switching diode
Q1—TIL414, NPN Infrared phototransistor
Q2, Q3, Q5—2N2222, NPN transistor
Q4—2N3906, PNP transistor
IC1—LM741 op-amp
IC2—LM567 tone decoder
IC3—7474 D flip-flop
IC4—7404 hex inverter
IC5—LM555 timer

Other components
T1—9–12-volt DC, 200 mA, wall transformer
S1, S2—SPST momentary switch
RY1—SPDT (Digi-Key PN Z701-ND) high-frequency relay, Omron
J1—phono jack
J2—5-mm DC power jack
J3-J5—coax F-connector jacks
PL1—phono plug
PL2—5-mm DC power plug

Miscellaneous
Two 1.5 N(size) cell batteries, shielded wire, hookup wire, hardware, plastic and metal enclosures, RFI shield tape.

Notes: The Omron high-frequency relay Z701-ND is available from Digi-Key Corporation for $6.96 plus shipping (800-344-4539). Etched and drilled PC boards are available from RAH, 16 Heritage, Irvine, CA 92714. The transmitter PC board is $4.00. The receiver PC board is $8.00. The relay PC board is $4.50. The three-board kit is $15.00. All prices are in US funds only. California residents must add sales tax.

The lens is made out of a clear-plastic bubble foot (Radio Shack, 64-2365), which has a natural magnifying ability. The sticky glue on the lens' back surface must be removed. Rubbing a little isopropyl alcohol across the surface with your finger tip should do the job. Apply a small amount of *Krazy Glue* to the bevel side of the mounting hole, then carefully install the lens so that the bubble faces outward, and the flat side faces Q1. Make sure that the lens is not angled.

Indicators LED1 and LED2 are located on both sides of the lens, and can be mounted in two ways. If you have miniature LED holders, then drill the prescribed hole size and mount them in the holders. The other way is to drill holes just large enough—a snug fit—to push the LED through. Find a washer that will fit over the LED but not past the lip, and use a drop of *Krazy* glue to anchor the LED to the washer; then place another drop on the washer and slide the assembly through the LED mounting

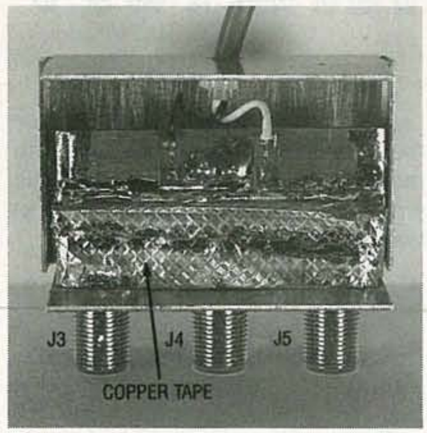


FIG. 10—LOOK AT THE DELICATE WORK needed to construct an RFI shield out of copper tape.

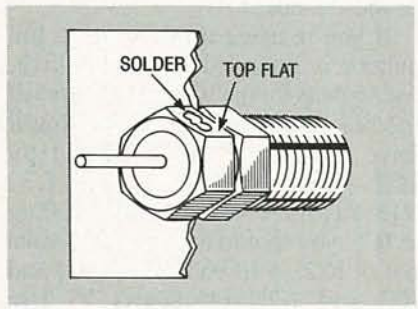


FIG. 11—HERE'S A TIP FOR constructing a RFI shield. Before soldering the copper tape to the nut flats, tin the flats with a little solder first. The relay is on the underside of the PC board as viewed from this angle.

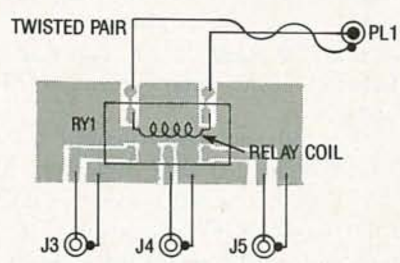


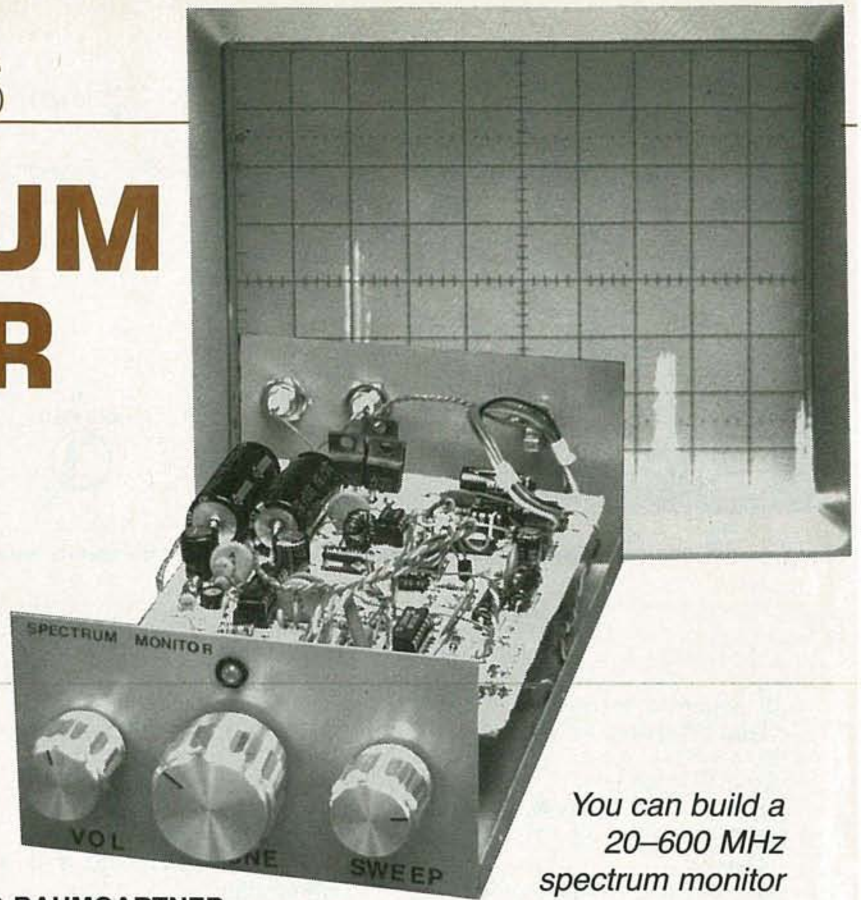
FIG. 12—THE RELAY MODULE'S PC board uses a large ground plane; that helps to shield the relay from stray RF-signals that could cause interference.

hole, anchoring it to the project box. The washer acts as a spacer to stop the LED from protruding outward too far.

If you hardwire the receiver circuit,

(Continued on page 48)

SPECTRUM MONITOR



You can build a 20–600 MHz spectrum monitor

FRED BAUMGARTNER

LAST MONTH WE WENT THROUGH ALL OF the details concerning the spectrum monitor's circuitry. We will continue with the construction procedures, as well as some troubleshooting.

Construction

The Parts-Placement diagram is shown in Fig. 1. This project is sufficiently easy to build and align that even those who shy away from RF construction shouldn't have any trouble. Reasonable care, especially in grounding, will allow successful construction on perfboard, protoboard, or the PC board.

If you're using a PC board (a foil pattern is provided in PC Service), use sockets for the IC's and Q1. Install R2 before C1 and C2 so that you'll have room to work, followd by IC1–IC3, IC5, D4, D5, L3, R15–R17, C30–C33, D2 and S1. Plug in IC5; you should now have +5 volts out of IC2, +10 volts out of IC1 and IC3, and +25 volts across D5. Use either pieces of clipped component leads or other stiff wire to make the pins of J8, the jack used to attach the tuner wires to the PC board. You can replace the tuner wiring-plug PL6 with any other compatible six-pin SIP versions, as long as you can find a matching socket that'll fit on the PC board.

The coils are hand-wound from No. 26 enameled wire. Inductors L1 and L2 are 12 and 8 turns on a ⅛-inch drill bit as the form. Transformer T2 is a 3:1 auto-transformer using a Mouser 542-T68-2 ferrite toroid-core with 3/16-inch inside diameter. Tie a small knot in the wire and wind 8 evenly spaced primary turns, twist in a 1.5-inch center tap, and do the 24 secondary turns. A toroid prevents the cabinet from being flooded with 10-kHz magnetic noise.

The metal cabinet is a 8- × 4.5- × 2.5-inch steel box. All wires between the PC board and the controls and jacks should be twisted in related groups, and made sufficiently long to route them to the side of the PC board with J8 and PL6 so the PC board can be easily removed from its 1-inch standoffs. Use plastic and styrofoam between the PC board and tuner to stabilize both and insulate one from the other, and install the rest of the parts.

Figure 2 shows a photograph of the

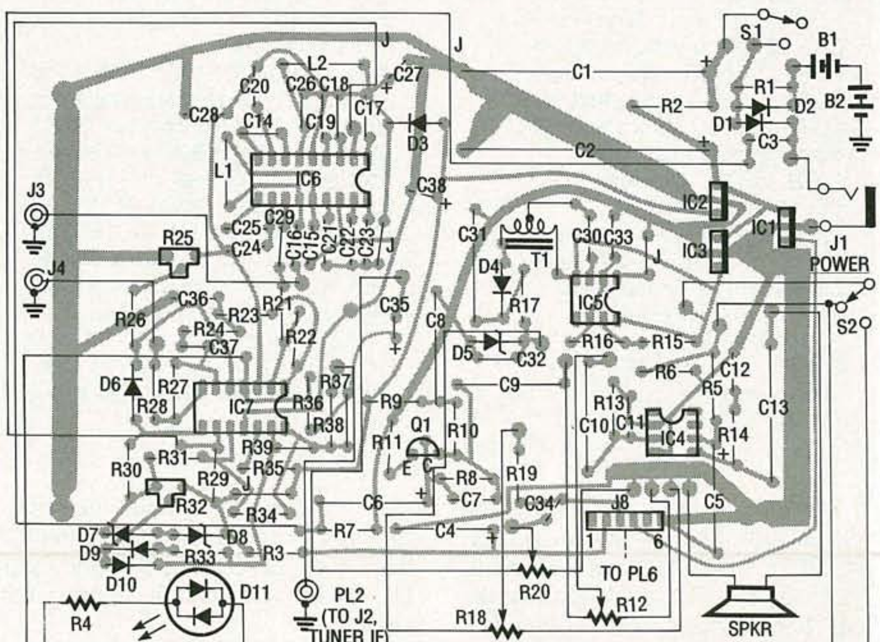


FIG. 1—PARTS-PLACEMENT DIAGRAM for the spectrum monitor. Use sockets for the IC's and Q1. Use plastic or styrofoam between the PC board and tuner to stabilize and insulate both.

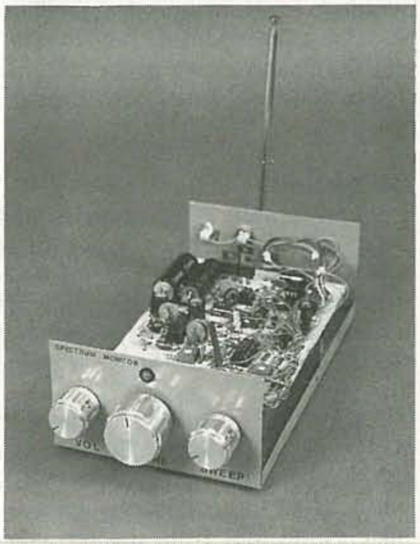


FIG. 2—THE COMPLETED MONITOR. The telescoping antenna is connected to J5 via a BNC-to-"F"-type adapter.

Figure 2 shows a photograph of the spectrum monitor with its case open. The coaxial cable in the center is the IF OUT from the tuner (J2), and the wiring for the front potentiometers and switches, as well as for the rear jacks is on the right so the PC board can be removed for maintenance. However, proper construction techniques should eliminate the need for maintenance. Note the positions of the IC's, Q1, and the PC-board-mounted potentiometers. The monopole antenna (ANT) is connected to J5 via a BNC-to-"F"-type adapter (PL3-J6), and gives good reception.

Checkout and setup

After everything is installed and wired, remove the DIP's and verify that the +5-volt and +10-volt supplies work. Replace the 555 (IC5), and verify the +25 volts from the voltage tripler and clamp. Replace the LM386 (IC4) and verify the audio by turning up the volume with the sweep off. Insert a little audio hum into pin 2 of the TDA7000 (IC6) socket by using a piece of wire to couple to your hand; if you don't hear anything, something's wrong.

Replace the NE5514 (IC7), turn on the sweep, and observe the HORIZ OUT (J4) on an oscilloscope. If you see a sawtooth, adjust the sweep frequency potentiometer R32 for a stable waveform. To lock to 60-Hz, use AC. With the oscilloscope sweep on line, adjust R32 for a single sweep waveform per 60-Hz cycle. The vertical output from J3 should be a straight line with a short +5-volt pulse, in sync with the horizontal sweep retrace portion.

Replace the TDA7000 (IC6); with the sweep off and the volume turned up, you should hear white noise. Tune the TDA7000 using C26 to 63 MHz, the middle of TV channel 3. You can tune the converter to a channel-3 TV station if you have one in your area.

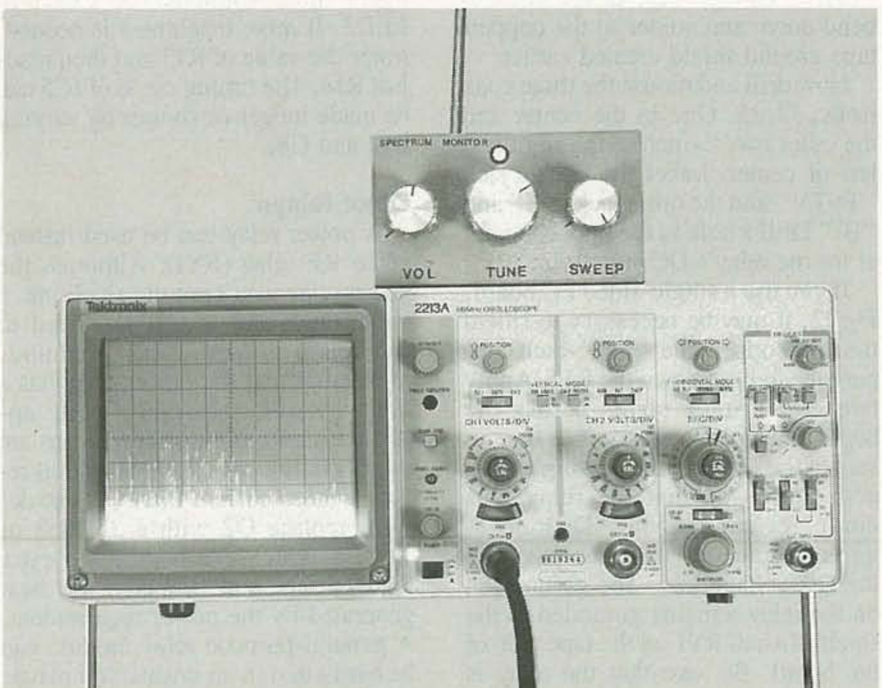


FIG. 3—THE SPECTRUM MONITOR in operation, examining a portion of the New York area spectrum.

Disconnect the coaxial cable from IF OUT (J2), and use another cable to connect the IF OUT (J2) to a TV on channel 3, using the fine tuner to pick a station.

Without moving the fine tuner, reconnect the IF OUT to the TDA7000 simultaneously, and tune C26 to match the audio of the selected station. You could also use an RF generator producing a 63-MHz carrier with a modulated FM tone, if you prefer, but keep the level low, as the TDA7000 is quite sensitive.

With the sweep at maximum (fully clockwise), an oscilloscope displaying the VERT OUT (J3), and a small wire in J4, adjust R18 and C26 to produce a display with maximum sensitivity and clarity. Set the baseline, adjusting R25 so the display is as vertically large as possible, with no downward mirror image (lower portion of the signal envelope); some slight noise should show above the baseline. Repeat to maximize performance before closing the cabinet.

The two-color LED (D11) in the front panel should be green for receive/audio and red for sweep; both it and R4 are mounted off the PC board. When you rotate the center-frequency potentiometer R18, clockwise corresponds to a lower-central frequency, and counter-clockwise to a higher value. That is as if you were looking through a moving window at the spectrum, the window width determined by the sweep-width potentiometer R20.

Using the spectrum monitor

A photograph showing the spectrum monitor in operation, examining a portion of the New York area FM spectrum is shown in Fig. 3. The monitor has quite good RF sensitivity, so use an RF attenuator before J5 when making comparative level measurements, or when handling strong signals. Comparing RF levels is straightforward, with the accuracy limited only by the tuner gain linearity. With the exception of the extreme ends of the tuning range, most converters have fairly flat response.

The cheapest attenuator pads are the in-line "barrel" type used in cable TV, available in 3-, 6-, 10-, 12-, or 20-dB sizes, with "F"-type jacks. You can also use a switchable gain set as discussed in the Radio Amateur's

Handbook. To connect an oscilloscope to the spectrum monitor, set the vertical amplifier to DC mode at 1 volt/div, and the horizontal sweep to external (x-y mode). Hook the VERT OUT (J3) to the vertical amplifier (the y-axis), and the HORIZ OUT (J4) to the horizontal amplifier (the y-axis). The spectrum monitor outputs have +5-volts DC bias and 5-volts AC maximum swing. If the oscilloscope can't be offset enough in the DC mode, use AC coupling.

If the oscilloscope has no x-y mode, use the VERT OUT (J3) alone. It contains the positive blanking pulse mentioned earlier, and the oscilloscope can use that as the trigger in a free sweep. If you're running the spectrum monitor off AC, it'll sync with the 60-Hz line voltage, so line triggering will suffice. Don't overload the RF input, otherwise the display will clip on strong signals, and the front end of the tuner will either generate modulation products which will appear on the oscilloscope or be damaged. The spectrum monitor can be used with either a marker or RF generator of known output frequency to mark a specific value.

To use the spectrum monitor as a continuously tuned receiver, turn-off sweep potentiometer R20. The signal in the center of the oscilloscope screen will be demodulated, which is very useful in identifying an offending carrier, or in hearing FM noise. You'll be able to listen to signal levels that consumer FM receivers would have trouble with.

Some modifications

A couple of changes can make the tuned-receiver approach more useful. The first is to extend the frequency range downward. Converters typically contain high-pass filters to remove frequencies below 50 MHz, which can be shorted out with a wire and cutting the relevant foils.

Tapping the IF OUT (J2) lets you use the spectrum monitor as a cable converter. Use two 50-ohm resistors and a switch as a "Y" to feed both the TDA7000 (IC6) and a back-panel "F"-type jack. One way to find the center frequency is to tap pin 4 of the tuner (the FIRST LOCAL-OSCILLATOR TUNING VOLTAGE) to an outside pin jack for a high-impedance VOM or DMM. That lets you graph known frequencies and voltages to find unknown ones. **R-E**

REMOTE A/B SWITCH

continued from page 45

remember to place the components as close together as possible to keep stray capacitance low. If you use the PC board, follow the parts placement in Fig. 9, making sure that the IC's and components that are polarity-sensitive are correctly orientated. Mount Q1 with enough lead length to be positioned directly behind the bubble lens. The collector (flat side) of Q1 is connected to the positive supply. The cathodes of LED1 and LED2 (flat side) are connected to IC4-b and IC4-c, respectively.

3. Figure 10 shows what the relay module should look like. If you choose to hard wire the relay module, use a double-sided copper board, and a shielded enclosure such as a LMB box chassis, Model No. *M00*. Another RFI shield should be constructed out of copper tape, and should enclose jacks J3, J4, and J5. Constructing that RFI shield isn't easy. With a small file, remove the plating from the top flat of the nuts securing the coax jacks in place. Figure 11 shows you how that's done. Apply some solder to the flats, and secure a piece of copper-shield tape at a 90-degree angle across the flats, then heat the tape so that the solder melts and adheres to the tape. Be sure to leave enough tape at the ends to bend down and solder to the copper-tape ground shield created earlier.

Now drill and mount the three coax jacks, J3–J5. One in the center and the other two ¾-inch to the right and left of center. Label the center jack "To TV" and the other jacks "A" and "B." Drill a hole in the opposite panel for the relay's DC supply line.

If you use a single-sided PC board, Fig 12, it may be necessary to shield the non-copper side with ½-inch copper tape to hold down the RFI. Apply two copper-tape strips across the board's length; however, be sure to scrape the copper tape—using an *Exacto* knife—so that the relay pins don't get shorted out. Drill feed-through holes for the relay pins and the DC voltage line. The ground pin on the relay remains grounded to the shield. Install RY1 on the tape side of the board. Be sure that the relay is properly orientated before soldering into place.

The DC line to the relay can be made out of any two-conductor wire. Be sure to leave enough wire length to place the relay module behind the TV set. The positive wire to the relay is connected to the center conductor of PL1.

Calibration

Apply power to the receiver and make sure that nothing gets hot. If something does, that indicates trouble, so immediately turn the power off and check the board for incorrectly placed parts such as diodes, capacitors, and IC's.

Calibration should be made with RY1 connected to the circuit. Attach a DC voltmeter or oscilloscope to IC2 pin 8. Hold the transmitter approximately one foot from the receiver, aiming it directly at the lens. While depressing the transmitter switch, adjust R17 until IC2 pin 8 drops low. Release the switch and IC2 pin 8 should return high. If you don't have a meter handy, then watch the indicators LED1 and LED2. If the circuit is working properly, the indicators will light alternately each time S1 is pressed. After 10 seconds or so, both indicators should turn off. Place your finger on the relay module and you should feel a click each time S1 is pressed. Vary the adjustment of R17 to find the limits at which IC2 will respond, then center the adjustment between the two limits. Adjust R18 to match the brightness of LED1 to LED2. If more brightness is needed, lower the value of R13 and then readjust R18. The timing cycle of IC5 can be made longer or shorter by varying R12 and C8.

Other relays

A power relay can be used instead of an RF relay (RY1). Although the power relay won't require shielding, a metal enclosure is recommended to provide a proper chassis ground. Make sure that the power relay has a high enough rating for your appliance; contacts rated at 10 amps are usually sufficient. If the relay coil requires more current than Q2 can deliver, replace Q2 with a 2N3053 or TIP 31, which can handle the extra load current and dissipate the heat generated by the power requirement. A general-purpose relay module can be hardwired in an unshielded plastic enclosure. Q2 should be able to energize the relay coil. **R-E**

ONE-BAND SHORTWAVE CONVERTER

RUDOLF F. GRAF and WILLIAM SHEETS

With our shortwave converter and your car radio, cruising for burgers won't ever be the same.

BORED WITH AM TALK-RADIO? TIRED OF FM rock-n-roll and obnoxious DJ's? Wish you had another choice, but don't think that one's around? Then look no further—try our converter that turns any ordinary car radio into a shortwave receiver.

Because our converter goes between your antenna and car radio, no vehicle or radio modifications are required. The converter covers any 1-MHz segment between 5–30 MHz depending on the components you select. It draws only 10 mA at 12 volts, so a simple hookup to your car battery is all you'll need. The front end has good sensitivity, and works well with any 31-inch car antenna, although a longer whip works slightly better below 10 MHz.

Circuit description

Figure 1 shows that switch S1, a 3-*P*ole *D*ouble *T*hrow (3PDT), selects whether the antenna signal is routed directly into the converter for shortwave reception, or bypassed around the converter for standard AM/FM reception.

For shortwave reception, place switch S1 in the SW position. The radio signals enter jack J1, to S1-a, where they're inductively coupled to the converter's RF front-end via two turns of insulated wire around L1, which resonates at the input frequency due to C1 and C2. Finally, capacitor C1 is primarily for tuning, while C2 matches the L1-C1-C2 tank to Q1.

Transistor Q1 is a grounded-base amplifier. The signal developed across R1-C2 is fed to the emitter; R1 is a bias resistor for Q1. Components R2 and R3 bias the base of Q1, and C3 is a bypass capacitor that keeps the base at AC ground. The common-base transistor allows easy matching from a tuned circuit over a wide frequency range, and is less likely to suffer from RF instability at the shortwave frequencies that our converter covers. Resistor R4 suppresses parasitic oscillations, preventing Q1 from oscillating spuriously at VHF–UHF frequencies. The C4-L2 tank is tuned to the converter's input frequency, and serves as a load for RF-amplifier Q1. DC power is supplied through R5, and C5 is a supply-bypass capacitor.

The amplified signals are coupled through C6 to the emitter of Q2, a

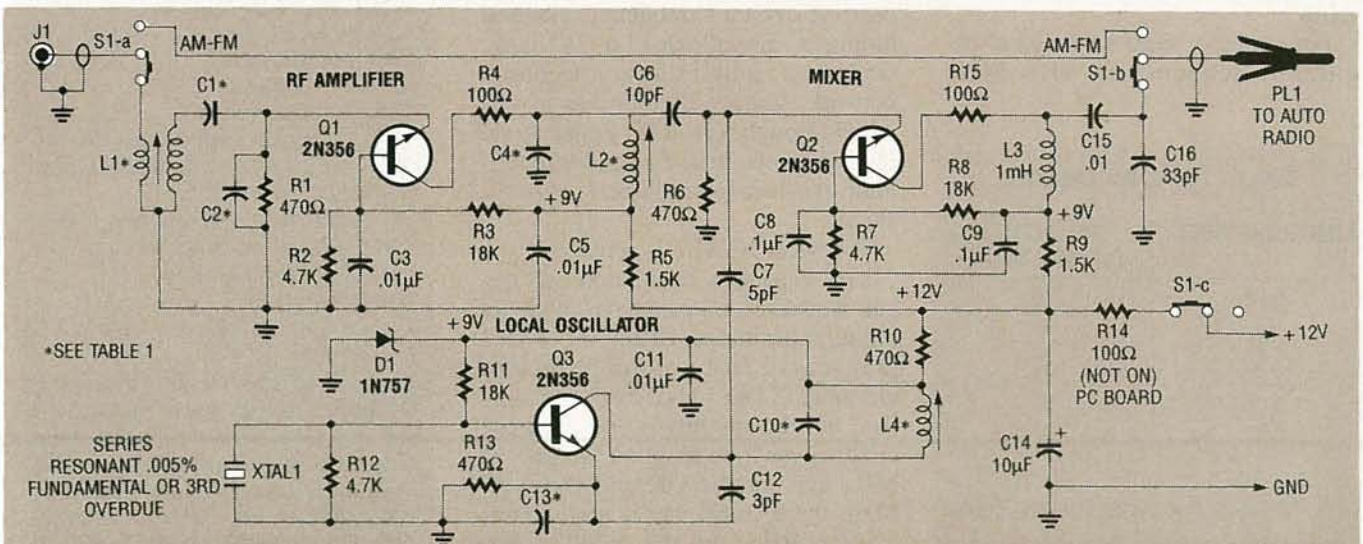


FIG. 1—VHF TRANSISTORS Q1, Q2, AND Q3 work easily up to 50 MHz, where they're "loafing" and still have high gain. Transistor Q1 is the RF amplifier, Q2 is the mixer, and Q3 is the local oscillator.

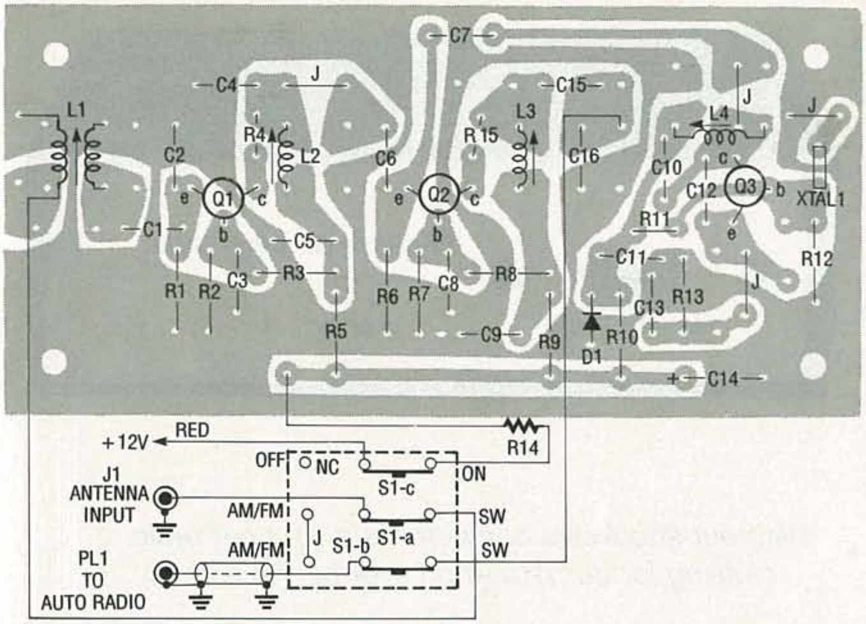


FIG. 2—PARTS PLACEMENT IS STRAIGHTFORWARD. The copper pads are extra wide to accommodate coil forms of different sizes; drill an extra hole wherever your coils fit best.

common-base mixer, which heterodynes the incoming RF signals with the local oscillator. Capacitor C7 couples the local-oscillator signal to the emitter of Q2. Resistor R6 biases the emitter, and R7-R8 biases the base, which is AC-grounded for RF signals. DC power is supplied through R9, and C9 is a supply-bypass capacitor. The mixer output is developed across L3, a 1-mH RF choke. Capacitor C15 blocks DC, and C16 bypasses unwanted mixer products to the ground. The difference-frequency output across C16 is equal to the input frequency minus the local-oscillator frequency. That difference signal is routed through S1-b, then through PL1, and finally inputted to the car radio.

For example, suppose the local-oscillator frequency is 11.0 MHz (11,000 kHz), then the shortwave converter will receive frequencies in the 11.5–12.5-MHz range. After the shortwaves are down-converted in the mixer, the frequencies going into the car radio will be in the 500 kHz–1,500 kHz range. And because the AM band lies between 525 kHz and 1,605 kHz, our converter makes tuning the shortwave band on your AM dial quite an easy task.

The Colpitts local-oscillator (Q3) uses crystal XTAL1 as the frequency-controlling element. The crystal is a series-resonant, fundamental or third overtone type, which AC grounds Q3's base only at its series-resonant frequency; that prevents Q3 from oscillating at any other frequency except the crystal's frequency. General tuning is through the L4-C10 tank, while C12 and C13 form a feedback network. Voltage-divider bias is provided through R11–R13. Zener diode D1 and components C11 and R10 regulate the local-oscillator's +9-volt supply.

If crystal XTAL1 is replaced by a .01-μF capacitor, oscillation will occur whenever L4 resonates with its tuning capacitance (C10 + C7 + C12 plus strays). That fact can be used to eliminate XTAL1 and save a few dollars, but the stability of the local-oscillator won't be as good. Below 10 MHz that may be OK; but above 30 MHz there might be excessive frequency drift, and that could make tuning difficult. We therefore suggest that you use the crystal as your frequency-determining element.

TABLE—1 COIL DIMENSIONS

L MICROHENRIES	NO. TURNS (APPROXIMATE)
0.75	8
1.3	10
1.8	15
2.2	17
3.0	19
5.5	27

COIL FORM ¼" DIA. WITH TUNING SLUG.

INDUCTANCE RANGE DEPENDS ON TUNING SLUG, BUT TYPICAL TV COIL SLUG WILL GIVE −30 TO +50%.

Assembly

- As shown in Fig. 2, the converter is constructed on a single-sided PC-board whose size is 2 inches × 4¼ inches. Printed-circuit artwork is provided in PC service for those wishing to etch their own, or a kit containing the PC board and all parts that mount on the board is available from the source in the Parts List.
- First install the resistors and capacitors, then the transistors, and finally the coils L1, L2, L3, and L4. Suggested coil dimensions are given in Table 1, while the various inductance values are specified in Table 2.
- The shortwave signals are inductively coupled into the RF front-end by winding a two-turn link over L1. The link is formed using ordinary insulated hookup wire: Solder one end of the wire to the PC-board

PARTS LIST

All resistors are ¼-watt, 5%
R1, R6, R10, R13—470 ohms
R2, R7, R12—4700 ohms
R3, R8, R11—18,000 ohms
R4, R14, R15—100 ohms
R5, R9—1500 ohms
Capacitors
C1, C2, C4, C10, C13—see Table 2
C3, C5, C8, C11, C15—.01 μF, ceramic disc
C6—10 pF, ceramic disc
C7—5 pF, ceramic disc
C9—.1 μF, mylar
C12—3 pF, ceramic disc
C14—10 μF, electrolytic
C16—33 pF, ceramic disc
Inductors
L1, L2, L4—see Table 2
L3—1 mH, RF choke
Semiconductors
Q1–Q3—2N3563
Other components
XTAL1—crystal frequencies, see Table 2, series resonant, .005% fundamental or 3rd overtone.
J1—automotive antenna jack
PL1—automotive antenna plug
S1—3PDT slide switch
Miscellaneous
Cabinet, wire, hardware, solder, PC board, etc.

Note: A 14-30-MHz kit containing PC board and all parts that mount on the board is available from North Country Radio, P.O. Box 53, Wykagyl Station, New Rochelle, NY 10804. (A 5-14-MHz kit is available upon request.) Price: $32.50 plus $2.50 for postage and handling.

TABLE—2 FREQUENCY DETERMINING COMPONENTS

FREQUENCY RANGE	XTAL 1 FREQ. (MHz)	TUNING INDUCTANCE μH			CAPACITANCE pF				
		L1*	L2*	L4*	C1	C2	C4	C10	C13
5.5–6.5 MHz (49 METERS)	5.0	5.5	5.5	8.0	150	1000	120	220	100
9.2–10.2 MHz (3-METERS)	8.7	3.0	3.0	3.2	100	820	91	150	100
11.5–12.5 MHz (25 METERS)	11.0	2.2	2.2	2.1	82	680	68	100	100
13.2–14.2 MHz (21 METERS)	12.7	1.8	1.8	1.6	82	680	68	100	100
14.5–15.5 MHz (19-METERS)	14.0	1.6	1.6	1.6	82	470	68	82	82
17.5–18.5 MHz (17 METERS)	17.0	1.3	1.3	1.1	68	470	56	82	82
21.0–22.0 MHz (13 METERS)	20.5	0.9	0.9	1.0	68	470	56	68	68
25.5–26.5 MHz (11 METERS)	25.0	0.8	0.8	0.74	56	330	47	56	56
26.5–27.5 MHz (11-METER)	26.0	0.76	0.76	0.72	56	330	47	56	56

*SHOULD BE ADJUSTABLE −30 TO +50% OF VALUE SHOWN.
SEE TABLE 1 FOR SUGGESTED DIMENSIONS.
L1 HAS 2-TURN LINK AROUND COLD END FOR ALL VALUES.

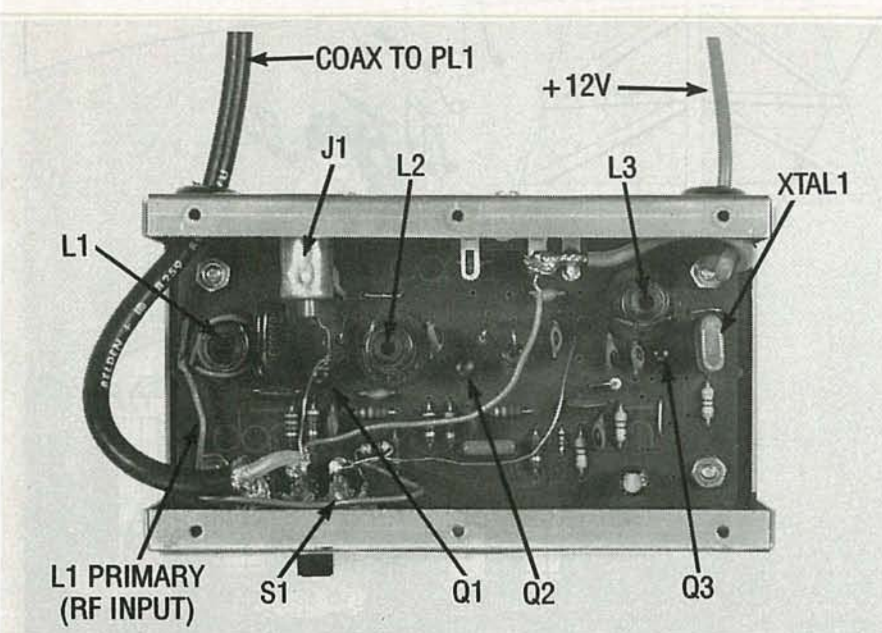


FIG. 3—THE AUTHOR'S CONVERTER is neatly assembled inside a metal case. Switch S1 and plug PL1 have been carefully installed, so as not to bump against any other PC-board components.

ground, wind two turns around L1 (that's the link), and then connect the other end of the wire to switch S1-a. Finally, position the link close to the grounded (bottom) side of L1.

- For inductors L1–L3, the author used IF coils taken from an old TV set. If preferred, standard ¼" diameter slug-tuned forms may be substituted. The PC layout has generous-size pads, so different-size coil forms can be accommodated; that simplifies construction for the hobbyist with a limited parts inventory.
- Resistor R14 should be installed off the PC board, between the PC board and S1-c.
- Figure 3 shows the completed project. The converter is housed in a metal box that can be mounted under a car's dashboard. The enclosure should be big enough to house the PC board, automobile plug, and switch; a suitable size might be 3-inches deep × 5-inches long × 1-inch high. Preferably, the 12-volt DC power lead should have a ½- or 1-ampere fuse.

Alignment and testing

Hook up a 12-volt bench supply and turn on the converter. Check for about +2 volts at the emitter of transistors Q1, Q2, and Q3. Check for +9 volts across Zener D1. For the rest of the converter test, you'll need a car radio or other AM-broadcast receiver with a shielded input. Connect the converter between the antenna and the AM radio. If a frequency counter is available, connect it across C13 and adjust L4 until the crystal oscillator begins operating. Now tune the radio over the AM-broadcast band; you should hear shortwave signals. Pick a weak signal you find interesting, and adjust L1 and L2 for best reception. There should be a definite point of maximum response; if not, add or subtract a turn from L1 or L2 as required, and try again.

In the shortwave broadcast bands between 6 and 15 MHz, plenty of signals should be heard whether day or night. The lower frequencies (5–15 MHz) are best at night, while the higher frequencies (15-30 MHz) are best during daylight hours; however, that is not always the rule. If no signals are head, re-check your wiring and solder connections.

That completes the alignment and testing of the shortwave converter. If you desire different frequency bands, a rotary switch can be used to switch in various values of components and crystals, but it is probably easier to build several converters, and simply switch the power and signal leads.

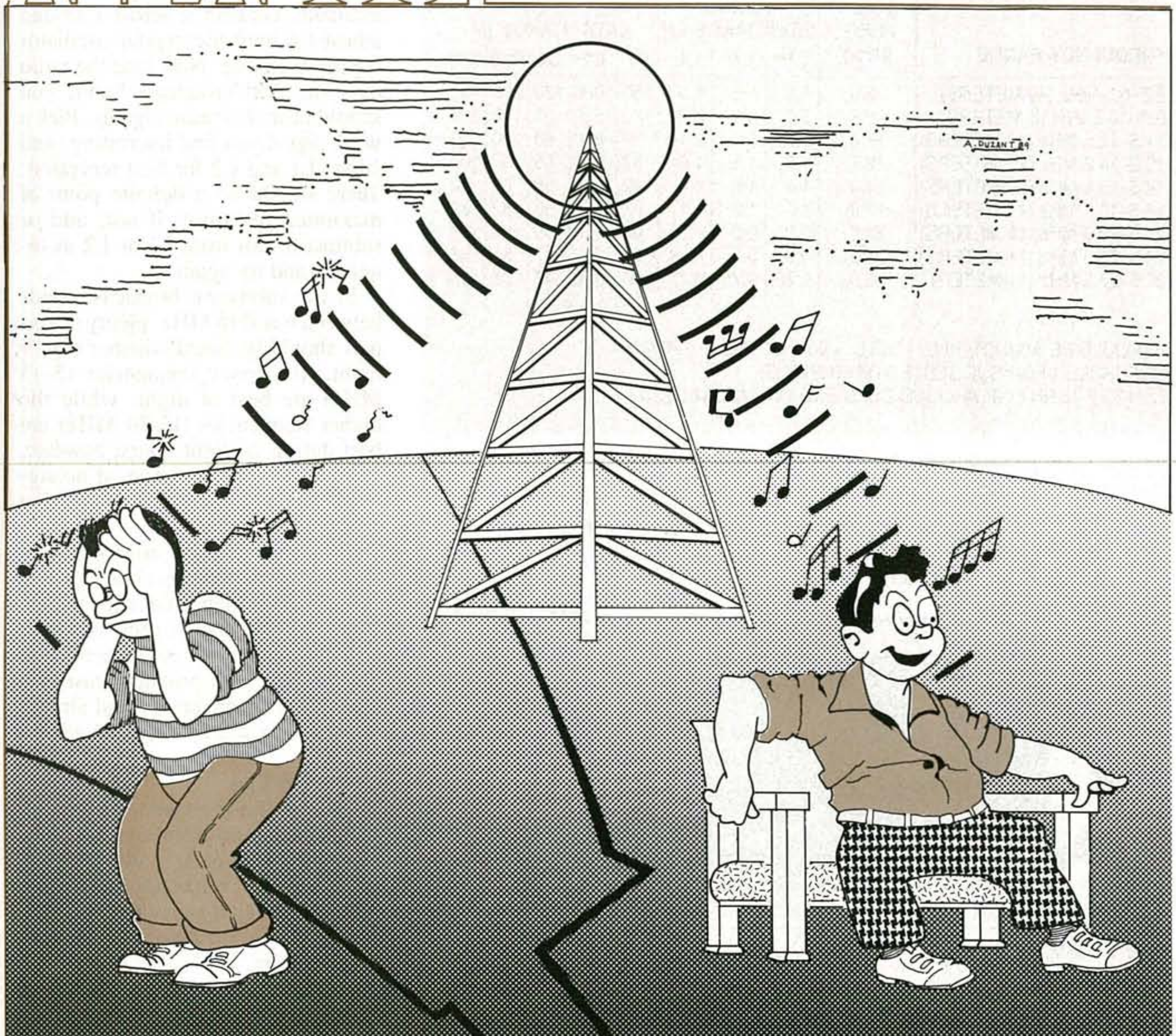
Operating tips

The shortwave converter makes it very easy to tune in stations, because it spreads the 1-MHz portion of the shortwave band across the entire AM radio's dial. That provides you with lots of "room" to tune in each individual station.

Another thing to keep in mind is the fact that it will be easier to tune in a station on an AM car radio that has manual tuning, as opposed to a radio with digital tuning. That's because regular AM stations are spaced 10 kHz apart from each other, and a digitally tuned radio is set up so that the tuner advances in precise 10-kHz increments with each "turn" or advancement of the dial.

Shortwave stations may be found anywhere on the dial, as they are not spaced with any kind of order. A manually tuned radio will allow you to adjust each station for best reception. A digitally tuned radio can be used, but the reception of some stations may not be perfect. It's also possible that you may not be able to tune in some stations at all on a digital radio, that you could actually receive on a manually tuned radio. **R-E**

ALL ABOUT



FMX: IS IT GOOD FOR FM?

Can FMX improve stereo FM reception?

LEN FELDMAN

THERE'S A BATTLE BREWING IN THE broadcast industry, and it's one that could affect the way in which we listen to FM radio and, more specifically, FM stereo radio broadcasts. On one side is a company called Broadcast Technology Partners. Its president, Mr. Emil Torick, is a distinguished engineer who spent many years at the CBS Technology Center in Connecticut before it was shut down a few years ago.

During his last years at CBS, Mr. Torick worked out a system that he maintains will decrease the background noise commonly encountered when listening to FM stereo stations whose transmitters are at a considerable distance from the FM tuner or receiver. Torick calls his system FMX. As anyone who has ever listened to stereo FM under fringe-area conditions knows only too well, programs whose background noise levels are perfectly acceptable in mono can become unlistenable when you switch to stereo. The increase in noise level can be as much as 23 dB or, in arithmetic terms, there's a 200-to-1 increase in noise power!

If FMX can make stereo FM almost as noise-free as mono FM, the number of listeners in any given area who could enjoy noise-free stereo reception would increase. From a commercial standpoint, stations could then charge higher rates to sponsors based upon a greater audience potential. It's easy to understand why many stations jumped on the bandwagon and converted to FMX. Today, some 50 to 70 FM stations are actually transmitting signals in the FMX format, even though, other than some experimental tuners, there are no home FM tuners or receivers equipped to receive FMX signals. Several manufacturers are said to be ready to produce such sets, especially car-stereo systems where noise has always been a big problem. (Many car radios already use a form of "blending," that gradually switches reception to mono, when stereo reception is weak.)

If FMX sounds like a panacea for FM listeners and broadcasters alike, hold on a moment! In a press conference held at the Massachusetts Institute of Technology, Dr. Amar Bose, a Professor of Electrical Engineering at MIT (who also happens to be Chairman of The Board of the Bose Corporation, the well-known manufacturer of loudspeakers and other audio components), and Dr. William Short, a researcher at Bose Corporation, presented their findings about the operation and limitations of FMX. The revelations from Dr. Bose and Dr. Short can best be summarized as:

- Broadcast station coverage, instead of being increased as originally hoped, is actually decreased by the FMX system.
- FMX transmissions degrade reception even on existing FM stereo receivers.
- Receivers designed specifically for FMX reception are inferior to existing FM stereo receivers, even for receiving FMX transmissions.

Such claims, of course, were not made without a substantial amount of backup. Those in attendance received a massive document detailing the mathematical modeling, computer simulation of the effects produced by FMX, and a summary of results obtained from actual broadcasting experiments that led to those startling conclusions. Since the MIT event took place, the full report has become available as an MIT Technical Research Report. Readers interested in the complete report (which goes into far more detail than is possible in this article) can obtain a copy for $7.50 (shipping and handling costs included) by writing to the Research Lab of Electronics, Room 36-412, Massachusetts Institute of Technology, Cambridge, MA 02139, and requesting a copy of Technical Report #540, entitled *A Theoretical and Experimental Study of Noise and Distortion in the Reception of FM Signals*.

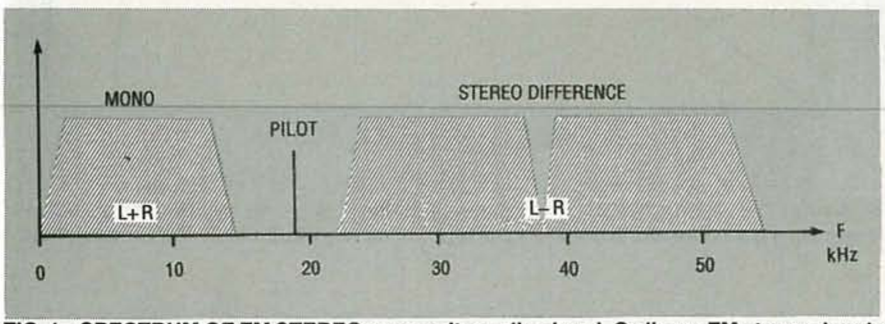


FIG. 1—SPECTRUM OF FM STEREO composite audio signal. Ordinary FM stereo signals consist of a monophonic signal, a stereo difference signal, and a pilot signal.

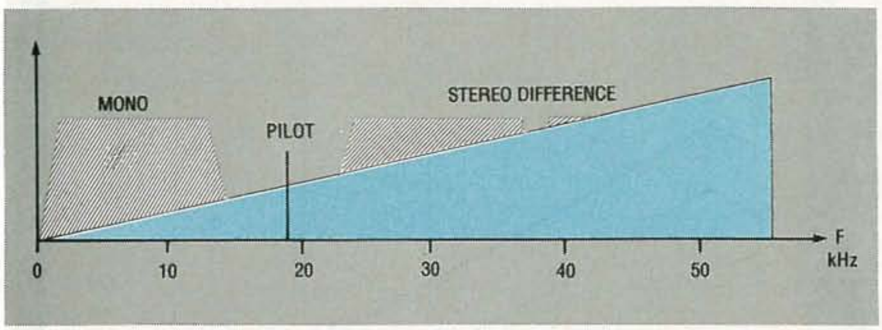


FIG. 2—IN STEREO FM TRANSMISSION, noise is added to the signals, and the amplitude of the noise increases with frequency.

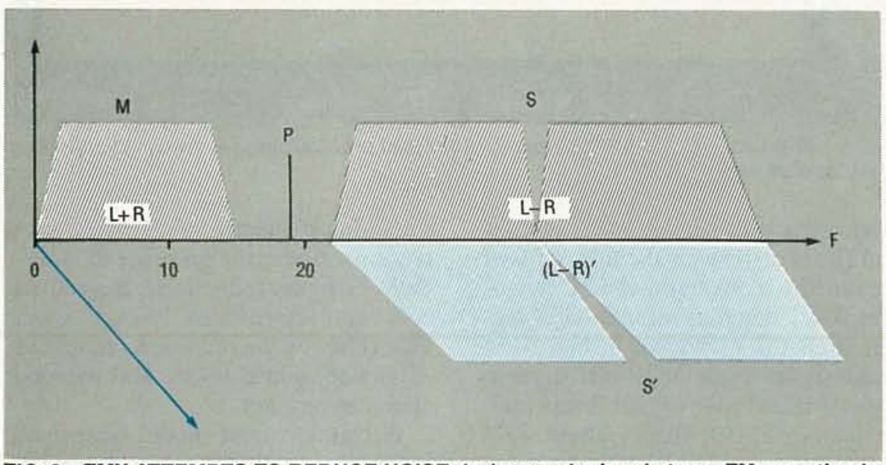


FIG. 3—FMX ATTEMPTS TO REDUCE NOISE during weak-signal stereo FM reception by adding another subcarrier signal that is 90 degrees out of phase with respect to the regular L − R signal.

FM stereo and FMX stereo

To understand the issues raised by Bose and the counter arguments put forth by Torick, it's helpful to review how FM stereo works, and how FMX is supposed to work. Ordinary FM stereo signals consist of three parts (see Fig. 1). A monophonic signal, consisting of the sum of the left and right stereo signals is transmitted as the main channel, and received on both mono and stereo FM sets. A difference signal, created by subtracting the right signal from the left (L − R) is used to modulate a 38-kHz subcarrier. The subcarrier itself is suppressed, but the modulation products ride along in what has best been described as "piggyback" on the main RF carrier. In addition, a pilot signal, at a frequency of 19 kHz, or half the suppressed subcarrier frequency, is transmitted at a low 10%

modulation level. That's so that the receiver can recreate the 38-kHz subcarrier for subsequent demodulation or detection of the L − R signal. The original left (L) and right (R) signals are then recovered by adding L + R to L − R and, in a separate signal path, by subtracting L − R from L + R.

As illustrated in Fig. 2, random noise is added to those signals along the way from the transmitter to the receiver and by the circuits in the receiver as well. The amplitude of that noise, when recovered by the detector in the receiver, increases with frequency. Since, in the case of stereo, more information is being inserted at higher baseband frequencies, signal-to-noise (S/N) ratios are poorer than during mono reception. The difference in the S/N ratio can be as great as 23 dB!

Figure 3 shows how FMX attempts to reduce noise during weak-signal stereo FM reception by adding yet another subcarrier signal that is 90 degrees out of phase with respect to the regular L − R. The audio used to modulate the second subcarrier is a *compressed* version of the difference signal. At low modulation levels, the audio level is raised by about 14 dB, as shown in Fig. 4. Compression is reduced for audio levels that are approximately 20 dB below 100% modulation (for louder audio signals).

Expansion at the receiver end is the converse of the compression, so that low-level signals are made even quieter and, along with them, noise is reduced as well. At or near maximum modulation levels, the secondary L − R signal nearly vanishes, allowing maximum modulation levels to be as high with FMX as they are with conventional stereo FM transmissions. An ordinary receiver is supposed to ignore the presence of the quadrature-related extra "difference" subcarrier, while a specially built FMX receiver would use the expanded, new difference signal to recover the proper L − R components. The conventional L − R signal, though present in such receivers, would act only as a level guide, ensuring that the correct amount of expansion takes place.

Under ideal conditions, the scheme appears to be a good one, as evidenced by the fact that many stations are using it and are, in fact, experiencing increased coverage with reduced noise. Bose conceded that in his report. In fact, the report even contains a diagram comparing the S/N ratios of mono FM, conventional FM stereo, and FMX stereo as a function of signal strength. As shown in Fig. 5, at weak signal levels of 30 dBf (a measure of relative RF signal levels and, in this case, 30 dBf is about 17.4 microvolts across a 300 ohm antenna input), FMX stereo S/N ratios are some 12 dB better than the S/N ratios for ordinary stereo FM. Bose's contention is that in the presence of multipath, or signal reflections, the gain in S/N ratio afforded by FMX is more than offset by the increased amount of distortion, added noise, and reduced stereo separation.

A mathematical model developed by Dr. Bose and Dr. Short was used to create an audible computer simulation of how normal stereo FM suffers

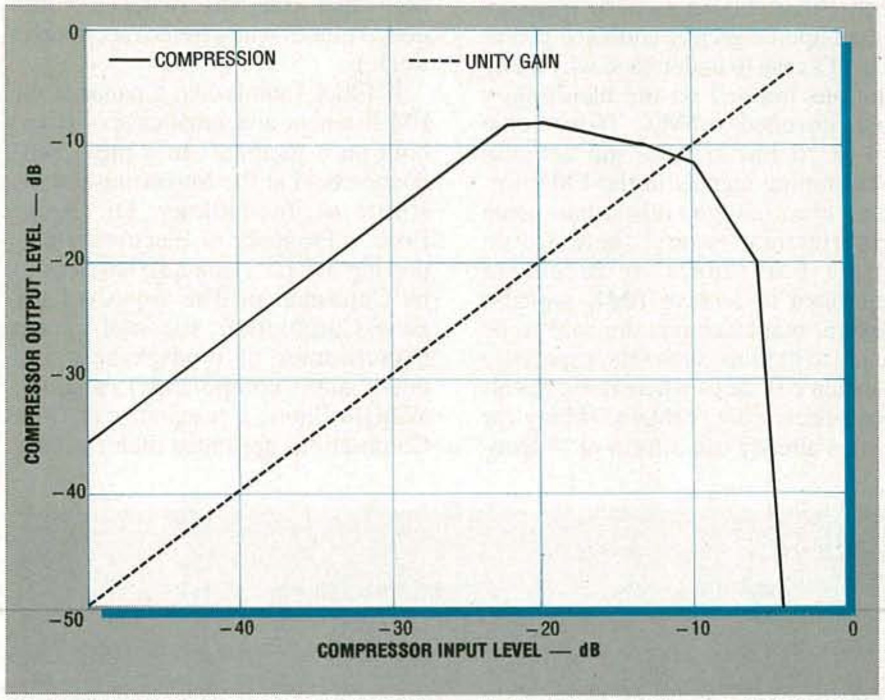


FIG. 4—AT LOW MODULATION LEVELS, the audio level is raised by about 14 dB. Compression is reduced for audio levels that are approximately 20 dB below 100% modulation.

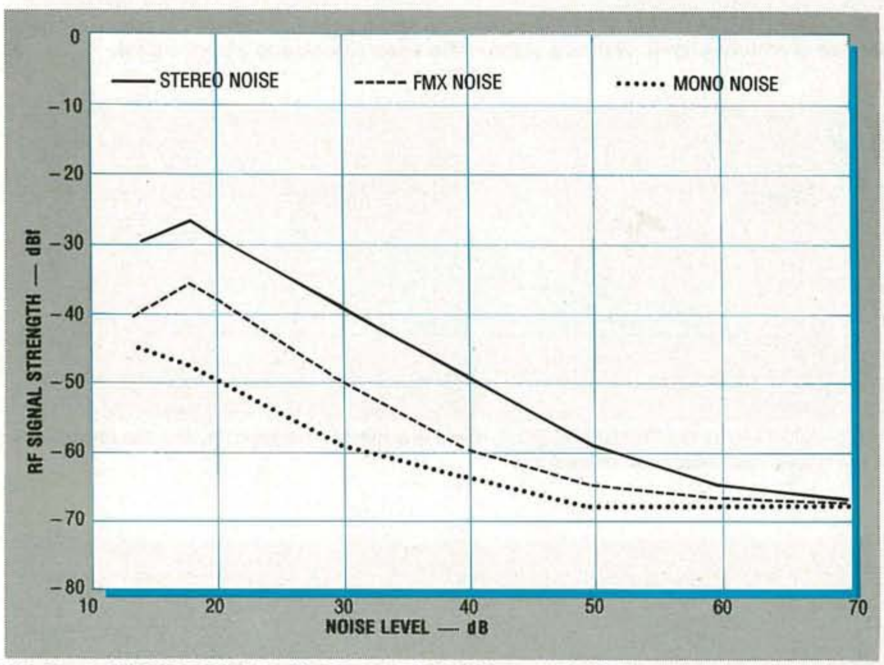


FIG. 5—AT WEAK SIGNAL LEVELS of 30 dBf, FMX stereo S/N ratios are some 12 dB better than for ordinary stereo FM.

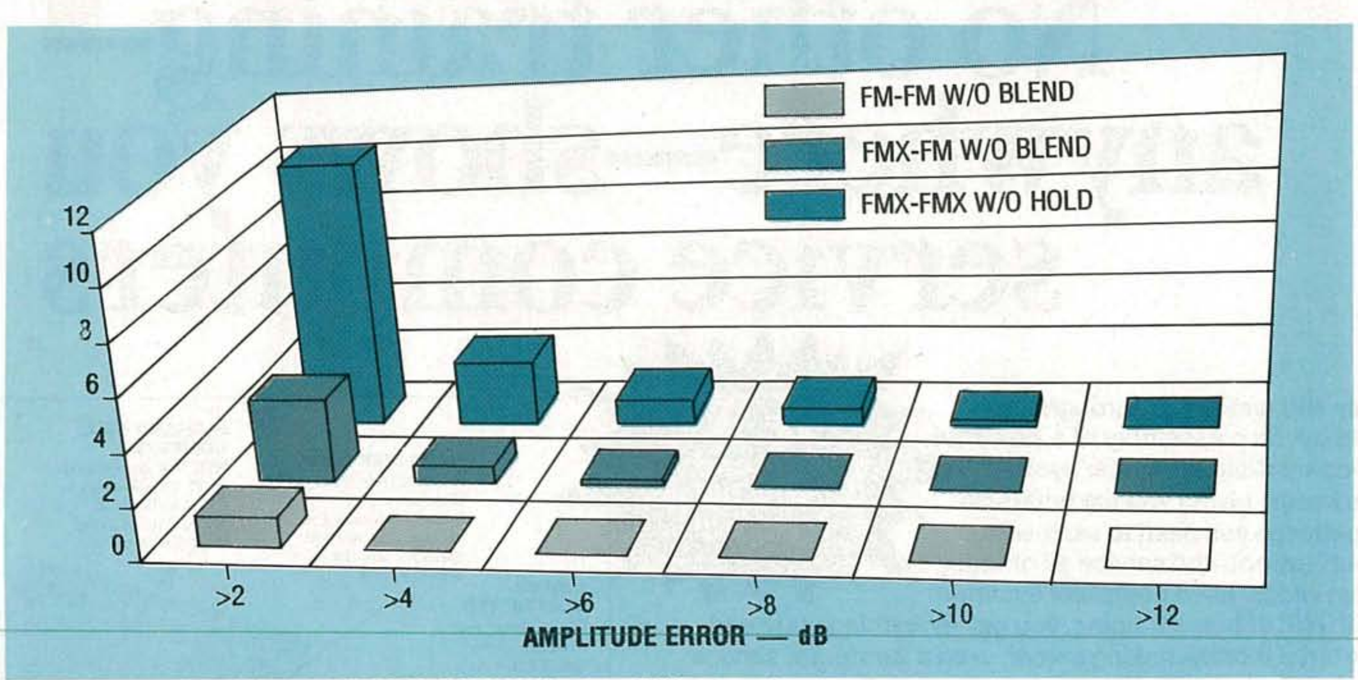


FIG. 6—GREATER AMPLITUDE ERRORS OCCURRED when FMX stereo signals were received. Results are shown from ordinary FM transmitted and ordinary FM received, FMX transmissions received on an ordinary FM set, and FMX transmitted and received on an FMX receiver. The worst degradation occurred when FMX was transmitted and received by an FMX receiver.

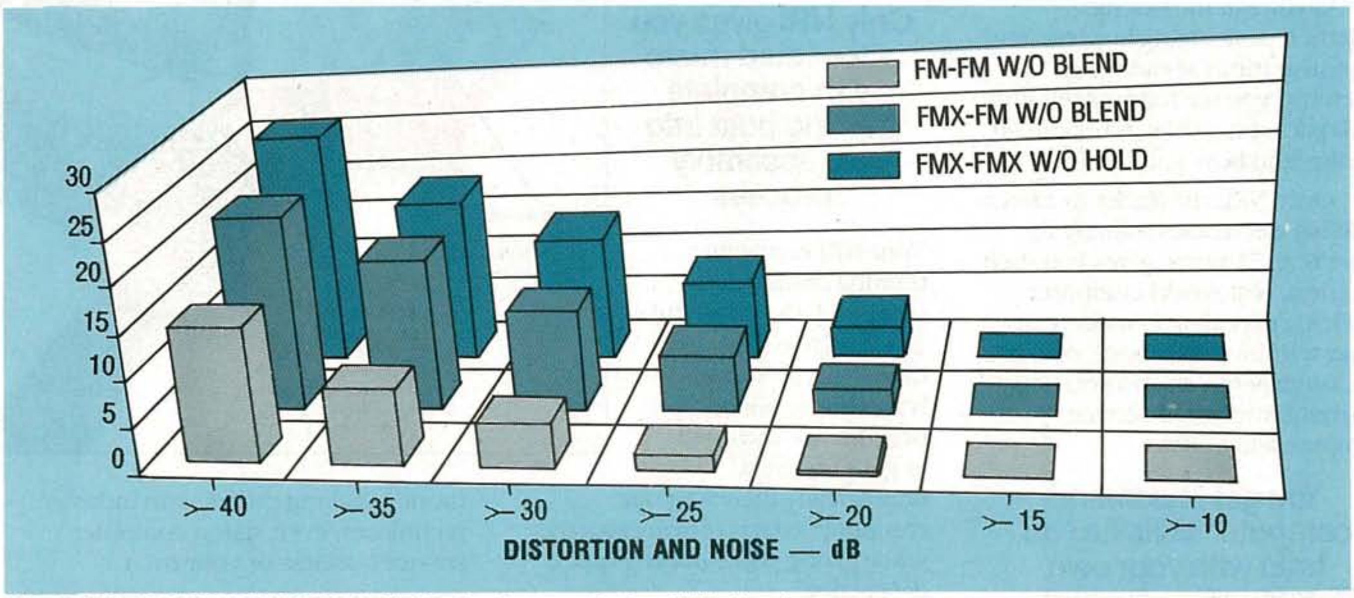


FIG. 7—DISTORTION AND NOISE LEVELS also increased when FMX signals were received.

when multipath conditions exist. The mathematical model, say its developers, reveals three factors that cause increased multipath effects: high-level modulation, the addition of modulation at higher frequencies in the composite "baseband" signal, and long distances between the direct and reflected signals.

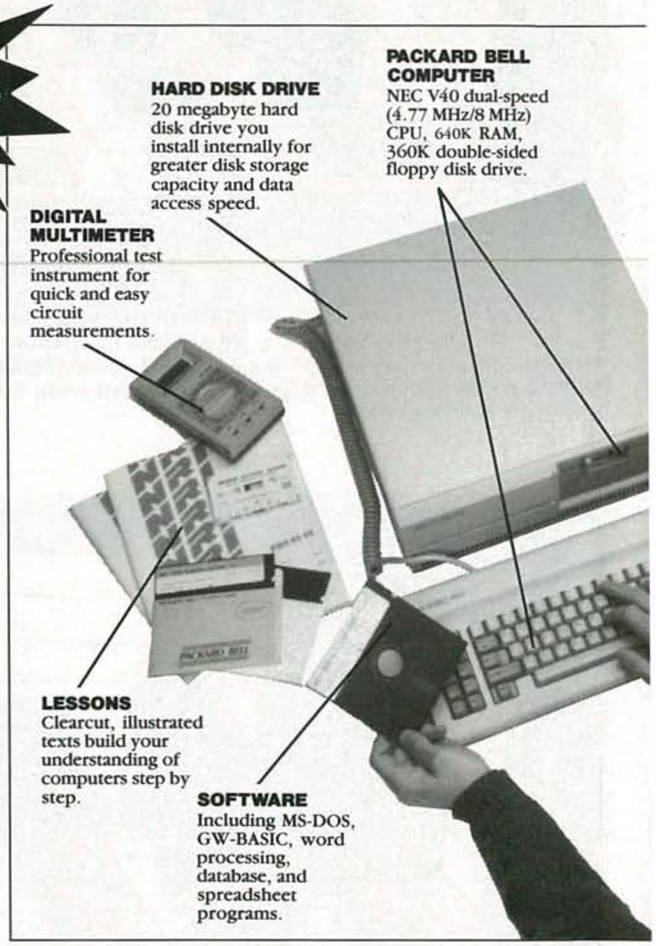
According to Bose, since FMX injects more energy at high frequencies with its added quadrature-related subcarrier, that fact alone will increase multipath problems. But in addition, the effect of phase error between the 19-kHz pilot and the subcarrier is to attenuate the recovered L – R signal, thereby decreasing stereo separation. And because multipath may cause varying amounts of the conventional L – R signal to mix with the FMX L – R signal, overall volume changes and an upset of tonal balance can occur. Furthermore, since the FMX receiver uses the regular L – R signal to adjust the level of the expander circuit, any relative phase error between the pilot signal and the subcarrier that occurs in the presence of multipath will cause the expander to operate on a mixture of normal and compressed signals, introducing more audible problems.

To further substantiate their findings, Dr. Bose and Dr. Short installed a car-stereo receiver, modified to in-

No other training—anywhere—shows you service computers

NEW! Hard drive and voice synthesis training included!

Only NRI walks you through the step-by- step assembly of a powerful XT-compatible computer system you keep—giving you the hands-on experience you need to work with, troubleshoot, and service all of today's most widely used computer systems. With NRI at-home training, you get everything you need to start a money-making career, even a computer service business of your own.



No doubt about it. The best way to learn to service computers is to actually *build* a state-of-the-art computer from the keyboard on up. As you put the machine together, performing key tests and demonstrations at each stage of assembly, you see for yourself how each part of it works, what can go wrong, and how you can fix it.

Only NRI, the leader in career-building electronics training for more than 75 years, gives you such practical, real-world computer servicing experience. Indeed, no other training—in school, on the job, *anywhere*—shows you how to troubleshoot and service computers like NRI.

You get in-demand computer skills as you train with your own XT-compatible system—now with 20 meg hard drive and 640K RAM

With NRI's exclusive hands-on training, you actually build and keep the powerful new Packard Bell VX88 PC/XT compatible computer, complete with 640K RAM and 20 meg hard disk drive.

You start by assembling and testing the "intelligent" keyboard, move on to test the circuitry on the main logic board, install the power supply and 5-¼" floppy disk drive, then interface your high-resolution monitor. But that's not all.

Only NRI gives you a top-rated micro with complete training built into the assembly process

Your NRI hands-on training continues as you install the powerful 20 megabyte hard disk drive—today's most-wanted computer peripheral—included in your course to dramatically increase your computer's data storage capacity while giving you lightning-quick data access.

Having fully assembled your Packard Bell VX88, you take it through a complete series of diagnostic tests, mastering professional computer servicing techniques as you take command of the full power of the VX88's high-speed V40 microprocessor.

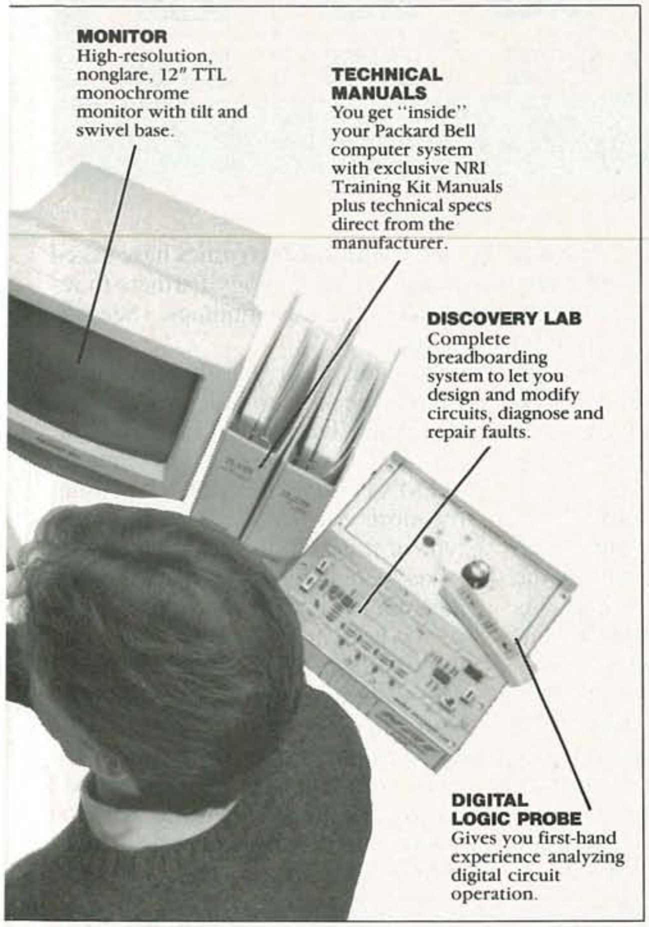
In no time at all, you have the confidence and the know-how to work with, troubleshoot, and service every computer on the market today. Indeed, you have what it takes to step into a full-time, money-making career as an industry technician, even start a computer service business of your own.

New voice synthesis training adds an exciting new dimension to your computer skills

Now NRI even includes innovative hands-on training in voice synthesis, one of today's most exciting and widely applied new developments in computer technology.

You now train with and keep a full-featured 8-bit D/A converter that attaches in-line with your computer's parallel printer port.

in school, on the job, how to troubleshoot and like NRI



Using your D/A converter along with the exclusive text-to-speech software also included, you explore the fascinating technology behind both digitized and synthesized computer speech.

You discover how you can use your computer to access and play back a variety of prerecorded sounds . . . you see how to add speech and sound effects to programs written in BASIC, C, Pascal, and others . . . you even learn how to produce high-quality speech directly from your own original printed text.

NRI's exclusive new hands-on training in voice synthesis is just one more way NRI gives you the confidence-building experience you need to feel at home with the latest advances in computer technology.

No experience needed, NRI builds it in

You need no previous experience in computers or electronics to succeed with NRI. You start with the basics, following easy-to-read instructions and diagrams, moving step by step from the fundamentals of electronics to sophisticated computer servicing techniques.

With NRI's unique Discovery Learning Method, you're sure to get the kind of practical hands-on experience that will make you fully prepared to take advantage of every opportunity in today's top-growth field of computer service.

With NRI, you learn at your own pace in your own home. No classroom pressures, no night school, no need to quit your present job until you're ready to make your move. And all throughout your training, you have the full support of your personal NRI instructor and the NRI technical staff.

Your FREE NRI catalog tells more

Send today for your free full-color catalog describing every aspect of NRI's innovative computer training, as well as hands-on training in robotics, video/audio servicing, telecommunications, electronic music technology, and other growing high-tech career fields.

If the coupon is missing, write to NRI School of Electronics, McGraw-Hill Continuing Education Center, 4401 Connecticut Avenue, NW, Washington, DC 20008.

PC/XT and XT are registered trademarks of International Business Machines Corporation

NRI School of Electronics

McGraw-Hill Continuing Education Center
4401 Connecticut Avenue, NW
Washington, DC 20008

For career courses approved under GI Bill
☐ check for details

☑ **CHECK ONE FREE CATALOG ONLY**

- ☐ **Computers and Microprocessors**
- ☐ Robotics
- ☐ TV/Video/Audio Servicing
- ☐ Computer Programming
- ☐ Security Electronics
- ☐ Electronic Music Technology
- ☐ Basic Electronics
- ☐ Telecommunications

Name ______ (Please Print) ______ Age ______

Address ______

City/State/Zip ______

Accredited Member, National Home Study Council

3-109

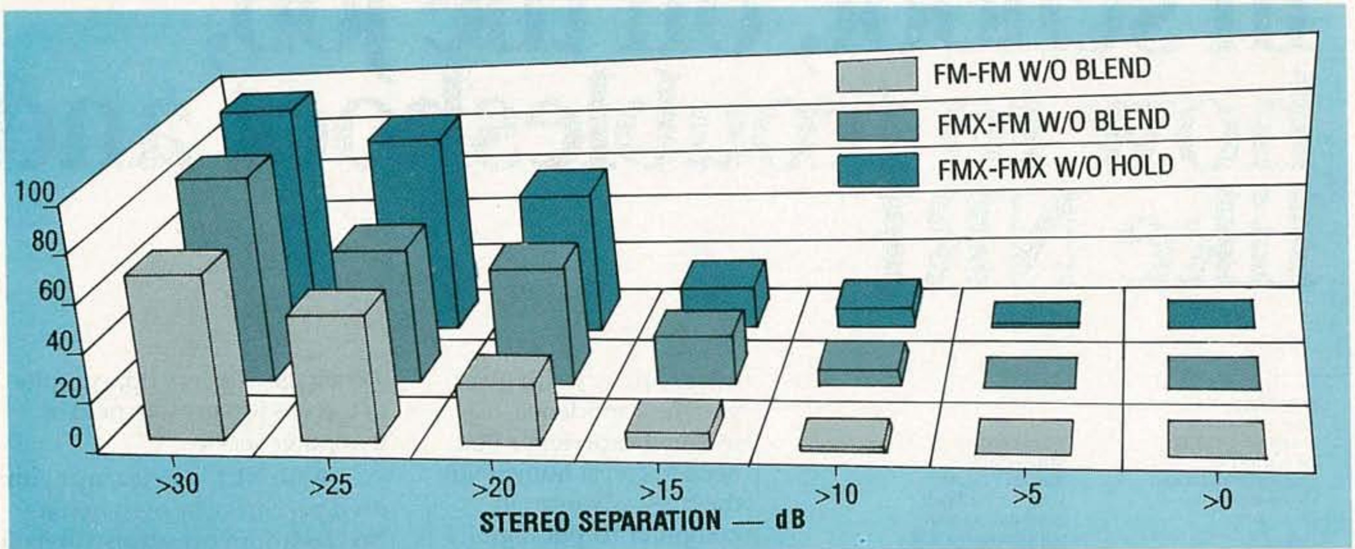


FIG. 8—STEREO SEPARATION also suffered when FMX signals were received.

clude FMX, in an automobile and drove the car over a considerable distance while recordings were made of transmissions by the local MIT FM radio station, which had installed an FMX system that could be switched in and out. The automobile radio was also capable of being switched from conventional FM to FMX. Later, by processing the resulting tape recordings, it was possible to analyze three types of reception conditions for the equivalent of 1500 separate locations or "samples" along the car's route.

Figures 6, 7 and 8 show what happened to amplitude errors, distortion, and separation, respectively, for the following three conditions: ordinary FM transmitted and ordinary FM received, FMX transmissions received on an ordinary FM set, and FMX transmitted and received on a set modified to receive FMX. The bar graphs clearly show that greater amplitude errors, reduced separation, and higher distortion levels occurred when FMX signals were received, even on a conventional FM set. The worst degradation occurred when FMX was transmitted and received by an FMX receiver.

Mr. Emil Torick of Broadcast Technology Partners was present at the MIT session, but because much of the data presented was new to him, his response during the question and answer period following the presentation was limited. Since then, Mr. Torick and his associates have had a chance to examine the report in full and have questioned many of its findings.

Rather than attempt to speak for Mr. Torick, I understand that the editors of **Radio-Electronics** have asked Broadcast Technology Partners to respond to the Bose findings. (See box below.)

It seems clear that the debate between the Bose/MIT people and Broadcast Technology Partners concerning the relative merits or demerits of FMX can only be resolved, in time, by more experience with this new type of transmission. Do the benefits of noise reduction outweigh the disadvantages introduced when multipath is present? How often will severe multipath cause the type of signal degradation demonstrated by Bose? Will the effects be as obvious in a home environment, where the FM antenna is generally in a fixed position? All of those questions must still be answered before the final verdict concerning FMX is rendered **R-E**

FMX: Is it bad for FM?

Broadcast Technology Partners (BTP) and Mr. Emil Torick believe that the Bose-Short presentation was misleading in many aspects, that their tests were improperly done, and that the intent of the presentation was to manipulate the press and denigrate the FMX system.

BTP claims that the tests were seriously flawed. For example, they believe that WMBR's transmission equipment (a 200-watt college station) used for the over-the-air tests was not adjusted properly. BTP offered to help align the transmitter and adjust the FMX compression levels, but their offer wasn't accepted. As a result, the tests showed clear evidence of compressor misadjustment and synchronous amplitude modulation. BTP engineers have been able to correct similar effects in other FMX installations.

Another test using a modified car radio to test for off-the-air compatibility resulted in misleading stereo-FMX comparisons. The Bose-Short tests were done with a radio without stereo-blend and high-frequency-cut circuitry (which is common to all modern car radios). The car was then taken to a fringe-reception area for the tests—exactly the kind of area where such circuitry is normally activated.

BTP also pointed out that an experimental FMX-equipped Bose radio using an unapproved prototype version of the Sanyo LA-3440 FMX decoder IC was used in vehicle tests. BTP permitted the use of the chip for preliminary design purposes, but specifically rejected it as inadequate for vehicular use.

The Short-Bose bi-path laboratory simulation was also flawed according to BTP. The equipment used permitted the simulation of a direct signal from a transmitter and a reflection from a building or a mountain.

The equipment also allowed the mountain to be "moved" to a position that apparently created the most disruptive interference. Had the "mountain" been misplaced by a few inches, there would have been no audible differences between FMX and stereo transmission. Also, BTP engineers have calculated that the chances of encountering the effects simulated by Short and Bose are 1 in 6.7 million. Besides, as any listener knows, when a multipath condition occurs in a stationary or slow-moving vehicle, it is corrected after moving only a few inches. **R-E**

AUTOMATIC TEST EQUIPMENT

Automatic test equipment is revolutionizing electronic testing and troubleshooting

ALLAN C. STOVER

WHERE TECHNICIANS AND ENGINEERS once tested products on work benches surrounded by test equipment and a maze of cables and wires, they now connect the product to *A*utomatic *T*est *E*quipment (ATE), press a button, and have a cup of coffee. Companies build ATE in all sizes and complexities, in both off-the-shelf and customized versions. The advent of ATE has revolutionized electronics troubleshooting.

A typical ATE approach

Figure 1 is a block diagram of a typical piece of ATE. It contains:

- A computer to control the test cycle, which can be a micro, mini, mainframe, or dedicated processor. The computer controls ATE over a bus, most often the *G*eneral *P*urpose *I*nterface *B*us (GPIB), although RS-232C and others are sometimes used. Some HP computers use a 16-bit parallel version called GPIO, very useful for inhouse test panels. (See **Radio-Electronics**, July 1988, "General-Purpose Interface Bus".)
- A controller to sequence through test steps, control test equipment and the

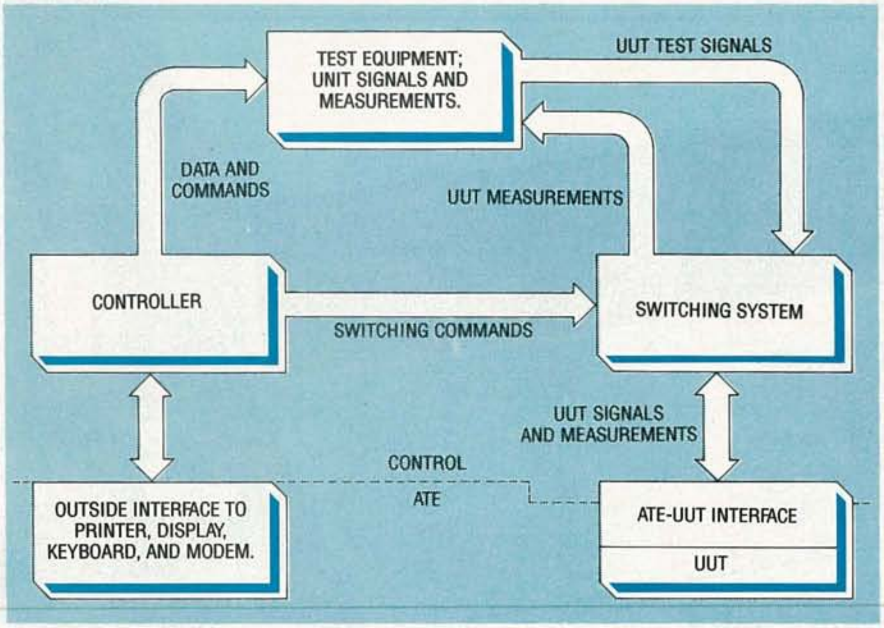


FIG. 1—A TYPICAL ATE BLOCK DIAGRAM. The test equipment provides test signals to the UUT through the switching system and interface, and the results are routed through to the test equipment for measurement. The controller sequences through the test cycle, and controls the test equipment, switching system, and interfaces.

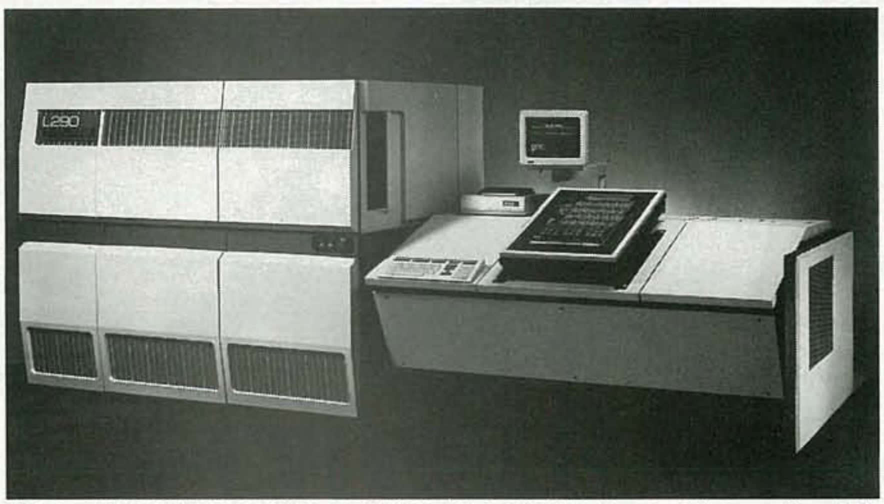


FIG. 2—TERADYNE L290 VLSI MODULE TEST SYSTEM. The test fixture with a UUT mounted on it is in the center of the operator console on the right. The console also contains a monitor, keyboard, printer, and analog and digital channel cards. The left console contains system and user power supplies, the DEC MicroVAX II, and analog instruments.

bus, read measurement results, perform calculations, and send results to a display or printer. Most "smart instruments" have memory and microprocessor control so an ATE controller can communicate via a bus, downloading computer programs to a smart instrument for use. While a controller is busy, a smart instrument can perform computations, and the controller can read the results later.

- A switching system to route signals between the *U*nit-*U*nder-*T*est (UUT) and the rest of the ATE. The switching system might route UUT digital signals to an ATE panel, and video to a frequency counter. Also, RF switches may route signals from a frequency synthesizer to the UUT input, then route UUT RF responses to a spectrum analyzer or power meter for measurement.
- Test equipment or circuitry to provide signals to the UUT and make measurements of UUT parameters. Most test equipment with GPIB capability can be used with ATE. Logic analyzers can analyze digital signals and provide results via GPIB, while spectrum analyzers and digital oscilloscopes can do the same for RF and analog signals. Also, RF generators and the function and pulse generators that modulate them can also be controlled via GPIB.
- An operator interface like a keyboard, display, printer, host computer over a network, or switch array.
- An interface between the UUT and the ATE, like a cable, a test fixture with pins to touch test points on a PC board, a fixture with cooling air and UUT connector, component sockets, or some combination. The interface type depends on what's tested; in some ATE, drivers and sensors handle signals to and from the UUT. They often have *R*andom *A*ccess *M*emory (RAM) to store the test patterns and UUT responses.

Types of ATE

There are versions available today for almost any electronic device. Some varieties may overlap two or more categories, while some may not fit any. The following types cover most versions:

- *I*n-*C*ircuit *T*est (ICT): This category can test PC boards for shorts, opens, continuity, and defective components. Some test only for shorts and opens, some only digital, and others both digital and analog. Most ICT memories have a component-characteristic library. The board is positioned on a "bed-of-nails" fixture, with an array of spring-loaded probes or pins connecting to test points on the board to test equipment, and the board is held down pneumatically, manually, or by vacuum. Sharp pins can penetrate coatings, while blunt pins make contact without damage. Drivers provide test signals, sensors measure responses, and RAM stores test patterns.
- Functional test: This variety tests signals at UUT inputs and checks for a correct response. Functional testers can test boards, assemblies, even entire systems. To test a board, the functional tester might input test signals at an edge connector, then check the response at the output pins on the same connector or a different one.
- Hot mockup, or known-good system: This incorporates an entire system known to be good (called a "gold" system). In testing a UUT subsystem, the known good one is removed, a questionable version is substituted, and the whole system is tested. If it passes, the UUT should be good because it operates as well as known good one. Hot mockup is most often built in-house, and can test only gold-system components. Since the

UUT may be far removed from system *I*nput/*O*utput (I/O), subtle faults may be missed, but it's economical and tests a UUT operationally.

- Comparison test: This compares a UUT and a gold unit of the same type, applying the same signals to both and comparing responses. If the UUT responses differ from those of the gold version, the UUT fails. A comparison test is economical because it avoids the need for large reference memory. The gold unit represents the correct response.
- Component test: This tests components ranging from VLSI and memory chips to resistors and capacitors. It's especially useful for digital devices, which use a myriad of high-speed test patterns.

A battle has been raging over functional versus ICT approaches. Functional supporters claim that a board can be tested only if signals are applied to simulate actual operating conditions, while ICT supporters claim that only individual components and subsections need be tested. Fortunately, many testers use both methods.

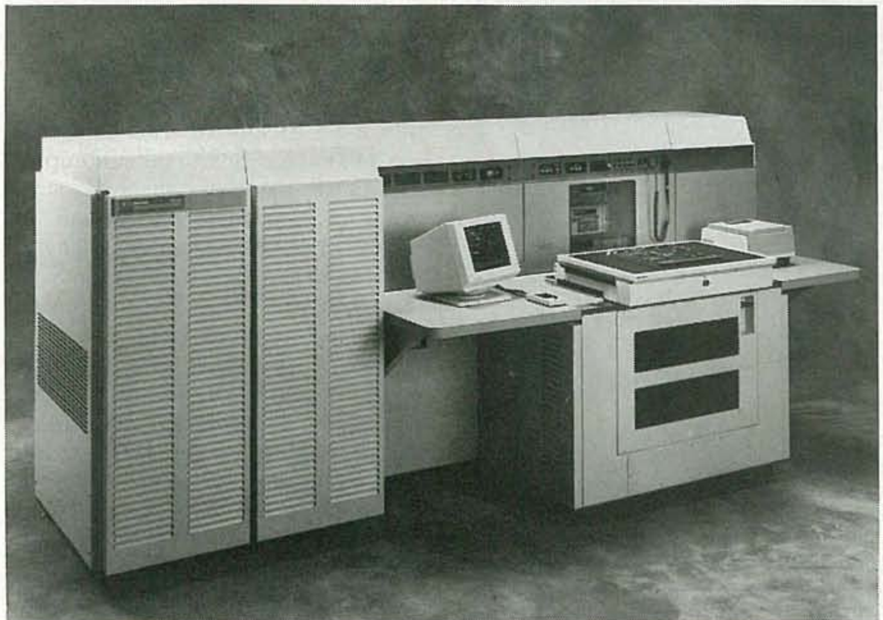


FIG. 3—GENRAD GR2282 BOARD TEST SYSTEM. The operator console with the UUT fixture is at left. The GR2282 performs ICT and functional testing of digital boards.

FIG. 4—ZEHNTEL 1800 BOARD TESTER. A PC serves as controller, and the UUT fixture is on the console at left. Note the vacuum hose to the right. The 1800 is prewired for 640 analog/digital test points.

ATE software

Since ATE controllers manage test cycles, software is as important as hardware. Subtle software errors can result in passing defective UUT's. Since ATE uses computer-controlled hardware, a programmer must know the ATE, the UUT, and the commands and idiosyncrasies of the bus involved. An ATE processor uses the same instructions as in most computers for calculation, branching, and display. However, instructions that control hardware interfaces and bus devices, and that communicate with test equipment to read results are unique.

Many ATE manufacturers offer packages like component-characteristic libraries to keep prices competitive, since ATE software costs can exceed those of hardware. Interactive packages are also available to produce test programs from circuit data and test requirements provided by an engineer. Diagnostic software to locate UUT faults is also available. Many ATE systems have menu-driven hardware and software. Sometimes, ATE uses a "guided-probe" technique, where software guides a technician step by step, showing him which measurements to make.

While technicians may balk at taking orders from a computer, they'll find it operates more methodically and rapidly for routine problems. Computers fail when problems are no longer routine and require human judgment. Even that may no longer hold true when ATE successfully incorporates *A*rtificial *I*ntelligence (AI) for fault isolation. With AI, ATE hardware can learn from its own mistakes.

ATE pro and con

Any discussion of ATE must include justifications before spending money for it. Here are some common favorable arguments:

- Speed: ATE gives a significant increase in test speed, until the number and complexity of the tests tax it enough to slow it down. Also, speed is limited by test-equipment performance, which may operate slowly via a bus or require settling/setup time.

FIG.5—THE FLUKE 900 DYNAMIC TROUBLESHOOTER uses comparison testing as a low-cost alternative to isolate faults to the component level without programming or knowledge of a board. The 900 captures timing errors, intermittent faults, and static device failures, and performs dynamic ICT tests on each IC while operating.

- Quality: We're all human, make mistakes, and are inconsistent. Once ATE hardware and software are error-free, they can operate almost perfectly without many human errors. However, getting it that way is difficult because of the complexity and volume of the software, involving thousands of lines of code, any one of which may conceal subtle errors.
- Lifetime operating cost: Installing ATE may be expensive, but if it operates faster, makes fewer errors, and requires less operator experience, it'll be cost-effective. That doesn't mean that an organization doesn't need experienced technicians. Someone has to fix UUT's when ATE can't find a fault, or fix the ATE itself. The work, then, should be more interesting, because ATE has done most of the repetitious testing.

Today's ATE

Let's look at some current off-the-shelf ATE. Figure 2 shows the Teradyne L290 VLSI Module Test System. The UUT test fixture is in the middle of the console at right, and can use bed-of-nails, edge-connector, or test-socket interface modes. The console contains analog and digital cards. The L290 has room for up to 1152 bidirectional test channels. The console at left contains analog instruments, voltage references, power supplies, and any user-supplied test equipment. A DEC MicroVAX II computer is the system controller, operating dedicated processors on its Q-bus. All L290 test programs are written in a variant of PASCAL.

A color monitor, keyboard, dot-matrix printer, and control console provide for human interaction, and an optional DECnet/Ethernet interface can link the L290 with other computers. The test-station console can rotate from 22.5 degrees to horizontal or vertical, to allow it to integrate with an automatic UUT handler or test-point prober. The L290 can use a guided-probe approach, where a hand-held, automatic probe examines the nodes leading to a failing output using a "fault signature" dictionary, operating at up to 80 MHz. When a fault is detected, diagnostic software is used to determine which nodes to probe in what order. The expected responses to the nodes can come from simulation software, or learned by the tester beforehand by probing good nodes manually.

Fault-simulation software uses a fault dictionary, which is a computer file containing a UUT's fault signatures for a given cause. Using it normally takes less time than guided probing, which requires manual probing and rerunning a test at each node. The two methods are often combined. Figure 3 shows a GenRad GR2282 Board Test System, which performs both ICT and functional testing on complex digital boards, also using a DEC MicroVAX II as system controller. Its software has a library of over 6,000 devices.

The GR2282 can handle up to 3,840 pins, each with 16K of driver and sensor memory behind it. The GR2282 has a variety of diagnostic software, including guided-probe diagnostics, and one routine that the manufacturer calls BusBust automatically identifies a failing bus component without operator intervention. The GR2282 uses a device known as a Scratchprobe to allow an operator to distinguish between defective components and assembly failures (like broken foils, poorly soldered joints, and bent leads).

FIG.6—THE JULIE RESEARCH LABORATORIES LOCOST 106. This version automatically calibrates test equipment and calibration standards. The desktop-computer controller is at top right.

Figure 4 shows a Zehntel 1800 board tester, with 640 pins; this is a small, low-cost piece of ATE. The controller is a PC, using an MS-DOS spreadsheet environment. Test programs can be executed automatically; either a list of inputs to a given board is read in as a file of components and interconnections, or the configuration of a board is specified interactively. Both approaches generate a debugged test program and board input list. The 1800 has an expandable library of over 3,500 digital devices, tests for opens and shorts, and performs ICT of active and passive analog and digital devices. All of that adds up to a very thorough test.

Figure 5 shows the Fluke 900 Dynamic Troubleshooter, a low-cost alternative using comparison testing to isolate faults to the component level without programming or knowledge of a board. The 900 captures timing errors, intermittent faults, and static device failures, and performs dynamic tests on each IC while in-circuit and operating at speed.

Figure 6 shows a Locost 106 from Julie Research Laboratories, used for automatic calibration of test equipment and calibration standards like meters, precision dividers, resistance standards, platinum thermometers, and power supplies. The Locost 106 has precision DC/LF calibration standards under GPIB control of a PC or Hewlett-Packard 9826S desktop micro, reducing calibration times by 80% and minimizing operator error and the need for calibration experts to be present.

A variety of ATE is available to test almost anything. Each has hardware and software to test UUT's and perform diagnostics. It's worthwhile even for small companies, has revolutionized testing and troubleshooting, and is here to stay. You should understand that ATE, like most other things, isn't a panacea. However, it's a very powerful tool when used carefully by experienced technicians and engineers, and frees them to use their time more productively. **R-E**

HARDWARE HACKER

Solid state visible laser
Laser hacking resources
Picking filter capacitors
Stereo wireless broadcaster
International power standards

Picking filter capacitors

DON LANCASTER

WE SEEM TO HAVE A PAIR OF REALLY unusual new hacker components for this month. One is a micropower FM stereo multiplexer, while the other is a solid-state red visible-laser diode. But first, let's discover a real simple answer to what seems to be an unduly complex question.

Ripple-filter capacitors

How do you pick the correct value of ripple-filter capacitance for a line-operated power supply? Some of the older textbooks will give you wildly wrong curves that just do not apply to today's circuit components.

But I will let you in on an insider secret—you can *instantly* choose the right value of filter capacitor for any line-operated power supply simply by memorizing a unique capacitor value of 8300 microfarads, and then remembering an ultra-simple rule.

These days, you usually use a *brute-force* capacitor AC-input power supply driven from a pair of silicon rectifiers, or else a full-wave silicone rectifier bridge. One or more voltage regulators will normally get placed between your brute-force supply and the actual circuit.

Figure 1 shows you two typical line-operated full-wave power supplies. We'll assume that a transformer is used to drop the voltage down to an acceptable value. You could use a center-tapped transformer and two diodes, or else an untapped transformer winding and a four-diode full-wave bridge.

NEED HELP?

Phone or write your **Hardware Hacker** questions to:

Don Lancaster
Synergetics
Box 809-RE
Thatcher, AZ, 85552

(602) 428-4073

In Fig. 1-*a*, your peak output voltage will equal 0.7 times the full RMS transformer secondary voltage under load, minus a volt or so for the diode drop. In Fig. 1-*b*, the peak output voltage will equal 1.4 times the RMS transformer secondary voltage under load, minus two volts or so for the series drop of two diodes.

For instance, if you are using a 12.6-volt-RMS center-tapped filament transformer in the Fig. 1 circuit, the output voltage will be $(12.6 \times 0.7) - 1 = 7.8$-volts DC peak voltage. In the real world, you'll allow a tad extra and expect a little less.

Contrary to a popular belief, those diodes do *not* conduct for an entire half cycle. In fact, each diode will intensely turn on very

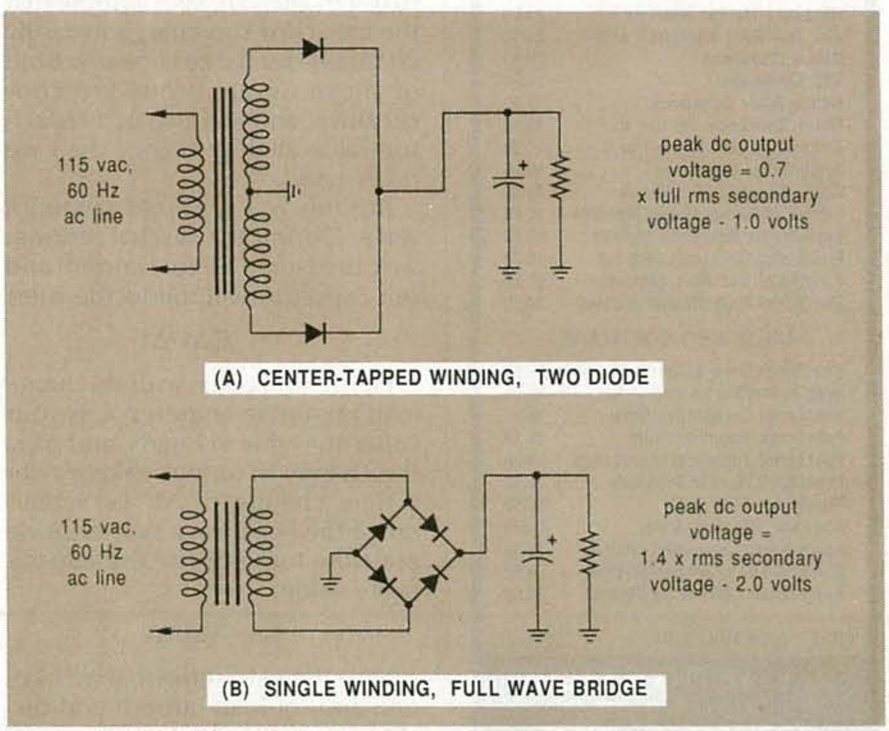


FIG. 1—TYPICAL FULL-WAVE LINE-OPERATED "brute force" DC power supplies. Picking the correct value for a ripple capacitor turns out to be a lot easier than you might first suspect. The resistor can represent a voltage regulator or other circuit load.

briefly during the *middle* of each half cycle, thus delivering a large current slug into the filter capacitor at that time.

Figure 2 shows you the actual and the simplified ripple waveform across your capacitor. Normally, you will want to design for some reasonable amount of ripple. Otherwise the capacitor value gets too high and the current slugs through the diodes get excessive. You do have to make sure that the ripple troughs do not crash into your regulator headroom.

What happens is that a diode will turn on only when its input voltage exceeds the capacitor voltage. That will occur only briefly at the very center of each half cycle. Twice during each AC line cycle, that capacitor will quickly charge. It will then discharge for the rest of the half cycle. The discharge rate is determined by the load resistance, or else by the load current drawn by the regulator and the circuit being powered.

Let us make several simplifying assumptions, which can clean up the waveform to make it much easier to analyze. Let's assume that the capacitor can charge instantly and then discharges linearly. Both of those assumptions are conservative, and will give us a capacitor value slightly higher than we really need.

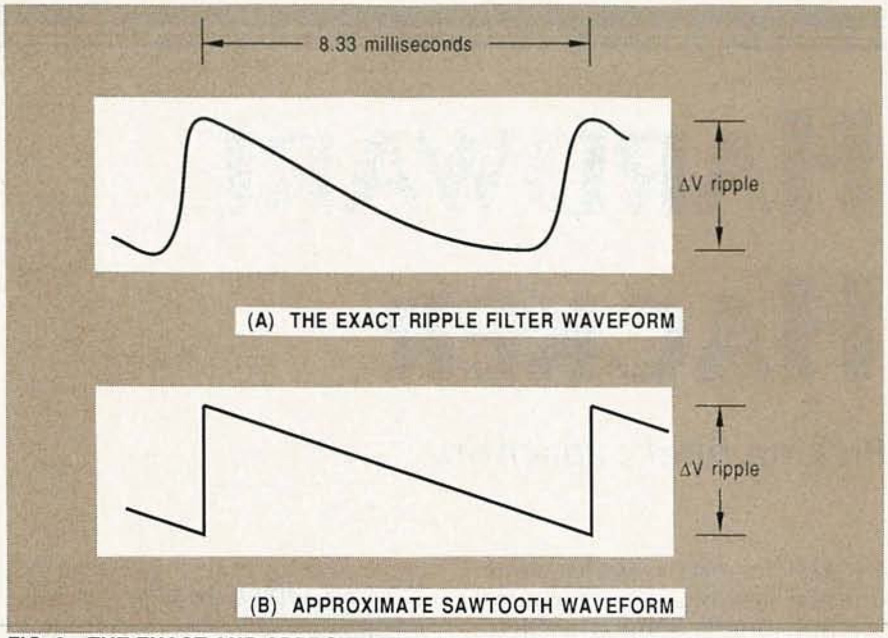


FIG. 2—THE EXACT AND APPROXIMATE voltage waveforms as found across the ripple-filter capacitor. Note that the diodes conduct only briefly during the middle of each AC-line half cycle. The capacitor supplies the load energy for the majority of the time.

In an 8300 Microfarad Capacitor,
the VOLTS of ripple will equal
the AMPS of load current.

FIG. 3—MEMORIZE THIS MAGIC VALUE and do simple scaling to instantly calculate the correct-size filter capacitor. For half-wave supplies, simply double the final capacitor size.

But this is a plain old sawtooth wave. During the discharge time, we can assume a linear current and our capacitor will follow the rule:

$$i = C\Delta v/\Delta t$$

Here, i will equal your discharge load current in amperes, C is your capacitor value in Farads, and Δv is the change in output voltage over a time change of Δt. Let's rearrange the equation a tad, since we are now looking for the capacitance value:

$$C = i\Delta t/\Delta v$$

Next, let us assume that we have one amp of load current and discharge one volt during a half power cycle, which equals 1/120 Hz, or 0.00833 seconds, or 8.33 milliseconds. The magic capacitance value that handles that is 8.33 millifarads, equal to 8330 microfarads—let's say 8300 μF for short.

Which leads us to the magic rule of Fig. 3: In an 8300-μF capacitor used in a full-wave line-operated supply, *the volts of ripple will equal the amps of load current.*

Any other capacitor value is found by scaling. You do not even need to use a calculator. For instance, an 830-μF capacitor will yield one volt of ripple with 100 milliamps of current drain. A 1660-μF capacitor will give you one volt of ripple for 200 milliamps of current. Or to get slightly fancier, a 700-mA supply allowing three volts of ripple will need a capacitor value of:

$$8300 \times 700/1000 \times 1/3 = 1917\mu F$$

Call it an even 2000μF to round off to the next highest stock value. The capacitance value will vary *directly* with your load current and *inversely* with the allowable amount of output ripple.

Do not, under any circumstances, mention this insider secret to your electronics teacher. He will fail you for suggesting such an absurdly simple rule—especially since your value will be correct and his will not. However, two semesters from now, he will try teaching this heretical and super-elegant method—but only to his best students.

What about half-wave supplies that use only a single diode? Just *double* the capacitor values from those calculations and you are home free.

LASER RESOURCES

Applied Laser Tech
7707 East Acoma Drive
Scottsdale, AX 85260
(602) 483-1214

Edmund Scientific
101 E. Glouchester Pike
Barrington, NJ 08007
(609) 573-6250

Fiberoptic Product News
301 Gibralter Drive
Morris Plains, NJ 07950
(201) 292-5100

Fiberoptics World
1421 South Sheridan
Tulsa, OK 74112
(918) 835-3161

Heath Company
PO Box 1288
Benton Harbor, MI 49022
(616) 982-3200

Herbach & Rademan
401 E Erie Avenue
Philadelphia, PA 19134
(215) 426-1700

Jerryco
601 Linden Place
Evanston, IL 60202
(312) 475-8440

Laser Focus World
1421 South Sheridan
Tulsa, OK 74112
(918) 835-3161

LaserCraft
PO BOX 696
Santa Rosa, CA 95402
(707) 528-1060

Lasers and Optonics
Box 650
Morris Plains, NJ 07950
(201) 898-9281

Meredith Instruments
6403 North 59th Avenue
Glendale, AZ 85301
(602) 934-9387

Nuts and Volts
Box 1111
Placentia, CA 92670
(714) 632-7721

Photonics Spectra
PO Box 1146
Pittsfield, MA 01202
(413) 499-0514

Sharp
Sharp Plaza
Mahwah, NJ 07430
(201) 529-8757

3-D Systems
26081 Avenue Hall
Valencia, CA 91355
(818) 898-1533

Toshiba
9775 Toledo Way
Irvine, CA 92718
(714) 455-2000

A stereo FM broadcaster

As we found out last month, *Rohm* is an outstanding hacker source for unusual integrated circuits. And one that's super hard to find, since they have not been advertising very much in the trade journals.

Anyway, I finally did get a few samples and data on their BA1404 FM stereo modulator chip. Sadly, I just have not had enough time to fully put it through its paces.

This is a single integrated circuit which could convert two high-quality stereo audio channels into a miniature FM broadcast-band transmitter output. Since the chip needs only three mils from 1.25 volt supply, it is also ideal for new wireless microphones, surveillance devices, and for other low-power broadcast uses. Separation can be 45 dB and a flatpack version is available for miniature applications.

Another intended use is to accept the stereo output of a CD player and broadcast it to an FM car radio, without needing any special add-on connections between the CD player and the receiver. You should also be able to use it for some offbeat applications, such as model rocketry, telemetry, computer data linkups, CB communications, or remote controls. The possibilities boggle the mind. A typical broadcast range is 50 to 100 feet.

Figure 4 shows you one possible schematic. The two audio channels go in by way of a typical FM pre-emphasis network. A 38-kHz crystal oscillator is used to create the L−R stereo multiplexed signal, which is routed to an internal varactor-tuned RF oscillator that operates in the 88- to 108-MHz range. That modulated oscillator signal is then sent to a final isolating RF amplifier, and then gets routed to an antenna. The RF output voltage is somewhere around 600 millivolts.

Cost of the chip is around $1.50, and free engineering evaluation

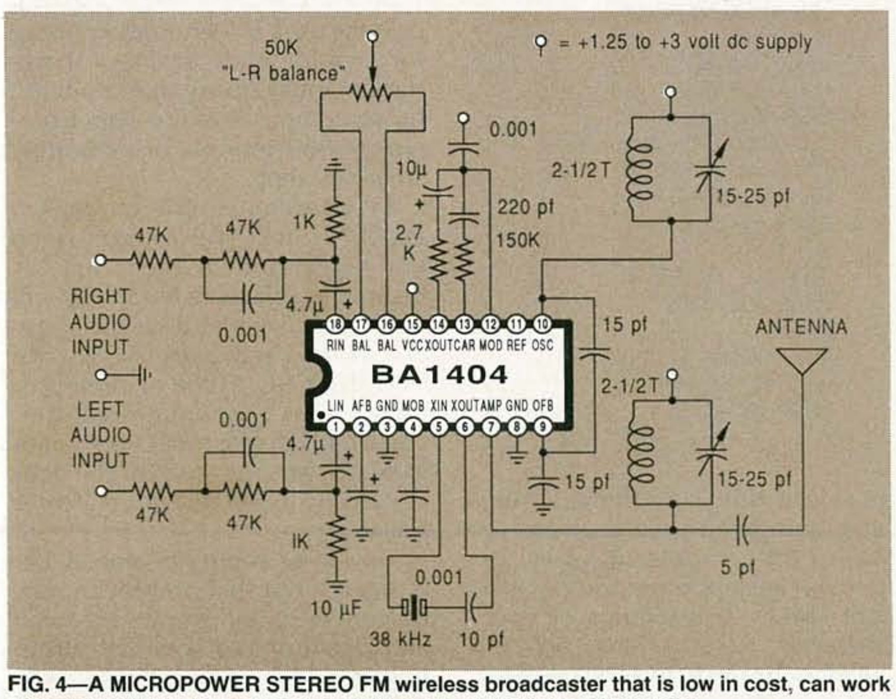


FIG. 4—A MICROPOWER STEREO FM wireless broadcaster that is low in cost, can work off a single AA battery, uses few parts, and offers high audio quality.

samples are often available on letterhead requests. Several **Radio-Electronics** classified advertisers offer ready-to-go component kits and printed-circuit boards for the circuit.

Be sure to check Rohm's entire product line. They have dozens of unique and oddball integrated circuits available that have outstanding hacker potential.

Laser resources

Until recently, I guess I was pretty much down on the laser people. After all, those turkeys have had over 25 years to get their act together, and the best they have offered us hackers are some overgrown neon lamps that are fragile, insanely overpriced, grossly inefficient, short-lived, color-limited, hard to power, and harder yet to modulate, linearly.

Worse yet, our $49.95 home-shop radial-arm laser is nowhere in sight and, worst of all, that ongoing SDI starwars atrocity is giving the entire laser industry a bad name.

But things just might be changing. There are a few new developments, especially several new high-volume solid-state *visible* laser diodes that should drop down into the $5 range in a year or two. So today just might be a good time to review some laser resources that are suitable for hardware hacking. Several of them appear over in the *Laser Resources* sidebar.

So what's the big deal about lasers and lasing? A laser is nothing but a special kind of light bulb. Apply power and it puts out light. The light gets created by exciting electrons to a higher energy level through a *pumping* process. As the electrons drop back down to their normal energy levels, they output a precise packet of energy, usually in the infrared, visible, or ultra-violet portions of the spectrum.

There are several very interesting properties of laser light that let lasers solve problems that can be difficult or impossible to do otherwise. Let us look at some quickly.

Laser light often turns out to be *monochromatic,* meaning that it is all one color, just like a single pure audio tone or radio carrier. That quickly leads to such things as red, blue, and green projection television or for computer displays; or for color laser printing; or for laser light shows at laseriums or rock concerts.

Monochromaticity is also useful for chemistry and pollution control, where some reactions take place best at very specific light wavelengths. Monochromatic light is very easy to focus into a continuous and non-divergent beam. Such a beam of light is called a *collimated* beam. Think of it as a non-sagging red string that you can point anywhere you like.

Now, ordinary light bulbs obey an *inverse square law,* which means that if you double the distance, you get only one quarter the intensity, and so on. But with a collimated beam, you can sometimes gather in your *entire* beam at the receiving site.

In theory, inverse square-law loses can be entirely eliminated. In practice, they can be dramatically reduced. Thus, a laser gives us *unattenuated action at a distance,* which leads us to blackboard and lecture pointers; or survey gear; or construction levels. Out here in Arizona, cotton farmers use laser beams to level all of their irrigation fields precisely to one inch per acre or less, very much reducing their need for irrigation water while producing a more uniform crop. Collimated laser beams can also be used as *aiming devices,* both for use on weapons or for supermarket bar-code readers.

Some laser beams are not only monochromatic but also will maintain a very precisely controlled phasing over their entire beam. That leads to *coherent* light. Important uses of coherent light are for creating and viewing a three-dimensional *holographic* image, or sometimes for the super-precise measurements of extremely small distances.

As an example, one of *Hewlett Packard's* favorite photos is an end-supported six-inch thick "I" beam. Their laser *inferometer* will easily measure the deflection sagging of the beam as the weight of a single dime is added or removed. Other uses of laser inferometry include earthquake detection, solid-state gyroscopes, and for the generation of extremely short power pulses.

Most laser beams are not all that powerful. But that power can now be concentrated over a very small area, leading to a very high beam *power density.* For instance, a 5-milliwatt laser imaged on a 1 mil

NAMES AND NUMBERS

Coilcraft
1102 Silver Lake Road
Cary, IL 60013
(800) 322-COIL
Hewlett-Packard
PO Box 10161
Palo Alto, CA 94303
(415) 857-1501
Hygenic Corporation
1245 Home Avenue
Akron, OH 44310
(216) 633-8460
Lambda Semiconductors
121 International Blvd.
Corpus Christi, TX 78406
(512) 289-0403
Maxim
120 San Gabriel Drive
Sunnyvale, CA 94086
(408) 737-7600
Miller-Stephenson
George Washington Hwy
Danbury, CT 06810
(203) 743-4447
Murata-Erie
2200 Lake Park Drive
Smyrna, GA 30080
(404) 436-1300
National Semiconductor
2900 Semiconductor Drive
Santa Clara, CA 95051
(408) 721-5000
OKI Semiconductor
785 North Mary Avenue
Sunnyvale, CA 94086
(408) 720-1900
Panel Components
PO Box 6626
Santa Rosa, CA 95406
(800) 662-2290
Rohm Corporation
Box 19515
Irvine, CA 92713
(714) 855-0819
SGS-Thompson
1000 East Bell Road
Phoenix, AZ 85022
(602) 867-6100
Synergetics
Box 809
Thatcher, AZ 85552
(602) 428-4073
Xicor
851 Buckeye Court
Milpitas, CA 95035
(408) 432-8888

spot has an energy density of 8 kilowatts or so per square inch, or over *one megawatt per square foot!*

That in turn, can lead us to laser welding and cutting. Medical uses include blasting out clogged arteries or optically welding detached retinas in place. Industrial uses include both welding the unweldable and precision cutting to extreme accuracy. Artistic uses include laser carving of wood or plastics, and upgrading the quality of diamonds by zapping any included impurities.

A rather interesting new use for high energy density ultraviolet laser beams involves *stereo lithography,* where three-dimensional objects are selectively hardened out of a liquid photo polymer resin. That can be the ultimate *Santa Claus* machine where a plastic copy of anything can be replicated any place and any time. Detroit model-making time can drop from months to minutes with stereo lithography. *3-D Systems* is a major supplier of that sort of thing.

Some laser beams can be rapidly turned off and on at high frequencies. We say that the beam is *modulatable.* By turning the beam off and on, we can place information onto that beam. Three of the highest-volume uses of lasers are for CD players, desktop-publishing printers, and fiber-optic communication. All of those crucially depend on laser-beam modulation to operate.

So where can you start? Far and away the best source of hacker laser parts in the country is *Meredith Instruments,* who also have a new light-show BBS up and on line at (602) 867-7258. Their competitors include *Herback and Rademan* and *Jerryco,* along with a number of other sources that advertise in *Nuts and Volts* and right here in **Radio-Electronics**.

The really big news is the new TOLD-9200 visible-red solid-state laser by *Toshiba.* Those dudes are now in volume production, are easy to modulate, rugged, foreverlasting, and simple to battery-power. And costs should drop ridiculously in the future. Among its numerous other features, that new product can single-handedly quadruple the storage on a CD disk or double the resolution of a desktop-publishing laser printer. Not to mention the fact that you can actually see where the beam is pointing.

Sharp has a very interesting *Laser Diode User's Manual* out. This one is both free and an essential resource. Many infrared laser diodes now have built-in photodetectors, such that a feedback loop can be used for constant optical power.

Two obvious sources of educational laser stuff include both *Heathkit* and *Edmund Scientific.* Picking a few names at random, *LaserCraft* does beautiful wood carvings for yuppie desk accessories, while the *Applied Laser Tech* folks have some interesting laser engraving machines with features that you might want to check into. And, as we have seen, *3-D Systems* is now in the center of laser stereolithography.

There are a number of free laser trade journals. As always, you can subscribe to them by getting a qualification card using your business letterhead. Four of the more useful laser trade journals include *Laser Focus World, Lasers and Optonics, Fiber Optic System News,* and that *Photonic Spectra.* Those bar-code trade journals that we've looked at in a previous issue also have lots of laser stuff in them.

Those new solid-state red laser diodes should open up all sorts of new hacker opportunities. For our contest this month, just tell me what you would do with some of them, especially if they cost only $5. There will be all of the usual *Incredible Secret Money Machine* book prizes, along with an all-expense-paid (FOB Thatcher, AZ) *tinaja quest* for two going to the very best of all. As usual, send your entries directly to me at *Synergetics,* and *not* to **Radio-Electronics** editorial department.

Foreign power supplies.

I've now gotten several calls from people who want to take all their computers overseas or to some other country, and were asking about the power-line voltage and frequencies, the connectors, the video standards, adaptors, and so on.

Well, the overwhelming majority of the civilized world runs on 220-volt 50-hertz power using strange power connectors and oddball video standards.

The bottom line is this: Do *not* ake your computer out of the country. Ever. The hassles, both electrical and bureaucratic, will eat you alive. Rent or buy a local computer when you get there instead.

There's an outfit known as *Panel Components Corporation* who have issued a new and free *Export Designer's Reference and Catalog #5*. That beauty can show you which connectors get used in what country, and lists the standard voltages and frequencies for pretty near every country in the world. Even Svalbard (220 volt, 50 Hz, S chucko plugs) and Burkina Faso (220 volt, 50 Hz, ungrounded eurocord) are included. A complete list of all the world-wide standards organizations and regulatory agencies are also provided.

New tech literature

New data books for this month include the *Lamda Semiconductors Databook* on high-current power-supply regulators and controllers, and a Memory Databook from OKI. SGS has a pair of application books out, one on *Zero Power Memories* and a second on *Cache Memories.*

Free electronics evaluation samples include the LM6321 op-amp from *National Semiconductor.* That is a higher performance replacement for their old hybrid units, usable for video and fast gain blocks. Xicor is also offering free samples of their X2402 electrically erasable PROM, which is organized as 2K × 8 over a two-wire serial interface.

Murata has a wide selection of surface-mounting kits in stock, even including a free packet of surface-mountable ceramic capacitors. Some interesting and sanely priced RF coil-designer and current-sensor kits are available from *Coilcraft*.

Free samples of rubber and plastic tubing useful for pneumatic robotics is available from *Hygenic*. And two free publications from *Maxim* should prove most useful to hackers, namely the *Maxim Engineering Journal* and the *Maxim Design News*. Those folks have lots of great hacker integrated circuits, including power video multiplexers, filters, and micropower regulators.

An *MS-111* stripping agent which could dissolve epoxy and urethane encapsulations is obtainable through *Miller-Stephenson;* they also provide free samples of their wide line of electronic chemicals, available to anyone simply for the asking.

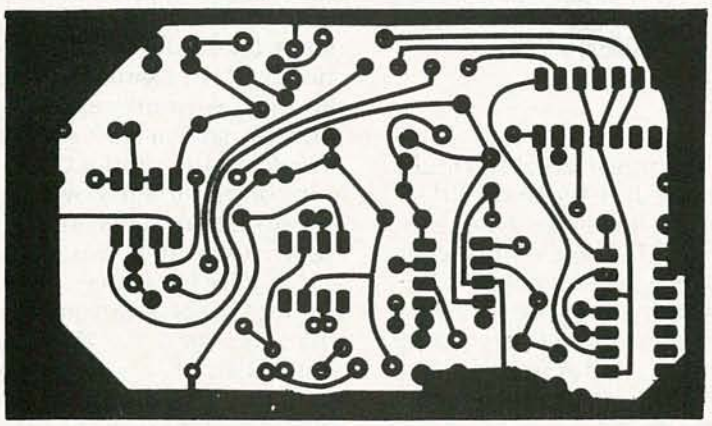
Turning to my own products, my classic *Active Filter Cookbook* has somehow gotten up to its fourteenth printing. I now have autographed copies in stock for you here at *Synergetics*. I have also completely redone my *Introduction to PostScript* VHS video. It now includes details on toner-cartridge reloading, the *Kroy Kolor* process, desktop-publishing resources, and some information on new binding systems. All the figures you see in this column were created full camera-ready by using nothing but PostScript and an ordinary word processor.

PostScript is the key secret to tabletop book-on-demand publishing, such as my *Hardware Hacker* reprints.

Note that there are once again two *Names and Numbers* sidebars for this month, one for the laser stuff and one for just about everything else.

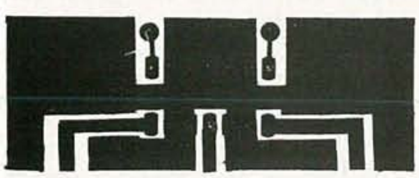
As per usual, this is your column and you can get technical help or off-the-wall networking per the *Need Help?* box. Best calling times are 8–5 weekdays, Mountain Standard Time. Let's hear something from you. **R-E**

PC SERVICE



3 5/8 INCHES

A/B RECEIVER.



2 1/8 INCHES

A/B RELAY MODULE.

MORE PC SERVICE ON PAGE 82.

AUDIO UPDATE

LARRY KLEIN,
AUDIO EDITOR

Happy 10th anniversary, Sony Walkman!

EARLY DURING THE SUMMER OF 1979, I was invited to attend a press conference where a "revolutionary new entertainment device" would be introduced. Although announcements of revolutionary new developments are far from rare in the life of an audio editor, that one lived up to its promise. The company involved was Sony, and the new entertainment device turned out to be a smallish portable stereo-headphone cassette player called the "Soundabout," shown in Fig. 1. We now know it as the Walkman.

As I recall, I wasn't particularly knocked out by the product, but virtually everyone else at the conference was. In fact, I have never witnessed such a positive response from usually blasé audio writers to *any* hi-fi product, before or since. As each writer put on the headphones and pressed the PLAY button, there was *instant* conversion to the joys of what would come to be known as "personal stereo."

Probably because stereo heard through headphones was nothing new to me, I wasn't especially impressed by the Walkman's "enlarged" head-filling sound. And I had used pocket dictating machines that were even smaller than the Walkman player. From a technical perspective, neither the use of a stereo playback head instead of a mono one or the addition of an IC for the second channel seemed like much of a breakthrough. But, as I said, what *did* impress me was the virtually universal acclaim that greeted the new product. So although I knew

FIG. 1

that no *technical* breakthroughs were involved, it seemed evident that Sony had developed a winner. What I couldn't guess, however, was how big a winner it would be.

Incidentally, the concept of a portable stereo cassette player feeding headphones was certainly not new at the time of the Walkman's introduction—which probably accounts for Sony's subsequent lack of patent protection. In fact, about a year earlier I had been given a demonstration of a portable headphone player meant, I was told, for skiers. It was a slightly modified Pioneer under-dash car cassette deck that had straps attached and was designed to run on built-in batteries. It was obviously too bulky and heavy to have wide appeal, especially for something like skiing.

Initial resistance

I've been told that Sony initially met some resistance from their U.S. audio dealers, who couldn't believe that any large number of their customers would shell out $200 for a pocket cassette unit that didn't have a speaker and couldn't even record. In any case, sales were originally quite modest in the U.S.—until, suddenly, the product took off.

I think that can be explained by the Walkman's special nature. It is/was one of those devices that you have to hear to appreciate, and every early Walkman owner became an enthusiastic advocate/demonstrator. And, obviously, it didn't take long for the effect to snowball! For example, it seems to me that, without really trying, I probably sold at least a half-dozen friends on the product.

In contrast to the slow U.S. start, I'm told that sales in Japan instantly exceeded expectations—and that by Christmas, 1979, Sony was looking at a four-month back-order situation for the Walkman units. The only hindsight explanation I can offer for the disparity is that at that time hi-fi ownership was perhaps four times that found in the U.S., and that Japanese audiophiles were already avid headphone users.

Once the Walkman's success became evident, dozens of Japanese, Taiwanese, and Korean competitors frantically began churning out their own versions of the personal stereos. Those eventually appeared in the U.S. under a variety of foreign and American brand names.

The headphone story

Sony wisely saw lightweight headphones as part of the Walkman package, despite the fact that Japanese headphones were generally fairly bulky, using heavy magnets and large diaphragms to ensure reasonable bass response. There were some reasonably lightweight (mostly) American-made phones available, but Sony, of course, decided to make their own.

An integral part of the Walkman design was the use of mini-stereo phone jacks and plugs, instead of the ¼-inch stereo plugs and jacks used with conventional stereo headphones. Sony patented the mini-stereo jacks and plugs, but offered the design to others royalty-free.

Sony's excursion into lightweight-headphone design was unusually successful, considering the crowded state of the field. Miniature long-throw plastic diaphragms "powered" by newly developed high-gauss samarium-cobalt magnets provided a level of performance in ultra-lightweight phones that was to set new fidelity standards for the type. In fact, Sony's phones were so well regarded that they were frequently sold as upgrade equipment for other manufacturers' versions of the Walkman.

A visit to the source

During a 1980 visit to Sony's headquarters in Tokyo, I had a chance to talk to Akio Morita, Sony's Chairman and one of the two original supporters of the Walkman concept. As with many other momentous historical events, a kind of mythic haze obscures the exact circumstances surrounding the genesis of the Walkman. In any case, Sony's founder, Masaru Ibuka, and Chairman Morita both saw the potential of a lab prototype that was based on an existing Sony dictating machine and they threw their considerable weight behind its further development.

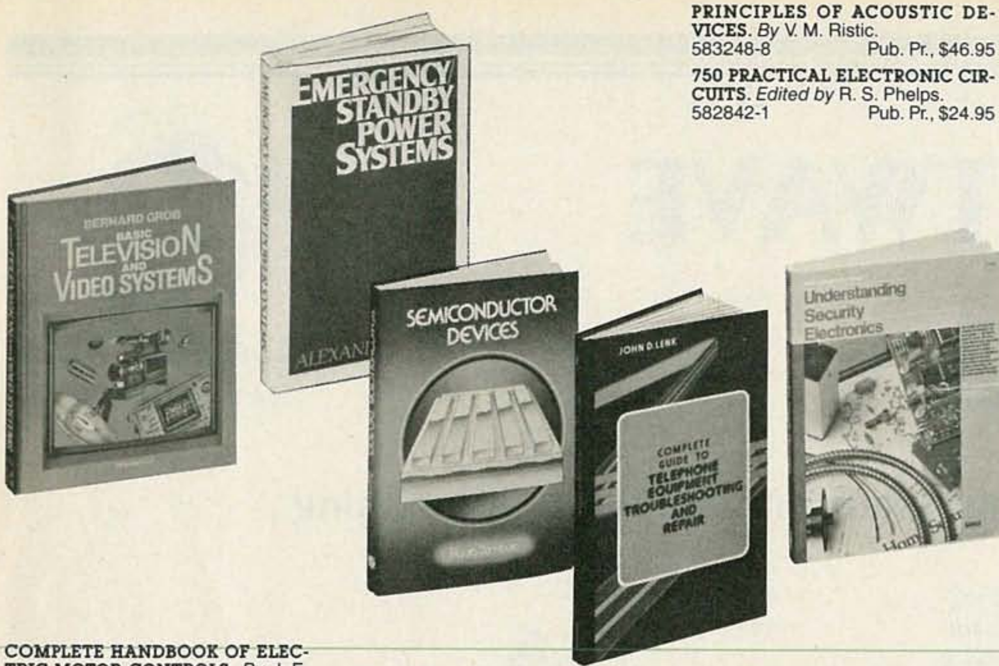
A preproduction prototype Walkman was subsequently developed. Dr. Morita presented it to his Board of Directors—where he met unexpected opposition. It could be that they were originally unimpressed for the same reasons I was. Morita persisted, and even stated (not too seriously, he told me) that he would resign his chairmanship if the product was not successful.

Dr. Morita took me to visit his Walkman "museum" room, which housed some of the early sales displays, original Walkman models, and dozens of samples of other companies' versions of the product. I asked Morita whether he forced his originally recalcitrant board members to undergo regular "penance" visits to the museum, but he assured me that it was not necessary because they had long since seen the light.

Painting the lily

According to the latest figures, Sony has sold a total of over 50 million units worldwide, 25 million of them in the U.S. And if you were to count the models sporting other companies' brand names, over 22 million units were sold last year in the U.S. alone! Given every manufacturer's constant need to differentiate this year's products from those of last year—and, of course, from those of their competitors—variations on the basic Walkman theme have proliferated wildly. For example, this year Sony promises to have 44 models available, not counting the Discman personal CD player and the Watchman personal TV.

That is quite an achievement for a product category that was created a mere decade ago! **R-E**



PRINCIPLES OF ACOUSTIC DEVICES. *By* V. M. Ristic.
583248-8 Pub. Pr., $46.95

750 PRACTICAL ELECTRONIC CIRCUITS. *Edited by* R. S. Phelps.
582842-1 Pub. Pr., $24.95

ATE: AUTOMATIC TEST EQUIPMENT. *By* A. C. Stover.
617/929 Pub. Pr., $44.95

Bob Middleton's HANDBOOK OF ELECTRONIC TIME-SAVERS AND SHORTCUTS. *By* R. G. Middleton
583865-6 Pub. Pr., $29.95

MICROELECTRONICS, 2/e. *By* J. Millman and A. Grabel.
423/30X Pub. Pr., $51.95

A HANDBOOK FOR INVENTORS: How to Protect, Patent, Finance, Develop, Manufacture, and Market Your Ideas. *By* C. D. MacCracken.
582811-1 Pub. Pr., $18.95

MICROPHONE MANUAL: Design and Application. *By* D. M. Huber.
584660-8 Pub. Pr., $29.95

ELECTRONIC SPEECH RECOGNITION: Techniques, Technology, and Applications. *Edited by* G. Bristow.
079/137 Pub. Pr., $53.95

TROUBLESHOOTING AND REPAIRING SATELLITE TV SYSTEMS. *by* R. Maddox.
583703-X Pub. Pr., $26.95

John D. Lenk's TROUBLESHOOTING AND REPAIR OF AUDIO EQUIPMENT. *By* J. D. Lenk.
583895-8 Pub. Pr., $21.95

THE SATELLITE TV HANDBOOK. *By* A. T. Easton.
585121-0 Pub. Pr., $16.95

COMPLETE GUIDE TO VHS CAMCORDER TROUBLESHOOTING AND REPAIR. *By* J. D. Lenk.
585166-0 Pub. Pr., $41.00

Any 3 books for $3.95 .... if you join now and agree to purchase two more books—at handsome discounts—during your first year of membership.

COMPLETE HANDBOOK OF ELECTRIC MOTOR CONTROLS. *By* J. E. Traister.
584542-3 Pub. Pr., $33.00

THE ILLUSTRATED DICTIONARY OF ELECTRONICS. *By* R. P. Turner and S. Gibilisco.
584808-2 Pub. Pr., $23.95

ADVANCED DIGITAL TROUBLESHOOTING. *By* A. J. Evans.
584763-9 Pub. Pr., $19.95

ELECTRICAL SYSTEMS FOR COMPUTER INSTALLATIONS. *Edited by* R. J. Lawrie.
367/299 Pub. Pr., $34.50

UNDERSTANDING FIBER OPTICS. *By* J. Hecht.
583896-6 Pub. Pr., $17.95

INTRODUCTION TO RADIO FREQUENCY DESIGN, *By* W. H. Hayward.
582748-4 Pub. Pr., $39.00

BATTERIES AND ENERGY SYSTEMS, 2/e. *By* C. L. Mantell.
400/318 Pub. Pr., $48.50

DIGITAL FILTERS: Theory and Application. *By* N. K. Bose.
584509-1 Pub. Pr., $44.95

HOW TO MEASURE ANYTHING WITH ELECTRONIC INSTRUMENTS. *By* J. A. Kuecken.
584537-7 Pub. Pr., $19.95

MASTERING ELECTRONICS, 2/e. *By* J. Watson.
684/804 Pub. Pr., $24.95

ADAPTIVE ANTENNAS: Concepts and Performance. *By* R. T. Compton, Jr.
584767-1 Pub. Pr., $50.00

CIARCIA'S CIRCUIT CELLAR, VOL. V *By* S. Ciarcia.
109/627 Pub. Pr., $21.95

ELECTRONIC CIRCUITS COOKBOOK. *By* H. L. Helms.
584640-3 Pub. Pr., $28.00

COMPLETE GUIDE TO TELEPHONE EQUIPMENT TROUBLESHOOTING AND REPAIR. *By* J. D. Lenk.
583851-6 Pub. Pr., $35.00

CALCULUS FOR ELECTRONICS, 4/e. *By* A. E. Richmond and G. W. Hecht.
532/55X Pub. Pr., $34.95

OPERATIONAL AMPLIFIERS AND LINEAR INTEGRATED CIRCUITS: Theory and Applications. *By* D. J. Dailey.
399/31X Pub. Pr., $34.95

IBM PC TROUBLESHOOTING AND REPAIR GUIDE. *By* R. C. Brenner.
585123-7 Pub. Pr., $19.95

CMOS COOKBOOK, 2/e. *By* D. Lancaster as rev. by H. M. Berlin.
584591-1 Pub. Pr., $18.95

FEEDBACK AMPLIFIER PRINCIPLES. *By* S. Rosenstark.
539/146 Pub. Pr., $35.95

More Books to Choose from

ELECTRICAL AND ELECTRONIC DRAWING, 5/e. *By* C. J. Baer and J. R. Ottaway.
030/286 Pub. Pr., $39.50

INTEGRATED CIRCUITS FOR COMPUTERS: Principles and Applications. *By* W. L. Schweber.
536/244 Pub. Pr., $28.95

PASCAL FOR ELECTRONICS. *By* E. J. Pasahow.
487/243 Pub. Pr., $17.95

TURBO PASCAL FOR ELECTRONICS. *By* E. J. Pasahow.
487/324 Pub. Pr., $14.95

UNDERSTANDING IC OPERATIONAL AMPLIFIERS, 3/e. *By* R. Melen and H. Garland.
585120-2 Pub. Pr., $12.95

MICROCOMPUTER TROUBLESHOOTING AND REPAIR. *By* J. G. Stephenson and B. Cahill.
585106-7 Pub. Pr., $24.95

LENK'S TROUBLESHOOTING AND REPAIR OF MICROPROCESSOR-BASED EQUIPMENT. *By* J. D. Lenk.
585122-9 Pub. Pr., $21.95

EASY-UP ANTENNAS FOR RADIO LISTENERS AND HAMS. *By* E. M. Noll.
585108-3 Pub. Pr., $16.95

COMPACT DISC TROUBLESHOOTING AND REPAIR. *By* N. Heller and T. Bentz.
585099-0 Pub. Pr., $19.95

INTRODUCTION TO TELEVISION SERVICING. *By* W. C. Brandenburg.
071/764 Pub. Pr., $26.96

UNDERSTANDING AUTOMOTIVE ELECTRONICS, 3/e. *By* W. B. Ribbens.
584761-2 Pub. Pr., $17.95

Here's how the Practical Electronics Book Club works to serve you:

- **Practical information . . . we make it easy to get!** For reliable hands-on information, turn to the Practical Electronics Book Club. Every 3 or 4 weeks (12-15 times a year) members receive the Club Bulletin offering more than 30 books—the best, newest, most important books from all publishers.
- **Dependable service . . . we're here to help!** Whether you want information about a book or have a question about your membership, just call us toll-free or drop us a line. To get only the books you want, make your choice on the Reply Card, and return it by the date specified. If you want the Main Selection, do nothing—it will be sent to you automatically. (A small shipping and handling charge is added to each shipment.)
- **Club convenience . . . we do the work!** You get a wide choice of books that simply cannot be matched by any bookstore. And all your books are conveniently delivered right to your door. You also get 10 full days to decide whether you want the Main Selection. (If the Club Bulletin ever comes late and you recieve a Main Selection you don't want, return it for credit at our expense.)
- **Substantial savings . . . and a bonus program too!** You enjoy substantial discounts—up to 40%!—on every book you buy. Plus, you're automatically eligible for our Bonus Book Plan which allows you extra savings on a wide selection of books.
- **Easy membership terms . . . it's worthwhile to belong!** Your only obligation is to purchase 2 more books—at handsome discounts—during the next 12 months, after which you enjoy the benefits of membership with no further obligation. You or the Club may cancel membership anytime thereafter.

Fill out the card and mail today! If the card is missing, write to:

D10003

PRACTICAL ELECTRONICS BOOK CLUB

11 West 19th Street—Dept. PRD, 4th Floor, New York, NY 10011.

SHORTWAVE RADIO

STANLEY LEINWOLL

The Soviet jamming system and the future of jamming

IN ORDER TO MAKE A REASONABLE PREDICTION of the future course of jamming, it is first necessary to have a closer look at the system, and how it worked. Over the past fifty years, the Soviet Union and its European satellites developed the most elaborate system ever conceived solely for the purposes of disrupting foreign broadcasts to the Soviet Union.

The Soviet jamming system was administered by a secret department in the Ministry of Communications. Privately, the department was known as the Krestyaninova Section, after Natalia Krestyaninova, who organized and headed the department for more than twenty-five years.

Reportedly now disbanded, the Section was responsible for about 5,000 people, and more than 2,000 jamming transmitters. Most of the personnel responsible for the operation of the intricate web of transmitters were highly skilled and trained technicians. That's because jamming demands swift communications, quick decisions, careful coordination, and constant monitoring in order to block the programs which they consider most objectionable to their own interests. Here is how the system was set up:

- Each city with a population of more than 250,000 had its own local jamming network. In general, local jammer complexes consisted of about fifteen jamming transmitters, each having from 5 to 50 kilowatts power. Although that was the norm, large population centers such as Moscow had more than seventy-five jamming transmitters serving them.
- Each local jamming station had a monitoring station associated with it, located about twenty kilometers from the transmitters. The local jamming-transmitter site and the monitoring station were connected by dedicated line. The monitoring station constantly scanned the shortwave bands checking schedules of transmissions directed toward its target area. If a frequency was penetrating the jamming screen, the monitoring station called upon the transmitter site for additional jamming.
- Both the transmitter site and the monitoring station operated twenty-four hours per day. The monitoring station had at least two people working per shift, as did the transmitter site.
- Each monitoring station also reported by dedicated line to a larger regional monitoring station. If the local transmitter site was overloaded, then the regional station was responsible for calling in additional jammers via sky-wave propagation.
- The sky-wave stations used high-power transmitters, up to one hundred kilowatts each. The sky-wave stations were situated at

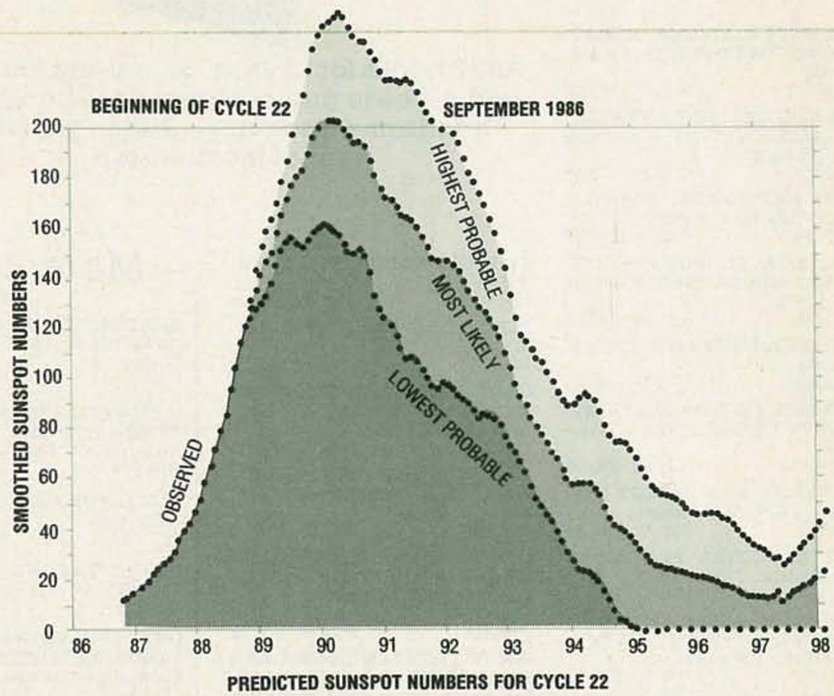


FIG. 1

various strategic locations throughout the USSR, and were located about 2500 kilometers away from densely populated areas.

- For sky-wave propagation, 2500 kilometers is the optimum distance for one-hop propagation. Each sky-wave site had as many as fifty transmitters associated with it.

The current situation

Since the cessation of jamming directed against Radio Free Europe, Radio Liberty, Radio Israel, and Deutsche Welle (Radio Germany) at the end of November 1988, there has been an increase of approximately fifty percent in the number of shortwave broadcasts of Radio Moscow, as well as the regional shortwave outlets of the USSR.

It is clear that a major shift away from formal jamming operations has taken place, and that recent stories in *Pravda* to that effect are true. It must be pointed out, however, that the core of the jamming system—the transmitters—has been kept in place, at the ready, and that its use, albeit for broadcasting, represents a different form of jamming. The high-frequency broadcasting spectrum is already overcrowded by a factor close to three, and the redeployment of hundreds of transmitters from the jamming service to the broadcasting service constitutes a somewhat modified version of harmful interference.

It is clear, from those recent developments, that in the event that full-scale jamming is required, the re-scheduling of the transmitters now in the broadcasting service, as well as those transmitters that have been mothballed, can be accomplished quickly. There is little doubt that if the political climate in the USSR should change drastically, then the raucous, irritating racket that the noise jammers produced would be back with us in a matter of days or weeks.

Although the production of noise for the sole purpose of obliterating unwanted broadcasts has ended, it does not appear that jamming, in the broader context, has entirely disappeared.

General conditions

In the equinox months (March and September) during years of high sunspot activity, periodic ionospheric disturbances occur, which may disrupt shortwave communications for one to three days. During those disturbances, signals can be all but blacked out, particularly in the higher bands. The disturbances are usually preceded by massive flares on the sun, which produce SID's (*S*udden *I*onospheric *D*isturbances). The immediate effect is a period of one to two hours, in the daylight portion of the world, during which much of the shortwave spectrum is severely disturbed. The SID is caused by a burst of radiation from the sun, which takes approximately eight minutes to reach Earth. After a SID, conditions return to normal relatively rapidly. Twenty-four to forty-eight hours later, particles emitted by the sun during the period of the flare, start reaching the ionosphere, causing the prolonged disturbance.

When a severe radio storm occurs, it is often accompanied by a display of northern lights, or aurora borealis. Sometimes, shortwave, VHF, or even UHF signals will propagate off the aurora borealis, making FM and/or TV DX possible.

During normal periods, DX will be good. During daylight hours all bands from 19 to 11 meters will be possible; at night DX will be possible from 49 to 16 meters.

Sunspot cycle progress

Figure 1 indicates how Sunspot Cycle 22 is progressing. It still appears that this cycle will be the highest ever observed. The solid line shows actual observed smoothed sunspot numbers. The dotted lines indicate the range of predicted values for the remainder of the cycle. The upper curve indicates the highest probable numbers, the lower curve gives lowest probable values. The center curve gives the most likely smoothed numbers.

Inasmuch as the highest smoothed number ever observed was a little over 201, it can be seen the Cycle 22 is shaping up as a probable record-breaker. **R-E**

DRAWING BOARD

ROBERT GROSSBLATT,
CIRCUITS EDITOR

Laying out a PC board.

ALTHOUGH THERE ARE LOTS OF WAYS TO solve any particular electronic-design problem, the details of the solution are always a reflection of the individual doing the design. Different people see different ways of getting a job done. When you have two designers each build a circuit to do a unique job, you're sure to wind up with two completely different circuits. The final products might do the same thing, but it's a safe bet that they'll follow two separate paths from input to output. That is particularly true when it comes to PC Boards.

Laying out foil patterns can be mind-boggling. I can't tell you how many times I've ended a day's work absolutely convinced that I was at a dead end, only to find myself staring at a solution when I started up again in the morning. After doing more PC boards than I care to count, I've come to the conclusion that the real key to laying out a board is persistence. There's always a solution but you're the only one that can find it; so if you don't put in the time, it's not going to happen.

Finishing the layout

Once you've got the layout done in blue pencil, the chances are that your piece of graph paper is going to be a real mess. There will be lots of places where the paper is worn thin from erasures; and then, since the traces were done in pencil, some of the first ones you did might have lightened up from being repeatedly rubbed by your hands.

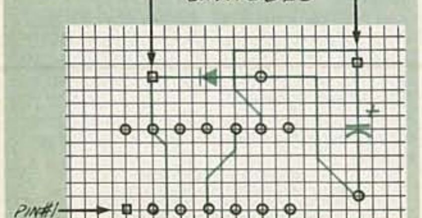


FIG. 1

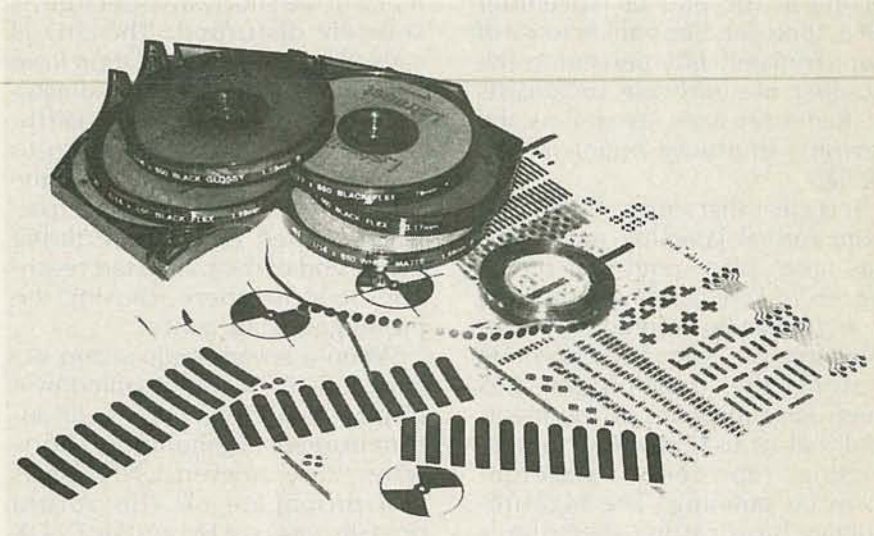


FIG. 2

After you make the last connection on the paper, the first thing to do is examine it carefully and make sure that all the traces and pads are visible. Go over them with the blue pencil—and if the paper is worn really thin, copy the entire layout on another piece of paper. It's a lot of work, but you've got major amounts of time invested in creating the layout, and it's the world's only copy of the layout. So it makes a lot of sense to protect your investment.

Even though you've been constantly checking the layout against the schematic, do it again—carefully. The closer you get to producing the board, the harder it is to correct mistakes. One of the easiest mistakes to make when you're at this stage of the game is to screw up the orientation of the parts. After all, an IC is represented only by a handful of circles on the graph paper, and polarized two-legged components like diodes and electrolytics are even less distinctive. A mistake at this point can be fixed with a few wipes of an eraser, but if you don't catch it until you've gone to copper, it can be impossible to correct.

I once laid out a board and made all the IC connections as if I were looking at them from the top, not the bottom. I drew the IC's with pin 1 on the lower left, not the lower right, and didn't catch the error until I had made the board, stuffed it, and started wondering why it didn't work. That is the kind of thing you do only once!

The best way to guard against mistakes in orientation is to mark the appropriate pads during the blue-pencil stage of the layout. As shown in Fig. 1, I use a square to represent the positive leg of polarized components and pin 1 of the IC's. You can distinguish those pins any way you want (after all, this is America), but keep the marks small yet distinctive. Layouts can get very crowded, and large labels will only make it worse. Once you're sure that the layout is correct and that the hole spacing matches the parts you'll be using, you're ready to prepare the artwork for the next step—photography.

Producing the film

Once the board is laid out, you can breathe a bit easier because all the steps that follow are mechanical ones—they might be complex, but at least they involve an absolute minimum of thought. Now you have to transform your blue-pencil layout into a black-and-white drawing that can be photographed with lithographic film. You need some basic photographic equipment but, if you don't have all of it, almost all of the steps can be done by a photo lab or blueprinting shop. The full list of equipment is:

1. 1/16-inch wide drafting tape
2. PC-board drafting symbols.
3. An Exacto knife with a good supply of #11 blades.
4. A single-lens-reflex camera (35mm or larger)
5. Lithographic film for your camera.
6. Lithographic sheet film as large as the board you're making.
7. Two photoflood bulbs (EAL's, FLB's, etc.)
8. A copy stand or tripod.
9. An enlarger capable of holding your camera film.
10. A contact-printing frame.
11. Chemicals to process the lithographic film.

That may seem like an imposing list of stuff, but as we go through the process of producing the film, I'll let you know which steps you can farm out and which you should really do yourself.

Converting the blue-pencil layout to something photographable means covering all your blue lines with drafting tape and pads. You can get the tape in any good art-supply store. There are several companies that make tape in varying thicknesses, textures, and finishes. What you're looking for is flexible, matte-finished tape. The finest trace that can be securely transferred to copper is 1/32-inch so, since we've been doing a double-sized layout, you should use 1/16-inch wide tape for most of your traces.

The pads and donuts for the components are available at electronics suppliers. Companies such as Bishop Graphics and Vector make them in a wide variety of shapes and sizes but you have to specify that you want double-sized patterns (or whatever size you've used). The tapes and pads shown in Fig. 2 are only a small sample of the variety available, so you shouldn't have any trouble getting exactly the ones you need.

Put the IC and component pads on the drawing first. The center of the drill holes should be laid over the center of the blue-pencil circles on the graph paper. Once you've got them in place, you'll find it easy to cover the blue trace lines with tape of the appropriate thickness. Most traces will use the

FIG. 3

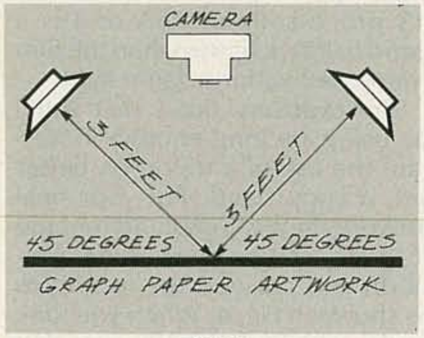


FIG. 4

1/16-inch wide tape although you can use thicker tape for power, ground, or any other trace that needs it. The 1/16-inch tape will produce traces that aren't so thin that they'll disappear in the etch, or be so wide that they're not cleanly separated on the final board. The 1/32-inch final size is also a good thickness for traces that are routed between IC pins.

Don't worry about any uncovered blue lines, whether they are ones that you've drawn or the original grid lines on the paper, because the lithographic film is not sensitive to blue and it's also incredibly forgiving about smudges, rips, and different shades of black. Plus you'll be going a few film generations beyond the original camera film, so the imperfections will tend to disappear by the time you get to the final negative.

Once the traces and pads are on the paper, you're ready to get the artwork on film. Now is a good time to label the board with transfer-type lettering if you wish. It's a very good way to permanently mark revision numbers, dates, part numbers, or whatever else on the board.

Lithographic film comes in all the standard film sizes, as well as sheets smaller than 4 × 5 and larger than 16 × 20 (see Fig. 3). I use Kodak film because it's carried by my local dealer (and can also be special ordered by any Kodak dealer). The term "Ortho Film" refers to the fact that the particular film is "Orthographic," meaning that it is sensitive only to a very narrow frequency of light. Although the film's effective speed depends on what type of light is used and how it's processed, an ASA of 8 is a good ballpark figure when the film is exposed with tungsten light.

The exposure times that you'll be using are long enough to warrant the use of a tripod or, better yet, a copy stand. Put your final artwork on the copystand (or tape it to the wall if you're using a tripod), and position the two lights as shown in Fig. 4. When you look in the viewfinder, make sure that there are no reflections bouncing into the camera from the artwork, as they will probably result in black spots on the negative.

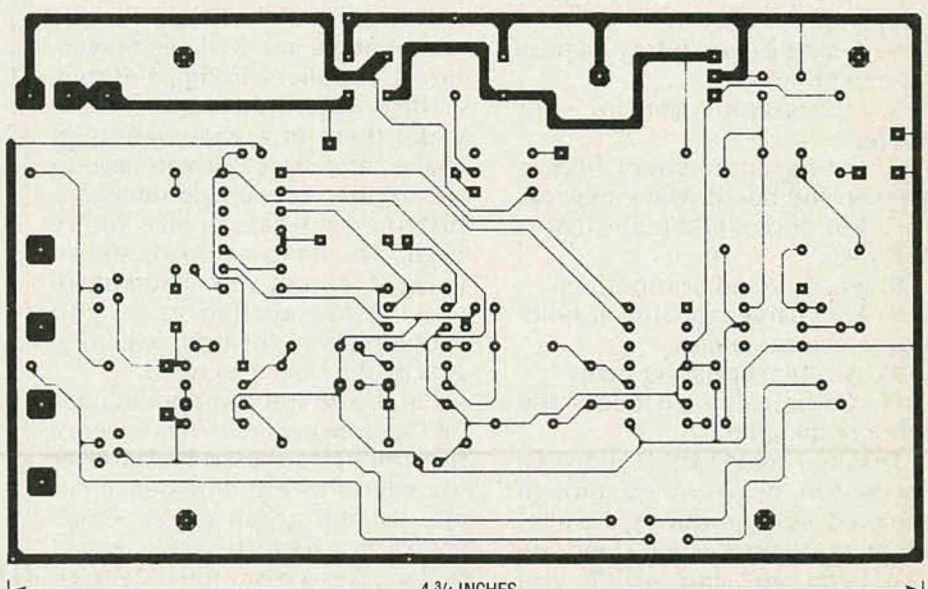
It's murder to work out the correct exposure, but here's where you can benefit from my personal heartaches. If you use the bulbs that I specified, and maintain the distances shown in Fig. 4, you'll get good results with a half-second exposure at f5.6.

Process the film according to the recommendations packaged with the chemicals (Kodalith developer, stop bath, and fixer), and wash it for about ten minutes before you finally let it dry. The film can be handled under a bright-red safelight, so you can actually watch it develop. As soon as you see a clear image, put the film in the stop bath to halt the development. If you overdevelop the film, the traces (which are clear on the negative) will start to darken and the film will be useless. Knowing when to pull the film from the developer comes with experience, but generally it's better to have the dark areas a bit too light, rather than having the light areas a bit too dark.

When we get together next time, we'll see how to produce the full-sized film for the board, and I'll tell you exactly how to sensitize, develop, and etch the board. That will be the trickiest part of the whole process, and the information I'll be giving you is the result of years of experimenting and aggravation. **R-E**

PC SERVICE

MORE PC SERVICE ON PAGE 90.

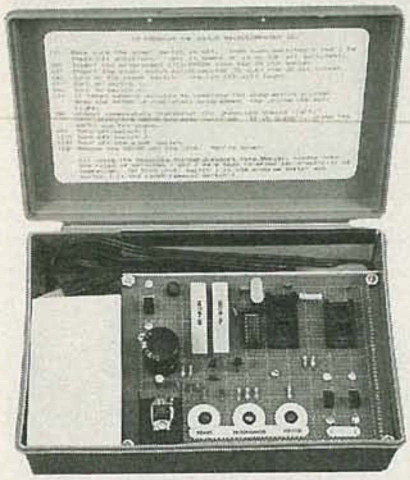


FAXMATE FOIL PATTERN.

COMPUTER DIGEST

68705 MICROCONTROLLER

THOMAS HENRY



Use the versatile 68705 microcontroller to build a programmable alarm clock.

Part 2 Last time we discussed basic hardware and software theory of Motorola's versatile 68705 microcomputer-on-a-chip. We also built a special programmer used to transfer software from a standard 2716 EPROM into the 68705's built-in EPROM.

This time we will put the theory to work and build a digital alarm clock. The project is not just an educational exercise; you'll find that it is useful and that it incorporates several features not found in commercial units. By studying the example, you'll find numerous hints for designing with the 68705.

Design goals

We want a four-digit readout for hours and minutes, a blinking colon to indicate seconds, fast and slow display-set buttons, clock- and alarm-set buttons, an AM/PM indicator, an enable switch and a volume control for the alarm, the ability to show either hours and minutes or minutes and seconds, a power-outage warning, and the ability to display either a 12- or a 24-hour clock.

Those may seem like ambitious design goals. As it turns out, however, the 68705's versatility lets us build the project using only two IC's. And one of them is a dedicated sound generator, which means that the clock really requires only the 68705!

The basic plan of attack is to derive the 60-Hz timebase from the 117-VAC power lines. In most communities, that frequency is accurate to 0.02 Hz, or 3 parts in 10,000. By using the AC lines (which are more than accurate enough for a clock), we can simplify the design tremendously, and even eliminate the need for a crystal oscillator. (See part one of this story for more information on clocking the 68705.)

To simplify things even further, we multiplex the four seven-segment LED displays. Doing so means we need no latches or decoders, reducing the number of passive components as well. Port B of the 68705 can sink 10 mA of current directly, so no display drivers are needed either. Decoding is handled by means of a look-up table burned into the internal EPROM. Since we don't use a

Continued on page 86

EDITOR'S WORKBENCH

Announcement

Mario Maniscalco's $100 challenge to **Computer Digest** readers to crack the secret message published in the April 1988 issue has gone unanswered, so he will now send the key to anyone who sends an SASE to P.O. Box 110083, Cleveland, OH 44111. Mario also plans a newsletter on the encryption program; write to him at that address for more information.

RS-232 Debugging with SAM 2000

Woe be it to anyone trying to connect two pieces of equipment via the RS-232 "standard." Making successful connections is partly art, partly science, partly trial and error, and partly just plain luck.

If getting serial devices to communicate is important to you, you'll want to check out the SAM 2000 from IQ Technologies. (See Fig. 1.) This big brother to the Smart Data Meter (reviewed in the March 1989 issue) provides several powerful features designed to help set up and debug serial communication links.

SAM is about the size of a hand-held DMM. The basic unit includes a 2-line by 16-character LCD display, a six-button front panel, two 26-pin header con-

FIG. 1

nectors, two cables with both male and female DB-25 connectors, and two 9-to-25 pin adapters. SAM runs on an AC adapter; you can bolt an optional battery pack to the bottom of the case. A parallel port adapter is also available. Prices vary, ranging from about $800 for the basic unit to about $1100 for a complete setup.

You can use SAM to debug all sorts of RS-232 problems. For example, the device can help you determine the communications parameters (baud rate, number of stop bits, and parity settings) of both sending devices and receiving devices. To check a sender, make the connection, and don't worry about whether pin two is an input or an output; SAM will figure it out and then report all parameters.

To check a receiver, SAM sends one of several test patterns at various settings. When you get a correct printout (like "19.2K Baud, 8 Bits, Parity: None"), you'll know you've got the baud rate right. Because of the way some devices treat the parity bit, you may have to do a little experimenting to find the correct parity setting. But once you lock in on the correct baud rate, you can test various parity settings by setting SAM up to dump a test string over and over.

Not sure whether a device is a DTE or a DCE? No matter; SAM also helps with cable problems. SAM's automatic mode can probably figure it out for you. If not, there's a breakout box mode that allows you to monitor the RS-232 control lines. In addition, a manual mode that works like an electronic patchbox allows you to specify which input signals connect to which output signals (including multiple connections).

SAM can also test and analyze cables, reporting all connections. That's a valuable and time-saving ability. For example, the manufacturer of a PC communications package shipped a "special" cable with the software, claiming that the cable had to be used in some high-performance modes. But what if the cable broke or wasn't available? I had been meaning to use a continuity checker to document the connections, but hadn't got around to it. SAM did it in about five seconds, revealing that the cable was wired in a fairly common null-modem configuration.

In addition, SAM has an 8K buffer for recording data from the sending and receiving devices, and status of the control lines from the receiver. You can inspect the contents of the buffer; each byte is shown in hex, decimal, and ASCII forms. You can also dump the buffer to an external device in both formatted and unformatted forms.

Using SAM is like setting a two-button digital clock. After turning the power on, you use keys labeled Next and Last to move through a circular series of menus, and keys labeled Yes and No to select items from particular menus. The arrangement is quite intuitive, so you become proficient at using SAM almost immediately.

SAM has a few faults. For one, in the cable-analysis mode, it assumes you have a good ground connection (pin 7 to pin 7); the manual suggests checking the cable with a DMM if you suspect trouble. SAM itself should alert you to a possible ground fault.

Also, SAM does not check all possible interconnections, but limits itself to checking pins 2–8, 11, 19, 20, and 22. Letting it check all 25 pins would not objectionably increase analysis time, and would be useful for documenting the occasional tricks manufacturers play attempting to keep hardware proprietary.

The 2-by-16 display is also rather limiting, because it requires you to scroll through long lists of menu choices and operating parameters, and makes it hard to view the data buffer. A larger bit-mapped LED matrix could represent the breakout box and interconnection scheme graphically, and allow you to view a larger chunk of the data buffer.

But those faults do not detract from SAM's real utility. If making connections is part of your business, check it out. You won't be disappointed. ◆CD◆

Living With DOS and OS/2: MultiBoot

If you install IBM's version of OS/2 (and versions from several other manufacturers as well), you can forget about booting DOS from your hard disk; you'll have to do it from floppy. Two steps forward, one step back. Upcoming versions of the new operating system will most likely correct that deficiency; in the meantime, there's MultiBoot, a slick utility that gives you the best of both worlds.

Using MultiBoot, you can select either DOS or OS/2 as your default operating system. Every time you boot, whichever you chose as the default will load and run. However, merely by pressing the Caps Lock key during the boot process, you can load the other. In addition, a MultiBoot utility program allows you to change the default at will.

Installing MultiBoot may be somewhat involved, depending on which manufacturer issued your copy of OS/2. In my case, due to hardware problems, I had more trouble installing OS/2 than MultiBoot.

The program works by altering the common names of the DOS and OS/2 system files (IBMBIO.COM, IBMDOS.COM, CONFIG.SYS, and AUTOEXEC.BAT) and patching OS/2 so it will find its versions of those files.

All in all, MultiBoot is a beautifully simple solution to a problem we shouldn't have. The program works with all versions of OS/2 through Extended Edition 1.1, and DOS versions through 4.0. ◆CD◆

Upgrade

DoubleCOM is a software-controlled dual serial-port card discussed here in the January 1989 issue. The card allows you to share two devices at one port address (COM1 or COM2), allowing you to switch between them via a rear-panel toggle switch or via a hot-key combination. DG Electronic Developments has now upgraded the software to allow for port switching at higher baud rates (19200, 38400, and 57600), has improved support for Windows, and has added a system-configuration utility.

Working With PLD's

You can't pick up a memory card, video adapter, or disk controller without seeing one or more programmable logic devices. The problem is that few engineers know the ins and outs of PLD design. Roger Alford does, and he shares his knowledge in a book called *Programmable Logic Designer's Guide*, published by Sams. The book starts off with a review of various device families (SSI/MSI, LSI, standard cells, etc.) and shows how PLD's fit in. Then the book reviews logic fundamentals. Chapter three is where the real action starts, with its discussions of PLD families and architectures. Later chapters deepen the earlier discussions, and include specific information on devices available from various manufacturers, as well as software tools for developing PLD's. Several appendices include detailed information on manufacturers of PLD's and supporting hardware and software. If you want to be where the design action of the 1990's will be, pick up a copy of Roger's book. And watch for articles by him in future issues of **Radio-Electronics**.

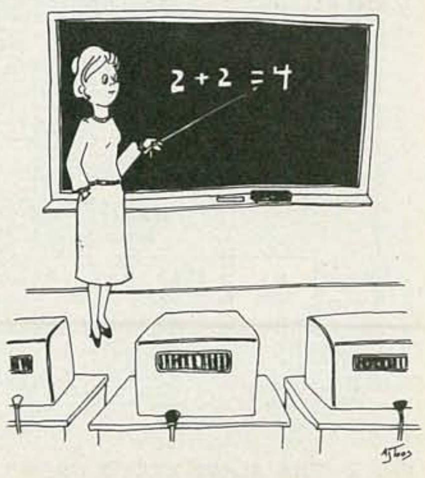
ITEMS DISCUSSED

- DoubleCOM ($149), DG Electronic Developments, 700 South Armstrong, Denison, TX 75020. (214) 465-7805.
CIRCLE 49 ON FREE INFORMATION CARD

- SAM 2000 ($795), battery pack ($79.95), parallel adapter ($199.95), IQ Technologies, Inc., 11811 N.E. First Street, Bellevue, WA 98005. (206) 451-0232.
CIRCLE 48 ON FREE INFORMATION CARD

- MultiBoot ($49.95 + $3 s/h), Bolt Systems, Inc., 4340 East-West Highway, Bethesda, MD 20814. (301) 656-7133.
CIRCLE 47 ON FREE INFORMATION CARD

- *Programmable Logic Designer's Guide* ($29.95), Howard W. Sams, 4300 West 62nd Street, Indianapolis, IN 46268. (800) 428-SAMS, (317) 298-5699.
CIRCLE 46 ON FREE INFORMATION CARD



Computer Training Class

MICROCONTROLLER

continued from page 83

commercial display decoder, we can create our own alphanumeric characters and display textual messages.

The clock uses the interrupt capabilities of the 68705 to keep track of the passage of time. Normally, the CPU runs a program that updates the display LED's, scans for switch closures, and checks to see if the alarm time has been met. But while all that is happening, the 60-Hz AC signal interrupts the main program every 1/60th of a second. After 60 such interrupts, a memory location in RAM is incremented to indicate that another second has elapsed. In a similar fashion, other RAM locations keep track of passing minutes and hours. Generally speaking, the two-program approach (a main program used in conjunction with an interrupt program) is a powerful technique with many applications in modern electronics.

Hardware

Now let's examine the schematic and see how the hardware works. As shown in Fig. 1, only two IC's are used (or three if you count the voltage regulator). First is IC1, the 68705. Second is a 94281 sound generator, which is used to create the alarm signal. Although it would probably be possible for IC1 to generate the alarm signal by itself, it seemed simpler to use a dedicated IC. Last is the voltage regular, IC3, a 7805.

Actually, the clock uses two voltages: an unregulated +8.9 volts for the sound generator, and the regulated +5 volts for the microcontroller and display circuitry. Note that we tap one leg of the transformer to derive the timebase. To keep the voltage to a safe level, the AC signal is clipped by diodes D2–D5, and then filtered by C4 to remove any remaining cusps. The resultant signal is then capacitively coupled to the $\overline{\text{INT}}$ input (pin 2 of IC1) by C5. A Schmitt trigger, internal to the 68705, squares up the signal.

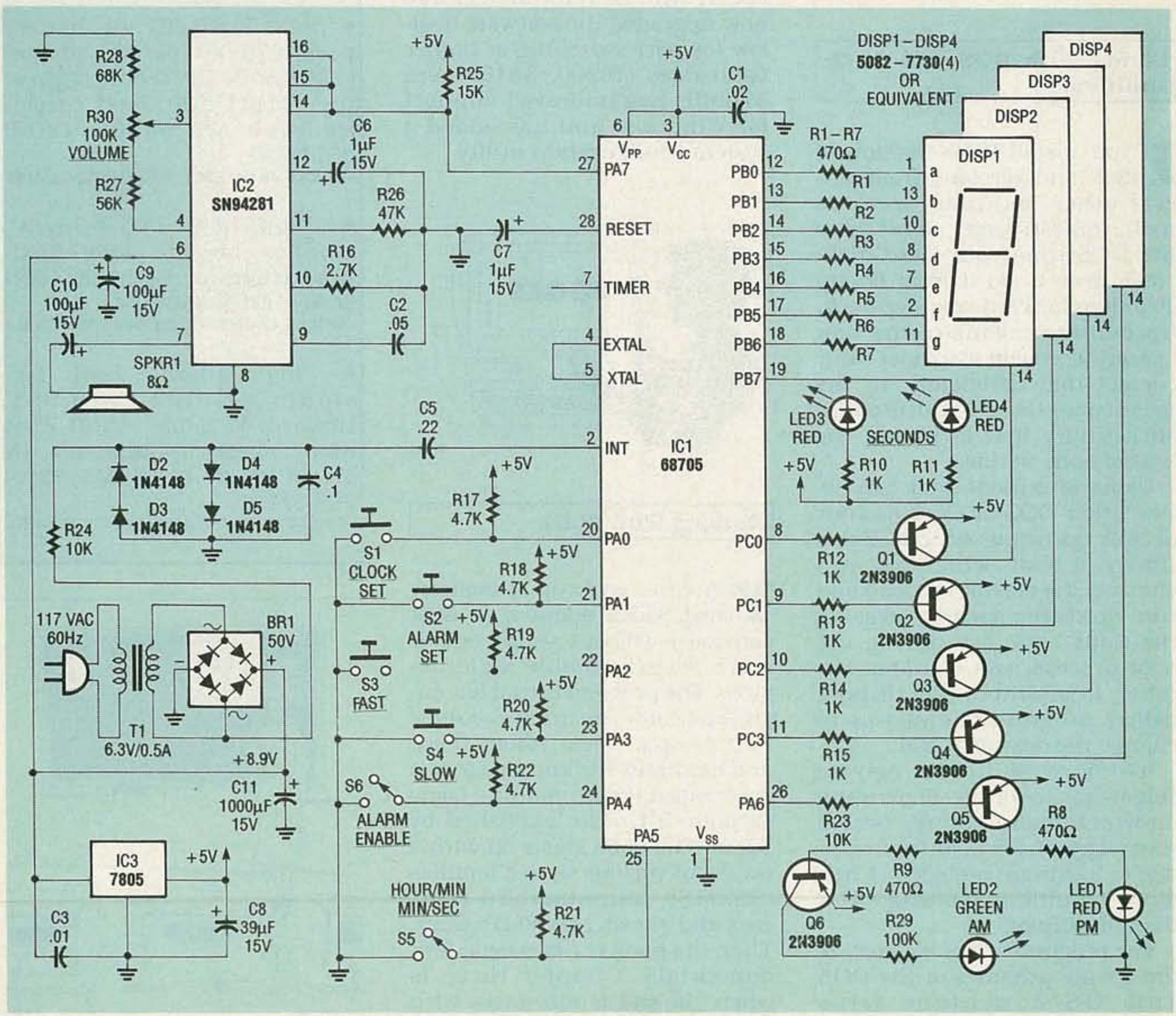


FIG. 1—THE ALARM CLOCK USES THREE IC'S: The microcontroller, a sound generator, and a voltage regulator.

Now let's consider the display. The secret of a multiplexed display is the concept of rows and columns. We define one set of output lines as rows and another as columns. We can supply voltage to a particular segment in a particular display by enabling specific row and column outputs of the microcontroller; the LED at the intersection thus lights up.

Transistors Q1 through Q4 function as the columns; they're enabled by four lines from Port C. Those lines can't source much current, which is why we need the transistors. However, because of its current-carrying capacity, Port B drives the row outputs (i.e., the display segments) directly.

Each segment in a display is labeled with a letter from *a* through *g*. All four *a*'s are connected to each other, and then to PB0, via R1, which limits current. Similarly, the *b* segments are tied together and connected to PB1 via R2, and so on, through PB6, which drives the *g* segment.

As for the columns, we must use common-anode displays, because of the current-sinking logic. (Incidentally, we specified Hewlett-Packard types in the schematic and Parts List, but you can substitute just about any common-anode type.) Note in Fig. 1 that the anode of each display is supplied current through a transistor (Q1–Q4). The software ensures that only one transistor is on at a time, thus only one display is enabled at a time. By successively turning on Q1, Q2, Q3, Q4, and then Q1 again (and so on), each display shows its current segment pattern. If that rotational multiplexing happens fast enough, then persistence of vision leads to the optical illusion that all four displays are illuminated continuously. And it's all handled in software, without any external logic!

We generate the blinking colon using two discrete LED's (D8 and D9), which are driven from PB7. Two other discrete LED's (D6 and D7) provide an AM/PM indicator. When PA6 goes low, Q5 turns on, so D6 (PM) lights up. However, Q6 turns off, so D7 (AM) turns off. On the other hand, when PA6 goes high, Q5 and D6 are off, and Q6 and D7 are on.

PA7 fires up the sound generator when an alarm must be sounded. The operation of IC2, the SN94281, is beyond the scope of this article, but suffice it to say, when PA7 of the 68705 goes low, IC2 emits a mighty "whooping" burst sufficient to arouse the soundest of sleepers. Alarm volume may be adjusted by potentiometer R30. However, that may be a dangerous control to leave in the hands of a confirmed late sleeper!

All the I/O lines examined so far (all of ports B and C, as well as PA6 and PA7) are used for output operations. Of course an alarm clock needs information from the user in order to be useful; S1–S6 provide that information.

For example, SPST pushbutton S1 acts as the CLOCK SET button. Pressing it along with either S3 (FAST) or S4 (SLOW) allows the user to set the proper time. The ALARM SET button (S2) works in a similar manner with S3 and S4 to set the alarm time.

Notice how simple the switch interfaces are. A pullup resistor ties a port line high until a switch pulls it to ground. Through software, the 68705 senses the change and can then take appropriate action. Note further that the switches needn't provide "clean" make/break operations; the 68705 handles the contact debouncing through software, thus eliminating yet more outboard circuitry!

Another point is that we get double duty out of the switches. Pushing both CLOCK SET and ALARM SET simultaneously toggles the display between 12- and 24-hour modes.

The remaining two slide switches are easy to fathom. The user specifies whether hours and minutes or minutes and seconds should be displayed, according to the position of S5. The minutes-and-seconds display is useful for timing household events. In addition, switch S6 enables and disables the alarm.

That wraps up the hardware side of the digital alarm clock. As you can see, the electronics are quite straightforward (and also, therefore, easy to wire). Since the electronics are so simple, it's reasonable to surmise that quite a lot must be happening in software.

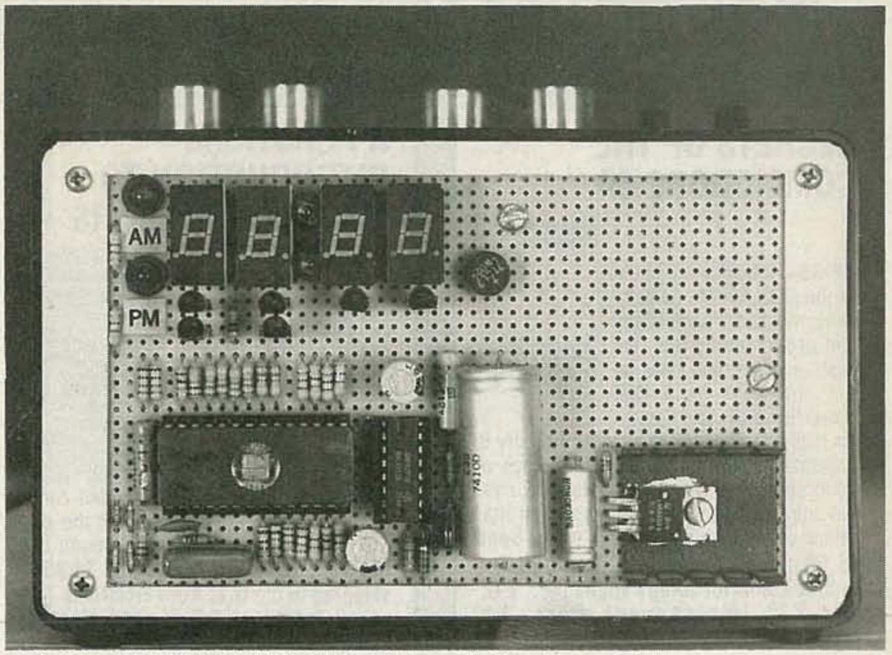


FIG. 2—THE AUTHOR'S PROTOTYPE was built using point-to-point wirewrap techniques.

Inside the software

Unfortunately, we don't have space to print the entire assembly-language listing here. However, the listing is available on the RE-BBS (516-293-2283, modem settings: 300/1200, 8N1). The source code is well annotated, so there is no reason to discuss it here in great detail. However, to simplify reading the code, we will point out some of the main features.

First we define several constants and variables. For example, there are variables (stored in RAM, of course) that keep track of the hours, minutes, seconds, and "jiffies" (1/60th of a second). Other variables keep track of the alarm time; yet others monitor the condition of the various switches.

The code itself begins in an initialization routine (INITIAL) that is called whenever power is applied to the clock. The reset vector (discussed last time) points to this location ($0100). INITIAL has two main functions: initialize all variables and display the message "HELP" while sounding the alarm.

That's a useful feature not found on commercial clocks. For example, imagine you are soundly asleep and that the AC power is interrupted. Most AC-powered digital clocks would be completely disrupted in that type of situation. When the power returned, a typical clock would be in an unknown condition, hence would not sound the wakeup alarm at the correct time. But with our clock, you'll be alerted that something has happened (by the alarm and the "HELP" message), so you can reset your clock and return to sleep.

The routine labeled MAIN (lines 2190–2290) forms the main loop of the program, sequentially checking for switch closures, updating the display, sounding the alarm if necessary, then starting over.

Most of the rest of the code is devoted to the subroutines needed to carry out the I/O activity. For example, the switches are checked by polling the associated I/O ports. When a change is detected, the change is debounced by the software.

Other areas to examine are the subroutines that update the display; those routines call other routines that convert the binary numbers used by the 68705 to binary-coded-decimal (BCD) format. Yet another subroutine converts the BCD number into the segment pattern required by the displays. The segment pattern table is found in lines 4880–5020.

One of the most important routines is the clock update routine (UPDATE, lines 3970–4210), which is driven by the 60-Hz interrupt signal.

Of course there's more to the code than that description, so you'll have to study it carefully to understand what's going on. But doing so is a worthwhile experience, even if you don't plan on building the clock, since you will come away with a real feel for the instruction set of the 68705.

Construction

To build a clock, first gather all the parts. The next step is to burn the program into the 68705's internal EPROM; that process was described in detail in the first installment (**Radio-Electronics,** September 1989), which also included complete details for building an EPROM burner that's good for the 68705.

Then you can build the clock. Because the circuit is so simple, the author built the prototype using wirewrap and point-to-point wiring techniques, as shown in Fig. 2. Note that for educational purposes, some components were mounted on the outside of the box; in fact, only the power transformer and volume control were mounted inside the box.

After connecting everything, check for wiring errors, clipped wires, shorts, and opens. If everything seems OK, apply power. You should see the "HELP" message on the display. Turn S6 on and R30 (VOLUME) to maximum, and you should hear the alarm. If not, remove power and check your work again.

Parts List

Resistors

All resistors are ¼-watt, 5%, unless otherwise noted.

R1–R9	470 ohms
R10–R15	1000 ohms
R16	2700 ohms
R17–R22	4700 ohms
R23, R24	10,000 ohms
R25	15,000 ohms
R26	47,000 ohms
R27	56,000 ohms
R28	68,000 ohms
R29	100,000 ohms
R30	100,000 ohms, audio potentiometer

Capacitors

C1, C2	0.02 µF, disk
C3	0.01 µF, disk
C4	0.1 µF, disk
C5	0.22 µF, disk
C6, C7	1 µF, 15 volts, electrolytic
C8	39 µF, 15 volts, electrolytic
C9, C10	100 µF, 15 volts, electrolytic
C11	1000 µF, 15 volts, electrolytic

Semiconductors

IC1	68705 microcontroller
IC2	SN94281 sound generator
IC3	7805 5-volt regulator
BR1	50 volt bridge rectifier
D1	not used
D2–D4	1N4148 switching diode
DISP1–DISP4	4082-7730 common-anode 7-segment display, or equivalent
LED1, LED3, LED4	red light-emitting diode
LED2	green light emitting diode
Q1–Q6	2N3906 PNP switching transistor

Other components

SPKR1	8 ohms
S1–S4	SPST pushbutton
S5, S6	SPST slide or toggle
T1	6.3 volts

Other ideas

Now that you've gotten your feet wet with the 68705, you might want to consider other projects that can exploit its power. Here are a few suggestions.

Astronomers use a clock that keeps track of "sidereal time," which is related to the apparent motion of the stars, rather than the sun. A sidereal day is 23 hours, 56 minutes and 4 seconds long. Can you modify the clock as presented to keep track of sidereal time?

Another astronomical application is telescope control. A telescope mounting has two axes; can you figure out a way for servo motors to control the rotation of those axes under control of the 68705?

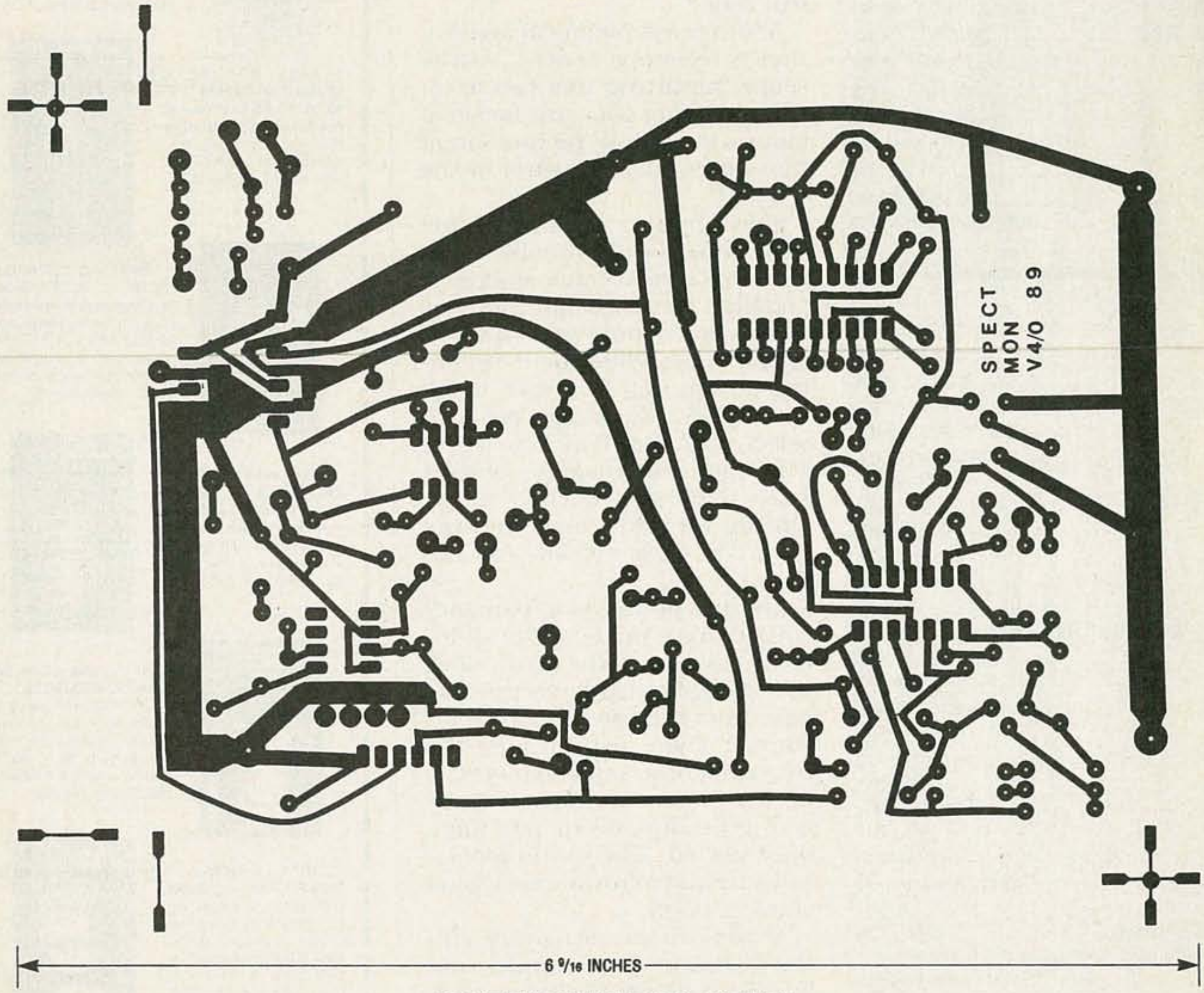
How about a programmable light show? With suitable opto-isolators (for electrical safety) and high-current semiconductor relays, that should be a straightforward task. What about designing a scanning keyboard using the 68705? By using Port A to select rows and Port B to select columns, you would be able to scan a 64-key keyboard. By adding an additional I/O line from Port C, you could scan 128 keys.

Another project is a frequency counter. You could use the multiplexed display in the alarm clock as is, and likewise derive the time base from the power-supply's AC source. Then, determining the frequency of an input signal is no harder than counting how many zero crossings occur per time-base period. The alarm clock's software and hardware are a good starting point.

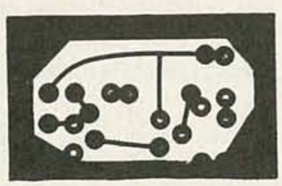
As you can see, designing with the 68705 is quite simple—and fun! So consider designing your next project around the 68705 and reap the rewards of the microcomputer revolution! CD

"Yeah, it makes mistakes like any other, but it's got a built-in excuse-making circuit!"

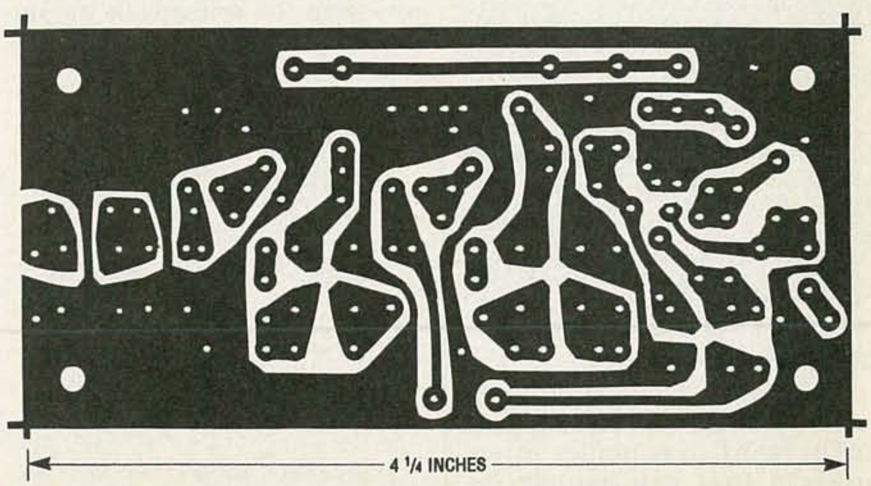
PC SERVICE



SPECTRUM MONITOR FOIL PATTERN.



A/B TRANSMITTER.



SHORTWAVE CONVERTER FOIL PATTERN.

MARKET CENTER

FOR SALE

PHOTOFACT folders, under #1400 $4.00. Others $6.00. Postpaid. **LOEB,** 414 Chestnut Lane, East Meadow, NY 11554.

GREAT buys! Surplus prices, ICs, linears, transformers, PS, stepping motors, vacuum pump, phototransistor, meters, LSASE, **FERTIK'S,** 5400 Ella, Phila., PA 19120.

DESCRAMBLERS. All brands. Special: Combo Jerrold 400 and SB3 $165. Complete cable descrambler kit $39. Complete satellite descrambler kit $45.00. Free catalog. **MJM INDUSTRY,** Box 531, Bronx, NY 10461-0531.

T.V. tunable notch filters. Free brochure. **D.K. VIDEO,** Box 63/6025, Margate, FL 33063. (305) 752-9202.

CABLE descrambler liquidation. Major makes and models available. Industry pricing! (Example: Hamlin Combo's, $44 each...minimum 10 orders). **Dealers only!** Call **WEST COAST ELECTRONICS,** (818) 709-1758.

CABLE-TV AT ITS BEST

DEALER DISCOUNT ON <5> UNITS

SCIENTIFIC ATLANTA:
Models 8500-8550-8580 ... $275.00
SA-3 [Add-On Descrambler] .. $ 99.00
JERROLD:
SB-3 [Inband Gated Sync] ... $ 74.00
TRI-BI [Trimode/Bistate] ..... $ 95.00
OAK:
M-35B [Combo W/Vari-sync] .. $ 99.00
N-12 [Add-On W/Vari-sync] ... $ 89.00
HAMLIN:
MLD-1200 [Add-On] .... $ 89.00
ZENITH: [Z-TAC Descrambler] . $169.00
CONVERTERS: [80-Channels] . $ 95.00

DISTRIBUTOR DISCOUNT ON <10> UNITS

N.A.S. INTERNATIONAL
LONG BEACH, CA (213) 631-3552

SURPLUS ELECTRONICS. New giant wholesale catalog. Hundreds of amazing bargains. $2. Box 840, Champlain, NY 12919.

SOLAR electric systems. Discount prices. **SUN POWER-TEXAS,** PO Box 2788A-R, Freeport, TX 77541. (409) 233-8350.

TUBES: "oldest," "latest." Parts and schematics. SASE for lists. **STEINMETZ,** 7519 Maplewood Ave., RE, Hammond, IN 46324.

CABLE converters and descramblers. Call or write for free catalog. Includes Jerrold, Oak, Zenith, Hamlin, Scientific Atlanta, many more. **NU-TEK ELECTRONICS,** 5114 Balcones Woods Dr. #307, Suite 298, Austin, TX 78759-5212. (512) 250-5031.

CB RADIO OWNERS!

We specialize in a wide variety of technical information, parts and services for CB radios. 10-Meter and FM conversion kits, repair books, plans, high-performance accessories. Thousands of satisfied customer since 1976! Catalog $2.

CBC INTERNATIONAL
P.O. BOX 31500RE, PHOENIX, AZ 85046

CABLE TV descramblers, Jerrold, Scientific Atlanta, Zenith, most major brands. Dealer inquiries welcome. Visa-M/C accepted. **E & O VIDEO,** 9691 E. 265th Street, Elko, MN 55020. **1 (800) 638-6898.**

STEPPER motor drive & control with **Commodore 64.** Affordable hardware, interface, & software. Send for detailed literature & prices to: **MASE,** R.D. #2 Box 166, Mohrsville, PA 19541.

RENTAL movie stabilizer. Connect between **VCRs** or to monitor. Satisfaction guaranteed. $69.95, $4.00 handling. **1 (800) 367-7909.**

FEB 87 Triparts $59.00. Feb 84 SB parts $49.00. $3.50 shipping. **OCTE,** Box 276, Alburg, VT 05440. (514) 739-9328.

CLASSIFIED AD ORDER FORM

To run your own classified ad, put one word on each of the lines below and send this form along with your check to:

Radio-Electronics Classified Ads, 500-B Bi-County Boulevard, Farmingdale, NY 11735

PLEASE INDICATE in which category of classified advertising you wish your ad to appear. For special headings, there is a surcharge of **$25.00.**

( ) Plans/Kits ( ) Business Opportunities ( ) For Sale
( ) Education/Instruction ( ) Wanted ( ) Satellite Television
( ) ____________________

Special Category: $25.00

PLEASE PRINT EACH WORD SEPARATELY, IN BLOCK LETTERS.
(No refunds or credits for typesetting errors can be made unless you clearly print or type your copy.) Rates indicated are for standard style classified ads only. See below for additional charges for special ads. **Minimum: 15 words.**

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15 ($46.50)
16 ($49.60)	17 ($52.70)	18 ($55.80)	19 ($58.90)	20 ($62.00)
21 ($65.10)	22 ($68.20)	23 ($71.30)	24 ($74.40)	25 ($77.50)
26 ($80.60)	27 ($83.70)	28 ($86.80)	29 ($89.90)	30 ($93.00)
31 ($96.10)	32 ($99.20)	33 ($102.30)	34 ($105.40)	35 ($108.50)

We accept MasterCard and Visa for payment of orders. If you wish to use your credit card to pay for your ad fill in the following additional information (Sorry, no telephone orders can be accepted.):

Card Number ____________________ Expiration Date ____________________

Please Print Name ____________________ / Signature ____________________

IF YOU USE A BOX NUMBER YOU MUST INCLUDE YOUR PERMANENT ADDRESS AND PHONE NUMBER FOR OUR FILES. ADS SUBMITTED WITHOUT THIS INFORMATION WILL NOT BE ACCEPTED.

CLASSIFIED COMMERCIAL RATE: (for firms or individuals offering commercial products or services) $3.10 per word prepaid (no charge for zip code)...**MINIMUM 15 WORDS.** 5% discount for same ad in 6 issues; 10% discount for same ad in 12 issues within one year; if prepaid. **NON-COMMERCIAL RATE:** (for individuals who want to buy or sell a personal item) $2.50 per word, prepaid....no minimum. **ONLY FIRST WORD AND NAME** set in bold caps at no extra charge. Additional bold face (not available as all caps) **55¢ per word additional.** Entire ad in boldface, $3.70 per word. **TINT SCREEN BEHIND ENTIRE AD: $3.85 per word. TINT SCREEN BEHIND ENTIRE AD PLUS ALL BOLD FACE AD:** $4.50 per word. **EXPANDED TYPE AD: $4.70 per word prepaid.** Entire ad in boldface, $5.60 per word. **TINT SCREEN BEHIND ENTIRE EXPANDED TYPE AD:** $5.90 per word. **TINT SCREEN BEHIND ENTIRE EXPANDED TYPE AD PLUS ALL BOLD FACE AD:** $6.80 per word. **DISPLAY ADS:** 1" × 2¼"—$385.00; 2" × 2¼"—$770.00; 3" × 2¼"—$1155.00. **General Information:** Frequency rates and prepayment discounts are available. **ALL COPY SUBJECT TO PUBLISHERS APPROVAL. ADVERTISEMENTS USING P.O. BOX ADDRESS WILL NOT BE ACCEPTED UNTIL ADVERTISER SUPPLIES PUBLISHER WITH PERMANENT ADDRESS AND PHONE NUMBER.** Copy to be in our hands on the 10th of the third month preceding the date of the issue. (i.e., Aug. issue copy must be received by May 10th). When normal closing date falls on Saturday, Sunday or Holiday, issue closes on preceding working day. Send for the classified brochure.

AMAZING
SCIENTIFIC & ELECTRONIC PRODUCTS

PLANS
Build Yourself — All Parts Available in Stock

- **LC7**— BURNING CUTTING CO_2 LASER $20.00
- **RUB4**— PORTABLE LASER RAY PISTOL $20.00
- **TCC7**— 3 SEPARATE TESLA COIL PLANS TO 1.5 MEV $25.00
- **IOG2**— ION RAY GUN $10.00
- **GRA1**— GRAVITY GENERATOR $10.00
- **EML1**— ELECTRO MAGNET COIL GUN/LAUNCHER $8.00

KITS
With All Necessary Plans

- **MFT3K**— FM VOICE TRANSMITTER 3 MI RANGE $49.50
- **VWPM7K**— TELEPHONE TRANSMITTER 3 MI RANGE $39.50
- **BTC3K**— 250,000 VOLT 10-14" SPARK TESLA COIL $249.50
- **LHC2K**— SIMULATED MULTICOLOR LASER $44.50
- **BLS1K**— 100.000 WATT BLASTER DEFENSE DEVICE $69.50
- **NIG7K**—NEGATIVE ION GENERATOR KIT $34.50
- **PSP4K**— TIME VARIANT SHOCK WAVE PISTOL $59.50
- **STA1K**— ALL NEW SPACE AGE ACTIVE PLASMA SABER $59.50
- **SD5K**—SEE IN DARK VIEWER KIT $199.50
- **PG5K**—PLASMA LIGHTNING GLOBE KIT $49.50

ASSEMBLED
With All Necessary Instructions

- **BTC10**— 50,000 VOLT-WORLD'S SMALLEST TESLA COIL $54.50
- **LGU40**— 1MW HeNe VISIBLE RED LASER GUN $249.50
- **TAT30**— AUTO TELEPHONE RECORDING DEVICE $24.50
- **ITM10**—100,000 VOLT 20' AFFECTIVE RANGE INTIMIDATOR $99.50
- **LIST10**— SNOOPER PHONE INFINITY TRANSMITTER $169.50
- **IPG70**— INVISIBLE PAIN FIELD GENERATOR MUTLI MODE $74.50

• **CATALOG** CONTAINING DESCRIPTIONS OF ABOVE PLUS HUNDREDS MORE AVAILABLE FOR $1.00 OR USE OUR PHONE FOR "ORDERS ONLY" 603-673-4730.

PLEASE INCLUDE $3.00 PH ON ALL KITS AND PRODUCTS PLANS ARE POSTAGE PAID. SEND CHECK, MO, VISA, MC IN US FUNDS.

INFORMATION UNLIMITED
P.O. BOX 716 DEPT. RE AMHERST, NH 03031

CABLE TV converters bargain headquarters: Zenith, Tocom, Scientific Atlanta, Hamlin. Jerrold 400-DRX3DIC w/remote $135, Oak M35B $60.00. Quantity discount. Visa-M/C-COD. Order yours today. **1 (800) 327-8544.**

TOCOM 5503VIP. "Turnon" module for descrambler. All channels; modes. $36.00. **MIKE,** Box 2837, Champaign, IL 61825-2837. COD's.

CABLE TV converters and descramblers. We sell only the best. Low prices. SB-3 $79.00. We ship C.O.D. Free catalog. ACE PRODUCTS, PO Box 582, Dept. E, Saco, ME 04072. (207) 967-0726.

FREE CATALOG

FAMOUS "FIRESTIK" BRAND CB ANTENNAS AND ACCESSORIES. QUALITY PRODUCTS FOR THE SERIOUS CB'er. SINCE 1962

FIRESTIK ANTENNA COMPANY
2614 EAST ADAMS
PHOENIX, ARIZONA 85034

LASER Listener II, other projects. Surveillance, descrambling, false identification, information. Plans, kits, other strange stuff. Informational package $3.00 refundable. **DIRIJO/BOND ELECTRONICS,** Box 212, Lowell, NC 28098.

ENGINEERING software, PC/MSDOS. Hobbyists — students — engineers. Circuit design, FFT analysis, mathematics, logic simulation, circuit analysis. Free catalog, (614) 491-0832, **BSOFT SOFTWARE,** 444 Colton Rd., Columbus, OH 43207.

Quality Microwave TV Antennas

Multi-Channel 1.9 to 2.7 GHz. 40dB Gain
30-Channel System complete $149.95
12-Channel System complete $104.95
2-Channel System complete $79.95

Phillips-Tech Electronics
P.O. Box 8533 • Scottsdale, AZ 85252
(602) 947-7700 (**$3.00 Credit all phone orders!**)
LIFETIME WARRANTY **MasterCard • Visa • COD's** Quantity Pricing

RESTRICTED technical information: Electronic surveillance, schematics, locksmithing, covert sciences, hacking, etc. **Huge selection. Free brochures. MENTOR-Z,** Drawer 1549, Asbury Park, NJ 07712.

CABLE TV descramblers M35B tested, Varisync available $39.00. Rolex President look-alike exact replica, goldtone, quartz movement, mens or womens $39.00. (818) 982-8931.

FREE power supply, connectors ($8.95 value) with **TV project assortment** #**103** (February 1984 G. Sync article) contains **PCB TOKO coils, transistors (BFQ85), IC's, diodes, article reprint.** $25.00. Five/$112.50. **Assortment #104 contains all other parts** $10.00. Shipping $3.00. **MC/Visa, COD accepted. JIM RHODES, INC.,** PO Box 3421, Bristol, TN 37625.

TUBES - 2000 TYPES
DISCOUNT PRICES!

Early, hard-to-find, and modern tubes. Also transformers, capacitors and parts for tube equipment. *Send $2.00 for 24 page wholesale catalog.*

ANTIQUE ELECTRONIC SUPPLY
688 W. First St. • Tempe, AZ 85281 • 602/894-9503

$35 A Year Membership Fee. Is It Absurd? Or Is It Smart?

Facts are that while most other Mail Order Companies will be more than happy to sell to anyone and start sending them (or the Current Resident) their Catalog several times a year, we at Electronic Buyers Club ask for a $35 a year Membership Fee. But since 1981, thousands of individuals, companies, schools and colleges and independent retailers have paid the Membership Fee annually which indicates that the idea is not as absurd as it sounds. In return, these people have received a Catalog that is in fact a three-ring binder, weighing more than 9 pounds, with hundreds of pages of pricing and Original Manufacturers' Catalogs not to mention the same day service at no additional charge and Toll Free WATS lines for customer service and ordering. But the most important reason of all is that they are saving from 20% to more than 70% when buying any of the more than 10,000 items that we stock. You see, by not sending catalogs to several hundreds of thousands of people every other month, and by not having to sell our company every month in multi-page advertisements in several magazines, we save a lot of money and that is how we can sell everything for less. We may not be the right choice for everyone, but if you buy $300 or more worth of electronic components a year, we definitely are what you have been looking for. Our double guarantee of saving and satisfaction protects you fully and you have nothing to lose but the high price blues.

12 Months Saving Guarantee
We will refund the first year Membership Fee of any member who has purchased $300 or more worth of products from Electronic Buyers Club and has not saved an amount greater than the first year Membership Fee, if buying the same items elsewhere.

30 Days Money Back Guarantee
We will refund the full Membership Fee of any new member of Electronic Buyers Club who within 30 Days after receiving the Membership Binder, returns the Binder to EBC and asks for the cancellation of Membership.

Electronic Buyers Club
A Division of International Components Corporation

1803 N.W. Lincoln Way • Toledo, OR 97391

PHONE (All 50 States & Canada): 1-800-325-0101

FAX: (503) 336-4400 • Hours: 6:00 AM - 6:00 PM PST

MasterCard VISA

CIRCLE 183 ON FREE INFORMATION CARD

MICROWAVE TV RECEIVERS 1.9 to 2.7 GHz

2 CH Compact Dish System - $77.95
5 CH Dish System - $93.95
12 CH Yagi (Rod) System - $123.95
30 CH Dish System-$163.90 Yagi-$183.90

SUN MICROWAVE INT'L, INC.
P.O. BOX 34522
PHOENIX, AZ 85067
(602) 230-0640

Send $1⁰⁰ for catalog on these and other fine video products.

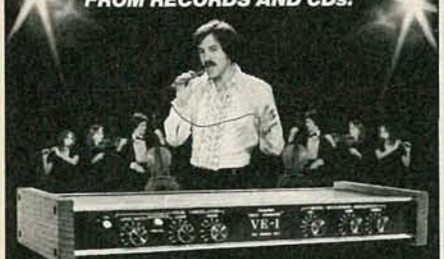
VISA/MC/COD **QUANTITY DISCOUNTS** **LIFETIME WARRANTY**

SOUTHWESTERN Bell home, business phone porducts. Wholesale dealer pricing to all. Cordless phone battery, antennas, more. $5.00 refundable, for dealer catalog. **RADD,** 104 S. Broadway, Peru, IN 46970.

PARTS for RE projects. Low prices, no minimum. Inductors, transformers, diodes, semiconductors, chokes, capacitors, ferrites, etc. Catalog $1.00 (refunded first order). **JS PRODUCTS,** Box 160113, Cupertino, CA 95016.

CABLE descramblers at wholesale prices — Oak-RTC-56 W/R $175.00, super TRI-BI $89.00, super SA-3 $89.00, Pioneer W/R $225.00, Z-TAC W/R $225.00, Hamlin MLD 1200 2/3 10 for $450.00, Tocom W/R $199.00, Jerrold 400 W/R $129.00, complete line of converters. **S.A.C.,** (702) 647-3799.

SINGERS!
REMOVE VOCALS FROM RECORDS AND CDs!



SING WITH THE WORLD'S BEST BANDS!

An Unlimited supply of Backgrounds from standard stereo records! Record with your voice or perform live with the backgrounds. Used in Professional Performance yet connects easily to a home component stereo. This unique product is manufactured and sold Exclusively by LT Sound - Not sold through dealers. Call or write for a Free Brochure and Demo Record.

LT Sound, Dept. R L-3, 7980 LT Parkway
Lithonia, GA 30058 (404) 482-4724
Manufactured and Sold Exclusively by LT Sound
24 HOUR PHONE DEMO LINE: (404)482-2485

TEST equipment pre-owned now at affordable prices. Signal generators from $50.00. Oscilloscopes from $50.00. Other equipment, including manuals available. Send for Catalog. **J.B. ELECTRONICS,** 3446 Dempster, Skokie, IL 60076. (312) 982-1973.

CAPACITOR cabinet — 150 quality radial electrolytic capacitors. 15 values, 0.47 μF-2200 μF, in labeled drawers. $29.95 + $3.00 shipping. Money back quarantee. **ZANEN ELECTRONICS,** (806) 793-6337, 2718A 44th, Lubbock, TX 79413.

CABLE boxes in 5 and 10 lots. Jerrold 400 W/R $600.00 — $1,100.00, Super TRI BI $425.00 — $800.00, Oak RTC 56 W/R $875.00 — $1,600.00, Pioneer W/R $1,050.00 — $2,000.00, Tocom W/R $975.00 — $1,800.00, MLD 1200 ⅔ 10 for $450.00, super SA3 $425.00 — $800.00. COD ok. **G.D. ELECTRONICS.** (602) 829-9441.

PC-ECAP, AC circuit analysis software for the IBM-PC, will calculate and display the frequency and phase response of your circuits. Very easy to use. Completely menu driven. Supports CGA, EGA, and Hercules graphics. High resolution plots on IBM/Epson printers. $99.50 To order or for info, write **CIRCUIT SYSTEMS,** 418 Church Road, Sicklerville, NJ 08081.

IF you want some of the best prices on converters, descramblers, call **(313) 979-8356.** We have Jerrold, Starbase, Tri Mode, Scientific Atlantic, Hamlin, Zenith, some Oak, Pioneer, filters for beeping channels, also other equipment from time to time. New volume control converters.

CABLE-TV

BONANZA!

ITEM	1 UNIT	10 OR MORE
HAMLIN MCC 3000 36 CORDED REMOTE CONVERTER (Ch. 3 only)	29 00	18 00
PANASONIC WIRELESS CONVERTER (our best buy)	98 00	79 00
STAR GATE 2000	88 00	69 00
*JERROLD 400 COMBO	169 00	119 00
JERROLD 400 HAND REMOTE CONTROL	29 00	18 00
*JERROLD 450 COMBO	199 00	139 00
*JERROLD 450 HAND REMOTE CONTROL	29 00	18 00
JERROLD SB-ADD-ON	99 00	63 00
*JERROLD SB-ADD-ON WITH TRIMODE	109 00	75 00
*M-35 B COMBO UNIT (Ch. 3 output only)	99 00	70 00
*M-35 B COMBO UNIT WITH VARISYNC	109 00	75 00
*MINICODE (N-12)	99 00	62 00
*MINICODE (N-12) WITH VARISYNC	109 00	65 00
*MINICODE VARISYNC WITH AUTO ON-OFF	145 00	105 00
ECONOCODE (minicode substitute)	69 00	42 00
ECONOCODE WITH VARISYNC	79 00	46 00
*MLD-1200-3 (Ch. 3 output)	99 00	62 00
*MLD-1200-2 (Ch. 2 output)	99 00	62 00
*ZENITH SSAVI CABLE READY	175 00	125 00
INTERFERENCE FILTERS (Ch. 3 only)	24 00	14 00
*EAGLE PD-3 DESCRAMBLER (Ch. 3 output only)	119 00	65 00
*SCIENTIFIC ATLANTA ADD-ON REPLACEMENT DESCRAMBLER	119 00	85 00

***CALL FOR AVAILABILITY**

Quantity	Item	Output Channel	Price Each	TOTAL PRICE

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.

SUBTOTAL	
Shipping Add $3.00 per unit	
COD & Credit Cards — Add 5%	
TOTAL	

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. **FEDERAL AND VARIOUS STATE LAWS PROVIDE FOR SUBSTANTIAL CRIMINAL AND CIVIL PENALTIES FOR UNAUTHORIZED USE.**

Dated: ______________ Signed: ______________________________

Pacific Cable Company, Inc.

7325½ RESEDA BLVD., DEPT. # R-10 • 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*

AMIGA Commodore chips. Amiga-Paula $56.95, 6526 $12.95 and many others. New updated version The Commodore Diagnostician II for fixing all Commodore computers, $6.95 postpaid. Heavy duty power supply $22.50. Exclusive parts/free catalog MC/VISA. **Grapevine Group** Inc., 35 Charlotte Drive, Wesley Hills, NY 10977. 1 (800) 292-7445.

PLANS AND KITS

FM stereo transmitter. Transmit your VCR/CD/Walkman to any FM stereo radio. One chip does it all! Free schematic and info. Send a self addressed/stamped envelope to: **DJ INC.,** 847A Second Ave., Suite 113, New York, NY 10017.

DESCRAMBLING, new secret manual. Build your own descramblers for **cable and subscription TV.** Instructions, schematics, for SSAVI, gated sync, sinewave, (HBO, Cinemax, Showtime, UHF, Adult) $8.95, $2 postage. **CABLETRONICS,** Box 30502R, Bethesda, MD 20814.

CB tricks booklet. Modifications, tune-ups, channel expansion, clarifier tricks. Send $19.95 to **MEDICINE MAN CB,** PO Box 37, Clarksville, AR 72830.

FM transmitter 88 to 108 MHZ kit $12.95. **SIERRA ELECTRONICS,** Box 709, Elfers, FL 34680-0709.

ELECTRONIC kits! Transmitters! Recorders! Phone devices! Bug detectors! Surveillance items! More! Catalog $1.00: **XANDI ELECTRONICS,** Box 25647, 60V, Tempe, AZ 85285-5647.

PRINTED circuit boards etched & drilled. Free delivery. **K & F ELECTRONICS, INC.,** 33041 Groesbeck, Fraser, MI 48026. (313) 294-8720.

RADIO astronomy! Monthly magazine, books, components. $3.00 brings sample package. **BOB'S ELECTRONIC SERVICE,** 7605 Deland, Ft. Pierce, FL 34951.

CATALOG: hobby/broadcasting/HAM/CB: Cable TV, transmitters, amplifiers, surveillance devices, computers, **more! PANAXIS,** Box 130-F10, Paradise, CA 95967.

INVESTIGATORS, experimenters — Quality new plans. Hard to find micro and restricted devices. Free catalog. Self addressed stamped envelope to **KELLEY SECURITY INC.,** Suite 90, 2531 Sawtelle Blvd., Los Angeles, CA 90064.

CB Tricks II book. Power amplifier design and theory, UHF CB tune ups. Send $19.95 **MEDICINE MAN CB,** PO Box 37, Clarksville, AR 72830.

SURVEILLANCE equipment design gives 58 schematics of Sheffield Electronics' surveillance devices. Circuits explained. Transmitters range from pens to one-mile VOX's including crystal, subcarrier, carrier current, infrared, firefly, automobile. Demodulators given. Cube tap and duplex mains powered transmitters presented. Eighteen telephone transmitters are leech and battery types including crystal and subcarrier. Countermeasures chapter. Much more. This 8 1/2 x 11 inch 110-page book is illustrated with photographs. Price $30.00 + $4.00 S & H. First class mail U.S. & Canada. Overseas Airmail S & H $9.00. One-day processing, pay with Money Order or Cashier's Check. Send to: **WINSTON ARRINGTON,** 7223 Stony Island Ave., Chicago, IL 60649-2806.

BUILD your own modems 300-2400 bps Hayes compatible, theory, manual, schematics $11.95. **PARKER ELECTRONICS,** 763 Rabun Lane, Rock Hill, SC 29730.

FIBER optic kits, also robotics. Call for free catalog. **TECHNOLOGY SALES,** (201) 735-0943, Box 29, RR-3, Pittstown, NJ 08867.

KIT catalog — Automotive, Audio, Phone, Sports, Surveillance, Test. Catalog $1.00. **BALLco,** PO Box 1078, Snellville, GA 30278-1078.

SATELLITE TV

CABLE TV secrets — the outlaw publication the cable companies tried to ban. HBO, Movie Channel, Showtime, descramblers, converters, etc. Supplier's list included $8.95. **CABLE FACTS,** Box 711-R, Pataskala, OH 43062.

VIDEOCYPHER II descrambling manual, schematics, video and audio. Explains DES, EPROM, CloneMaster, 3Musketeer. Pay-per-view (HBO, Cinemax, Showtime, adult, etc.) $13.95, $2 postage. **CABLETRONICS,** Box 30502R, Bethesda, MD 20814.

FREE catalog systems, Upgrades, Houston, Uniden, Chaparral, etc. **Save $$$$$. SKYVISION,** 2009 Collegeway, Fergus Falls, MN 56537. 1 (800) 334-6455.

DESCRAMBLER: Build our low cost **video only,** satellite TV descrambler for most satellite channels. Uses easy to get, everyday parts. Boards & plans $35.00 US funds. Board, plans & parts $99.00 US funds. Wired & tested unit $189.00 US funds. Send check, money order or Visa to: **VALLEY MICROWAVE ELECTRONICS,** Bear River, Nova Scotia, Canada B0S 1B0 or phone (902) 467-3577. 8am to 4pm eastern time. Note: educational project only. Not to be used illegally.

★★★★★PRESENTING★★★★★

CABLE TV DESCRAMBLERS

★★★★★ STARRING ★★★★★

JERROLD, HAMLIN, OAK

AND OTHER FAMOUS MANUFACTURERS

- FINEST WARRANTY PROGRAM AVAILABLE
- LOWEST RETAIL/WHOLESALE PRICES IN U.S.
- ORDERS SHIPPED FROM STOCK WITHIN 24 HOURS

FOR FREE CATALOG ONLY **1-800-345-8927**

FOR ALL INFORMATION 1-818-716-5914

PACIFIC CABLE CO. INC.
7325½ RESEDA BLVD., DEPT. RE1 89
RESEDA, CA 91335

DESCRAMBLER MODULE

LATEST technology alternative to Jerrold SB-3 or Radio-Electronics Feb. 1984 project. Featuring electronic tuning, AGC, auto-on/off, AC/DC power, mini-size, A&T, and more. For literature — **SOUTH-TECH DISTRIBUTING,** (813) 527-2190.

ATTENTION CABLE BROKERS

SURPLUS CATV converters and descramblers at wholesale prices. Unmodified units only. Oak M35B $30. **(415) 337-8301.**

INVENTORS

INVENTORS! Can you patent and profit from your idea? Call **AMERICAN INVENTORS CORPORATION** for free information. Over a decade of service 1 (800) 338-5656. In Massachusetts or Canada call (413) 568-3753.

NUTS & VOLTS MAGAZINE
P.O. Box 1111-E
Placentia, CA 92670
714-632-7721

GIVE YOURSELF A BREAK — A PRICE BREAK! NUTS & VOLTS WILL *Save* YOU MONEY ON ELECTRONIC PARTS & EQUIPMENT *Plus* SHOW YOU WHERE TO FIND UNIQUE, UNUSUAL AND HARD-TO-FIND ITEMS.

SUBSCRIBE TODAY!

Subscription Rates (U.S. FUNDS REQUIRED)	
3rd Class Mail - USA	
One Year	$12.00
Two Years	$21.00
Lifetime	$60.00
1st Class Mail	
One Year USA	$20.00
Canada/Mexico	$22.00
Air Mail	
Foreign 1 Yr	$55.00

A National Publication For The Buying And Selling Of Electronic Equipment

WANTED

SEISMOMETER wanted to measure earthquakes. Pay cash. **D. HUTCHISON,** 4000 Little Timber, Edmond, OK 73034. (405) 341-9615.

INVENTIONS/new products/ideas wanted: Call **TLCI** for free information 1 (800) 468-7200 24 hours/day - USA/Canada.

NEW HE NE LASER TUBES $35

Dealer Inquiries Invited.
Free Catalog!

MEREDITH INSTRUMENTS: 6403 N. 59th Ave.
Glendale, AZ 85301 • (602) 934-9387
"The Source for Laser Surplus"

COMPUTER BOOKS

DISCOUNT computer books. All titles available, including recent releases. Please call or write for our latest catalog. **BOOKWARE,** 147 Campville Road, Northfield, CT 06778. 1 (800) 288-5662.

CABLE TV DESCRAMBLERS

		10 Lot
JERROLD™ Tri-Bi Mode.	$105.00	$85.00
JERROLD™ SB-3 OR 2	$89.00	$65.00
Hamlin MLD-1200.......	$99.95	$62.00
Oak N-12 W/V.S..........	$99.95	$62.00
Oak-M-35-B W/V.S......	$99.00	$78.00
OAK E-13................	$99.95	$58.00
Zenith SSAVI............	$185.00	$145.00
Eagle PD-3...............	$120.00	$85.00
Scientific Atlanta..........	$129.95	$105.00
SA-Combo's.............	CALL	$Call
Tocom....................	$350.00	$295.00
Oak N-12 W/ Auto.......	$140.00	$105.00
Jerrold Starcom CSV....	$139.95	Call

M.D. ELECTRONICS WILL MATCH ANY ADVERTISED PRICE IN THIS MAGAZINE

*NEW STARGATE 2000 CABLE CONVERTER

1-$89.00 10-$69.00 100-Call

Last channel recall-Favorite channel select-75 channel-Channel scan-Manual fine tune-One year warranty-surge protection-HRC & Standard switchable- and much more. Call Today!

INFORMATION(402)554-0417

Orders Call Toll Free
1-800-624-1150

M.D. ELECTRONICS
115 NEW YORK MALL
SUITE 133E
OMAHA, NE. 68114

M.C.
VISA
C.O.D.

CIRCLE 53 ON FREE INFORMATION CARD

MARK V ELECTRONIC KITS MAKE YOUR PROJECTS A COMPLETE SATISFACTION

▲ indicates the level of difficulty in the assembling of our Products. ▲ Beginner ▲▲ Intermediate ▲▲▲ Advanced ★ Fully Assembled

PROFESSIONAL COLOR LIGHT CONTROLLER SM-328 ★

Assembled & tested **$150.00**

The SM-328 professional color light controller is keyboard programmable for ease of use, it allows full control of intensity and flash rate. It has four separate channels with capacity of 1170 watts per channel. Total wattage capability is 4.68 killowatts. This is equivalent to bulbs or 9365-watt colored bulbs and is sufficient for the largest halls and auditoriums. • Independent input signal control • Professional styled control panel • 4 inde pendent outputs • 4 independent dimmer controls • Chaser speed controls • Automatic chaser operation • 4 preset chaser programs • Clockwise chaser control • Anticlockwise chaser control.

SPECIFICATIONS: Input sensitivity (music model): 100mV, (music & program): 2V • Output power: 1170W per channel 4680W total • Power requirement: 105-120V, 60hz • Dimensions: 14.32" wide, 9" high, 3.19" deep.

AMPLIFIERS

MODEL	DESCRIPTION	KIT	ASSEMBLED
TA-001	1W Mini-Amplifier ▲	$ 5.07	
TA-006	6W Mini-Amplifier ▲	6.90	
TA-007	12W Mini-Amplifier ▲	11.20	
TA-10	Stereo Pre-Amp. w/magnetic mic. amp. ▲	8.20	
TA-28MK2	Digital Voice Recorder ▲▲	30.00	$ 40.00
TA-50A/B	Multi-Purpose Melody Generator ▲	11.84	16.58
TA-50C	Multi-Purpose Melody Generator ▲	12.65	17.71
TA-120MK2	Class "A" Main Power Mono Amp. ▲▲	31.25	
TA-300	30W Multi-Purpose Single Channel Amp. ▲	20.00	
TA-302	60W Stereo Power Booster ▲▲★	50.00	70.00
TA-322I	50W + 50W IC Stereo Amp. w/led level display ▲	35.50	
TA-323A	HQ 30W + 30W Stereo Amp. ▲	29.50	
TA-377A	FET Stereo Pre-Amp. ▲▲▲	59.95	75.00
TA-400	40W Solid State Mono Amp. ▲	28.00	
TA-477	120W Mosfet Power Mono Amp. ▲▲	68.00	
TA-800	80W + 80W DC Pre-Main & Power Amp. ▲▲	60.92	
TA-802	80W + 80W DC Stereo Main Power Amp. ▲▲	45.94	
TA-820A	60W + 60W OCL DC Pre-Main Stereo Amp. ▲▲	48.00	
TA-1000A	100W Class "A" Main Power Mono Amp. ▲▲	59.69	80.58
TA-1500	100W x 2 Class"A" DC Stereo Pre-Main Amp. ▲▲▲	73.70	
TA-2400A	Electronic Echo & Revelation Amp. ▲▲▲★	93.30	116.80
TA-2500	HQ Pre-Amp. w/10 band graphic equalizer ★		90.00
TA-2800	Hi-Fi Bi-Fet Pre-Amp. w/3 way tone control ▲▲	48.90	
TA-3000	Stereo Simulator ▲▲	33.20	43.38
TA-3600	300W HQ Hi-Fi Power Mono Amp. ▲▲▲	86.00	110.00

300W HI-FI POWER AMPLIFIER (MONO) TA-3600 ▲▲▲

Assembled & tested **$110.00**

Complete Kit **$86.00** Transformer **$38.00**

10,000 UF 80V E. Cap **$20.00**

The TA-3600 is an extremely high power amplifier specifically designed to reproduce the high dynamic range available on compact discs. It has low noise, high stability, low distortion, extended frequency range and high efficiency in a compact package. Two of these units with appropriate power supply and pre-amplifier are required for stereo reproduction.

SPECIFICATION: Power output: 300 watts sine wave 540 watts music power • Frequency response: Total harmonic distortion: Less than 0.05% • Sensitivity 1Vms at 47K • Power requirements: 60 to 75VDC at 8amp.

MISCELLANEOUS

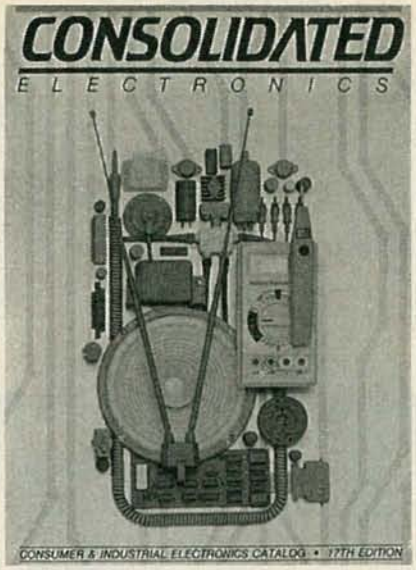
MODEL	DESCRIPTION	KIT	ASSEMBLED
TY-1A	Battery Flourescent Light Driver ▲	$ 5.19	
TY-7	Electronic Touch Switch ▲	7.15	
TY-8	ELectronic Lotto ▲	15.00	
TY-11A	Multi-Functional Control Switch ▲	5.19	
TY-12A	Digital Clock w/timer ▲	16.63	
TY-13	Color Led Audio Level Meter ▲	20.15	
TY-14	Electronic Shock ▲	6.25	
TY-18	High Precision Sound Control Switch ▲	9.22	
TY-20	V Shape Color Led Level Meter ▲▲	21.45	
TY-23B	3 Channel Color Light Controler ▲▲▲★	71.50	$82.50
TY-25	Stereo Loudspeaker Protector ▲	12.65	
TY-35	FM Wireless Microphone ▲	9.22	
TY-36	AC/DC Quartz Digital Clock ▲	18.00	
TY-38	Sound/Touch Control Switch ▲	12.00	
TY-41MK111	Infrared Remote Control Unit ▲▲▲	15.00	25.00
TY-41MKV	Infrared Remote Control Unit ▲▲▲	20.00	35.00
TY-42	Bar/Dot Level Meter ▲▲	24.15	
TY-43	3½ Digital Panel Meter ▲	33.00	46.20
TY-45	20 Steps Bar/Dot Audio Level Display ▲▲	38.45	
TY-47	Superior Electronic Roulette ▲▲	19.46	
SM-222	7 Bands Graphic Equalizer ▲▲▲★	26.80	38.80
SM-328	4 Channel Professional Color Light Controller ★		150.00
SM-333	Audio/Video Surround Sound Processor ▲▲▲★	62.00	83.00
SM-666	Dynamic Noise Reduction △	26.00	34.00
T-1	LCD Thermometer Clock w/in-outdoor sensor ★	22.00	
T-2	LCD Thermometer Clock w/ F & C measurement ★	19.80	
# 8501	Parrot Talking Clock ★	15.50	
# 8504	Mynah Talking Clock ★	15.50	

— WE ACCEPT MAJOR CREDIT CARDS, MONEY ORDERS AND CHECKS — BUSINESS & SHOWROOM HOURS: (PACIFIC TIME) MON. – FRI.: 9:30 A.M. – 5:00 P.M., SAT.: 10:00 A.M. – 5:00 P.M. TERMS: $10.00 MIN. ORDER • $20 MIN. CHARGE CARD ORDER • WE SHIP UPS GROUND • ADD 10% OF TOTAL ORDER (MIN. $3.00) FOR SHIPPING OUTSIDE USA, ADD 20% (MIN. $5.00) • TRANSIT INSURANCE: ADD 5% OF TOTAL (OUTSIDE USA ONLY). CA RESIDENTS ADD SALES TAX • ALL MERCHANDISE SUBJECT TO PRIOR SALE • PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE • WE ARE NOT RESPONSIBLE FOR TYPOGRAPHICAL ERRORS.

INFORMATION: (213) 888-8988. CALL OR WRITE FOR OUR FREE CATALOG • PHONE ORDER: 1-800-423-3483 (IN CALIF.) 1-800-521-MARK FAX: 213-888-6868

MARK V ELECTRONICS, INC. — 8019 E. Slauson Ave., Montebello, CA 90640

CIRCLE 93 ON FREE INFORMATION CARD



THE ULTIMATE ELECTRONICS CATALOG.

Order your 260 page catalogue packed with over 10,000 money saving electronic parts and equipment. Send $3.00 check or money order, or call **1-800-543-3568** today and use your Mastercard or Visa.
Consolidated Electronics, Incorporated
705 Watervliet Ave., Dayton, Ohio 45420-2599

NAME
ADDRESS
CITY
STATE ZIP

CIRCLE 70 ON FREE INFORMATION CARD

EDUCATION & INSTRUCTION

MAGIC! Four illustrated lessons plus inside information shows you how. We provide almost 50 tricks including equipment for four professional effects. You get a binder to keep the materials in, and a one-year membership in the International Performing Magicians with a plastic membership card that has your name gold-embossed. You get a one-year subscription to our quarterly newsletter "IT's MAGIC!" Order now! $29.95 for each course +$3.50 postage and handling. (New York residents add applicable state and local sales tax). **THE MAGIC COURSE,** 500-B BiCounty Boulevard, Farmingdale, NY 11735.

IBM PC. Learn assembly language. Spaceship game. Find princess game. $5 each. Book $18. **ZIPFAST,** Box 12238, Lexington, KY 40581-2238.

CCD Video camera. Learn how imaging IC's work and how to use them to build a low cost video camera. Send $19.95, **VITRONICS,** PO Box 7, Station G, Calgary, Alberta, T3A 2G1.

MAKE $10.00 to $30.00 an hour repairing videogames. Our instructional video tapes show you how. Send $1.00 for list. **VIDEO REPAIR SCHOOL,** PO Box 121, Glen, MS 38846.

MULTI CHANNEL MICROWAVE ANTENNAS
- CRYSTAL CONTROLLED MICROWAVE ANTENNAS FOR OVER THE AIR CABLE SYSTEMS (WIRELESS CABLE)
- CAPABLE OF RECEIVING 30 CHANNELS
- CONVERTERS AVAILABLE FOR ZENITH SYSTEMS

CALL FOR PRICE (203) 622-4386

VIDEO-LINK ENTERPRISES
165 W. PUTNAM AVE. GREENWICH, CT 06830

FOR INVENTORS

INVENTORS! Confused? Need Help? Call **IMPAC** for free information package. In U.S. and Canada: 1 (800) 225-5800.

PC-OSCILLOSCOPE $259

TURN YOUR PC, PC-XT, PC-AT OR COMPATIBLE INTO A POWERFUL 25MHZ DIGITAL STORAGE OSCILLOSCOPE.

SEND $5.00 FOR DEMO PACKAGE OR WRITE FOR FREE INFORMATION

CHASE SCIENTIFIC COMPANY
P.O. BOX 1895, APTOS, CA 95001

INCLUDES:
EXPANSION BOARD
SOFTWARE
MANUAL
PROBES

BUSINESS OPPORTUNITIES

EASY work! Excellent pay! Assemble products at home. Call for information. **(504) 641-8003** Ext. 5192.

MECHANICALLY inclined individuals desiring ownership of small electronics manufacturing business-without investment. Write: **BUSINESS-R,** C.S. 9008, Baldwin, NY 11510-9008.

MAKE $50/hr working evenings or weekends in your own electronics business. Send for free facts. **INDUSTRY,** Box 531, Bronx, NY 10461.

YOUR own radio station! AM, FM, TV, cable. Licensed/unlicensed. **BROADCASTING,** Box 130-F10, Paradise, CA 95967.

INVENTIONS, ideas, technology wanted for presentation to industry/exhibition at national innovation exposition. Call **1 (800) 288-IDEA.**

ASSEMBLE digital dashboards. Details $2.00. **MODERN LABS,** Digidash Division, 2900 Ruisseau, Saint-Elizabeth, Quebec, J0K 2J0, Canada.

DIGITAL CAR DASHBOARDS

BUILD yourself complete electronic dashboards. Informational package: $2.00 (rufundable). **MODERN LABS,** 2900-F Ruisseau, Saint-Elizabeth, QC, J0K 2J0, Canada.

Parts Express International Inc.

EMINENCE · THRUSTER by EMINENCE · MOTOROLA · Polydax · PIONEER

1-800-338-0531

3-WAY 100W CROSSOVER

12 dB/octave rolloff. 800Hz, 5000Hz crossover points. 8 ohm. 100 watts RMS.

#260-210 — $12.50 (1-9) — **$9.95** (10-up)

SPEAKER CONTROL PANEL

Panel with 50 watt L-pads for tweeter and midrange and built-in LED power meter. 5"x 2 1/2" **100 watt version available**

#260-235 — $14.50 (1-5) — **$12.90** (6-up)

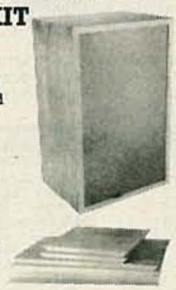
12" POLY WOOFER

Super duty, 40 oz. magnet. 100 watts RMS, 145 watts max. 4 and 8 ohm compatible (6 ohm). 2" voice coil. fs = 25 Hz. QTS = .166, VAS = 10.8 cu ft. Response: 25-1500 Hz. Net weight: 9 lbs. Pioneer #A30GU40-51D

#290-125 — $36.80 (1-3) — **$34.50** (4-up)

WALNUT SPEAKER CABINET KIT

Super quality, genuine walnut veneer cabinet. Kit includes: routed and mitred top, sides, and bottom in unfinished 3/4" walnut veneer. Cut your own custom holes in the front and rear to match your drivers. 15" x 24" x 11". Volume: 1.9 cubic feet.



#260-350 — $22.50 (1-3) — **$19.95** (4-up)

PIONEER HORN TWEETER

Mylar dome. 2.93 oz. barium ferrite magnet. 8 ohm. Response: 1800-20000 Hz. 35W RMS, 50W max. fs = 2000 Hz, SPL = 106 dB. Pioneer #AHE60-51F

#270-050 — $6.50 (1-9) — **$5.90** (10-up)

12" SUB WOOFER

Dual voice coil sub woofer. 30 oz. magnet, 2" voice coils. 100 watts RMS, 145 watts max. fs = 25 Hz. 6 ohm (4 and 8 ohm compatible). SPL = 89 dB 1W/1M. Response: 25-700 Hz. QTS = .31, VAS = 10.3 cu. ft.. Pioneer #A30GU30-55D. Net weight: 6 lbs.

#290-145 — $39.80 (1-3) — **$36.80** (4-up)

15" THRUSTER WOOFER

Thruster by Eminence. Made in USA. Poly foam surround, 56 oz. magnet. 2-1/2", 2 layer voice coil. 150 watts RMS, 210 watts max. 4 ohm. fs = 23.5 Hz, QTS = .33, VAS = 17.9 cu ft. SPL = 94.8 dB 1W/1M. Net weight: 15 lbs.

#290-180 — $43.50 (1-3) — **$39.80** (4-up)

GRILL FRAME KIT

With this kit you can make speaker grill frames up to 30" x 40". Kit includes 4 corner pieces, 2 "T" brackets, and 7 frame bars. Grill mounting kit included.

#260-333 — $8.50 (1-9) — **$7.80** (10-up)

18" EMINENCE WOOFER

MADE IN USA

100 oz. magnet, 3" voice coil. 250 watts RMS, 350 watts max. 8 ohm, 30 Hz resonant frequency. 22-2700 Hz response. Efficiency: 98 dB 1W/1M. Paper cone, treated accordian surround. Net weight: 29 lbs.

#290-200 — $98.90 (1-3) — **$89.50** (4-up)

TITANIUM COMPOSITE TWEETER

Titanium is deposited on a polymer dome to combine the advantages of both hard and soft dome technologies. 8 ohm. Ferro fluid cooled voice coil. fs = 1200 Hz, SPL = 90 dB 1W/1M. 50 watts RMS, 70 watts max. 4" round. Polydax part #DTW100T125.

#270-047 — $27.50 (1-9) — **$24.80** (10-up)

Parts Express
340 E. First St., Dayton, Ohio 45402
Local: 1-513-222-0173
FAX: 513-222-4644

• 15 day money back guarantee • $15.00 minimum order • We accept Mastercard, Visa, Discover, and C.O.D. orders • 24 hour shipping • Shipping charge = UPS chart rate + $1.00 ($3.00 minimum charge) • Hours: 8:30 am - 6:00 pm EST, Monday - Friday • Mail order customers, please call for shipping estimate on orders exceeding 5 lbs.

CIRCLE 56 ON FREE INFORMATION CARD

★QUALITY PARTS ★DISCOUNT PRICES ★FAST SHIPPING

ALL ELECTRONICS CORP.

3 to 6 Vdc MOTOR with GEARBOX

Probably designed for childs toy. Lever selects 2 forward and one reverse speed. 1st gear aprox. 120 rpm/6vdc, 2nd gear aprox. 300 rpm/6vdc, Reverse aprox. 120 rpm/6vdc.
3.35" X 1.75" X 3.25"
CAT# DCM-10 $6.00

CASSETTE MECHANISM

Alpine cassette transport mechanism. Includes stereo tape head, Mitsubishi # MET-3RF2B 13.2 Vdc motor, belt, pulleys, capstan, fast-forward, rewind and eject actuator. Does not include amplifier section.
6 1/2" X 5 1/4" X 1 3/4".
CAT# CMEC-5 $7.50 each
10 for $65.00

6 VOLT D.C. 9.5 AMP/HOUR GEL-CELL

Elpower# 695
6 volt, 9.5 amp/hour rechargeable gel-cell battery.
4.25" X 2.75" X 5.5".
Quick connect terminals.
CAT# GC-695
$15.00 each

12-36 VDC GEAR-HEAD MOTOR

Brevel# 780-953075
Rated for 36 Vdc: 95 rpm. 0.5 amps no load. 65 rpm, 1.5 amp @ 12 lb/in torque. Gearbox is 3 1/4" X 3 1/4" X 1 15/16" deep. Motor is 1 1/2" diameter X 3 1/2" long with double flatted 5/16" X 1" shaft. Ideal for pumps, lift mechanisms, robotics and other high torque applications. **CAT# MOTG-11**
$15.00 each • 2 for $25.00

WALL TRANSFORMERS

ALL PLUG DIRECTLY INTO 120 VAC OUTLET

6 Vdc @ 200 ma.	CAT# DCTX-620	$2.25
6 Vdc @ 750 ma.	CAT# DCTX-675	$3.50
9 Vdc @ 250 ma.	CAT# DCTX-925	$2.50
12 Vac @ 930 ma.	CAT# ACTX-1293	$3.50
18 Vac @ 1 amp.	CAT# ACTX-1885	$3.50

SWITCHES

ITT PUSH BUTTON

ITT MDPL series. 3/4" X 1/2" gray rectangular key cap. S.P.S.T. N.O.
Push to close. RATED: 0.1 amp switching, 0.25 amp carry current. P.C. mount. **CAT# PB-8**
65¢ each • 10 for $6.00 • 100 for $50.00

10 POSITION MINI-ROTARY

Grayhill# 56P36-01-1-10N-C
Mini rotary switch. Non-shorting. 1 deck, 10 positions. .125" dia. shaft X .375" long. .377" behind the panel depth. P.C. pins.
CAT# MRS-10 WAS $2.50 NOW $1.50 each

SPDT PUSHBUTTON

Marquardt# 1843
Rated 6 amps @ 125/250 Vac.
Black plastic pushbutton.
Switch body: .92" X .94" X .65".
CAT# PB-18 $1.65 each • 10 for $1.50 each

A.C. LINE CORDS

Black 6ft., 18/2, spt-2
NON POLARIZED PLUG
CAT# LCAC 2 for $1.00 • 100 for $45.00
POLARIZED PLUG
CAT# LCP-1 60¢ each • 100 for $50.00

LOOK WHAT $1.00 WILL BUY

200 ASSORTED 1/4 WATT RESISTORS
Bent leads, carbon comp. and carbon film.
CAT# GRES $1.00 per assortment

200 ASSORTED 1/2 WATT RESISTORS
Bent leads, carbon comp and carbon film.
CAT# GRABRE $1.00 per assortment

50 ASSORTED DISC CAPACITORS
Most are cut (p.c. leads). Some to 500 volts
CAT# GRABDC $1.00 per assortment

15 VALUES OF ELECTROLYTICS
Contains both axial and radial styles from 1 mfd.
CAT# GRABCP $1.00 per assortment

LED'S

STANDARD JUMBO
DIFFUSED T 1-3/4 size
RED **CAT# LED-1**
10 for $1.50 • 100 for $13.00
GREEN **CAT# LED-2**
10 for $2.00 • 100 for $17.00
YELLOW **CAT# LED-3**
10 for $2.00 • 100 for $17.00

FLASHING LED

with built in flashing circuit operates on 5 volts...
RED $1.00 each
CAT# LED-4 10 for $9.50
GREEN $1.00 each
CAT# LED-4G 10 for $9.50

BI-POLAR LED

Lights RED one direction, GREEN the other. Two leads.
CAT# LED-6 2 for $1.70

LED HOLDER

Two piece holder.
CAT# HLED 10 for 65¢

RELAYS

12 VOLT D.C. COIL S.P.D.T.

Omron# G2E-184P 4 Amp contacts
335 ohm coil.
Sugar cube size.
.61" X .42" X .44" high.
P.C. mount with pins on DIP spacing.
CAT# RLY-787 $1.50 each

5 VOLT DC SIP RELAY

Gould, Allied Control# SR-1A-5VDC
SPST-normally open SIP reed relay. 95 ohm coil. 2 amp contacts. .9" X .29" X .39" high. Housing resists flesists fluoro-carbon and chlorinated commercial solvents. **CAT# RLY-SIP6**
$1.00 each • 10 for $8.50

10 AMP SOLID STATE RELAY

ELECTROL# S2181
CONTROL:
Rated 5.5 to 10 Vdc (will operate on 3-32 Vdc).
LOAD: 10 amp @ 240 Vac
2 1/4" X 1 3/4" X 7/8"
CAT# SSRLY-10B $9.50 each
QUANTITY DISCOUNT
10 for $85.00 • 25 for $175.00
50 for $300.00 • 100 for $500.00

XENON TUBE

1" long flashtube prepped with 3 1/2" red and black leads. Ideal for electronic flash or strobe projects.
CAT# FLT-3 2 for $1.00

DOOR/WINDOW ALARM

Protects doors and windows from intruders.
Opening of door or window pulls pin from alarm module and triggers loud buzzer. Simple instalation. Operates on 2 AA batteries (not included). Plastic case is 3.32" X 2.29" X 1.19". Ivory with brushed aluminum face.
CAT# DWA $2.00 each
5 for $9.00

SOUND AND VIDEO MODULATOR

TI# UM1381-1. Designed for use with T.I. computers. Can be used with video cameras, games or other audio/video source. Built in A/B switch enables user to switch from T.V. antenna without disconnection. Operates on channel 3 or 4. Requires 12 Vdc. Hook up diagram included.
CAT# AVMOD $5.00 each

LIGHT ACTIVATED MOTION SENSOR

This device contains a photocell which senses sudden change in ambient light. Could be used as a door anunciator or modified to trigger other devices.
5 1/2" X 4" X 1". Operates on 6 Vdc. Requires 4 AA batteries (not included)
CAT# LSMD $5.75 per unit

1/4 WATT RESISTOR KIT

Ideal for the workshop, this 1/4 watt resistor kit contains 10 pieces each of 42 of the most popular values (420 pieces total). Includes a divided box and a parts locator.

VALUES in this kit are:
1 ohm, 10 ohm, 39 ohm, 47 ohm, 51 ohm, 68 ohm, 100 ohm, 130 ohm, 150 ohm, 180 ohm, 220 ohm, 330 ohm, 470 ohm, 560 ohm, 680 ohm, 1K, 1.2K, 1.5K, 2K, 2.2K, 2.7K, 3K, 4.7K, 5.1K, 5.6K, 10K, 15K, 22K, 30K, 33K, 39K, 47K, 56K, 68K, 100K, 120K, 150K, 220K, 470K, 1 MEG, 5.1 MEG, 10 MEG

The resistors alone would sell for $21.00.
Complete kit • **CAT# REKIT-14 $17.00**

PIEZO WARNING DEVICE

Murata Erie # PKB8-4A0
High pitched audible alarm. Operates on 3 - 20 Vdc @ 20 ma. 1" high x 7/8" dia. P.C. board mount.
CAT# PBZ-84 $1.75 each

NICKEL-CAD BATTERIES (RECHARGEABLE)

SPECIAL!! AAA SIZE
Panasonic# P-18AAA
1.2 volt @ 180 MAh
CAT# NCB-AAAX $1.50 each
10 for $13.50 • 100 for $125.00

AA SIZE $2.00 each
1.25 volts 500 mAh
CAT# NCB-AA

AA SIZE $2.20 each
WITH SOLDER TABS
CAT# NCB-SAA

C SIZE $4.25 EACH
1.2 volts 1200 mAh
CAT# NCB-C

D SIZE $4.50 each
1.2 volts 1200 mAh
CAT# NCB-D

TRANSISTORS

ORDER BY PART #

PN2222 NPN
TO-92 5 for 75¢
PN2907 PNP
TO-92 5 for 75¢
2N3055 NPN
TO-3 $1.00 each
MJ2955 PNP
TO-3 $1.50 each
MJE2955T PNP
TO-220 75¢ each
MJE3055T NPN
TO-220 75¢ each
TIP31 NPN
TO-220 75¢ each
TIP32 PNP
TO-220 75¢ each
TIP121 NPN
TO-220 75¢ each
TIP126 PNP
TO-220 75¢ each

WIDE BAND AMPLIFIER

NEC# UPC1651G. 1200 Mhz @ 3 db.
Gain: 19db @ f=500 hz. 5 volt operation.
Small package 4mm dia. X 2.5 mm thick.
CAT# UPC-1651 2 for $1.00
10 for $4.50 • 100 for $35.00

N-CHANNEL MOSFET

IRF-511 TO-220 case
CAT# IRF 511
$1.00 each • 10 for $9.00
LARGE QUANTITY AVAILABLE

STROBE KIT

Variable rate strobe kit, flashes between 60 to 120 times per minute. Will operate on either 6 or 12 Vdc depending upon how you wire the circuit. Comes complete with P.C. board and instructions for easy assembly. **CAT# STROBE-1** $7.50 each

TELEPHONE COUPLING TRANSFORMER

Multi Products International# A19N-HO-1D/1
Primary 600 ohm
Secondary: 600/600 ohm
.77" X .61" X .63" high.
6 p.c. pins on .187" centers.
Primary inductance:
300 mH min., at 1kHz, 1 volt.
CAT# TCTX-1 $1.25 each
10 for $11.00 • 100 for $95.00

OPTO SENSOR

U shaped package with mounting ears. 1/8" opening. 3/4" mounting holes. **CAT# OSU-6** 50¢ each
10 for $4.50 • 100 for $40.00

12 VOLT DC SOLID STATE BUZZER

Star# CMB-12 fits 14 pin DIP socket.
CMOS compatible.
Operates on 7 - 17 Vdc @ 1 ma. PC pins.
Has trigger terminal. 70 dB @ 20 cm. 0.886" X 0.63" X .575" high.
CAT# CMB-12 $1.25 each

14.7 VOLT TRANSFORMER

Sprite Industries# CS-510A. 14.7 volt, 60 hz, 8.82 Va.
1.61" high X 1.95" X 1.47". Mounting holes on 2.32" centers.
CAT# TX-147 $3.00 each
10 for $27.00 • 100 for $250.00

CALL OR WRITE FOR OUR **FREE** *CATALOG OVER 4000 PARTS!*

Now 60 pages!

MAIL ORDERS TO:
ALL ELECTRONICS
P.O. BOX 567
VAN NUYS, CA 91408

TWX-5101010163 (ALL ELECTRONIC)

OUTSIDE THE U.S.A.
SEND $2.00 POSTAGE
FOR A CATALOG!!

ORDER TOLL FREE
800-826-5432
INFO: (818)904-0524
FAX: (818)781-2653
MINIMUM ORDER $10.00
QUANTITIES LIMITED
CALIF. ADD SALES TAX
USA: $3.00 SHIPPING
FOREIGN ORDERS INCLUDE SUFFICIENT SHIPPING. NO C.O.D.

DISCOVER VISA MasterCard

CIRCLE 107 ON FREE INFORMATION CARD

/orldwide • Since 1974

UALITY COMPONENTS • COMPETITIVE PRICING • PROMPT DELIVERY

15th ANNIVERSARY YEAR 1974 - 1989

SPECIAL! Monochrome Text Card

Sperry Monochrome Display Adapter

- IBM PC/XT Compatible
- Allows for Connection etween Computer and Ionochrome Monitor
- Use for Text only
- Great for Network ervers and Dedicated Vork Stations

TEXT $12.95

TEST EQUIPMENT

Metex Digital Multimeters

M4650 Pictured

Metex General Specs:
Handheld, high accuracy AC/DC Voltage, AC/DC urrent, Resistance, iodes, Continuity, Transtor hFE • Manual ranging w/overload protection
M3650/B & M4650 only:
Also measures frequency nd capacitance
M4650 only:
Data Hold Switch
4.5 Digit

13610	3.5 Digit Multimeter	$49.95
13650	3.5 Digit w/Freq. & Capacitance	$69.95
13650B	Same as M3650 w/Bargraph	$79.95
14650	4.5 Dig. w/Freq., Capacitance and Data Hold Switch	$99.95

Metex Autoranging Jumbo Readout DMM

- AC/DC Voltage, AC/DC urrent, Resistance, Diodes, ontinuity and Frequency
- 3.75 Digit (.8" High)
- Ruggedized, Water-esistant case
- Easy-to-use pushbutton witches

180....................$59.95

I.R.T. EPROM Programmer

Programs all current EPROMs the 2716 to 27512 range plus e X2864 EEPROM • May be perated by any RS232 port w/ rminal emulation • Fully intelgent • ASCII command driven Menu driven software included

EPP...............$179.95

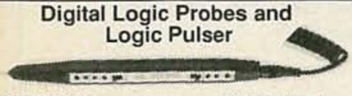
Oscilloscope Probes

LF180 Pictured

Attenuation: x1 / x10
Capacitance (LF180): 80pF / 22pF; (LF210): 0pF / 17pF

LF180	40MHz Oscilloscope Probe	$19.95
LF210	100MHz Oscilloscope Probe	$29.95

Digital Logic Probes and Logic Pulser



PRB20 Pictured

Logic Probes:
High, low and pulse indication • 20MHz and 50MHz versions available • Circuit powered w/ over/undervoltage indicators
Logic Pulser (LP540):
Generates "one-shot" pulse or continuous 5Hz pulse train • Audible tone • Compatible with: TTL, DTL, RTL, HTL, HINIL, MOS and CMOS ICs

PRB20	20MHz Logic Probe	$26.95
PRB20A	20MHz Audible Logic Probe	$33.95
PRB50	50MHz Logic Probe	$47.95
LP540	Logic Pulser	$19.95

JAMECO IBM PC/XT 8MHz Turbo Compatible Kit With 256K RAM

SAVE $108.06!

- Free! QAPLUS Diagnostic Software Included!
- Free! PC Write Word Processing Software Included!
- 256K RAM Included, Expandable to 640K
- AMI BIOS ROMs Included
- 4.77 or 8MHz Operation
- Flip-Top Case w/150 Watt Power Supply
- 360K Disk Drive
- Parallel Printer Port
- 84-Key Keyboard
- Monochrome Amber Monitor

JE3002	IBM Compatible PC/XT 8MHz Turbo Kit ~~$499.95~~	$479.95
EZDOS	Digital Research MS/PC-DOS Comp. Operating System	$49.95
EZDOSP	Same as above with TrueBASIC	$69.95

IBM COMPATIBLE DISPLAY MONITORS

NEW

QC1478 Pictured

AMBER	12" Amber Mono.		$99.95
HD55H	14" RGB 640x240		$249.95
TM5154	EGA 14" 720x350	~~$399.95~~	$369.95
JE1059	EGA Monitor & Card	~~$519.95~~	$499.95
TM5155	14" Multiscan 800x560	~~$549.95~~	$499.95
QC1478	14" VGA 720x480	~~$449.95~~	$399.95
JE2055	VGA Monitor & Card	~~$649.95~~	$599.95

JAMECO IBM PC/XT/AT COMPATIBLE CARDS

JE1050	Monochrome Graphics Card w/Parallel Printer Port (PC/XT/AT)	$59.95
JE1052	Color Graphics Card w/Parallel Printer Port (PC/XT/AT)	$49.95
JE1055	EGA Card w/256K Video RAM (PC/XT/AT)	$159.95
JE1071	Multi I/O Card w/Controller & Monochrome Graphics (PC/XT)	$119.95
JE1060	I/O Card w/Serial, Game, Printer Port & Real Time Clock (PC/XT)	$59.95
JE1061	RS232 Serial Half Card (PC/XT)	$29.95
JE1062	RS232 Serial Half Card (AT)	$34.95
JE1065	I/O Card w/Serial, Game and Parallel Printer Port (AT)	$59.95
JE1081	2MB Expanded or Extended Memory Card (zero-K on-board) (AT)	$99.95
JE1041	20/40MB Hard Disk Controller Card (PC/XT)	$79.95
JE1043	360K/720K/1.2MB/1.44MB Floppy Disk Controller Card (PC/XT/AT)	$49.95
JE1044	360K Floppy/Hard Disk Controller Card (PC/XT)	$129.95
JE1045	360K/720K/1.2MB/1.44MB Floppy/Hard Disk Controller Card (AT)	$149.95

SEAGATE HALF-HEIGHT HARD DISK DRIVES

ST225XT Pictured

ST225	20MB Drive only (PC/XT/AT)	$224.95
ST225XT	20MB w/Controller (PC/XT)	$269.95
ST225AT	20MB w/Controller (AT)	$339.95
ST238	30MB Drive only (PC/XT/AT)	$249.95
ST238XT	30MB w/Controller (PC/XT)	$299.95
ST238AT	30MB w/Controller (AT)	$389.95

Seagate 40MB and 60MB Hard Disk Drives Also Available!

IBM PC/XT/AT COMPATIBLE MOTHERBOARDS

JE3025 Pictured

JE1001	4.77/8MHz (PC/XT)		$89.95
JE1002	4.77/10MHz (PC/XT)	~~$109.95~~	$99.95
JE3005	Baby 8/12MHz (AT)	~~$329.95~~	$299.95
JE3010	Baby 8/16MHz *NEAT* (AT)	~~$469.95~~	$399.95
JE3020	Baby 16MHz 80386 (AT)	~~$1199.95~~	$999.95
JE3025	Baby 20MHz 80386 (AT)		$1199.95
JE3026	Full-Size 25MHz 80386 (AT)		$1999.95

IBM PC/XT/AT COMPATIBLE 3.5"/5.25" DISK DRIVES

JE1022 Pictured

352KU	3.5" 720KB (PC/XT/AT)	$109.95
356KU	3.5" 1.44MB (PC/XT/AT)	$129.95
JE1020	5.25" 360KB (PC/XT/AT) Black	$89.95
JE1021	5.25" 360KB (PC/XT/AT) Beige	$89.95
JE1022	5.25" 1.2MB (PC/XT/AT) Beige	$99.95

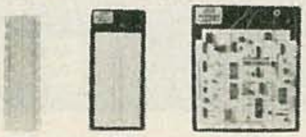
IBM PC/XT/AT COMPATIBLE INTERNAL MODEMS

1200H	1200/300 Baud Internal Modem w/MaxiMite Comm. Software (PC/XT/AT)	$69.95
2400H	2400/1200/300 Baud Internal Modem w/MaxiMite Comm. Sfwr. (PC/XT/AT)	$129.95

External Modems and Pocket-Size Modem Also Available!

PROTOTYPING PRODUCTS

Jameco Solderless Breadboards



JE23 JE24 JE27

Part No.	Dim. L" x W"	Contact Points	Binding Posts	Price
JE20	6.5 x .75	200	0	$1.95
JE21	3.25 x 2.125	400	0	$4.95
JE22	6.5 x 1.325	630	0	$5.95
JE23	6.5 x 2.125	830	0	$7.95
JE24	6.5 x 3.125	1,360	2	$12.95
JE25	6.5 x 4.25	1,660	3	$19.95
JE26	6.875 x 5.75	2,390	4	$24.95
JE27	7.25 x 7.5	3,220	4	$34.95

DATAK Photo Etch PCB Kit

Make your own circuit boards!

The ER4 photo etch kit contains all the chemicals necessary for any hobbyist, engineer or student to create professional circuit boards. Contains: Print frame, photo copy film, resist developer, etch resist, 2 copper circuit boards, concentrated etchant, film developer and fixer, resist patterns and complete instructions. Must be shipped ground (surface).

ER4 Photo Etch PCB Kit....................$34.95

Jameco Prototype PC Boards

JE401 Pictured

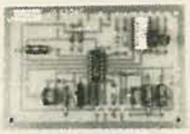
Specs: Laminated glass epoxy .062" thick 2 oz. copper clad with solder tin finish. All holes are .042" dia. on .10" x .10" grid pattern.

JE401	4.5"x6.5" 1-sided 3-hole pad pattern	$9.95
JE403	4.5"x6.5" 1-sided pwr & gnd busses	$9.95
JE405	4.5"x6.5" 1-sided general purpose	$9.95
JE407	5"x13.25" 2-sided general purpose	$19.95
JE417	4.2"x6.5" PC/XT 1/2 card proto board	$19.95
JE421	4.75"x3.7" IBM PC/XT Card Extender	$19.95

ENGINEERING/DATA BOOKS

21035	Sams TTL Cookbook (88)	$14.95
21398	Sams CMOS Cookbook (88)	$19.95
22453	Sams Op-Amp Cookbook (88)	$21.95
270645	Intel 8-bit Controller Hndbk. (89)	$19.95
270646	Intel 16-bit Controller Hndbk. (89)	$19.95
270647	Intel 32-bit Controller Hndbk. (89)	$19.95
400041	NSC Linear Data Book Vol. 1 (88)	$14.95
400042	NSC Linear Data Book Vol. 2 (88)	$9.95
400043	NSC Linear Data Book Vol. 3 (88)	$9.95
ICM89	1989 IC Master (3 Volume Set)	$119.95

EDUCATIONAL KITS



JE2206 Pictured

JE310/315: Fiber optics kits demonstrate the principles of fiber optic system design. Complete step-by-step instructions, theory of operation and tutorial info. incl.
JE2206: Function generator kit provides three basic waveforms: sine, triangle and square wave. Frequency range: 1Hz to 100kHz

JE310	Fiber Optics Experimenter Kit	$19.95
JE315	Advanced Fiber Optics Kit	$29.95
JE2206	Function Generator Kit	$19.95

1355 Shoreway Road
Belmont, CA 94002
24 Hour Order Hotline (415) 592-8097
FAX's (415) 592-2503 or (415) 595-2664
Telex 176043 - Ans. Back: Jameco Blmt
Data Sheets - 50¢ each
Send $2.00 Postage for a FREE 1989 CATALOG

MasterCard VISA

Mail Order Electronics • Worldwide
Jameco ELECTRONICS®

MEMBER Direct Marketing Association
MEMBER MMC Microcomputer Marketing Council

$20.00 Minimum Order - U.S. Funds Only
CA Residents Add 6%, 6.5% or 7% Sales Tax
Shipping - Add 5% plus $1.50 Insurance (May vary according to weight)
Terms: Prices subject to change without notice.
We are not responsible for typographical errors.
We reserve the right to substitute manufacturers.
Items subject to availability and prior sale.
Products pictured may only be representative.
Complete list of terms/warranties is available upon request.

24-Hour Order Hotline (415) 592-8097 • The Following Phone Lines Are Available From 7AM - 5PM P.S.T.:
• Customer Service (415) 592-8121 • Technical Assistance (415) 592-9990 • Credit Department (415) 592-9983 • All Other Inquiries (415) 592-7108

CIRCLE 114 ON FREE INFORMATION CARD

Cable TV

EXPERIMENTERS' DELIGHT!

We have a large supply of parts that we sold exclusively for two articles (FEB 84 & FEB 87) published in *Radio Electronics* magazine. However, we agreed not to sell these items for the purpose of building a device to intercept unauthorized cable TV signals. Therefore, we are selling these items as just electronics parts with no specific use intended.

SB-3 PARTS (1984)

#701 PARTS PACKAGE $19.00
Includes resistors, capacitors, diodes, transistors, IC's, coils, and Toko transformers (BKAN-K555AXX).

#702 PC BOARD $6.95
3″×4″ etched, drilled, and silk-screened pc board.

#704 AC ADAPTOR $6.95
14 Volts DC @ 200 ma adaptor.

#705 PAC-TEC ENCLOSURE $14.95
Crackle black plastic box that pc board fits.

For a complete listing of parts and specifications of either article send $2.00 ea. for a censored reprint.

TRI-MODE PARTS (1987)

#301 PARTS PACKAGE $39.00
Includes resistors, capacitors, diodes, IC's, transistors, potentiometers, LED's, Toko coil (E520HN-3000023) and Plessey SAW filter (SY323).

#302 PC BOARD $7.95
5″×8.8″ etched, drilled, and silk-screened pc board.

#304 AC ADAPTOR $6.95
14 Volts DC @ 200 ma adaptor.

#305 PAC-TEC ENCLOSURE $19.95
Crackle black plastic box that pc board fits.

TRI-MODE TUTORIAL $7.95
An in-depth gate-by-gate circuit analysis of the 1987 *Radio Electronics* article on the tri-mode method of scrambling. This informative technical paper includes chapters on: troubleshooting, corrected schematic, construction notes, circuit description, initial and final adjustments. 21 pages of text, 44 pages of illustrations for a total of 66 pages.

FOR OUR RECORDS

DECLARATION OF AUTHORIZED USE - I, the undersigned, do hereby declare under the penalty of perjury that all products purchased, now and in the future, will only be used or tested on cable TV systems with proper authorization from local officials or cable company officials in accordance with all applicable federal and state laws. Federal and various state laws provide for substantial criminal and civil penalties for unauthorized use.

Date ____________________ Signed ____

SNOOPER STOPPER $39.95
Cable TV descramblers are being sold by the thousands, and most people are unaware their use can be detected. Protect your privacy with Snooper Stopper and prevent cable companies from spying on you.

Send $2.00 for our "Cable TV Snooper" article.

MACROVISION .... Now you see it, Now you don't.

MS1-Kit $29.00
Includes all the parts, PC board, ac adaptor, and instructions published in *Radio Electronics* magazine.

JMAK-4 PAC-TEC ENCLOSURE $14.95
Original black box to house MS1-Kit.

ORDER TOLL FREE ANYTIME 1-800-227-8529

Inside MA 508-695-8699
VISA, MasterCard, or COD

Add $3.50 S&H, $6.00 for Canadian, Alaskan, and Puerto Rican orders.

J&W Electronics, Inc., PO Box 800, Mansfield, MA 02048

CIRCLE 65 ON FREE INFORMATION CARD

Radio Shack Parts Place℠

BIG SELECTION AND LOW PRICES—COME IN TODAY!

Parts Special-Order "Hotline"

ICs
Crystals
And More!

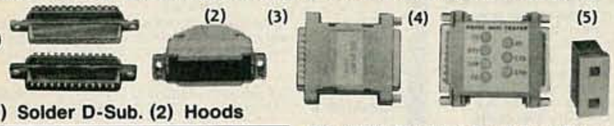
No
Minimum
Order!

Your Radio Shack store manager can special-order a wide variety of parts and accessories from our warehouse—tubes, ICs, phono cartridges and styli, crystals, even SAMS Photofacts®. There's no minimum order or handling charges. Fast delivery to the Radio Shack near you!

Battery Special-Order Service

In addition to our large in-store stock, Radio Shack can now supply almost any battery! Our expanding selection even includes special communications batteries for walkie-talkies and pagers. Batteries are sent from our warehouse to the Radio Shack near you. Never a postage charge!

RS-232 Connectors and Accessories



(1) Solder D-Sub. (2) Hoods

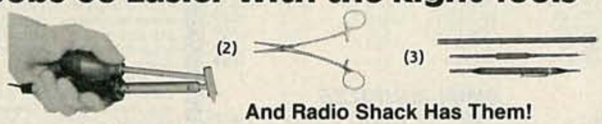
Positions	Type	Cat. No.	Each
9	Male	276-1537	.99
9	Female	276-1538	1.99
25	Male	276-1547	1.49
25	Female	276-1548	2.49
9	Hood	276-1508	2.19
25	Hood	276-1510	2.79

(3) NEW! Shielded Stunt Box. Cross-wire included PC board to suit your application. #276-1403 ...... **9.95**

(4) Inline RS-232 Tester. Spot line problems. #276-1401 .... **14.95**

(5) DIP Shunts. #276-1512, **10/1.29**

Jobs Go Easier With the Right Tools



And Radio Shack Has Them!

(1) Vacuum Desoldering Iron. Why put up with burned fingers and the hassle of spilled solder? This pro-quality tool is fast, effective and easy to use. Rated 45 watts. UL listed AC. #64-2060 .... **8.49**
Replacement Tip. #64-2061 . . **99¢**

(2) Stainless Steel Forceps. Ideal for a soldering heat sink. 6" long. 3-position lock. #64-1866 ...... **4.95**
(3) Anti-Static Alignment Tool Set. Helps prevents damage to sensitive circuits during alignment. Great for TV/VCR servicing. #64-2230, **4.19**

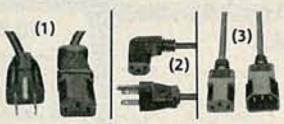
Mini Audio Amp

Only

11⁹⁵

With a built-in speaker, it's the perfect test amp and also well-suited for computer voice and music synthesis. 1/8" input and earphone jacks. Battery extra. #277-1008

PC Line Cords



Top-quality, grounded 6-foot AC cords for computers and printers.
(1) With Straight HP (CEE-Type) Connector. #278-1257 ..... **3.99**
(2) With 90° HP Connector. Ideal for tight spaces. #278-1260 . . **5.99**
(3) Extension. #278-1259 . . **4.99**

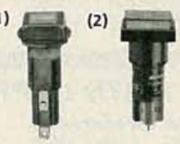
Harness the Sun

(1) Solar Project Kit. Includes mini solar panel, motor, propeller, project booklet.
#277-1201 .... **10.95**
(2) Silicon Solar Cell. This 2×4 cm cell produces about 0.3 amp at 0.55VDC. #276-124 .... **3.95**

Panel Mounts

Low As

1⁴⁹



(1) Square Holder for 1¼×¼" Fuses. #270-365 .... **1.49**
(2) Jumbo Lighted Pushbutton Switch. SPST. Rated 5A at 250VAC. With 12-volt lamp.
#275-678 .... **6.99**

Assortments

(1) 20 Assorted LEDs. May include MV-5054, MV-50, RL-209 in red, green, amber, infrared.
#276-1622 .... **1.98**
(2) 5 Photocells. CdS photoresistors. Ideal for experiments. Various styles and ratings.
#276-1657 .... **1.98**

Metal Cabinet

Only

5⁹⁹

Here's a great housing for your next project. Features steel top and easy-to-drill aluminum front, back, bottom. 3×5¼×5⅞".
#270-253 .... **5.99**

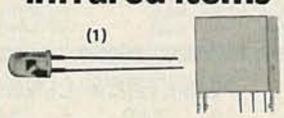
Power Plugs

Locking Type

Rated 250V Per Circuit

Positions	Type	Cat. No.	Each
2	Male	274-151	.99
6	Male	274-152	1.69
12	Male	274-153	1.99
2	Female	274-154	.99
6	Female	274-155	1.69
12	Female	274-156	1.99

Infrared Items



(1) SEP8703-1 IR LED. High power output. #276-143 .... **1.69**
(2) IR Detector Module. Combines detector, amp, limiter, filter, and comparator—in a board-mountable package. 5VDC. With data. #276-137 .... **3.49**

AC Power Strips

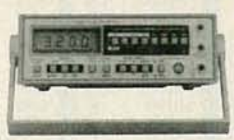
Add Outlets Safely!

(1) 6-Outlet. Ideal for workbench. Has six grounded outlets, heavy-duty 6-foot cord with grounded plug, on/off switch with indicator light and circuit breaker. Handles 15 amps. UL listed AC. #61-2619 .... **21.95**
(2) 4-Outlet. As above, but without on/off switch. UL listed AC. #61-2620 .... **15.95**

B-Board and Jumpers

(1) Deluxe Breadboard. Molded 2¼×6½" board is mounted on a 7×4" steel base with rubber feet. Has 640 plug-in points and three binding posts. #276-169 .... **19.95**
(2) NEW! Breadboard Jumper Wire Kit. Includes 140 insulated, pre-stripped wires—10 each of 14 different lengths—in a handy, snap-shut plastic box. #276-173 .... **Set 4.95**

Bench Test Instrument



Our finest! Precise LCD digital display plus 31-segment analog bargraph. Displays transistor gain directly. Diode-check, memory and continuity functions. Measures to 1000VDC, 750VAC, 10 amps AC/DC, resistance. With leads and manual. #22-195 .... **99.95**

Over 1000 items in stock! Binding Posts, Books, Breadboards, Buzzers, Capacitors, Chokes, Clips, Coax, Connectors, Fuses, Hardware, ICs, Jacks, Knobs, Lamps, Multitesters, PC Boards, Plugs, Rectifiers, Resistors, Switches, Tools, Transformers, Transistors, Wire, Zeners, More!

Radio Shack®
The Technology Store℠
A DIVISION OF TANDY CORPORATION

Prices apply at participating Radio Shack stores and dealers

CIRCLE 78 ON FREE INFORMATION CARD

JDR Microdevices®

MMC MICROCOMPUTER MARKETING COUNCIL of the Direct Marketing Association, Inc.

• 30 DAY MONEY BACK GUARANTEE • 1 YEAR WARRANTY ON ALL PRODUCTS • TOLL-FREE TECHNICAL SUPPORT

MEMORY

NEW LOW PRICES!

DYNAMIC RAMS

PART	SIZE	SPEED	PINS	PRICE
4116-150	16384x1	150ns	16	.99
4164-150	65536x1	150ns	16	2.49
4164-120	65536x1	120ns	16	2.89
4164-100	65536x1	100ns	16	3.39
TMS4464-12	65536x4	120ns	16	9.95
41256-150	262144x1	150ns	16	4.49
41256-120	262144x1	120ns	16	4.99
41256-100	262144x1	100ns	16	5.49
41256-80	262144x1	80ns	16	5.99
41256-60	262144x1	60ns	16	7.99
414256-100	262144x4	100ns	20	14.95
414256-80	262144x4	80ns	20	16.95
1 MB-120	1048576x1	120ns	18	13.95
1 MB-100	1048576x1	100ns	18	14.95
1 MB-80	1048576x1	80ns	18	15.95

SIMM MODULES

PART	SIZE	SPEED	FOR	PRICE
41256A9B-12	256K x 9	120ns	PC	59.95
41256A9B-80	256K x 9	80ns	PC	69.95
421000A8B-10	1MB x 8	100ns	MAC	169.95
421000A9B-10	1MB x 9	100ns	PC	169.95
421000A9B-80	1MB x 9	80ns	PC	179.95

STATIC RAMS

PART	SIZE	SPEED	PINS	PRICE
TMM2016-150	2048x8	150ns	24	3.25
HM6116LP-2	2048x8	120ns	24	5.49
HM6264LP-15	8192x8	150ns	28	8.95
HM6264LP-12	8192x8	120ns	28	9.95
HM43256LP-15	32768x8	150ns	28	19.95
HM43256LP-12	32768x8	120ns	28	21.95
HM43256LP-10	32768x8	100ns	28	24.95

Derick's HIGH-TECH SPOTLIGHT

Call our BBS: (408) 559-0253 for more info in SIG file "Hitech"

Last month I reviewed improved hard disk performance from proper interleaving. This month's topic is memory interleaving.

Although as important to memory design as access time, CYCLE time is seldom discussed beyond the board designers lab. ACCESS time is the time it takes a memory chip to either make its contents available to the processor (read), or store the data that the processor wants saved (write). CYCLE time is equal to access time plus precharge time. PRECHARGE time is the time it takes the memory chip to restore its internal charge after a read or write cycle. In many processor designs, the critical timing factor that prevents back to back memory accesses is the precharge delay, because without it, the processor could run full speed ahead with no WAIT states.

Interleaved memory is used to nullify that delay. First the memory is divided into left and right banks. The processor then accesses the memory by alternating from one bank to another. While the left bank is recovering from an access (precharging), the right bank is ready to go; on the next access from the left bank the right bank recovers.

While not all accesses are sequential, and sometimes the memory request will be to the same bank that was last accessed, the vast majority will be interleaved and the machine will run at NEAR ZERO wait states because of interleaving.

Derick Moore, Director of Engineering

PROTOTYPE CARDS

FR-4 EPOXY GLASS LAMINATE WITH GOLD PLATED EDGECARD FINGERS AND SILK SCREENED LEGENDS

FOR XT		
JDR-PR1	WITH +5V AND GROUND PLANE	27.95
JDR-PR2	ABOVE WITH I/O DECODING LAYOUT	29.95
JDR-PR2PK	PARTS KIT FOR JDR-PR2 ABOVE	8.95
FOR AT		
JDR-PR1016	BIT WITH I/O DECODING LAYOUT	34.95
JDR-PR10PK	PARTS KIT FOR JDR-PR10 ABOVE	12.95
FOR PS/2		
JDR-PR32	32 BIT PROTOTYPE CARD	69.95
JDR-PR16	16 BIT WITH I/O DECODING LAYOUT	49.95
JDR-PR16PK	PARTS KIT FOR JDR-PR16 ABOVE	15.95
JDR-PR16V	16 BIT FOR VIDEO APPLICATIONS	39.95
EXTENDER CARDS — SIMPLIFY PROTOTYPING AND TESTING		
EXT-8088	8-BIT FOR 8088 MOTHERBOARDS	29.95
EXT-80286	16-BIT FOR 286/386 MOTHERBOARDS	39.95
EXT-16	MICROCHANNEL 16-BIT	69.95
EXT-32	MICROCHANNEL 32-BIT	99.95

MATH COPROCESSORS

intel 5 YEAR WARRANTY

8-BIT COPROCESSORS

8087	5 MHz	89.95
8087-2	8 MHz	129.95
8087-1	10 MHz	169.95

16-BIT COPROCESSORS

80287	6 MHz	139.95
80287-8	8 MHz	209.95
80287-10	10 MHz	239.95

32-BIT COPROCESSORS

80387-16	16 MHz	359.95
80387-SX	16 MHz	319.95
80387-20	20 MHz	399.95
80387-25	25 MHz	499.95
80387-33	33MHz	649.95

INCLUDES MANUAL & SOFTWARE GUIDE

EPROMS

PART	SIZE	SPEED	Vpp	PINS	PRICE
2708	1024x8	450ns	25V	24	4.95
2716	2048x8	450ns	25v	24	3.49
2716-1	2048x8	350ns	25V	24	3.95
2732A	4096x8	250ns	21V	24	3.95
2764	8192x8	450ns	12.5V	28	3.49
2764-250	8192x8	250ns	12.5V	28	3.69
2764-200	8192x8	200ns	12.5V	28	4.25
27C64	8192x8	250ns	12.5V	28	4.95
27128	16384x8	250ns	12.5V	28	4.25
27128A-200	16384x8	200ns	12.5V	28	5.95
27256	32768x8	250ns	12.5V	28	4.95
27256-200	32768x8	200ns	12.5V	28	5.95
27C256	32768x8	250ns	12.5V	28	5.95
27512	65536x8	250ns	12.5V	28	8.95
27C512	65536x8	250ns	12.5V	28	9.95
27C101-20	131072x8	200ns	12.5V	32	29.95

PC BREADBOARD-ON-A-CARD

- 62 BUS LINES
- USE UP TO 24 14-PIN ICS
- 1940 TIE POINTS
- DB25 D-SUB CONNECT.

PDS-604 $49.95

SOLDER STATION

- UL APPROVED
- HEAT SETTING ADJUSTS
- TIP TEMPERATURE READOUT
- REPLACEMENT TIPS @ $2.95

168-3C $59.95

74 SERIES LOGIC

7400	.19	74LS32	.18	74LS245	.79
74LS00	.16	74LS73	.29	74LS273	.79
74LS02	.17	7474	.33	74S288	1.69
7404	.19	74LS74	.24	74LS322	3.95
74LS04	.16	74S74	.49	74LS367	.39
74S04	.29	74LS138	.39	74LS373	.79
7406	.29	74LS155	.59	74LS374	.79
7408	.24	74LS163	.39	74LS393	.79
74LS08	.18	74LS240	.69	74LS682	3.20
7432	.29	74LS244	.69	74LS688	2.40

EPROM ERASERS

DATARASE II $39.95

- SHIRT POCKET SIZE!
- ALL SIZES UP TO 4 AT A TIME
- ERASES MOST EPROMS IN 3 MINUTES

DATARASE II

SPECTRONICS CORPORATION

Model	Timer	# of Chips	Intensity (uW/Cm²)	Unit Cost
PE-140	NO	9	8,000	$89
PE-140T	YES	9	8,000	$139
PE-240T	YES	12	9,600	$189
PL-265T	YES	30	9,600	$255

IC SOCKETS/DIP CONNECTORS

SOLDERTAIL		WIREWRAP		ZIF SOCKETS	
8ST	.11	8WW	.59	ZIF14	5.95
14ST	.11	14WW	.69	ZIF16	5.95
16ST	.12	16WW	.69	ZIF20	6.95
18ST	.15	18WW	.99	ZIF24	7.95
20ST	.18	20WW	1.09	ZIF28	7.95
24ST	.20	24WW	1.49	ZIF40	10.95
28ST	.22	28WW	1.69		
40ST	.30	40WW	1.99		

VOLUME DISCOUNTS CALL!

SOLDER-CUP D-SUBS

MALE		FEMALE	
DB9P	.45	DB9S	.49
DB15P	.59	DB15S	.69
HDB15P	1.49	HDB15S	1.59
DB19P	.69	DB19S	.75
DB25P	.69	DB25S	.75
DB37P	1.35	DB37S	1.39
DB50P	1.85	DB50S	2.29

IDC'S

IDB09P	1.39
IDB09S	1.45
IDE20	.55
IDE34	.89
IDS20	.65
IDS34	.75
IDB25P	2.25
IDB25S	2.35

C.P.U.'s

8000

8052AH BASIC	34.95
8088	5.99
8250	6.95
8251A	1.69
8253-5	1.95
8254	9.95
8255-5	2.49
8741	9.95
8748	7.95
8749	9.95
8755	14.95

6500

65C02*	7.95
6522	2.95

V-20

V20	6.95
V20-8	8.95
V20-10	11.95
V30	13.95

MISC

DAC0800	3.29
1793	9.95
COM8116	8.95
MC146818	5.95
MM58167	9.95
INS8250	6.95
NS16450	10.95
LM317T	.69
NE555	.29
LM741	.29
7805T	.49
7812T	.49
75150	1.95
75154	1.95
14411	9.95

CRYSTAL OSCILLATORS

1.0MHz	5.95
1.8432	5.95
20.0	4.95
24.0	4.95

PALS

16L8	2.95
16R4	2.95
16R6	2.95
16R8	2.95
20L8	4.95
20R4	4.95
20R6	4.95
20R8	4.95
20X8	4.95

PAL KIT

AN ENTRY-LEVEL COMPLETE PAL DEVELOPMENT KIT FROM CUPL. FULL SUPPORT FOR 16L8, 16R4, 16R6, 16R8, 20L8, 20R4, 20R6, 20R8, AND 20X8.

MOD-MPL-SOFT $99.95

POWER SUPPLIES

135 WATT POWER SUPPLY

- UL APPROVED
- +5V @15A, +12V @ 4.2A, -5V @ .5A, -12V @ .5A

PS-135 $59.95
PS-150 150W SUPPLY $69.95

200 WATT POWER SUPPLY

- UL APPROVED
- +5V @ 20A, +12V @ 7A, -5V @ .5A, -12V @ .5A

PS-200 $89.95

APPLE TYPE SUPPLY

- WITH APPLE CONNECTOR
- +5V @ 6A, +12V @ 3A, -5V @ 1A, -12V @ 1A

PS-A $59.95

CABLES AND GENDER CHANGERS

MOLDED; GOLD-PLATED CONTACTS; 100% SHIELDED

CBL-PRINTER	6 FT. PC PRINTER CABLE	9.95
CBL-PRINTER-25	25 FT. PC PRINTER CABLE	15.95
CBL-PRINTER-RA	RIGHT ANGLE PRINTER CABLE	15.95
CBL-DB25-MM	DB25 MALE-DB25 MALE 6 FT.	9.95
CBL-DB25-MF	DB25 MALE-DB25 FEMALE 6 FT.	9.95
CBL-9-SERIAL	DB9 FEMALE-DB25 MALE 6 FT.	6.95
CBL-KBD-EXT	5 FT. KEYBOARD EXTENSION	7.95
CBL-CNT-MM	36-PIN CENTRONICS -M/M	14.95
CBL-FDC-EXT	37-PIN EXT. FLOPPY CABLE	9.95
CBL-MNT-9	9-PIN MONITOR EXTENSION	6.95
CBL-MNT-15	15-PIN MONITOR EXTENSION CABLE	9.95
CBL-MODEM	MODEM -DB25-DB25 FEMALE	6.95
GENDER-VGA	DB9-DB15 ADAPTOR	4.95
GENDER-9-25	DB9-DB25 SERIAL ADAPTOR	4.95

PARTIAL LISTINGS ONLY—CALL FOR FREE 84-PG CATALOG

CIRCLE 113 ON FREE INFORMATION CARD

CIRCLE 170 ON FREE INFORMATION CARD

ADVERTISING INDEX

RADIO-ELECTRONICS does not assume any responsibility for errors that may appear in the index below.

Gernsback Publications, Inc.
500-B Bi-County Blvd.
Farmingdale, NY 11735
1-516-293-3000
Fax 1-516-293-3115
President: **Larry Steckler**
Vice President: **Cathy Steckler**

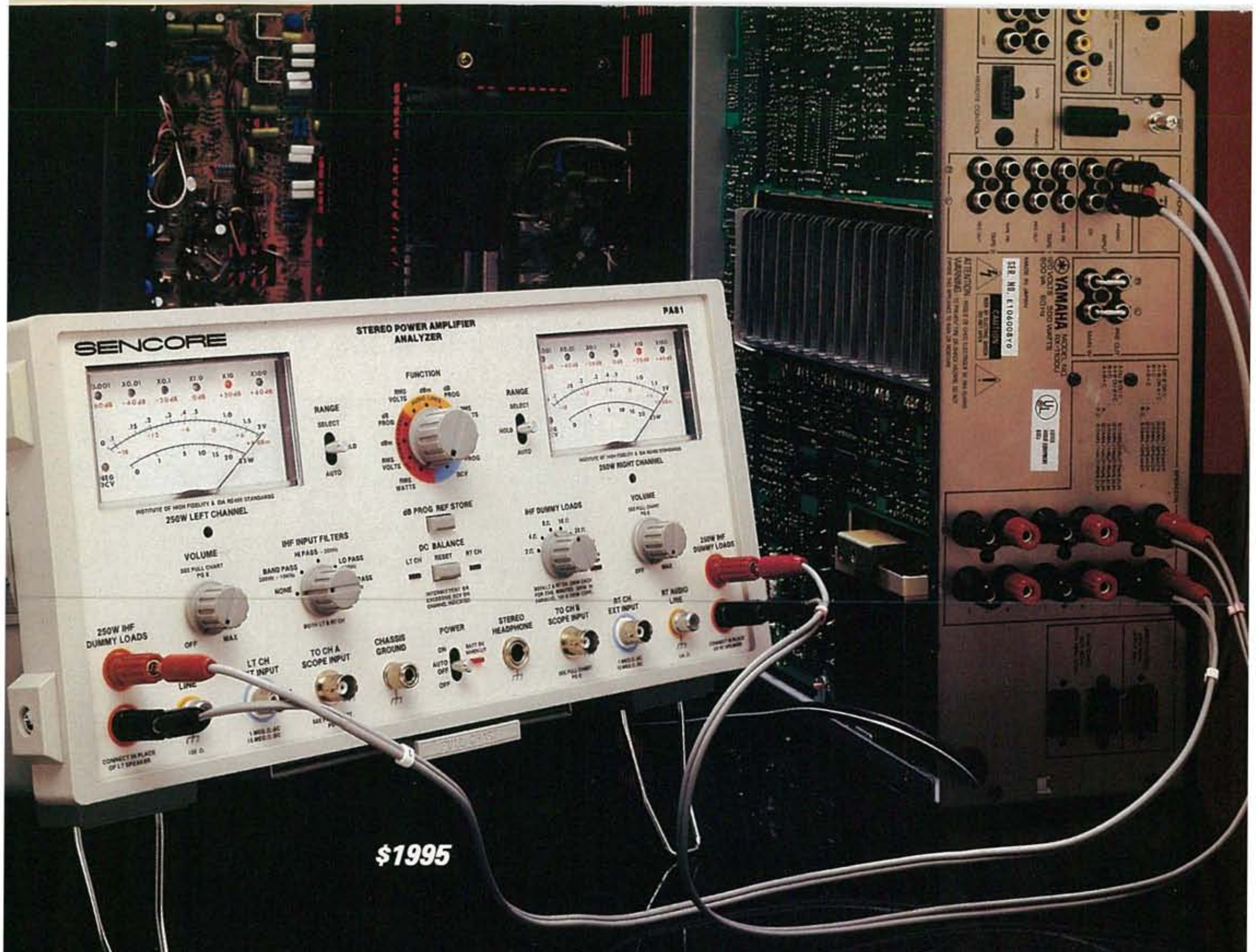
For Advertising ONLY
1-516-293-3000
Fax 1-516-293-3115
Larry Steckler
publisher
Arline Fishman
advertising director
Shelli Weinman
advertising associate
Lisa Strassman
credit manager
Christina Estrada
advertising assistant

SALES OFFICES

EAST/SOUTHEAST
Stanley Levitan
Eastern Sales Manager
Radio-Electronics
259-23 57th Avenue
Little Neck, NY 11362
1-718-428-6037, 1-516-293-3000

MIDWEST/Texas/Arkansas/Okla.
Ralph Bergen
Midwest Sales Manager
Radio-Electronics
540 Frontage Road—Suite 339
Northfield, IL 60093
1-312-446-1444
Fax 1-312-446-8451

PACIFIC COAST/ Mountain States
Marvin Green
Pacific Sales Manager
Radio-Electronics
5430 Van Nuys Blvd. Suite 316
Van Nuys, CA 91401
1-818-986-2001
Fax 1-818-986-2009

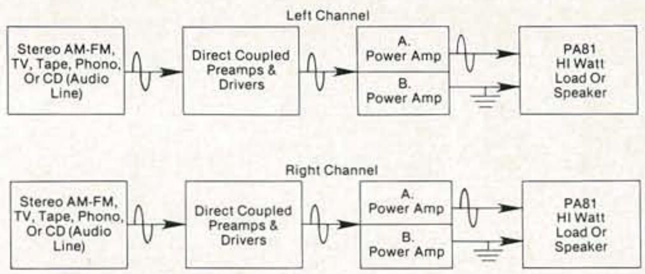


Dynamically Analyze Stereo Audio Power Amplifiers To A Full 500 Watts To IHF/EIA Specifications In Less Than 1/2 The Time It Now Takes*

The PA81 Is Truly The "Missing Link In Audio Servicing"

Introducing the "Missing Link In Audio Servicing," with the NEW PA81 Stereo Power Amplifier Analyzer™ from Sencore Electronics. The PA81 provides everything you need for power amplifier analyzing integrated into one complete package, with:

- **Twin Frequency Compensated Autoranged Wattmeters:** 250 watts per channel (500 watts if paralleled), and listen to audio clarity with built-in volume control.
- **Built-in IHF/EIA Testing Components At Your Fingertips:** 2,4,8,16, and 32 ohm-zero reactance loads, and all specified bandpass audio filters.
- **Measure RMS Volts And dB As You Trace Through Circuits:** Plus, programmable dB to measure stage gain.
- **Test Intermittents To Prevent Amplifier Damage:** Built-in DC balance test, automatically opens loads.
- **Test Audio Line Levels To Make Sure The Driver Input Signal Is Correct:** Check turntables, AM tuners, FM tuners, TV stereo demodulator outputs, CD players, etc. for standard line levels.
- **Monitor Stereo Separation To 126 dB:** Monitor, troubleshoot, or align AM-FM or TV Stereo separation circuits.



Walk troubles out of any power amplifier stage, step by step, with the PA81.

SENCORE

3200 Sencore Drive, Sioux Falls, South Dakota 57107

* IHF—Institute Of High Fidelity
EIA—Electronics Industries Association

Call 1-800- SENCORE *(736-2673)*

In Canada Call 1-800-851-8866

CIRCLE 178 ON FREE INFORMATION CARD

Ask About A 10 Day Video Preview

QUICK FIX

Super values on the tools and instruments you need to identify problems, get to them quickly and make repairs easily!

PRECISION HAND-HELD INSTRUMENTS

• Lightweight convenience. Easy to read
• Fast, precise results

B & K Precision Test Bench™

• 41 range voltmeter • Ammeter • Ohmmeter • Frequency counter • Capacitance meter • Logic probe • Transistor & diode tester • Extra-large LCD display

Model 388-HD
Reg. $129.95
Our Price **$119.00**

SCOPE Digital Multimeter

• 11 function, 38 ranges including: Logic Level Detector, Audible and Visual Continuity, Capacitance & Conductance measurements.

Model DVM-638
Reg. $87.50
Our Price **$79.95**

CA-92 Deluxe Padded Case for DVM meters $9.95
TL-216 Transistor and Capacitance Test Leads $9.90

ALL-PURPOSE 92-PC. TOOL CASE

• Complete kit for home, workshop and auto
• Includes 52-pc. socket set with extenders • 2 tool pallets with roomy rear storage compartments • Attractive, rugged carry case.

Model FTK-28
Reg. $169.95
Our Price **$129.95**

DUAL TRACE OSCILLOSCOPES

A.W. SPERRY 20 MHz OSCILLOSCOPE

• Built-in component checker • Z-axis input • Low power consumption • TV Video sync filter • High-sensitivity X-Y mode • Front panel trace rotator • Includes 2 test probes

Model 620C
Our Price **$349.95**
Special Price

HITACHI 35 MHz OSCILLOSCOPE

• 19 calibrated sweeps
• 6″ CRT with internal graticule, scale illumination & photographic bezel • Auto focus • X-Y operation
• TV sync separation
• Includes 2 probes (10:1 and 1:1)

Model V-355
Reg. $899.95
Our Price **$598.00**

ASK FOR YOUR FREE CATALOG

SCOPE ELECTRONICS
260 Motor Parkway
Hauppauge, New York 11788

TOLL FREE 800-648-2626
(In NY State 800-832-1446 Ext. 242)

TELEPHONE ORDERS NOW!

Service & Shipping Charge Schedule Continental U.S.A.

FOR ORDERS	ADD
$25-50	$4.50
$51-100	$5.50
$101-200	$7.00
$201-300	$8.00
$301-400	$9.00
$401-500	$10.00
$501-750	$12.50
$751-1000	$15.00
$1,001-1,250	$17.50
$1,251-1,500	$20.00
$1,501-2000	$25.00
$2,001 and Up	$30.00