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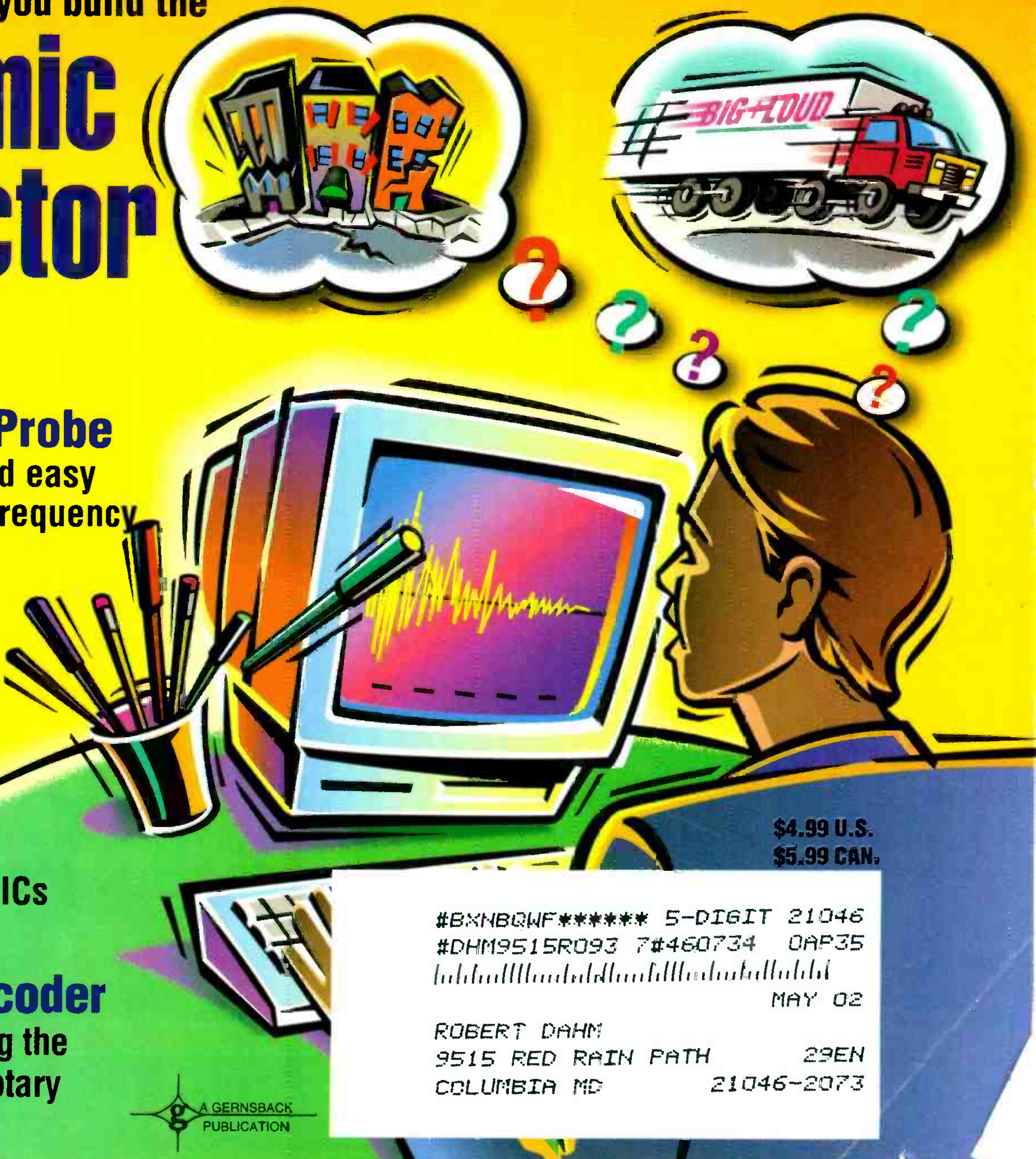

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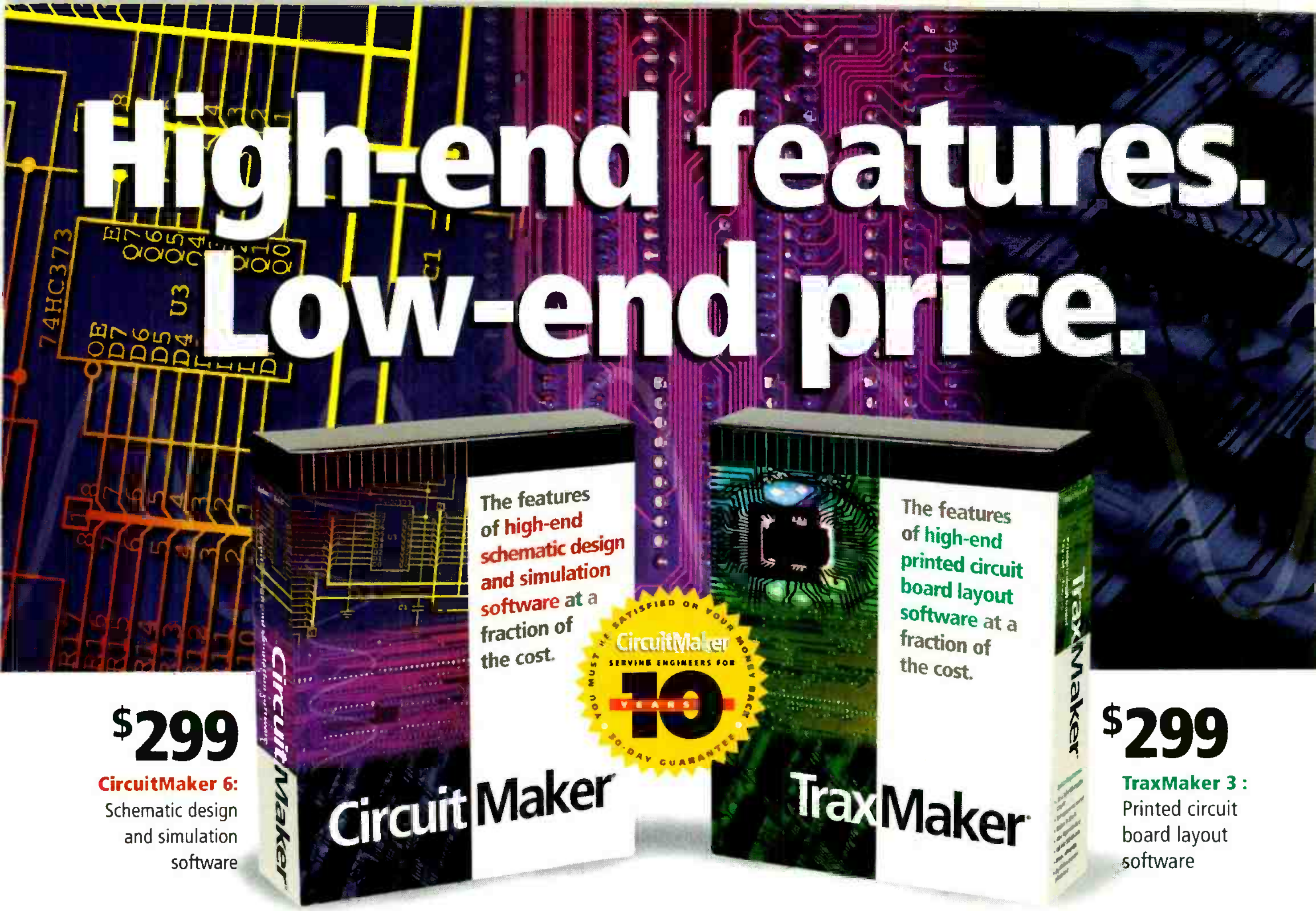

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LETTERS

SEND YOUR COMMENTS TO THE EDITORS OF ELECTRONICS NOW MAGAZINE

Upgrade Update

As author of the article "Controlling Servos From a Computer" (**Electronics Now**, August 1999), I would like to update the article and make a correction.

The correction concerns my e-mail address; it is listed incorrectly in the Part List box. The correct address is rmoro @compuserve.com—note that the first letter was omitted.

The manufacturer of IC1 has upgraded the chip, requiring an update to the software. That software is now on the Gernsback FTP site under the same name (ftp.gernsback.com/pub/EN/itc232.txt). If you are having difficulty with your project, re-download the updated software.

RICARDO MORO-VIDAL

An April Fool Revisited

I read the letter in the August 1999 "Letters" column on the April Fool's article and was reminded of an experience of many years ago. As a young man, say 15, I was reading a then old copy of ***Popular Electronics*** (April) and was truly inspired with an article on "Contra-Polar Energy," which detailed a circuit that would reverse the physical properties of common electrical devices. It was accompanied by a photo of an ice tray filled with ice and sitting on a hot plate, plus various other awe-inspiring photos.

Seeing great potential in this, I promptly wrote a letter to the editors requesting more information. (I am sure that this caused great hilarity when read.) They then sent me a reply explaining the relationship of the article and the issue date, Boy, was my face red upon receiving this much anticipated reply. I still remember the event clearly after some 37 years or so!

Keep up the humor; after all this time when reminded of that event I get a big smile and that tickle of humor down my back.

RICK LANE
Los Lunas, NM

Two-Cents Worth of Soldering Tips

Skip Campisi has authored the best instructions for hand soldering that I have ever seen in his article "How to Succeed In Soldering" (**Electronics Now**, July 1999). However, as an EE and an electronic hobbyist for over 40 years, I would like to add my two-cents worth. First, when working with electrostatic-sensitive semiconductors (as most ICs today are), you must use an iron with a grounded tip. That is why many technicians use a soldering station—they are almost always grounded. I don't know why, but individual pencil irons with a three-wire cord and a grounded tip are hard to find.

An old, old method for keeping an iron from overheating is to rig a circuit with an ordinary light bulb in series with the soldering iron along with a switch that shorts out the lamp. This keeps the iron cool enough to reduce tip oxidation, but still maintains an adequate soldering temperature. The lamp is switched out when heating the iron from a cold start and also whenever extra heat is needed. Standard 120-volt, 25-watt, or 40-watt lamps work well, depending on the wattage of the iron.

Any components that have been lying around in a junk box for a few years are likely to have oxidized leads. Resistor leads seem to be especially vulnerable. Cleaning such leads with a fiberglass brush or a small piece of extra-fine steel wool will reduce the incidence of cold solder joints. Keep up the good work.

MARTEN JENSEN
Redlands, CA

EN

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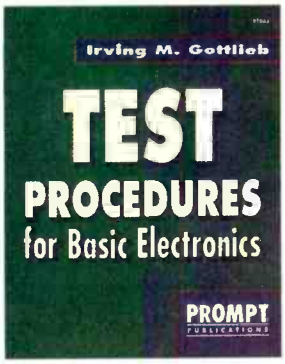

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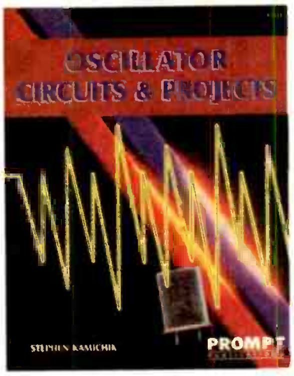

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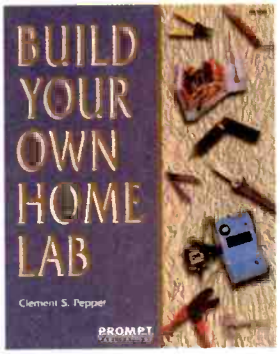

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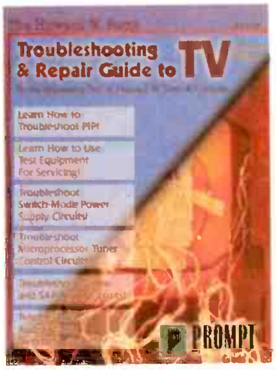

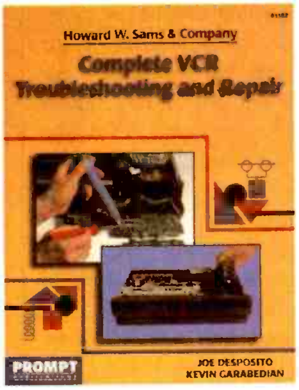

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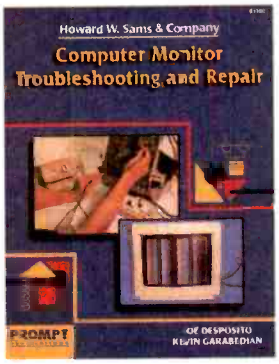

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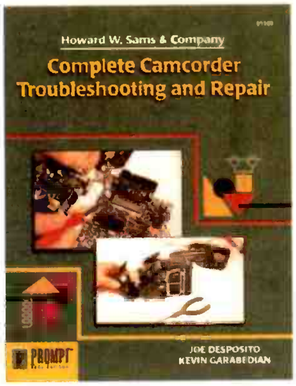

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EQUIPMENT REPORT

OLYMPUS C-2000 ZOOM DIGITAL CAMERA

Digital images swell to 2.1 megapixels with Olympus' new C-2000 Zoom digital camera. Pair it with their P-330 printer for a complete digital-photography solution.

CIRCLE 15 ON FREE INFORMATION CARD

Digital cameras have become good substitutes for traditional film-based cameras because they are now affordable and their image quality is good enough to compete with 35mm film. Well, the good news just keeps getting better as the latest digital camera from Olympus, the C-2000 Zoom, raises the bar for image quality and features set in consumer-priced digital cameras.

C-2000 Zoom

When it needs to be, the Olympus C-2000 Zoom is easy to use. The aluminum-body camera has a completely automatic "program" mode for point-and-shoot users, plus aperture-priority and shutter-priority modes for more advanced users. "Aperture priority" is where the user chooses the best aperture and the camera sets the shutter speed, and "shutter priority" is where the user selects a shutter speed and the camera sets the aperture. Aperture priority allows greater control over depth of field, while shutter priority lets the user select the best shutter speed. Sporting events, for example, generally require fast shutter speeds to capture motion without blurriness. On the other hand, blurriness is sometimes desired, and shutter priority would allow that. Shutter speeds range from fi to 1/800 second.

The C-2000 Zoom digital camera features a 2.1-megapixel CCD that produces images with a maximum resolution of 1600 × 1200. The standard image format is JPEG, with different image sizes and levels of compression available. The C-2000 Zoom can save standard quality (SQ), high-compression JPEG images in 640 × 480 and 1024 × 768 sizes. It can also save high quality (HQ), medium-compression images, or super-high-quality (SHQ), low-compression images, with a size of 1600 × 1200 pixels. The C-2000 Zoom also has a zero-compression, zero-loss TIFF mode for 1600 × 1200 images. Built-in high-speed DRAM provides buffering and allows for sequence shooting of 5 to 45 images in half-second intervals.

The C-2000 Zoom stores images on SmartMedia memory cards, and it comes with one 8-megabyte card. That is enough memory to store up to 122 640 × 480 SQ images or seven 1600 × 1200 SHQ images. The 8 megabytes will store only one 1600 × 1200 TIFF image. You can swap re-usable SmartMedia cards with higher or lower capacities like rolls of film. Except for buffering, the camera has no built-in memory.

The C-2000 Zoom has an all-glass, 8-element 3× zoom lens with a 35mm equivalency of 35 to 105mm and an aperture from f2.0 to f11. The camera also has a digital telephoto feature that works at any optical focal length. The digital telephoto provides 1.6×, 2×, and 2.5× magnification, and when used in conjunction with the optical zoom, the camera provides the equivalent of a 260mm lens. A macro capability allows focusing from as close as eight inches. The C-2000 Zoom also offers the user a choice of 100, 200, or 400 ISO film speed equivalency.

A built-in 1.8-inch LCD lets users review and compose images. Stored images can be inspected at up to 3× magnification, and the area of inspection can be moved as necessary. The C-2000 Zoom also has a video output for viewing stored images on a TV set or for transferring them to videotape. An included remote control allows images to be selected and viewed on a TV while seated at a distance from the camera.

The C-2000 Zoom has a built-in flash with four modes including red-eye reduction, force-fill, low-light/backlight, and force-off. External lighting can be synchronized to the camera, and the automatic metering system can be manually overridden.

Like most digital cameras, the C-2000 Zoom can link to a PC through the serial port. But a much slicker solution is Olympus' optional FlashPath floppy disk adapter. FlashPath looks like a regular floppy disk, but it has a slot on one side that SmartMedia cards slip into. After a quick software installation from an included diskette, a PC will recognize the FlashPath adapter as a floppy disk but with the capacity of the inserted SmartMedia card. Though it isn't terribly fast, FlashPath is an elegant image transferring solution that eliminates the need for any cables.

Olympus SmartMedia cards are specially formatted to allow the camera to lock successive exposure settings to that of the first exposure in a panoramic set of images. The included QuickStitch panorama software is then used to join multiple images together (tall and wide) for impressive panoramic and increased overall image resolution. Adobe PhotoDeluxe image manipulation and creation software is also included with the camera,

(Continued on page 97)

Q & A

READERS' QUESTIONS, EDITORS' ANSWERS

CONDUCTED BY MICHAEL A. COVINGTON, N4TMI

One-RPM Stepper

Q *For an astronomical instrument, I need to make a stepper motor turn at exactly 1 revolution per minute (rpm). The motor is a Mitsumi M68SP-4 unit with six wires. It moves in 1.8-degree steps. How do I do this?—M. McA., Tucson, AZ*

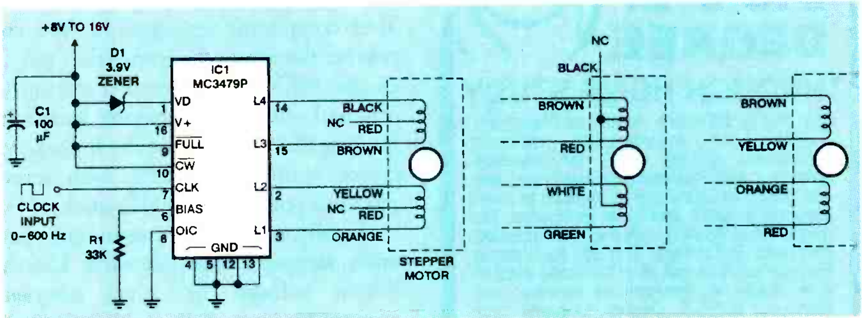


FIG. 1—MOTOROLA'S MC3479P CAN BE USED to drive most 4-, 5-, and 6-wire stepper motors with a minimum of additional components. To be on the safe side, don't assume your motor's wire colors match what's shown here; check things out with an ohmmeter to be sure.

A Your letter explains that you're building a "barn-door tracker," a simple gadget that lets you take long-exposure photographs of the stars by compensating for the earth's rotation. It consists of two pieces of wood, hinged together, with the axle of the hinges pointed toward Polaris and therefore parallel to the earth's axis. The hinges gradually swing open at an angular rate equal to the earth's rotation as the wooden panels are pushed apart by 20-thread-per-inch screw rotating at 1 rpm and positioned exactly 290mm from the hinge axle. Naturally, the device can only open up a few degrees before you have to reset the screw, but that's enough for a time exposure of five or ten minutes. For details, see *Astrophotography for the Amateur*, by Michael Covington, 1999 edition, pp. 120-121, or do a Web search for "barn-door tracker" or "Scotch mount."

Most people turn the handle of a barn-door tracker by hand, but you've elected to use a stepper motor. Accordingly, this is a two-part question: how to run a stepper motor, and how to get the desired speed. Let's tackle the second part first.

A stepper motor turns when its windings are energized in a specific sequence, and by far the easiest way to do this is to use a stepper motor driver chip such as the Motorola MC3479P (see Fig. 1). This chip moves the motor in either full or half steps depending on whether pin 9 is connected to V+ or to ground. Each step is triggered in turn by a clock pulse on pin 7.

Since your motor makes 1.8-degree steps, it needs 200 pulses (or, in half-step mode, 400 pulses) to make a complete circle. A frequency of 400 cycles per minute equals 6.667 cycles per second (Hertz). Accordingly, the second part of the task is to generate a precise 6.667-Hz clock signal.

That was the challenging part. The easy way would be to program a microcontroller to count the appropriate number of microseconds for each cycle. However, you requested a design using off-the-shelf parts, and after trying lots of combinations I came up with the quartz-controlled circuit in Fig. 2. Here a standard 4.9152-MHz microprocessor crystal is used with a CD4060 (MC14060) CMOS oscillator-divider, which divides it down to 600 Hz. Then two CD4017 (MC14017) decade counters divide the frequency by 9 and by 10, respectively. The output is a 6.667-Hz square wave.

Several cautionary notes: In the oscillator-divider circuit, don't use 74HC chips (74HC4060, 74HC4017) unless you're using a regulated 5-volt supply. In the motor circuit, the MC3479P can handle a maximum of 350 mA; for heavier currents than that, you need a similar but slightly different chip, the SAA1042A, described in this column in August 1996.

The color code for stepper-motor wires seems to vary haphazardly, so use an ohmmeter to check out your particular motor before hooking it up. If the windings have center taps (yours do),

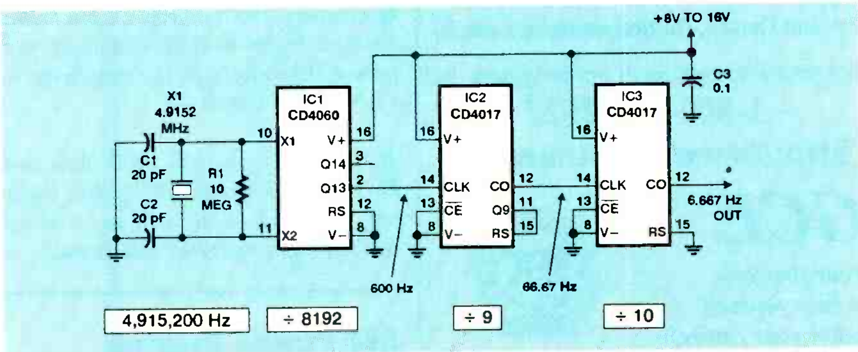


FIG. 2—THIS CIRCUIT GENERATES a precise 6.667-Hz clock signal using off-the-shelf components. The 4.1952-MHz crystal (X1) is used in many microprocessor circuits and is easy to find.

leave them unconnected. If the motor turns the wrong way, reverse the connections to one of the windings. With a motor that moves in 3.6-degree steps (100 steps or 200 half-steps per full circle), you'll need to cut the clock speed in half; you can do this by feeding IC2 from pin 3 of IC1 instead of pin 2.

You may want to implement a "fast reverse" mode for backing the screw out after completing an exposure. You can reverse the motor by connecting pin 10 of the MC3479P to ground instead of V+, and you can get higher speeds by feeding IC2 from one of the higher-frequency outputs of IC1 (try each output pin until you find a suitable one).

Finally, note that in continuous operation, stepper motors get warm. Use the lowest voltage that gives adequate torque. You can reduce the voltage to the motor by including some silicon rectifiers (1N4001 or equivalent) in series with the power supply; each one takes off about 0.7 volt, and they also protect against an accidentally reversed battery.

The MC3479P and some motors that work well with it are available from Jameco, 1355 Shoreway Road, Belmont, CA 94002; Tel: 800-831-4242; Web: www.jameco.com. Suitable motors are very common in junked printers and the like; it may be that all you need is the chip. The ECG1857 and NTE1857 are exact substitutes for the MC3479P.

To learn more about stepper motors, see "Robotics Workshop" in **Popular Electronics**, July 1999, pp. 64—66, 70 (available from our Reprint Bookstore) and Doug Jones' stepper motor FAQ on the Web at www.cs.uiowa.edu/~jones/step.

Audio Transformer Query

Q *I'd like to build the intercom in your February, 1997, issue, p. 14, but I cannot locate an 8-ohm-to-1000-ohm audio transformer. Where can I get this transformer?—G. N. K., Ft. Worth, TX*

A Use RadioShack's 1000-ohm-to-8-ohm transformer (273-1380), reversing the roles of the primary and secondary. That will work just as well.

AM Stereo Wanted

Q *Is there a circuit or a chip that will add AM stereo capability to an existing AM radio?—R. A. H., Lancaster, OH*

A Somehow, AM stereo has never been the commercial success that was predicted, perhaps because the talk-radio boom came along at about the same time. But it hasn't died out, either.

We published an AM stereo conversion circuit in our January 1984 issue, pages 41—46, 102, and 114 (see also the May 1984 issue, p. 20). It used a Motorola MC13020P chip, which is going out of production and may be hard to find.

You can buy a wide range of AM stereo receivers and tuners from AM Stereo Works (1555 State Road 207, St. Augustine, FL 32086; Tel: 904-810-5140; Web: www.stereoam.com). They have conversion kits for existing receivers, but they are fairly expensive (about $90); they can also convert your radio for you.

Pager Transmitter?

Q *Is there a way to rig a 9-volt transmitter to directly activate my pager (without going through the telephone lines or my pager company) when a motion detector is triggered?—H.E.R., Shell Beach, CA*

A It doesn't sound easy. You'd have to mimic the activation code sent to your pager by the pager company, which may be a fairly complicated signal. Consider using a separate receiver (such as a pocket FM radio) and building one of the FM transmitters in **Popular Electronics**, July 1999, pp. 37—42 . On using your PC to generate the digital codes used by pagers, see **Electronics Now**, February 1998 issue, pp. 42—45.

Parallel 4049s; Another Chip Quest

Q *Is it possible to connect two or more elements of the MC14049 (CD4049) buffer/inverter chip to increase the drive and sink capability?*

Also, I would appreciate any information you can give me about the BTS629 7-pin automotive dimmer chip.—S. B., Missisauga, Ont., Canada

A Your first question is easy: Yes, CMOS inverters (including units of the 4049) can be paralleled to increase their output current capacity. Connect inputs together and outputs together. I have sometimes paralleled all six gates for this purpose.

I wasn't able to track down the BTS629. The BTS prefix suggests it may be a Siemens (now Infineon) product, but it is not in their current product listing. Their BTS630 sounds like what you're asking about; it is a 7-pin, TO-220-packaged power controller that uses pulse-width modulation. That is, it switches the power on and off very rapidly, varying the percentage of the time that it is on. You can get a data sheet from Infineon's web site (www.infineon.com) or by writing to Infineon Technologies AG, P.O. Box 800949, 81609 Munich, Germany. They can also refer you to Infineon distributors in your area.

Infrared Link

Q *I need to increase the range of an infrared-linked computer and printer. Is it possible to transmit infrared over a fiber-optic cable? Is it possible to increase the range of the IR relay in your Fall 1994* **Electronics Hobbyists' Handbook**?—*G. R., Anchorage, AK*

A Using a fiber-optic cable sounds like the easiest solution; infrared signals should pass through it just fine. (If you try this, write again and let us know how well it worked.) As for the repeater circuit, you can place the LEDs a long way from the rest of the device, connected by speaker wire. But first make sure the repeater will work with your computer. Infrared data signals are chopped (switched on and off) at a high frequency (around 40 kHz), to distinguish them from other sources of infrared light, and your computer may not be using the same frequency as a TV remote control.

HOW TO GET INFORMATION ABOUT ELECTRONICS

On the Internet: See our Web site at http://www.gernsback.com for information and files relating to our magazines (**Electronics Now** and **Popular Electronics**) and links to other useful sites.

To discuss electronics with your fellow enthusiasts, visit the newsgroups sci. elec tronics.repair, sci.electronics.components, sci.electronics.design, and rec.radio. amateur.homebrew. "For sale" messages are permitted only in rec.radio.swap and misc.industry.electronics.marketplace.

Many electronic component manufacturers have Web pages; see the directory at http://www.hitex.com/chipdir/, or try addresses such as http://www.ti.com and http://www. motorola.com (substituting any company's name or abbreviation as appropriate). Many IC data sheets can be viewed online. www.questlink.com features IC data sheets and gives you the ability to buy many of the ICs in small quantities using a credit card. You can also get detailed IC information from www.icmas ter.com, which is now free of charge although it formerly required a subscription. Extensive information about how to repair consumer electronic devices and computers can be found at www.repair faq.org

Books: Several good introductory electronics books are available at RadioShack, including one on building power supplies.

An excellent general electronics textbook is *The Art of Electronics*, by Paul Horowitz and Winfield Hill, available from the publisher (Cambridge University Press, 1-800-872-7423) or on special order through any bookstore. Its 1125 pages are full of information on how to build working circuits, with a minimum of mathematics.

Also indispensable is *The ARRL Handbook for Radio Amateurs*, comprising 1000 pages of theory, radio circuits, and ready-to-build projects, available from the American Radio Relay League, Newington, CT 06111, and from ham-radio equipment dealers.

Copies of past articles: Copies of past articles in **Electronics Now** and **Popular Electronics** (post 1994 only) are available from our Claggk, Inc., Reprint Department, P.O Box 4099, Farmingdale, NY 11735; Tel: 516-293-3751.

Electronics Now and many other magazines are indexed in the *Reader's Guide to Periodical Literature*, available at your public library. Copies of articles in other magazines can be obtained through your public library's interlibrary loan service; expect to pay about 30 cents a page.

Service manuals: Manuals for radios, TVs, VCRs, audio equipment, and some computers are available from Howard W. Sams & Co., Indianapolis, IN 46214 (1-800-428-7267). The free Sams catalog also lists addresses of manufacturers and parts dealers. Even if an item isn't listed in the catalog, it pays to call Sams; they may have a schematic on file which they can copy for you.

Manuals for older test equipment and ham radio gear are available from Hi Manuals, PO Box 802, Council Bluffs, IA 51502, and Manuals Plus, PO Box 549, Tooele, UT 84074.

Replacement semiconductors: Replacement transistors, ICs, and other semiconductors, marketed by Philips ECG, NTE, and Thomson (SK), are available through most parts dealers (including RadioShack on special order). The ECG, NTE, and SK lines contain a few hundred parts that substitute for many thousands of others; a directory (supplied as a large book and on diskette) tells you which one to use. NTE numbers usually match ECG; SK numbers are different.

Remember that the "2S" in a Japanese type number is usually omitted; a transistor marked D945 is actually a 2SD945.

Hamfests (swap meets) and local organizations: These can be located by writing to the American Radio Relay League, Newington, CT 06111; (http://www.arrl.org). A hamfest is an excellent place to pick up used test equipment, older parts, and other items at bargain prices, as well as to meet your fellow electronics enthusiasts—both amateur and professional.

Ultrasonic Listener Found

Q *In the July issue, a reader asked for plans for an ultrasonic listening device.* **Popular Electronics** *has had at least two that I know of, one in the December 1994 issue (pp. 74—75) and one in February 1989 (pp. 46—48, 103).—Mick Palmer, by e-mail*

A Thanks! The 1989 project does exactly what the reader requested.

Writing to Q&A

As always, we welcome your questions. The most interesting ones are answered in print. Please be sure to:

(1) include plenty of background information (we'll shorten your letter for publication);

(2) give your full name and address on your letter (not just the envelope);

(3) type your letter if possible, or write very neatly; and

(4) if you are asking about a circuit, include a complete diagram.

Questions can be sent to Q&A, **Electronics Now** Magazine, 500 Bi-County Blvd., Farmingdale, NY 11735, or e-mailed to q&a@gernsback.com, but please do not expect an immediate reply (because of our backlog) and please don't send graphics files larger than 100K. Due to the volume of mail, we regret that we cannot give personal replies. EN

BY SAM GOLDWASSER
SERVICE EDITOR

Testing Semiconductors

THIS MONTH WE WILL TAKE A BREAK FROM HEAVY TROUBLESHOOTING TO GO OVER SOME OF THE BASIC TECHNIQUES FOR TESTING OF COMMON SEMICONDUCTORS. WHILE FANCY TRANSISTOR TESTERS AND CURVE TRACERS HAVE THEIR place, when you just want to know if your horizontal output transistor is toast or not they can be more trouble than they are worth. Most (though not all) failures of diodes, transistors, SCRs, and so forth, result in unambiguous changes to the device parameters that can be found with very simple tests typically using a DMM or VOM, a power supply, and a few resistors.

In most cases, these simple tests will identify bad silicon transistors. Gain, frequency response, etc., are not addressed here. While the tests can be applied to germanium devices, these are more likely to change characteristics, it would seem, without totally failing.

Safety Considerations

None of the tests described here require probing live circuits. However, before touching, probing, or unsoldering any component, make sure the equipment is unplugged and any large capacitors have been safely discharged. Not only can coming in contact with a live circuit or charged capacitor ruin your day, but your test equipment could be damaged or destroyed as well.

VOMs and DMMs

Analog and digital meters behave quite differently when testing nonlinear devices like diodes and transistors. For example, it is important to remember that an analog VOM on the lowest resistance range could put out too much current for smaller devices, possibly damaging them. Ironically, this is more likely with better meters like the Simpson 260, which can test to lower ohms (×1 scale). Use the next higher resistance range in this case or a DMM, as those never drive the device under test with significant current. However, this can result in false readings as the current may be too low to adequately bias the junctions of some power devices or devices with built-in resistors.

Testing Diode Junctions with a Multimeter

On the (analog) VOM, use the low ohms scale. A regular signal diode or rectifier should read a low resistance (typically ⅔ scale or a couple hundred ohms) in the forward direction and infinite (nearly) resistance in the reverse direction. It should not read near 0 ohms (shorted) or open in both directions. A germanium diode will result in a higher scale reading (lower resistance) due to its lower voltage drop.

For the VOM, you are measuring the resistance at a particular (low current) operating point—this is not the actual resistance that you will see in a power rectifier circuit, for example.

On a (digital) DMM, there will usually be a diode-test mode. Using this, a silicon diode should read between 0.5 to 0.8 V in the forward direction and open in reverse. For a germanium diode, it will be lower, perhaps 0.2 to 0.4 V or so in the forward direction. Using the normal resistance ranges—any of them—will usually show open for any semiconductor junction since the meter does not apply enough voltage to reach the value of the forward drop. Note, however, that a defective diode may indeed indicate a resistance lower than infinity especially on the highest ohms range. So, any reading of this sort would be an indication of a bad device but the opposite is not guaranteed.

Note: For a VOM, the polarity of the probes is often reversed from what you would expect from the color coding—the red lead is negative with respect to the black one. DMMs usually have the polarity as you would expect it. Confirm this using a known diode as a reference. Also, "calibrate" your meter with both silicon and germanium semiconductors so you will know what to expect with an unknown device.

Transistor Testing Methodology

As with diode junctions, most digital meters show infinite resistance for all six

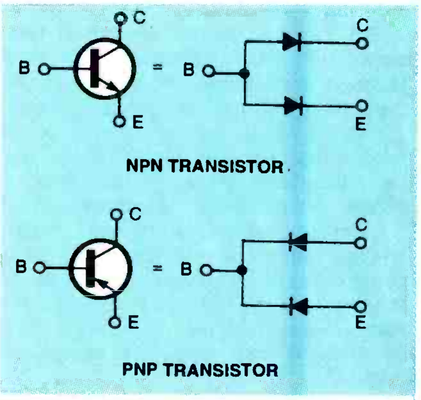


FIG. 1—A BIPOLAR TRANSISTOR can be modeled using diodes.

combinations of junction measurements since their effective resistance-test voltage is less than a diode junction drop (if you accidentally get your skin involved it will show something between 200K and 2M ohms). The best way to test transistors with a DMM is to make use of the "diode-test" function, which will be described after we talk about testing with an analog meter. Regardless of whether you test with an analog or digital meter, if you read a short circuit (0 ohms or voltage drop of 0) or the transistor fails any of the readings, it is bad and must be replaced. This discussion is for **out-of-circuit** transistors **only**.

One exception to this occurs with some power transistors, which have built-in diodes (damper diodes reverse connected across the C-E junction) and resistors (B-E, around 50 ohms) that will confuse these readings. If you are testing a transistor of this type—horizontal output transistors are the most common example—you will need to compare with a known good transistor or check the specifications to be sure. There are some other cases as well. So, if you get readings that do not make sense, try to confirm with a known good transistors of the same type or with a spec sheet.

Before testing an unknown device, it is best to confirm and label lead polarity (of voltage provided in resistance or diode test mode) of your meter whether it be an analog VOM or digital DMM using a known good diode (*e.g.*, 1N4007 rectifier or 1N4148 signal diode) as discussed below. This will also show you what to expect for a reading of a forward-biased junction. If you expect any germanium devices, you should do this with a germanium diode as well (*e.g.*, 1N34).

Note that this discussion assumes that a transistor can be tested for shorts, opens, or leakage, as though it is just a pair of connected diodes. The equivalent diode circuits for NPN and PNP bipolar transistors are shown in Fig. 1.

Obviously, simple diodes can be tested as well using this technique. However, LEDs (their forward drop is too high for most meters) and Zeners (their reverse breakdown—Zener voltage—is too large for most meters) cannot be fully tested in this manner. Those and other types of devices are discussed later in this article.

Testing With an Analog VOM

For NPN transistors, lead "A" is black and lead "B" is red; for PNP transistors, lead "A" is red and lead "B" is black (Note: This is the standard polarity for resistance, but many multimeters have the colors reversed since this makes the internal circuitry easier to design; if the readings don't jive this way, switch the leads and try it again). Start with lead "A" of your multimeter on the base and lead "B" on the emitter. You should get a reasonable low resistance reading. Depending on scale, this could be anywhere from 100 ohms to several thousand ohms. The actual value is not critical as long as it is similar to the reading you got with your "known good diode test" above. All silicon devices will produce somewhat similar readings and all germanium devices will result in similar but lower resistance readings.

Now move lead "B" to the collector. You should get nearly the same reading. Now try the other four combinations, and you should get a reading of infinite ohms (open circuit). If any of those resistances is wrong, replace the transistor. Only two of the six possible combinations should show a low resistance; none of the resistances should be near 0 ohms (shorted).

As noted above, some types of devices include built-in diodes or resistors, which can confuse these measurements.

Testing With a Digital DMM

Set your meter to the diode test. Connect the red meter lead to the base of the transistor. Connect the black meter lead to the emitter. A good NPN transistor will read a junction drop voltage of between 0.45v and 0.9v. A good PNP transistor will read open. Leave the red meter lead on the base and move the black lead to the collector. The reading should be the same as the previous test. Reverse the meter leads in your hands and repeat the test. This time, connect the black meter lead to the base of the transistor. Connect the red meter lead to the emitter. A good PNP transistor will read a junction drop voltage of between 0.45 V and 0.9 V. A good NPN transistor will read open. Leave the black meter lead on the base and move the red lead to the collector. The reading should be the same as the previous test. Place one meter lead on the collector, the other on the emitter. The meter should read open. Reverse your meter leads. The meter should read open. This is the same for both NPN and PNP transistors.

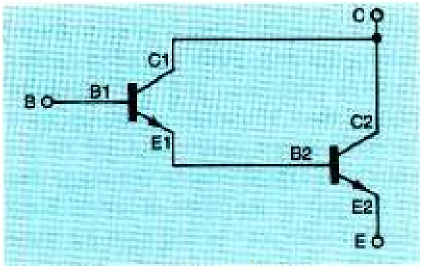


FIG. 2—A DARLINGTON TRANSISTOR is two transistors within a single package and is connected as shown here.

Again, as noted, some transistors will have built-in diodes or resistors which can confuse these readings.

Testing Power Transistors

Power transistors without internal damper diodes test just about like small signal transistors using the dual diode model, high in one direction, either B-E or B-C. If there is a built-in damper diode, it is across C-E junction and is back biased under normal operating conditions. Therefore, a reading between C-E will also test low in one direction and B-C will show a double diode drop in the reverse direction.

Also, there is often a low value resistor—about 50 ohms—between B-E when there is a built-in damper. This will show up as a nearly zero-volt junction drop on the diode test scale of a DMM, but such a reading does not indicate a bad part. Use the resistance scale to confirm.

Testing Darlington Transistors

A Darlington transistor—see Fig. 2—is a special type of configuration usually consisting of 2 transistors fabricated on the same chip or at least mounted in the same package. Discrete implementations as well as Darlingtons with more than 2 transistors are also possible.

In many ways, a Darlington configuration behaves like a single transistor where:

- the current gains of the individual transistors it is composed of are multiplied together and,
- the B-E voltage drops of the individual transistors it is composed of are added together.

Darlingtons are used where drive is limited and the high gain—typically over 1000—is needed. Frequency response is not usually that great, however.

Testing a Darlington with a VOM or

DMM is basically similar to that of normal bipolar transistors, except that in the forward direction, B-E will measure higher than a normal transistor on a VOM (but not open), and 1.2 to 1.4 volts on a DMM's diode-test range due to the pair of junctions in series. Note that 1.2 volts may be too high for some DMMs, and thus a good Darlington may test open—confirm that the open circuit reading on your DMM is higher than 1.4 volts or check with a known good Darlington.

Testing Digital or Bias Resistor Transistors

Occasionally you may find a transistor that includes an internal bias resistor network attached to the base and emitter so that it can be driven directly from a digital (e.g., TTL) source; see Fig. 3. These may be used in consumer elec-

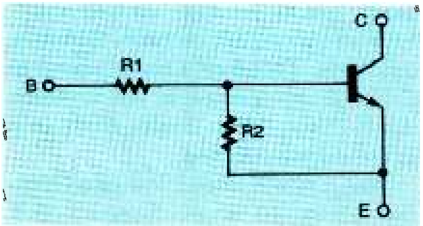


FIG. 3—AN INTERNAL BIAS RESISTOR is sometimes present to allow a transistor to be driven directly from a TTL-level signal.

tronics equipment where space is critical, or for no good reason other than to make it difficult to locate a suitable replacement device!

The addition of R1 makes testing with a multimeter other than for shorts more difficult. With a VOM, you should see a difference in the B-E and B-C junctions in the forward and reverse directions. However, a DMM will probably read open across all pairs of terminals.

Testing Zener Diodes

The following applies to both testing of Zeners for failure and determining the ratings of an unknown device:

With a VOM, a good Zener diode should read like a normal diode in the forward direction and open in the reverse direction unless the VOM applies more than the Zener voltage for the device. A DMM on its diode test range may read the actual Zener voltage if it is very low (*e.g.*, a couple of volts) but will read open otherwise. The most common failure would be for the device to short—read 0.0 ohms in both direc-

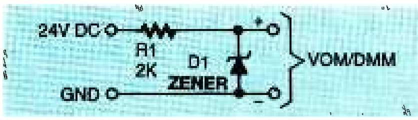


FIG. 4—USE THIS CIRCUIT to test Zener diodes.

tions. Then, it is definitely dead!

Some Zeners are marked with a JEDEC (1N) part number, others with a couple of colored bands (*e.g.*, for 18 volts the bands would be brown and gray), or a house number or house color code.

You can easily test a Zener and identify its voltage rating with a DC power supply, resistor, and multimeter. You will need a power supply (a DC wall adapter or AC wall adapter with a rectifier and filter capacitor is fine) greater than the highest Zener voltage you want to test. Select a resistor that will limit current to a few mA. For example, for Zeners up to about 20 V, you can use the circuit in Fig. 4. This same approach applies to other devices that exhibit a similar behavior, such as the B-E junction of a bipolar transistor.

Testing Unijunction and Programmable Unijunction Transistors

Unijunction Transistors (UJTs) and Programmable Unijunction Transistors (PUTs) are used in similar sorts of circuits, though the UJT is all but extinct. They both exhibit a negative resistance characteristic and can be used easily in low to medium frequency free-running relaxation oscillators and other trigger type circuits.

The UJT (see Fig. 5) goes into heavy conduction from E to B1 when E becomes more positive than a critical trigger voltage, $V_T = n \times V_{BB} + 0.6$. (Note, n, the "intrinsic standoff voltage," is typically about 0.6.) It continues to conduct until the emitter current drops

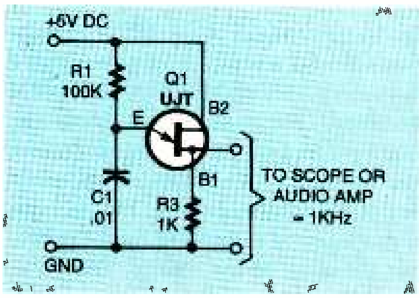


FIG. 5—UNIJUNCTION TRANSISTORS are not that common these days, but if you come across one this circuit can be used to test it.

below some minimum 'valley current' value. (Sounds sort of like a thyristor, right?)

The PUT (see Fig. 6) is even more like a thyristor in that the triggering takes place when the G terminal becomes more positive than the A (probably plus a diode drop, 0.6 V) so that the threshold voltage can now be set with a voltage divider feeding the anode.

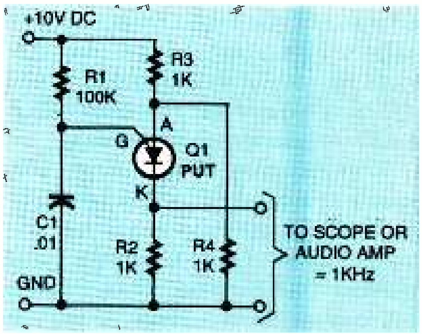


FIG. 6—A CIRCUIT FOR TESTING programmable unijunction transistors (PUTs) is shown here.

Then, current flows from the G to the K terminal. Note that its leads are even labeled like an SCR, but it behaves sort of backwards!

For an initial test, check between B1 and B2 (UJT) or A and K (PUT) with an ohmmeter. The resistance should be the same in both directions and typically a few thousand ohms or more. A short or wildly different readings would indicate a bad device. This doesn't prove that the device is good—only that it hasn't blown up. A more complete test requires a simple circuit and some means of detecting an audio output signal. For the UJT, use the set up in Fig. 5; for the PUT, an additional voltage divider (R3 and R4) is needed to set the threshold as shown in Fig. 6.

Testing SCRs and Triacs

Next, let's deal with testing various types of thyristors. For SCRs, the gate to cathode should test like a diode (which it is) on a multimeter. The anode to cathode and gate to anode junctions should read open. For Triacs, the gate to main terminal 2 (MT2) should test like a diode junction in both directions. MT1 to MT2 and the gate to MT1 junctions should read open. For diacs and sidacs, there is no gate terminal—resistance should be infinite in both directions.

Note: Some thyristors will have a low G-K/MT2 resistance but it should not read as a short.

The real test is quite simple but will

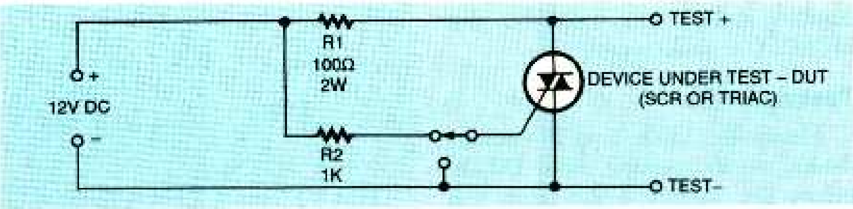


FIG. 7—IN THIS SCR/TRIAC test circuit, R1 limits current to the device under test, and R2 limits current to its gate.

require a low voltage DC power supply and two resistors. For Triacs, a negative output from the supply is also desirable to test the triggering when the gate is negative.

To test SCRs or Triacs, use the circuit shown in Fig. 7. There, R1 is used to limit current through the device and R2 is used to limit current to the gate. The 12-VDC supply should be capable of currents to at least 200 mA. Note that R1 calls for a unit with a 2-watt rating; a /-watt unit should be sufficient for R2. Those ratings should work for testing most small to medium power devices. Check the "minimum gate current" and "holding current" specs to be sure. For larger devices, R1 and/or R2 might need to be smaller.

Here's the procedure:

1. Connect the supply as shown.
2. Trigger the gate from the positive of the supply through the current limiting resistor (R2) and see that the DUT turns on and stays on when the gate is disconnected.
3. Open the circuit to the anode (with the gate connected to the cathode) and again reconnect the anode resistor. The DUT should now be off again.
4. For Triacs, repeat steps (2) and (3) with R2 supplied from a negative voltage.

If the device passes these tests, it is behaving properly and is probably functional. However, without applying full voltage or current, there is no way of knowing if it will meet all specifications.

You can replace the DC supply with a low voltage power transformer (say, 12 VAC). Use a scope to monitor the voltage across the DUT or R1. Then, when the gate is connected to R2, you should see the voltage across the DUT drop to nearly zero when it switches on partway through the positive cycle. This phase will be determined by the voltage and value of R2. It should remain off for the entire negative cycle (SCRs only) with the gate connected and remain off all the time with the gate connected to the cathode.

Testing Diacs and Sidacs

Diacs and Sidacs are thyristors without a gate terminal. They depend on the leakage current to switch them on once the voltage across the device exceeds their specified ratings. With an ohmmeter, they can be tested only for shorts. Resistance should be infinite in both directions.

However, you can test a diac or sidac with a resistor, variable power supply (you will need at least the rating of the device), and a DMM. Hook them in series as shown in Fig. 8 and monitor across the device. With care, your variable supply can be a Variac, a 1N4007 diode, and 1 µF, 200 V capacitor as shown. The 47,000-ohm resistor (R1) is used to limit the current:

CAUTION: This circuit is not isolated from the power line. I recommend using an isolation transformer between the variable voltage source (Variac) and the power line for safety. If the DUT is rated at more than about 180 volts, you will need to use a doubler and higher-voltage capacitor, but testing is otherwise similar.

As you increase the input, the voltage on the DUT will track it until the rated voltage, at which point it will drop abruptly to zero and stay there until the voltage is reduced below its holding current. Repeat with the opposite polarity.

With a scope, testing is even easier as you can use an AC supply directly (remove D1 and C1) and observe that the DUT will turn on at the proper voltage on both polarities of the AC waveform and stay on until the voltage crosses 0. But, again, use an isolation transformer for safety.

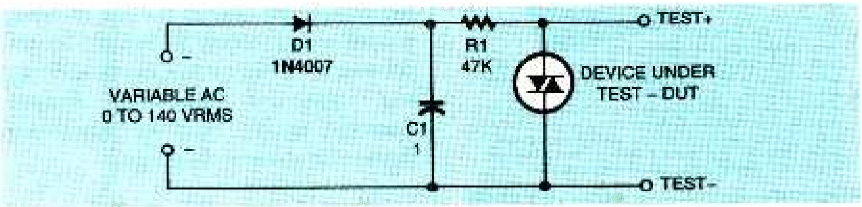


FIG. 8—A DIAC OR SIDAC is a thyristor without a gate. Use this circuit to test one.

Identifying Unknown Bipolar Transistors

The type (NPN or PNP) and lead arrangement of unmarked transistors can be determined using a multimeter and the back-to-back diode model discussed earlier. The collector and emitter can be identified based on the fact that the doping for the B-E junction is always much higher than for the B-C junction. Therefore, the forward voltage drop will be very slightly higher—this will show up as a couple of millivolts (sometimes more) difference on a DMM's diode-test scale or a slightly higher resistance on an analog VOM.

To determine the lead arrangement, label the pins on the unknown device 1, 2, and 3. Put the positive probe (as determined previously) of your multimeter on pin 1. Now, measure the resistance (VOM) or diode drop (DMM) to the other two pins. If the positive probe is on the base of a good NPN transistor, you should get low resistance readings or a low diode drop to the other two leads. The B-C resistance or diode drop will be just slightly lower than the B-E reading.

If one or both measurements to the other two pins is high, put the positive probe on pin 2 and try again. If still no cigar, try pin 3.

If this still doesn't work, you may have a PNP transistor—repeat with the negative probe as the common pin.

If none of the six combinations yields a pair of low readings—or if more than one combination results in a pair of low readings, your transistor is likely bad—or it is not a bipolar transistor at all!

As noted, some power transistors have built-in base resistors or damper diodes and will confuse these measurements. However, the lead arrangement of these types of transistors is usually self-evident (standard TO3, TOP3, or TO220 cases). There are also some transistors with series base resistors that may prove confusing. These are relatively rare, however.

Testing MOSFETs

Verify that the gate has infinite resistance to both drain and source. There is one exception to that: FETs with protection circuitry may act like there is a Zener shunting the gate and source terminals (*i.e.*, diode drop for gate reverse bias, about 20-volts breakdown in forward bias).

Connect the gate to the source. The drain to source junction should act like a diode.

Forward bias the gate-source junction with about 5 volts. The drain-source junction in forward bias should measure very low resistance. In reverse bias, it will still act like a diode.

The usual failure mode you are likely to see with these devices is both a gate-source and drain-source short: In other words, everything connected together. Also, when handling these devices remember that MOSFETs are static sensitive!

Testing LEDs

Electrically, LEDs (and IR-emitting diodes, strictly speaking called IREDs) behave like ordinary diodes except that their forward voltage drop is higher. Typical values are IR: 1.2 volts; Red: 1.85 volts; Yellow: 2 volts; and Green: 2.15 volts. The new blue LEDs will be somewhat higher (perhaps 3 volts). These voltages are at reasonable forward current. Depending on the actual technology (*i.e.*, compounds like GaAsP, GaP, GaAsP/GaP, GaAlAs, etc.), actual voltages can vary quite a bit. For example, the forward voltage drop of red LEDs may range at least from 1.5 to 2.1 volts. Therefore, LED voltage drop is not a reliable test of color, though multiple samples of similar LEDs should be very close. Obviously, if the device is good, it will also be emitting light when driven in this way if the current is high enough.

You can test for shorts and opens with a multimeter (but it must be able to supply more than the forward voltage drop to show a non-open condition). However, an LED can be weak and still pass the electrical tests, so checking for output is still necessary. Therefore, even if these tests don't find a problem, drive the LED from a DC supply and appropriate current-limiting resistor and observe the output. For the IR types, you will need a suitable IR detector. See the document: "Notes on the Troubleshooting and Repair of Hand-Held Remote Controls" on my Web site (www.repairfaq.org) for a variety of options.

Testing Optoisolators and Photo-Interrupters

Both of these classes of components are basically similar: a light source (usually an IR LED) and photodetector together in a single package. The optoisolator will be totally sealed with adequate separation between the two parts to provide the specified isolation voltage rating. The photo-interrupter (and similar devices) will provide a beam path that can be blocked or otherwise modified by external means.

For both types, the photodetector can be a photodiode, phototransistor, photothyristor, or another more complex device or circuit. Refer to an optoelectronics databook or the catalog of a large electronics distributor for specific pinouts and specifications.

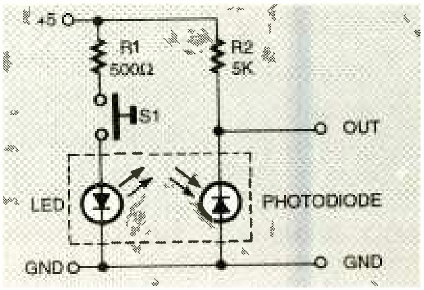


FIG. 9—A SIMPLE CIRCUIT for testing opto-isolators.

Assuming a photodiode or phototransistor type (most common), these can be tested for basic functionality pretty easily. Wire up the test circuit shown in Fig. 9. Depressing S1 should result in the output dropping from +5 volts to close to 0. For monitoring on a scope, drive the LED with a pulse generator and current-limiting resistor instead of S1. With a photo-interrupter type, blocking or adding a reflector to the optical path (as appropriate) should result in similar behavior.

Testing Thermistors

There are two types of thermistors: Positive Temperature Coefficient (PTC) types have a resistance that increases with increasing temperature. Negative Temperature Coefficient (NTC) types have a resistance that decreases with increasing temperature.

For a small thermistor, put an ohmmeter on it and heat the device under test with a blow dryer, heat gun, or the tip of a soldering iron—the resistance should change smoothly (up or down depending on whether it is PTC or NTC type). If the resistance changes erratically or goes to infinity or zero, the device is bad. However, you will need specifications, temperature measuring sensors, etc., to really determine if it is operating correctly.

Wrap-Up

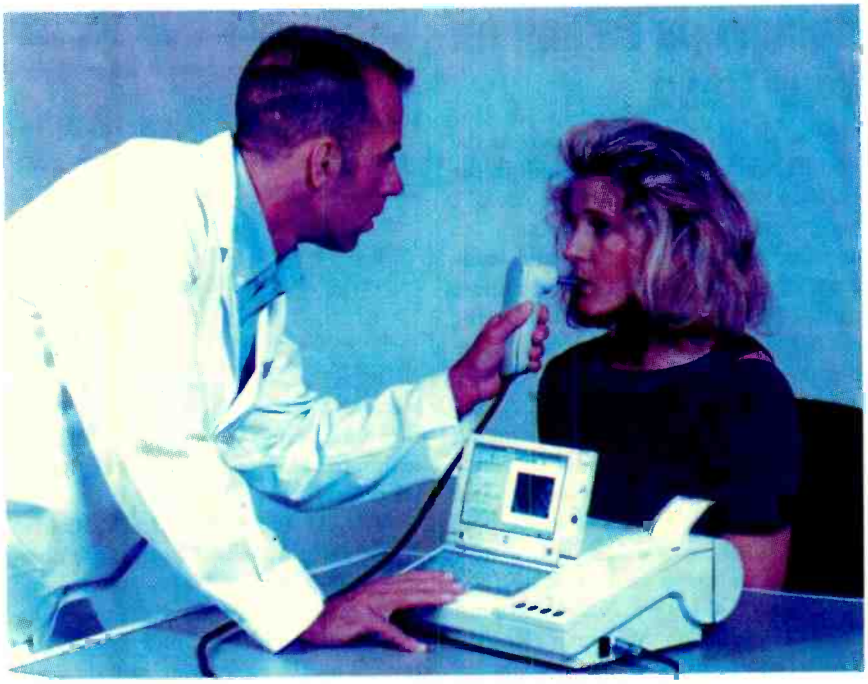
Next time, we will continue our discussion of semiconductor testing with additional service-related information and some very simple curve tracer and in-circuit tester schematics. In a future column, we'll discuss the specific problem of testing the laser diodes found in CD and DVD equipment and laser printers. Until then, check out my Web site: www.repairfaq.org. I welcome comments (via e-mail please at sam@stdavids.picker.com) of all types and will reply promptly to requests for information. See you next time! EN

Prototype

Blood Tests Without Needle Sticks

Thanks to a new electronic diagnostic aid, those annoying and even sometimes painful finger pricks to obtain blood samples could soon be a thing of the past. The name of this new medical device is the Hemoscan, and it is being developed by a Philadelphia-based company called Cytometrics.

With the Hemoscan, a probe is placed under the tongue much like a thermometer. The doctor or medical technician could then immediately read the red blood cell count and hemoglobin levels. Results would be displayed on a screen of the unit, which looks much like a laptop computer. The results of the test would also be printed out so that they can be included in the patient's records.



WITH THE HEMOSCAN, hemoglobin (Hb) and hematocrit (Hct) levels are measured by placing the probe under the tongue and results are displayed immediately on a device that resembles a laptop computer.

How it Works

The Hemoscan is a small, portable instrument with a hand-held probe attached to a computer imaging unit. Illuminated by a light source, the device captures reflected images of blood flowing through the tiny capillaries in the mouth's underlying mucous membrane. Then, using image-processing technology, the Hemoscan analyzes the different wavelengths of reflected light to calculate the patient's hemoglobin (Hb) and hematocrit (Hct) levels without drawing any blood.

Benefits

There are other benefits from using the Hemoscan besides eliminating the discomfort of a needle prick. This technique moves Complete Blood Count (CBC) testing from the clinical laboratory to the point-of-care. This makes results available immediately rather than having to wait hours or even days for results to come back from the laboratory. Since there is no blood drawn, the Hemoscan eliminates the risk of exposure to AIDS and other blood-borne diseases. Other advantages include reducing hazardous biomedical waste that has to be disposed of and an overall savings to the healthcare system.

Cytometrics plans to ship its first product, the *Hemoscan 1000*, to FDA- (Federal Drug Administration) regulated markets sometime this year. The expected cost of the unit is $5000 and about a dollar (the cost of the disposal probe shield) for each test

The American Red Cross is particularly interested in using the Hemoscan for screening blood donors. Currently, the ARC screens all donors for anemia prior to donation. This requires a needle prick of the finger or ear lobe. The Hemoscan would eliminate this needle stick to increase efficiency as well as decreasing discomfort and anxiety to donors.

The company is also developing the *Hemoscan 2000* which will provide a white blood cell count as well as measuring hemoglobin and hematocrit levels. The Hemoscan 2000 should be available commercially within two years.

The technique of viewing and mea-

FOR MORE INFORMATION

Cytometrics, Inc.
One Independence Mall
615 Chestnut Street, 17th Floor
Philadelphia, PA 19106
Web: www.cytometrics.com

suring micro-circulatory system underlying a mucous membrane has other applications beyond simple blood testing. This includes the diagnosis and treatment of shock, surgical transplants, cancer and infectious-disease cell detection, clinical chemistry, and veterinary medicine. For example, Cytometrics is currently developing Cytoscan, which could be used to observe blood flow in a variety of surgical and traumatic environments.—Bill Siuru PT

➤ Pattern Recogniton

Looking for a faster computer? How about an optical computer that processes data streams simultaneously and works with the speed of light?

In outer space, NASA researchers have been able to form optical "thin-films." By turning these thin-films into very fast optical computer components, scientists could improve various computer tasks, such as pattern recognition.

DR. HOSSIN ABDELDAYEM DEMONSTRATES a pattern-recognition setup that uses fast non-linear optical materials.

Dr. Hossin Abdeldayem, a physicist at NASA's Marshall Space Flight Center in Huntsville, AL , is working with lasers as part of an optical system for pattern recognition. These systems can be used for automated fingerprinting, photographic scanning, and the development of sophisticated artificial intelligence systems that can learn and evolve. PT

Raindrops Falling on Your Head

The world's largest atoll, part of the Republic of Marshall Islands in the Pacific Ocean, was recently the site of a two-month NASA-led experiment to improve weather forecasting and long-term climate modeling. In July, more than 200 participants traveled to the remote atoll, Kwajalein, a chain of coral islands that surrounds a 1000 square mile lagoon. Experts from NASA and other government agencies, including NOAA and the National Science Foundation; from universities and research institutions; and from Europe, Canada, Australia, and Asia participated.

The experiment, called KWAJEX, was part of a bigger NASA Tropical Rainfall Measuring Mission (TRMM). Researchers calibrated instruments on board the mission's TRMM satellite. Scientists throughout the world gathered detailed weather data that the satellite cannot obtain remotely—on the ground, by airplane, ship, and balloon. KWAJEX is the last of a series of experiments conducted as part of TRMM.

"NASA and the Japanese National Space Development Agency launched the TRMM satellite from which we'll get global precipitation measurements," said Steve Hipskind, Chief of the Atmospheric Chemistry and Dynamics Branch at NASA's Ames Research Center, Moffet Field, CA. "With its radar and microwave instruments, the satellite obtains a large-scale view of precipitation, but with less detail than many surface-based instruments. In contrast, ground and airborne measurements allow us to really understand the three-dimensional structure and evolution of tropical storm systems. Even without the satellite, these field experiments are leading to significant scientific progress in understanding precipitation processes."

TRMM Program Scientist Ramesh Kakar (NASA, Washington, DC) comments that though "very remote and logistically difficult, Kwajalein presents the ideal location for studying oceanic rainfall due to its location in the middle of the Pacific and its lack of any mountains or even hills that can cause their own small scale weather." By measuring tropical rainfall, researchers hope to have a better overall picture of how the Sun's energy, which is concentrated in the tropics, is transferred from the ocean to the atmosphere.

The goals of the experiment are to better understand the exact nature of oceanic rainfall and how it differs from the rain over land. Observations from TRMM revealed that thunderstorms tend to be much weaker over oceans. Differences in the clouds and possibly raindrops themselves must first be understood, before credible rainfall estimates can be made worldwide.

Three aircraft and a research vessel were also used during the experiment. The instrumented aircraft were the DC-8 "Flying Laboratory" from NASA Dryden Flight Research Center (Edwards, CA), a Cessna Citation II from the University of North Dakota, and a twin-engine Convair 580 from the University of Washington, Seattle. The DC-8 filled two roles: Firstly, it estimated satellite overpasses by flying above clouds with the same instruments that are aboard the TRMM satellite—radiometers and radar. Secondly, this plane also collected data from within clouds: It used cloud particle imagers and sampling equipment to measure the size of particles, as well as temperature, density, and motion within clouds. The newly commissioned NOAA research vessel, *The Ron Brown*, made additional observations, using meteorological Doppler radars on board and on Kwajalein to measure the three-dimensional motions of cloud droplets.

NASA Ames is responsible for KWAJEX project management and logistics. Ames has also managed three TRMM validation missions to Texas, Florida, and Brazil. Research goals include setting up long-term measuring stations at numerous locations around the world. TRMM is part of NASA's Earth Science Enterprise, a long-term research program designed to study the Earth's land, oceans, air, ice, and life as a total system, plus the effects of natural and human-induced changes on the global environment. PT

Caution—Trains Crossing!

On March 15, 1999, an Amtrak passenger train collided with a tractor-trailer truck loaded with heavy steel bars in Bourbonais, IL. Eleven people died and 120 were injured in that accident. In 1997, vehicle-train collisions caused 1020 crew injuries and 266 passenger injuries on Amtrak passenger trains alone. In addition, about 2000 motorists are seriously injured or killed each year at grade crossings, and such accidents cause tens of millions of dollars in property damage annually.

New technologies are under study by University of Illinois researchers trying to eliminate this kind of collision. The College of Engineering Railroad Program, which includes professors of both civil and environmental engineering and of electrical and computer engineering, is conducting research on how various applications of advanced technology—from fiber optics to steel cable barriers—can help improve grade-crossing safety.

THIS VEHICLE ARRESTING BARRIER is designed to stop even a speeding truck, using a net made of one-half inch steel cable that is lowered across a highway when a train approaches.

Professor Fred Coleman is evaluating alternatives to the familiar white-and-red crossing gate. One method is known as the Vehicle Arresting Barrier. Designed to stop even a speeding truck, the net is made of one-half inch steel cable that is lowered across a highway when a train approaches. Three test installations of this apparatus are in place on the Union Pacific line used by Amtrak trains between Chicago and St. Louis. Coleman and investigators for the Illinois Department of Transportation (IDOT) are testing their performance.

Another approach is to add a second set of gates at a grade crossing to prevent motorists from driving around the single gate on the right side. Coleman has completed an analysis of the proper design and operation of such a "four-quadrant gate," and he published his technical report this spring.

Alternative methods of warning drivers of an approaching train are also being studied, such as installing a device in highway vehicles similar to a speed radar detector. Professor Rahim Benekohal is studying a device to set off a flashing light or buzzer in the vehicle when a moving train is nearby. Benekohal and IDOT are also working on systems to improve the integration of roadway traffic signals with rail-crossing gates.

Also being studied is the use of fiber-optic technology to detect trains and measure their speed so that the grade-crossing systems can be better timed. Current technology relies mostly on electrical circuits running through the rail itself to detect an approaching train. Fiber optics might work by detecting the weight of an oncoming train. Professor Shun Lien Chuang is the lead researcher on this project.

In addition to IDOT, research on these new technologies has been funded by the Association of American Railroads (the trade association of major U.S. railroads) and the Transportation Research Board (an arm of the National Research Council). PT

ET—Phone Earth

Since Congress terminated NASA's Search for Extra-Terrestrial Intelligence program nearly six years ago, numerous grass-roots organizations have been keeping SETI science alive. SETI scientists are making microwave and optical measurements to determine whether humanity is alone in the universe. According to Dr. H. Paul Shuch, executive director of the nonprofit society, The SETI League, Inc., participation in SETI research by a wide range of dedicated amateurs is growing.

In a paper delivered at the Sixth International Bioastronomy Conference, Shuch argued that his colleagues in this area of research need to clearly and unambiguously define what constitutes interstellar contact. "Laymen have the time, energy, and enthusiasm to search in ways which the professional scientific community can not," stated Shuch. "However, there is valid concern as to whether those not schooled in the scientific method can do credible science. Premature announcement of an unverified contact especially could undermine the credibility and respectability not just of The SETI League's *Project Argus* search, but all of SETI experiments. Thus, one of The SETI League's duties is to educate its members in scientific restraint."

"The question (of proof) is complicated by the fact that the general public...may make only a vague distinction between proof and faith," Shuch's paper continues. "We must take pains to prevent such declarations of faith from clouding the judgment of our SETIzens."

Dr. Shuch added that there is a spectrum of view ranging from "Of course they exist—we couldn't possibly be alone!" to "I'll believe in the existence of intelligent extra-terrestrials only when one walks up and shakes my hand."

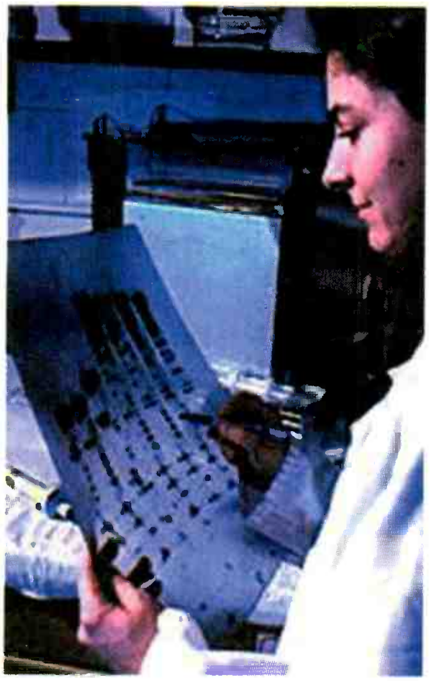
For further information, contact The SETI League, Inc.; Web: www.setileague.org; e-mail: join@setileague.org; Fax: 201-641-1771. The membership hotline is 800-TAU-SETI. PT

Charging Through DNA

A research team from the Georgia Institute of Technology has proposed an explanation for how electronic charge transfer occurs in strands of DNA. Researchers reported that electrical charge moves through the DNA bases by creating temporary distortions in their structure as the strands naturally flex. The work suggests that the charge transport process is much more complicated than previously believed.

"It's not at all like a conductor or a wire," said Dr. Gary Schuster, team leader and Dean of the school's College of Sciences. "When you inject a change into DNA, the DNA responds by changing its structure to accommodate that charge. That change in structure distributes the charge over several of the base pairs in the DNA. That creates a local distortion in the DNA." It's like the movement of a "Slinky" toy—a large spring that compresses and expands, he explained. Schuster added that the local distortion, just like the Slinky toy's compression, can move in the DNA as the structure stretches, bends, and rotates.

The distortion, known as a polaron, can carry the charge a distance of up to a few hundred Angstroms. The charge transfer stops when it encounters a specific pairing of the DNA structure known as a GG step—the location where two guanine bases exist side-by-side. The charge trapped at this location



DR. VALERIE SARTOR EXAMINES DNA sequences in the laboratory at Georgia Institute of Technology. (Photo by Gary Meek. Used with permission of Georgia Institute of Technology.)

then oxidizes the guanine, causing damage that can lead to genetic mutations.

The new charge transport model, dubbed "phonon-assisted polaron-like hopping," could help scientists to better understand the mechanisms by which DNA is damaged and repaired and could also help them to develop a technique for reversing the damage done by oxidation. Natural biological processes repair much of the damage, but some damaged sections aren't repaired fast enough to avoid further damage and genetic mutations.

"It may be possible to intervene and accelerate the repair mechanism or inhibit the damage through pharmaceuticals or procedures," Schuster stated. "That would be important for certain people who have diseases in which the mechanisms for repairing DNA are inefficient."

An experiment conducted in Schuster's lab by Dr. Paul T. Henderson showed that the charge moves rapidly through a duplex strand of DNA with an efficiency independent of the base sequence. The structural independence and efficiency of the transport process were unexpected and could not be explained by existing theories of electron transport. Schuster believes two "averaging" mechanisms inherent in the polaron process tend to even out the speed of the charge transport, possible only because of the dynamic nature of the DNA structure.

Understanding how an electrical charge moves through DNA could also lead to new diagnostic techniques for identifying the DNA of disease-causing organisms or even to finding mutated copies of DNA. Also possible would be mesoscale micromachines that take advantage of the self-assembly capabilities of one-dimensional DNA "wires" and the enzymes available to control that assembly.

Far down the road, DNA offers advantages over the micromachining processes now being used. "DNA has the amazing ability to construct itself," Schuster noted. "Rather than having to build a machine atom by atom, you can take advantage of the ability of DNA to organize itself into complex structures. DNA comes in prefabricated parts that fit together, and that offers a tremendous advantage." PT

Behind the "Mask:" Next-Generation Technology

IBM and Photronics, Inc. recently announced joint activities to speed the development of new "mask" technologies needed to manufacture smaller, more complex semiconductors. "As the industry runs up against new chip manufacturing obstacles, we have to find more creative ways to work around them," said Michael Polcari, director, Silicon Technology and Advanced Semiconductor Technology Lab at IBM. "In this case, IBM has the technology and Photronics has the experience as a leading commercial mask supplier. Working together, we can help keep the industry moving forward."

The companies plan to make the mask technology commercially available to the semiconductor community, helping the chip industry keep pace with "Moore's Law." This is an industry axiom that predicts a doubling of chip performance every twelve to eighteen months. Such growth is necessary to meet the accelerating demands for computing power on the Internet, in all-pervasive computing devices, and in e-business.

Masks act like photographic negatives in a chip manufacturing process known as lithography, where tiny circuit patterns are printed on chips. The demand for better performance and increased function drives the industry to print millions of circuits on a single chip—pushing the limits of today's mask-making and lithography techniques. A number of improved or "next generation lithography" (NGL) processes are being explored. The development of accompanying mask technology could account for up to half of this cost and effort.

Since NGL manufacturing techniques are similar enough to permit crosscutting mask development efforts, IBM and Photronics are developing mask technologies that can be used with any NGL approach. The companies have established a "Mask Center of Competency," located at IBM's Burlington, VT manufacturing facility. Drawing on their experience, they will focus not only on mask development, but will also pursue related issues in the use of masks that affect the productivity of chip manufacturing. These issues include superior circuit image placement and critical dimension control. Photronics will manage the mask development projects and intends to make the masks commercially available. PT

BY MARC ELLIS

Troubleshooting a Dead Receiver

APOLOGIES TO THOSE WAITING FOR THE OTHER SHOE TO DROP ON THE PHILCO 70 RESTORATION PROJECT. AS YOU KNOW, THE SET CAME TO LIFE AND PLAYED WELL AFTER ALL OF ITS BAKELITE BLOCK CAPACITORS WERE REBUILT, BUT IT STILL awaits cabinet refinishing and final touch-up alignment. Incidentally, does anyone know the whereabouts of a Philco alignment tool? I thought I had one in my tool kit until I needed it for the "70" project. Antique Electronic Supply shows one in their catalog but are out of stock until further notice.

The tool is nothing but a 1/4-inch hex-nut driver made of fiber or another non-conducting material. Metal doesn't work—especially in critical circuits such as the oscillator—because the metal influences the tuning. If you can provide one or know someone who can, write or e-mail your price—including shipping and handling. I've arranged to borrow one from a friend for the current project, but would definitely like to replace mine!

At the end of last year (September-November to be exact), I devoted three issues of my column (it was in **Popular Electronics** then) to a short series called "Radio Repair For Dummies." This was a radio-repair primer in which I reviewed the tools and resources that should be on the beginner's workbench; the basic cleaning, checking and housekeeping processes that can make the difference between an inoperative set and one that works when first plugged in; and the physical evidence that can lead the restorer to a faulty component. The last article in the series recommended the wholesale replacement of all paper and electrolytic capacitors in any radio undergoing a serious restoration. Suggestions were made on how to select and install the replacements.

Applying the simple suggestions in those three articles to your vintage set will give you excellent odds on coming up with a working radio without further troubleshooting. But, after all that, what if the set is dead as a doornail? In this column, we'll pick up where the original series left off and show you how to deal with a completely dead radio in a methodical manner.

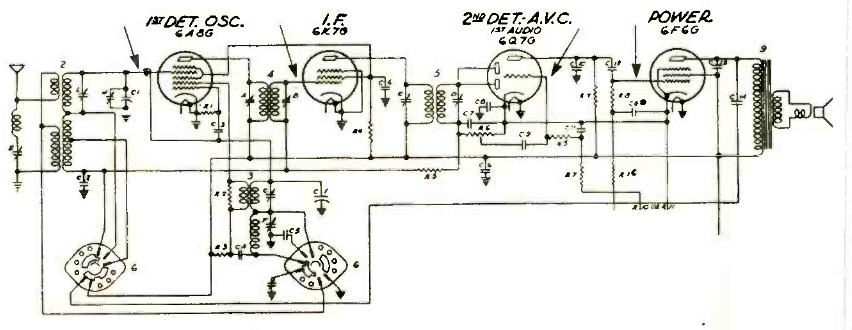
Click Your Way To The Trouble!

If you followed the start-up procedure in the October, 1998 column—which involved continuous monitoring of the set's plate voltage—you know the trouble probably does not lie in the power-supply circuitry. But where then do you look?

The simplest organized approach is sometimes called signal substitution or signal injection. And the simplest type of signal substitution does not require a single test instrument! All you need are your ears and a key or a small screwdriver. You should also have a copy of the schematic for your set. But before you start, review the safety procedures discussed in the September, 1998 column—particularly the material on AC/DC sets and isolation transformers.

This test method is quite crude, and the procedure I'm about to outline may not apply perfectly to every circuit variation you might encounter. However, it is something you can complete in just a few minute's time, requires only minimal technical skill, and will usually pinpoint the exact location of the circuit problem.

Turn the set on and advance the volume control all the way. Give the tubes a reasonable amount of time to warm up. Now hold the key or the metal screwdriver shaft in your hand and touch the tip to the control grid of the audio output tube (referring to your tube manual, the control grid will be the grid closest to the filament or cathode and might be labeled "G1"). The audio output tube is



THE ZENITH CHASSIS 5521 (shown without power supply) represents a simple superhet circuit you might encounter. The arrows show the "click test" points.

the one connected to your set's loudspeaker—usually through an output transformer.

Some larger sets have two audio-output tubes in push-pull or parallel. (Here's where having a circuit diagram on hand will be helpful.) If so, touch your key to the control grid of either tube.

If the audio-output stage is operating, you should hear a loud clicking, probably accompanied by humming. If no sound is heard, you've located the defective stage. But assuming that stage was fine, move back to the previous tube (usually the first audio amplifier) and touch the tip of your key to that tube's control grid. If there is a separate triode detector tube ahead of the first audio tube, test there also.

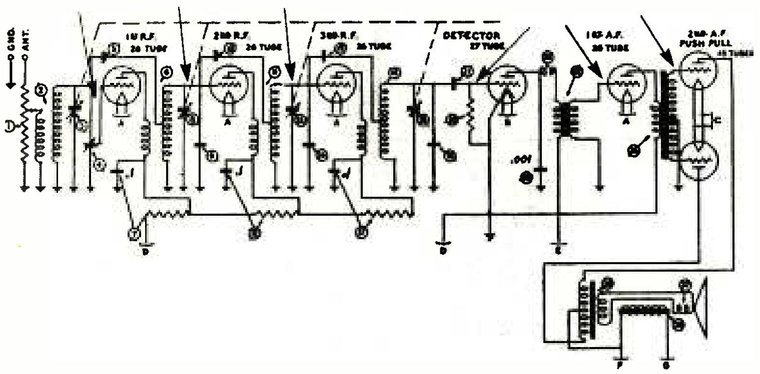
A few words of caution here! Sometimes, the control grid terminal is a convenient "grid cap" atop the tube. However, more often than not, it will be located on the tube base under the chassis, sometimes partially concealed by wiring. Check it carefully before touching it with the key or screwdriver!

There are high voltages on the leads to other tube elements such as the plate and (if present) screen grid. Actually, you may also find high voltage on the control grid if a preceding coupling capacitor is shorted. These will only be dangerous to you if another part of your body is touching chassis ground—so follow the old electrician's rule of keeping one hand in your pocket as you test!

Since tube-base terminal lugs can be very close together, you should also take care that the tip of your "test probe" does not short between adjoining ones. You could easily place a destructive high voltage in a circuit where it doesn't belong, thereby compounding your problem by frying other components!

Continue click-testing your way back through the receiver until you find a control grid that is silent. If the set is a superhet, you'll be working your way through the IF stage, or stages; the mixer stage (if the set has a separate oscillator tube), or the converter stage (if it doesn't); and—if present—the RF amplifier stage. If the set has a separate oscillator tube, do not include it in this test. By the way, the mixer or converter is often called "the first detector."

Finding the right grid to check on a converter or mixer stage can be confusing. However, with the help of your handy schematic you should be able to



THE PHILCO 87 TRF uses a simpler circuit than the Zenith superhet example, but also uses more tubes. Note the three RF amplifiers, separate detector, and push-pull audio output. Again, the arrows show "click test" points.

locate the grid that receives the output of the RF amplifier tube (if it is present) or the set's antenna tuning circuit (if it is not).

If the set is a TRF (tuned radio frequency) model, things are simpler. There is no converter, mixer, or oscillator stage to worry about. After working your way back past the first audio amplifier, you'll pass through two or more RF amplifier stages before reaching the antenna-tuning circuit.

With the click testing completed, the trouble is now isolated between the circuit points where the click was last heard and where the click disappeared. This is a very small portion of the radio's circuitry, and it will, therefore, be easy to check for defective components or other difficulties.

Did you get through the entire procedure without finding any "silent" control grids? If so, your trouble may be in the set's oscillator stage or the oscillator section of its combined oscillator/mixer. Check the voltages on that stage according to the methods outlined in the section that follows.

Finding The Problem

Once again, we'll be outlining a very crude procedure that will be successful in a majority of cases, but will not deal with more subtle problems. As with most of the procedures I talk about in this column, I try to speak to folks who are newcomers to the hobby and as yet have limited experience. But keep in mind that it isn't rare for a problem to elude even the most advanced serviceman. Back in the days when radio servicing was a common business, reams of print were generated by authors advising technicians on how to deal with "tough dog" problems.

The first and most obvious thing to do is to observe if the tube where the trouble is localized is lit. If it is a glass tube, a simple glance will tell you. If it is a metal tube or a glass one encased in a tight-fitting tube shield, check for proper voltage (refer to your tube manual) at the tube's filament pins. Remember to use the AC ranges of your multimeter unless you are working with a battery-operated set. If there is no voltage (unlikely if the other tubes are lit), you need to trace the filament wiring to find out why. If there is voltage, remove the tube and use your ohmmeter function to make sure that there is continuity at the tube's filament pins.

If the tube is lit, you should next check to see if its plate and screen grid are receiving the DC voltages they need for proper operation. Don't worry about the exact readings unless you have service data telling you what to expect at each tube pin. This is just a crude check, but you can expect to see voltages of over 200 at the plate, somewhat less on the screen grid. If the set is an AC/DC model (no power transformer), voltages will be proportionately lower. Also check the voltage on the control grid. There should be no measurable amount using an ordinary multimeter.

If you find something amiss with the voltages, study your schematic to see if you can deduce the reason. You will want to look at capacitors, resistors, and any IF or audio transformers. First check the capacitors and resistors for obvious signs of charring or overheating. The bulk of radio failures are caused by a shorted capacitor—which then puts high voltage on a circuit point where it should not be, possibly destroying other components.

See if you can figure out which capacitor would, if leaky or shorted, cause the voltage anomaly you found. (Of course—gentle hint—if you'd replaced all the caps before turning on the set you wouldn't be dealing with this problem now!) If there is a likely candidate, you'll need to check it with your ohmmeter—temporarily disconnecting one end to isolate the unit from the set's circuitry. After an initial "kick" caused by the charging of the cap from your ohmmeter battery, there should be virtually no resistance reading at even the highest range of your meter.

Was the cap the problem? If so, check the associated component that also probably failed—perhaps a resistor or an IF or audio-transformer primary winding. Use a heavy helping of common sense to spot the probable failure. At this level, troubleshooting is not rocket science! Use your ohmmeter to check the suspect resistor(s) for the proper value and the winding for continuity. You'll probably have to disconnect one end of each suspect resistor to isolate it for checking. Chances are you'll be able to check the transformers as wired because one end is connected only to the tube plate and not to any other circuitry.

If all voltages and components seem OK, you'll want to see if there are any gaps in the path of the signal passing through the set. Once again, don't feel intimidated even if your experience is limited. Use common sense and logic! A typical problem is an open circuit in the coupling capacitor between the first and second audio stages or (older sets) in the secondary of the coupling transformer. A less common one would be an open IF-transformer secondary winding. Such failures probably would cause no detectable anomalies in your voltage readings. Check for the open cap by bridging a known good one across it. Check for an open winding with your ohmmeter. There's usually no need to remove it from the circuit first.

I hope this short course in fixing inoperative receivers will help you solve most of your problems! Let me hear about your servicing experiences. Write me at "Antique Radio," c/o **Electronics Now**, 500 Bi-County Blvd., Farmingdale, NY 11735. You can also contact me via my personal e-mail address: ellis@eneteract.com. Regretfully, time limitations do not always permit me to respond individually. EN

BY DON JENSEN

Weird Antennas of Yesteryear

LAST MONTH, WE LOOKED AT THE START OF SHORTWAVE BROADCASTING, AND SHORTWAVE LISTENING, SOME 70 YEARS AGO. IN THE EARLY DAYS OF SHORTWAVE LISTENING, EVERYTHING WAS NEW, INCLUDING THE TECHNOLOGY. IF there were no known truths, any "truth" seemed worth trying. Experimentation—some of it pretty silly in today's light—was the name of the game for pioneer SWLs. Nowhere was that more evident than in the design of antennas.

The most popular receiving antenna, then as now, was the longwire. But, as Jerome S. Berg points out in his new history of international broadcasting, *On The Shortwaves, 1923-1945* (McFarland & Co., Inc., Publishers) "various oddball alternatives were available as well...."

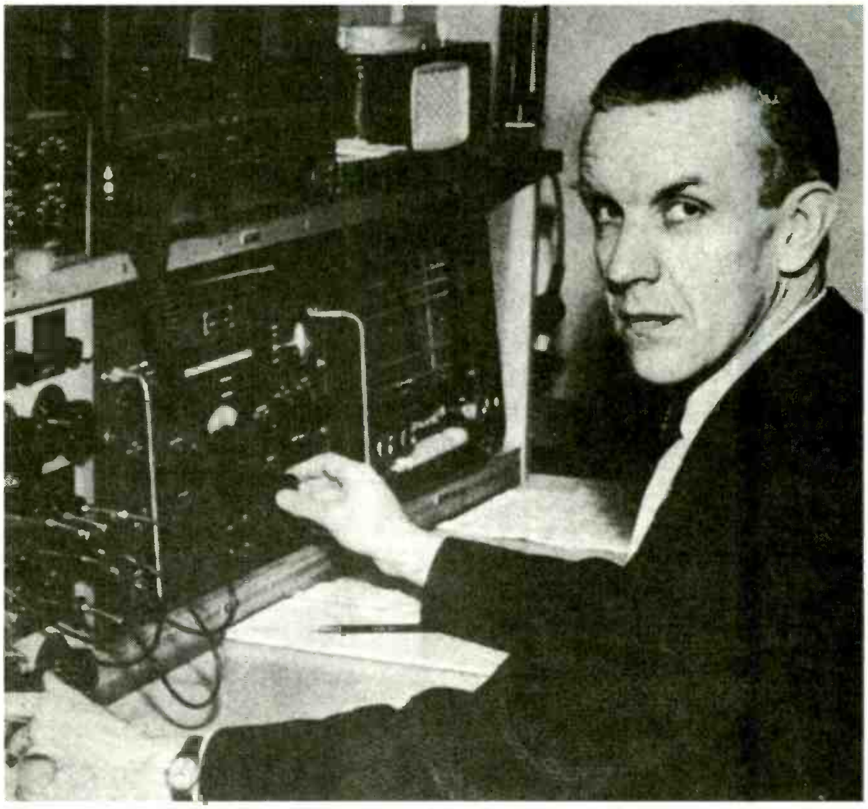
For example, there was the Dubilier Light Socket Aerial—"The static is about gone, interference is reduced, and you've done away entirely with sooty aerials, lead-in wires, ground switches. and lightning arresters."

Others included the Yahr-Lange Super Ball Antenna—"Greater selectivity, volume and distance due to its conductive surface of 364 square inches." Or the Rogers Underground Antenna—"Dig a small hole in the ground outside a window near your set, drop the Rogers Underground Antenna in the hole, cover it over with dirt...and tune in on loud, clear, steady reception!"

Foolish as some of these sound, goofy antennas were still being touted by some would-be experimenters decades later. I recall reading an article in the 1960s proposing that a lead-in wire be clipped to the bedspring, using the bed as a homebrew SW antenna. And, in the 1970s, someone suggested running a roll of aluminum foil around the room, gluing it down, then wallpapering over it to make an "invisible antenna." Some of these gizmos may have been better than no antenna at all ... but not much better!

Proper grounding of the receiver also got a lot of attention in the early years of DXing. Berg quotes pioneer listener Carleton Lord's tongue-in-cheek "recollections" on the subject of good grounds:

"There was little magic in the common cold water pipe, but consider what you could do with a 6 foot copper-plated stainless steel rod, an old auto radiator, or



THE LATE ARNE SKOOG, in a 1960s photo, tuning his SW receivers. Skoog, who died in June, was the editor of "Sweden Calling DXers," a popular program for SW listeners aired for well over three decades by Radio Sweden.

a 40 gallon water tank. Burying such contraptions was not enough; you were supposed to dig a full-sized grave away from the light of the full moon, drop a tea kettle to the bottom, fill the pit with a proper mixture of gravel, rock salt, peat moss, Vigoro and top soil, then hook up an automatic sprinkler system to moisten the filled pit for three hours before you turned a dial. Then you also had the U.S. Standard ground, the Ollie Ross (renowned early listener) Ground, the inverse counterpoise, and many others."

"One DXer," Lord claimed, "buried 100 feet of trolley wire in a 3 foot deep trench that circled a spring, and another night-owl (listener) tossed 500 feet of wire into the Pacific Ocean."

Farewell, Arne Skoog

For three decades, from 1948 to 1978, Arne Skoog was the moving force behind "Sweden Calling DXers," Radio Sweden's pioneer program for SWLs. Though more than 20 years have passed since he retired, many longtime shortwave listeners fondly remember him as one—perhaps the most—important reason why they got started in this hobby.

Arne Skoog died June 7, at the age of 86.

Skoog was a 35-year-old engineer at Radio Sweden when he inaugurated "Sweden Calling DXers" as a way of keeping shortwave listeners in touch with what was happening in international radio.

As SW historian Jerry Berg says, "You always hoped that Tuesday night reception from Sweden would not be too 'watery' (which it often was) because that was SCDX night."

The 10-minute program, largely the latest tips on what to tune, where, and when, was followed up with a printed version of the program, which was airmailed free to any listeners who requested it.

At its peak, there were between 1500 and 2000 SWLs worldwide on the station's mailing list for this program summary. Skoog and his program introduced countless casual listeners to the SWLing hobby.

After his death, early in the summer, many of them wrote to the station to

CREDITS: Brian Alexander, PA; Ralph Brandi, NJ; Jeff Findlater, CA; Mark Humenyk, ONT; David Krause, OH; Jerry Lineback, NE; Jim Moats, OH; Don Nelson, OR; Ed Newbury, NE; Chuck Rippel, VA; North American SW Association, 45 Wildflower Road, Levittown, PA 19057.

ABBREVATIONS

DX, DXing, DXer = Distant shortwave stations; listening to them as a hobby; one who hunts DX radio signals.
ID = Voice identification announcement.
IS = Distinctive interval signal used as a station identifier.
kHz = kilohertz, unit of frequency measurement.
SW, SWL, SWLing = Shortwave; shortwave listener, shortwave listening.
UTC = Universal Coordinated Time, a standard used by most major international broadcasters and listeners. It is equivalent to Eastern Standard Time plus 5 hours; CST+6; MST+7 or PST+8.

express their condolences. So strong was Skoog's impact on this influential program that some said they well remembered him reading those listening tips on "Sweden Calling DXers." In fact, Arne gathered much of the information and wrote the detailed scripts, but various colleagues read them on the air.

SCDX was aired first in English, then, in later years, in all of Radio Sweden's language services—except, ironically, Swedish. Skoog also was one of the founders of the Swedish DX Federation, and later, the European DX Council, both organizations dedicated to supporting SWL clubs in that part of the world.

On the 30th anniversary of SCDX, Arne retired, turning over the program to a young American announcer, George Wood, who continued as its editor and on-the-air host for years.

But changing times and new Radio Sweden management led to a shifting emphasis. The mailing list was discontinued and SCDX became a twice a month English-only program called MediaScan.

MediaScan can be heard every other Tuesday at 1130 UTC on 18,960 and 21,810 kHz; at 1330 UTC on 15,240 kHz; at 0230 UTC (Wed.) on 9495 kHz, and 0330 UTC (Wed.) on 9495 and 12,060 kHz.

The old SWDX program of SW listening tips, however, gave way to a new format, focusing on satellite broadcasts, computers, and general Scandinavian media news. Although in retirement, Skoog expressed his disapproval of this change in focus, but to no avail. In his later years, he concentrated his attention on his second hobby of violin making.

Merlin's Magic Act

Just when we were getting used to the fact that the BBC wasn't the only international broadcasting voice from the United Kingdom, Merlin Network One pulled a vanishing act. MNO cut its worldwide SW presence from a wall-to-wall 24 hours a day to just one hour daily, five days a week, a few months ago. And that single hour, 1600 to 1700 UTC, is aired on 6175 kHz, when it's not likely to be heard well in North America.

MNO is the programming arm of Merlin Communications, the British company that now owns the privatized shortwave transmitting facilities formerly owned—and still used—by the BBC.

Merlin Network One offered a rather wide range of music programming on shortwave that, it seemed, should have earned it a decent audience worldwide. All that is left on SW at this writing is a recorded religious program.

According to Christopher England—a rather appropriate name, don't you think—of Merlin Communications International, the MNO broadcasts on shortwave were intended as a programming research experiment to determine SW listening patterns. In the future, England says, this collected data on who's listening and where will be used to help clients interested in reaching specific geographical targets via shortwave. In other words, look for Merlin to become like the handful of US commercial shortwavers and others who sell airtime to religious, political, and ideological groups for their canned programs.

Down The Dial

Here's our monthly list of interesting things to tune on shortwave:

ALASKA—9615 kHz, KNLS is heard here in English at 1329 UTC, with ID, short features, and a religious talk. The signal is subject to fading.

BELARUS—7210 kHz, Radio Minsk broadcasts in English around 0200 UTC, with news, commentary, and identification.

GUINEA—7125 kHz, RTV Guineene is a West African SW outlet that signs on just before 0600 UTC, with guitar IS, French ID, and news.

GUYANA—5950 kHz, Guyana Broadcasting Corp. is in Guyana, a South American country—not to be confused with Guinea—which has a sizable population whose ethnic origins are in India. So its not surprising that musical programming includes Hindi vocals. Look for this one from before 0900 UTC.

ITALY—11,900 kHz, RAI in Rome noted around 2220 UTC with a variety of music, from ballads to jazz. It operates in parallel on 9675 kHz.

MONGOLIA—12,015 kHz, Voice of Mongolia is heard here at 1200 UTC, with its tuning signal and English ID, and then an English newscast.

NIGER—5020 kHz, La Voix du Sahel broadcasts from Niger; and yes, it is Niger, not Nigeria, which is a different West African country. Listen around 0430 UTC for African music and French language announcements.

PAKISTAN—17,895 kHz, Radio Pakistan is heard with English news, read very slowly, from 0230 to 0244 UTC. It signs off quite abruptly a minute later. This one operates in parallel on 15,485 kHz.

PAPUA NEW GUINEA—4890 kHz, National Broadcasting Co. is heard on this frequency around 1000 UTC, with English news and commentary. By 1045 UTC, programming is in one of the local pidgin languages.

PHILIPPINES—15,190 kHz, Radio Pilipinas has English from 1800 to sign off at 1930 UTC. Programming is mostly music, with occasional IDs. It also uses 17,720 kHz at the same time.

SEYCHELLES—9770 kHz, British Broadcasting Corp. World Service is relayed from this transmitter site in the Indian Ocean. It has been reported here at 0225 UTC, in English, of course, with talks, stock market news, program preview, and the "World of Music" program. EN

BY KONSTANTINOS KARAGIANNIS
COMPUTER EDITOR

Buyer Beware

SEEN ANY RIDICULOUSLY LOW PRICES ON NEW COMPUTERS LATELY? THAT IS, WHILE THE BIG BOYS (NATIONAL CHAINS AND DIRECT DEALERS) ARE SELLING PENTIUM III SYSTEMS PRICED IN THE $1500 AND UP RANGE, IN THE NEW YORK AREA AND elsewhere, many local ads for PIII systems in the $700 to $900 range are popping up. One of these catch your eye?

They sure caught mine. These ads are in most every newspaper and tempt quite a few consumers. I recently decided to find out just how these stores could afford to offer such allegedly hot systems at closeout prices. Something about these bargain PIII deals seemed a little too good to be true, and sure enough, that was the case. These machines turned out to be empty promises from less-than-honest vendors.

You won't believe what these con artists are up to. Read on to make sure you're not made a victim next time you go computer shopping.

Selective Truthtelling

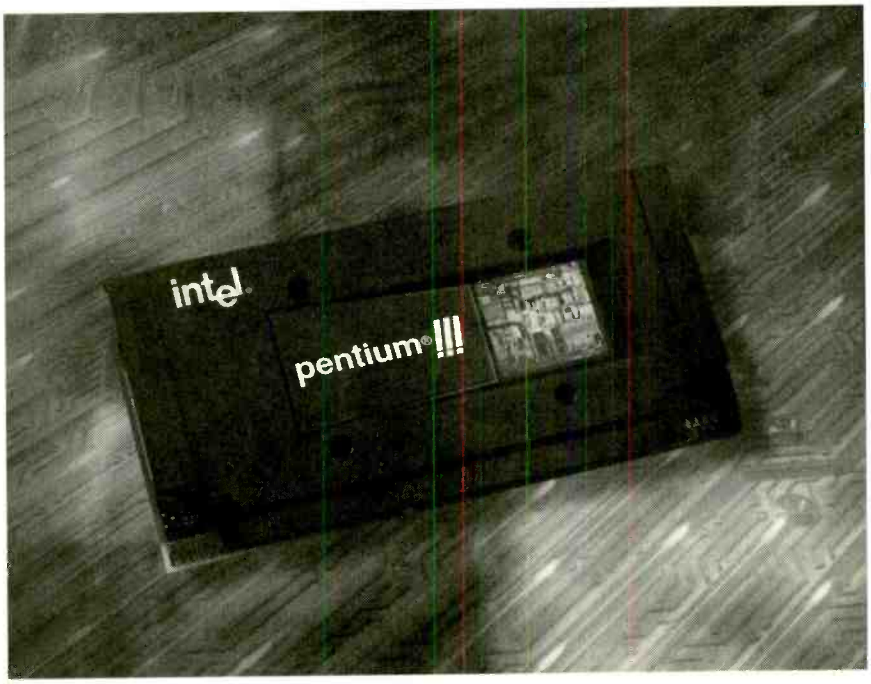
Most every kid in the world has gotten into an argument about semantics with Mom and Dad when it comes to lying. Parents will claim that not telling the whole truth is just as bad as lying, while the child being "charged" with the offense will stick to the notion that leaving out certain details is not the same thing as fibbing. Take whichever stance on this issue that you want, but when it comes to the world of retail, holding back certain details is downright low.

If you have an ad handy that seems to match the too-good-to-be-true criteria, read it carefully. Perhaps it claims a PIII 450 processor, 128MB of RAM, a 6.4GB hard drive, and a 17-inch monitor, all for, maybe, $800. To drive the phenomenal nature of the offer home, the system may be labeled with a name brand, say IBM or Compaq. Wow, what a deal!

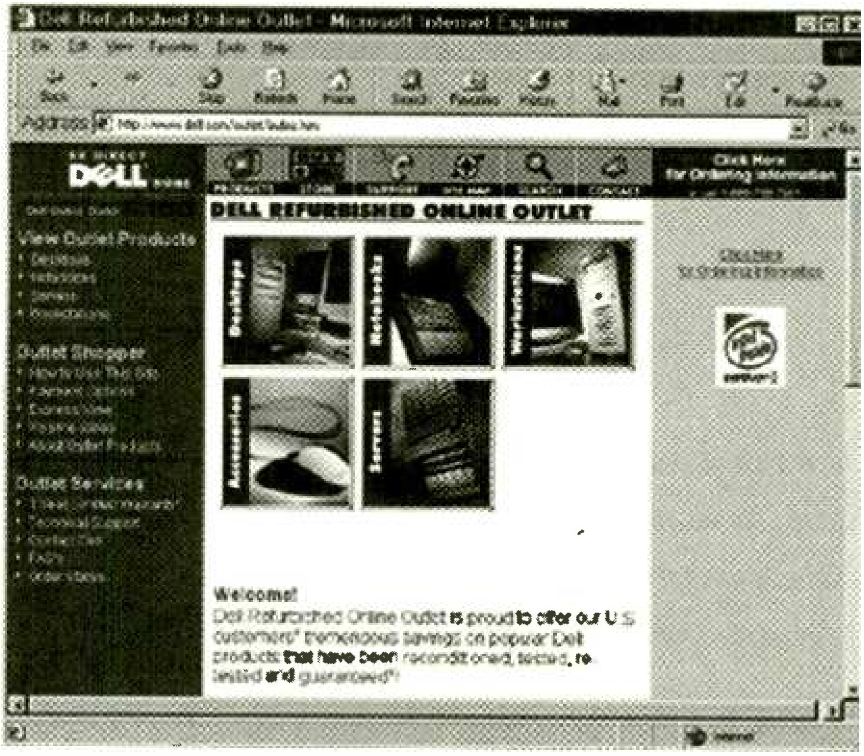
Think about the specs you just read for a minute. What's missing? As for the processor, a chip's a chip. If it says PIII, then it's a PIII. Fine, but does a 450-MHz processor always run at 450 MHz? No. You may know that the clock speed of a CPU is dependent on a multiplier of the system bus. A PIII 450 is designed to run at 4.5 times the speed of the 100-MHz bus in Intel 440BX or equivalent motherboards.

Ready for the horrid truth? For the most part, these "bargain" machines are *NOT* running on 100-MHz motherboards!

To assemble such a dream (nightmare?) machine cheaply, these crooked vendors are putting Pentium III chips on outdated 66-MHz motherboards. The result is a crippled PIII, with a relative performance just under that of a Pentium *II* at 300 MHz. As a result of the slow motherboard, the system memory is limiting, too. As these older boards use 66-MHz RAM, the boosts gained by PC-100 SDRAM memory are lost. Cheap and slow 66-MHz memory, often EDO DRAM, is used instead.



AMONG THE SHIFTIER COMPUTER DEALERS, Intel's Pentium III processor may be the most misused CPU ever—read our tips this month for avoiding a bum deal.



FOR A GOOD-QUALITY REFURBISHED or bargain machine, check out Dell's Outlet online.

Again, these are details that are left out. The memory is listed by amount only, and the processor according to its "labeled" clock speed.

So right off the bat, you have a machine that will likely be buggy (the PIII will not "play nice" with the older chipset used in the inferior motherboards), and much slower than you'd expect from the newest class of Intel chip.

But it keeps on getting worse. The hard drive could have a horrifically slow access speed and may be a refurbished unit. The 17-inch monitor will likely turn out to be a 0.39-mm(!) pitch unit—practically a step above one of those old-fashioned Lite-Brite toys when it comes to graininess. In one case, I asked one of these shifty vendors how much it would cost to upgrade from such a terrible display to a .28-mm *15* inch monitor, and he said quite calmly that it would be $69. Think about the ramifications of having to pay to upgrade to a smaller monitor.

We've looked at the misrepresented facets of a typical bargain system so far. But what about the details you never even read of? Expect such a system to have a 16X or 20X CD-ROM (a $5 item nowadays). Count on the video to be a mere 1MB integrated system (capable of displaying only 256 colors at a decent resolution and incapable of playing most modern games). And the modem? If the system has one, it will likely be of the quality that should disconnect you about every ten minutes or so.

Now ... ready for the final kicker? In these "bargain" systems, many of the parts just described, as undesirable as they are, are not even new! That's right, to add insult to quality-injury, many components being used in these machines are refurbished or repaired, being salvaged from older PCs. However, because these parts and motherboard were once used in, say, an IBM machine and are now contained in a new (or relatively new) case from the same manufacturer, the computer can be sold as an IBM. Of course, the dealer couldn't put a model number on the machine, because that really would be fraud. For this reason, the too-good-to-be-true ads just say the company name, only adding to the appeal of the system.

Know what you're buying. Ask what components are really in the system. Be wary of dealers who won't let you look inside. One such dealer had the nerve to tell me he wouldn't even let me look at the back of the case, let alone inside. Nice, huh? Would you buy a computer from such a shifty salesperson with so much to hide? I don't think so. There are enough reputable places to shop—stick to them.

SOME WEB SITES OFFERING RELIABLE REFURBISHED MACHINES

DAMARK International
Web: www.damark.com
Great prices on refurbished name-brand computers, as well as numerous other gadgets and gizmos.

Dell
Web: www.dell.com/outlet/index.htm
Contains some of the most cutting-edge refurbished deals around.

Egghead
Web: www.egghead.com
Click on "liquidation & refurbished" to search their changing selection.

IBM
Web: refurbishedpcs.financing.ibm.com
While some machines may be a bit old, the prices are worth checking.

Refurbished Is Not Always A Dirty Word

For the sake of fairness, it is important to point out that not all systems in the refurbished category are bad buys. Many companies, direct-marketing-giant Dell and IBM included, have extensive selections of refurbished machines at great prices. In most cases, these were just returned because buyers decided they couldn't pay for them, or because one component was faulty and replaced. Dell's refurbished buys even have the same warranty that a new system would have, giving you a safe way to save some money.

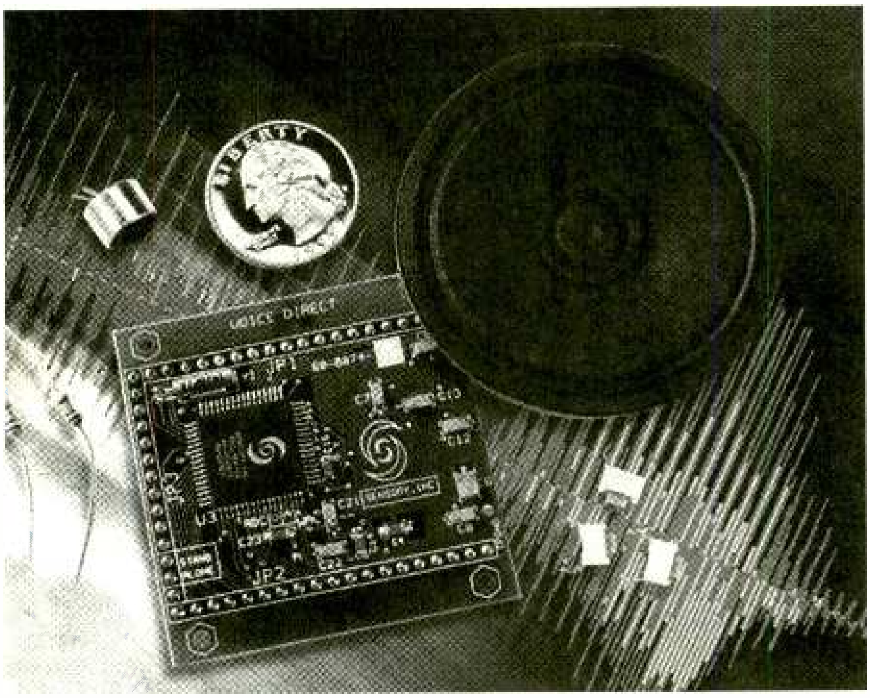
You may even be able to save money by buying a refurbished PC through an independent distributor. Just make certain of two things when doing so. For one, check that the system in question has its original specifications. That is, buy a Compaq model XYZ, but not a system just referred to as a refurbished Compaq. Second, be sure that your refurbished system comes with a warranty. Saving $300 or so isn't a great idea if it will mean twice as much in parts replacement and labor down the road.

That about wraps it up for this month. If you'd like to get in touch, you can send e-mail to connections@gernsback.com or snail-mail to Computer Connections, **Electronics Now**, 500 Bi-County Blvd., Farmingdale, NY 11735. EN

NEW PRODUCTS

USE THE FREE INFORMATION CARD FOR FAST RESPONSE

Speech Recognition Kit



CIRCLE 338 ON FREE INFORMATION CARD

THE VOICE DIRECT SPEECH RECognition Kit is an ideal development tool to apply speech recognition to everyday household electronics. With Voice Direct, items like TV remote controls, alarm clocks, microwaves, toys, motors, telephones, and numerous other common household appliances can come to life using voice commands.

The kit can support slave-mode operation for developers who want to customize their applications. It is a development tool designed for anyone from high-school students and beyond to electronic hobbyists to engineers. Using a speaker-dependent (user-trained) speech-recognition module, the unit can learn to recognize up to 15 words or phrases in any language that lasts up to 3.2 seconds. The module is powered by the Voice Direct speech-recognition processor.

The speech-recognition kit comes complete with the assembled Voice Direct module (which contains a microphone pre-amplifier, serial EEPROM, and oscillator), a microphone element, speaker, (3) microswitches, (2) 100k resistors, and a quick setup guide. A 5-volt (±10%)/50mA power source, hookup wire, 0.1-inch headers, and 3-by 3-inch prototyping board are needed for installation.

The Voice Direct Speech Recognition Kit has a suggested retail price of $49.95.

SENSORY, INC.
521 East Wendell Street
Sunnydale, CA 94089-2164
Tel: 408-744-9000
Fax: 408-744-1299
Web: www.SensoryInc.com

Smart Automobile Compass

DESIGNED TO GIVE DRIVERS essential trip information, the V5000 Series Multi-Sensor Vehicle Compasses use state-of-the-art sensor technology to provide a variety of readouts: directional and altimeter readings, digital clock, automatic trip timer, trip logs, inside and outside temperatures, and black-ice warnings. All three V5000 units come standard with a large digital compass LCD readout that displays both numeric and cardinal points, have a back-light for easy viewing at night, and feature simple electronic calibration. The compasses also include "SMART" sensor features, such as an auto shut-off when the car is not in use for ten minutes, magnetic distortion detection and correction elements that tell when the compass reading may be affected by an outside source, and a multiple trip log that stores information for up to three trips.

CIRCLE 339 ON FREE INFORMATION CARD

Each V5000 Series compass comes with a fully adjustable mounting bracket that rotates 180 degrees and can be attached with heavy-duty suction cups. The compasses operate on two AAA batteries for over 250 hours or with an optional 12-volt lighter adapter power cord (standard in some models).

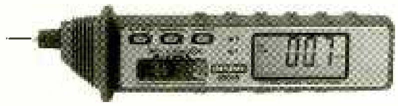
The suggested retail prices range from $79.95 for the V5000 basic model to $129.95 for the fully-loaded V5000TA.

PRECISION NAVIGATION, INC.
5550 Skylane Blvd., Ste. E
Santa Rosa, CA 95403
Tel: 707-566-2260
Fax: 707-566-2261
Web: www.precisionnav.com

Pen Multimeter

IDEAL FOR TROUBLESHOOTING logic and general AC/DC circuits, the

Craftsman Pen Multimeter with Logic Test is an autoranging DMM with Data Hold and Range Hold functions. Among its other functions are DC and AC voltage up to 500 volts, DC and AC current, resistance, logic test for indicating digital threshold levels, and audible continuity and diode tests. The pen point makes it easy to touch component leads, PC board traces, tie points, IC points, and other small devices. The safety probe tips can be stored when not in use.



CIRCLE 340 ON FREE INFORMATION CARD

Measurements are displayed on a large, 3200-count, high-contrast LCD with bargraph. Auto power off, and overload- and low-battery-indication are also featured. The Pen Multimeter with Logic Test includes case, extra fuses, manual, and test lead with alligator clip.

The Craftsman Pen Multimeter with Logic Test has a list price of $44.99.

SEARS ROEBUCK, INC.
Tel: 800-390-8792 (information) or 800-377-7414 (sales)

Electro-Optical Adapter

THE NU-VIEW SX-2000 IS AN ELECtro-optical adapter that when attached to practically any camcorder, produces stereoscopic three-dimensional (S3D) video recordings. A threaded optical adapter is first attached to the cam-

CIRCLE 341 ON FREE INFORMATION CARD

corder's filter threads, providing a stable optically aligned bayonet mount. Once it's attached to the camcorder, the auto focus, auto exposure, zoom, and white balance camera functions are performed as usual.

After they are connected together, the camcorder is used in a normal manner to view and record. A simple, single convergence control allows the user to converge on objects near or far, and the Stereo-Optix technology provides the camcorder with the needed parallax view to create a true stereoscopic image. Best of all, 3-D content can be viewed on a standard TV.

The Nu-View SX-2000 elctro-optical adapter has a suggested retail price of $399.95.

3-D VIDEO, INC.
418 Chapala Street
Santa Barbara, CA 93101
Tel: 888-883-3843 or 805-963-5990
Fax: 805-963-9770
Web: www.3-dvideo.com

Pattern Generator

THE PORTABLE PC SCAN PATTERN Generator, Model LT 1607, is only a little larger than a paperback book; and it meets the test-signal needs of most computer monitors, handling NTSC and Y/C monitors as well. Designed for both bench and field use, the instrument uses simple controls to call up raster formats for VGA, SVGA, XGA, MAC13, MAC 16, and MAC 19 computer monitors. The raster can be set to white, yellow, cyan, green, magenta, red, blue, and black.

CIRCLE 342 ON FREE INFORMATION CARD

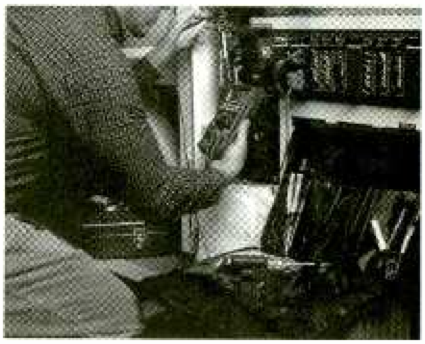
Among the test signals are color bars, circle/crosshatch, window, and computer characters. The unit outputs composite NTSC and Y/C feeds for adjustments of very large-screen displays and video walls. Selectable auto pattern sequencing is also available.

The suggested retail price for the model LT1607 is $995.

LEADER INSTRUMENTS CORP.
380 Oser Avenue
Hauppauge, NY 11788
Tel: 800-645-5104 or 516-231-6900
Fax: 516-231-5295
Web: www.leaderusa.com

Test Accessory Kits

THESE THREE NEW TEST ACCESsory kits feature different combinations of DMM test accessories for use with Amprobe's most popular meters (the AM-50, AM-71, AM90, and AM-1200 Series). Ideal for field use, these kits contain a wide variety of test accessories, ranging from: sets of test probes, both Maxigrabber and large alligator test clips, an extended tip adapter, flexible test leads, and spade lugs to modular electrical probes with durable stainless steel tips.



CIRCLE 343 ON FREE INFORMATION CARD

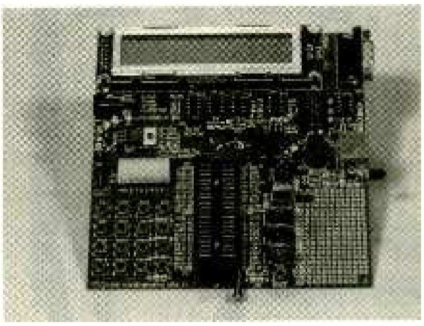
Kits are offered with either a large briefcase, shoulder pack, or tri-fold pouch for a variety of test environments, including plant maintenance, electrical, HVAC, automotive, and field repair. The test accessories are safely stored in multiple zippered and Velcro-enclosed compartments that also provide easy and convenient access. Constructed from durable material, the briefcases and shoulder packs are designed so that the test accessories can be stored with the meter.

The suggested retail prices range from $49 for the Basic Test Companion Kit and $89 for the shoulder pack to $189 for The Deluxe Test Companion Kit (IP9020), which is pictured here.

POMONA ELECTRONICS
1500 E. Ninth St.
Pomona, CA 91766
Tel: 909-623-3463
Fax: 800-444-6785
Web: www.pomonaelectronics.com

Experimenter's Board

THE PIC-X1 IS THE FIRST PRE-assembled experimenter's platform for the Microchip Technology PICmicro micro-controllers. It provides an assembled testbed containing most of the circuitry commonly used with PICmicros: 5-volt power supply, a crystal-controlled oscillator that includes jumpers, a reset circuit, as well as additional application circuits. The PIC-X1 can run programs written in assembler, C, and PicBasic or PicBasic Pro, and allows the resident PICmicro to be reprogrammed on the fly (with a flash device) using programmers that support this feature.



CIRCLE 344 ON FREE INFORMATION CARD

Application circuits include a switch matrix, potentiometers, LEDs, LCD module, serial EEPROMs, real-time clock, temperature sensors, servo connectors, RS232 and RS485 interfaces, IR interface, speaker, and a prototyping area. Designed to work with 40-pin PICmicros, it may be jumpered to work with smaller devices. The PIC-X1 is available in either bare PCB, kit, or assembled form; and it comes bundled with a parts list, schematic, and PicBasic Pro example programs.

The suggested retail price for the standard assembled version is $199.95. Educational pricing is lower.

MICROENGINEERING LABS, INC.
Box 7352
Colorado Springs, CO 80933
Tel: 719-520-5323
Fax: 719-520-1867
Web: www.melabs.com

HDTV Monitor

WHILE STILL COMPATIBLE WITH the NTSC signal, the AF3.0HD HDTV monitor is the first direct-view 16:9 aspect-ratio monitor to display all HDTV formats. The 30-inch viewable HDTV monitor includes six preset memories for DTV-resolution formats

CIRCLE 345 ON FREE INFORMATION CARD

and for VGA, SVGA, and XGA. It has a horizontal scanning range up to 50kHz, three color temperature settings, and custom memory settings for black level, contrast, geometry, and masking.

The AF3.0HD offers multiple inputs for digital, analog, and HDTV, plus color difference signals, VGA, S-video (Y/C), and composite inputs. Two remote controls, a built-in stereo audio amplifier, and two speakers are bundled with the monitor.

The AF3.0HD HDTV monitor has a suggested retail price of $4100.

PRINCETON GRAPHIC SYSTEMS
2801 South Yale Street
Santa Ana, CA 92704
Tel: 800-747-6249 or 714-751-8405
Fax: 714-751-5736
Web: www.prgr.com

Digital Mini-Camera

SMALL ENOUGH (3.1 BY 3.8 BY 1.3 inches) to fit into a shirt pocket, the MX-2700 Digital Camera is a double-megapixel model that lets photographers instantly see the images they want to shoot. The 2.3-million pixel MX-2700 features a 3mm equivalent lens with macro capability. Depending on the compression selected

CIRCLE 346 ON FREE INFORMATION CARD

(fine, normal, or basic), the camera can record 8, 17, and up to 35 images in 1800 × 1200 mode; or 47, 90, and up to 142 images in 640 × 480 mode.

The camera is equipped with both a precision, 2-inch polysilicon color LCD monitor with 130,00 pixels and an optical viewfinder, and it has video output and serial ports for computer connection. Automatic playback, a digital 2.5× telephoto mode, and the multi-frame playback that enables nine images to be viewed at once on the LCD are all features of the MX-2700.

The MX-2700 Digital Camera has a suggested retail price of $699.

FUJI PHOTO FILM U.S.A., INC.
555 Taxter Road
Elmsford, NY 10523
Tel: 800-800-FUJI
Web: www.fujifilm.com

DC Power Supply

A SINGLE-OUTPUT, VARIABLE 50-volt DC output (0–5A) power supply, the Model 5050S offers short-circuit and overload protection and provides fully isolated outputs. Ideal for lab, service, industrial, and educational uses, the Model 5050S has constant voltage/constant current modes, load/line regulation, and ripple specs.

CIRCLE 347 ON FREE INFORMATION CARD

Both fine and coarse voltage controls are available, along with indicators for constant voltage and current as well as for overload operation. The three-digit red LED display indicates both current and voltage output. The unit operates at 100/120/220/230V and has a power consumption of 420VA.

The 5050S variabel output power supply sells for $651.

HC PROTEK
154 Veterans Drive
Northvale, NJ 07647
Tel: 201-767-7242
Fax: 201-767-7343
Web: www.hcprotek.com

The Electronics Industry is looking for a lot of good people!

Here is your chance to get in on the ground floor as an Associate CET. Is your job title "Electronics Service Technician?" Would you like to have that title? You can prove you qualify for the title with a CET Associate Certificate. It can be your career door-opener and begin your rapid advancement!

A technician or student of electronics with less than a total of four years of basic experience may take the Associate Level Exam. The exam is the basic electronics portion of the full-credit CET exam. The 75-question, multiple-choice test covers basic electronics, math, DC and AC circuits, transistors and semiconductors, instruments, measurements and troubleshooting. A successful Associate CET will receive a wall certificate valid for four years and is eligible to join ISCET as an Associate Member. ISCET is the International Society of Certified Electronics Technicians.

The ISCET Computer-Aided Associate-Level Study Guide prepares you for the Associate CET Certificate by randomly selecting sample questions with appropriate diagrams, provides multiple-choice answers, grades the test and provides a summary of your strong and weak points.

Diskette requires IBM computer or compatible with VGA color monitor, 3.5-in. drive and a hard-disk drive.

CLAGGK INC. – CET Computer-Aided Study Guide Offer
PO Box 4099, Farmingdale, New York 11735

YES, I want to step up to a career in servicing. Here is my order for the CET Computer-Aided Study Guide on a 3.5 diskette. I am enclosing **$39.95** (price includes U.S. shipping and handling) in U.S. funds. Canadians and overseas add $6.00 per order for shipping.

Bill my ☐ VISA ☐ MasterCard Expire Date __/__/__
☐ USA Bank Check ☐ US or International Money Order

Card No. ____________________

Signature ____________________

Name (Please Print) ____________________

Address ____________________

City ____________ State ____ Zip ________

New York residents add local sales taxes. Do not send cash. Checks drawn on US Bank and International Money Orders in US funds only. Credit card users may telephone or FAX orders. Telephone 516-293-3751 or FAX 516-293-3115. Price subject to change. Allow 6 to 8 weeks for delivery.

CB06

Proof Positive that you are a Certified Electronics Technician

A New Computer Software Program — ISCET Computer-Aided Associate-Level Study Guide

Prepare yourself for the 75-question CET Associate Examination. Model examinations provide the technician with a study program and introduction to the actual examinations. The model examinations are automatically graded in decimal numbers and bar graphs that can be outputted on your printer. The questions for each exam are selected randomly from a loaded data base—no two exams are exactly the same. When you answer a question, the correct answer is displayed and an explanation is given. From the printouts you will determine whether you need more practice and in which topic areas, or if you are ready to take the real test and continue to promote your electronics career today!

Listen to the Earth with this Seismic Detector

RON NEWTON

Want to find out what's happening underfoot? You can do just that with this inexpensive unit.

If you live in a seismically active area, you are no doubt aware of the "non-permanence" of the ground that you are standing on. Did you ever wonder if you have just felt a small earthquake, or was it only a passing truck? Perhaps you would like to explore the concept of volcanic eruption predictions.

The human body can detect a seismic event of about 2.5 or above on the Richter scale. A seismograph would be nice, but who can afford to have reams and reams of paper spewing out on the floor day after day? Besides, commercial seismographs are very expensive instruments and most are not portable.

To the rescue comes the Seismic Detector presented here, a portable and paperless device that is inexpensive and versatile. In addition to seismometers, the basic circuit can be used with other transducers such as LVDTs, differential pressure sensors, and accelerometers to name a few. Even with the use of expensive low-power components, the cost for parts is currently about $40; lower-cost standard components can be used if battery life is not a concern.

Design Features. Several features of the Seismic Detector contribute not only to its low cost but its usefulness as a geologist's instrument. Sensitivity is less than 2 on the Richter scale. At that level, it will be able to detect and record seismic events that we wouldn't notice. Up to eight separate one-minute events can be recorded and stored by the unit. Once an event has been detected and recorded, a light-emitting diode indicates that a seismic event has taken place and is stored in the system's memory.

The Seismic Detector can be connected to a PC for real-time monitoring of seismic events. That does not mean, however, that the Seismic Detector is restricted to any area that has a convenient wall outlet. Designed for portability and use in the field, it can run for about one year on a fresh set of batteries. Since it can collect data that might occur months apart, the date and time of each event is also stored by the unit.

Naturally, the computer interface can also be used for downloading any stored information for plotting and analysis.

Circuit Description. The schematic diagram of the Seismic Detector is shown in Fig. 1; follow it during the following discussion.

The heart of the system is SEN1, a vibration transducer. Manufactured by Geophone for use by the oil industry, it is a small can measuring 1 inch in diameter by 1.3 inches in height. It has a natural frequency of 10 Hz. If you open up a sensor, you'll find that it consists of little more

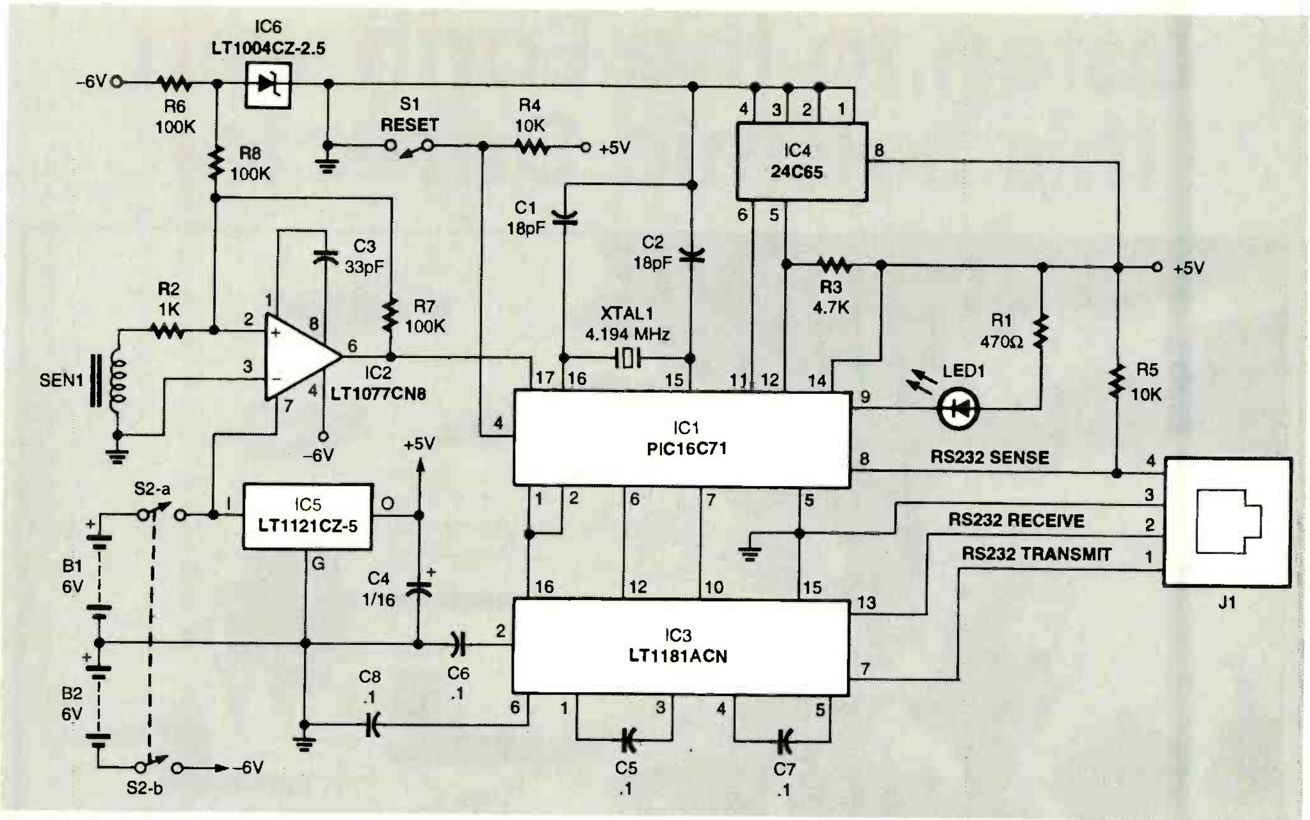
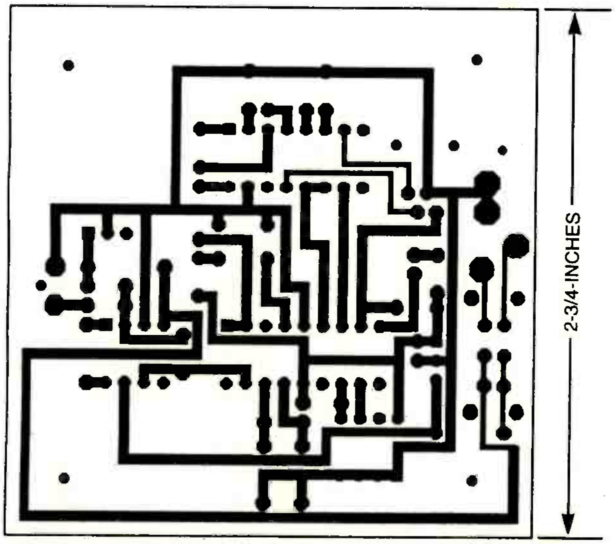


Fig. 1. Using low-power components to extend its battery life to a year of continuous operation, the Seismic Detector can store eight separate seismic events. Enough memory is provided for a minute's worth of samples per event—at 16 samples per second.

than a coil with a magnet suspended by a spring. When the sensor shakes, the magnet moves up and down within the coil. As everyone remembers from basic electricity, an electric current is generated when a conductor passes through a magnetic field. The sensor uses that effect to generate an AC voltage when it is moved. The intensity and shape of the AC signal is related directly to the amount of vibrational shock detected.

The output from SEN1 is very weak; IC2 amplifies it 100 times to boost the Seismic Detector's sensitivity. The amplified signal is applied to one of the inputs of IC1, a PIC16C71. That particular microcontroller features an on-board 8-bit analog-to-digital converter. There is a limitation on the input signal to the A/D converter—it cannot go negative, making measuring an AC waveform a bit difficult. The solution is to raise the voltage level of the signal so that it doesn't exceed the input specifications of the 16C71. Take another look at IC2; it is set up as a summing amplifier. A 2.5-volt offset is added to the sensor signal by using a precision reference diode, IC6. That voltage is at the halfway point on the A/D converters limits (128 on a 0–255 scale). Thus, a negative voltage will read



Here's the foil pattern for the Seismic Detector.

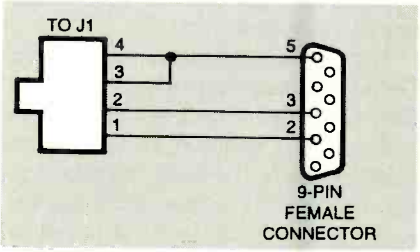


Fig. 2. This cable connects the Seismic Detector to a PC for downloading the recorded data as well as setting up the unit.

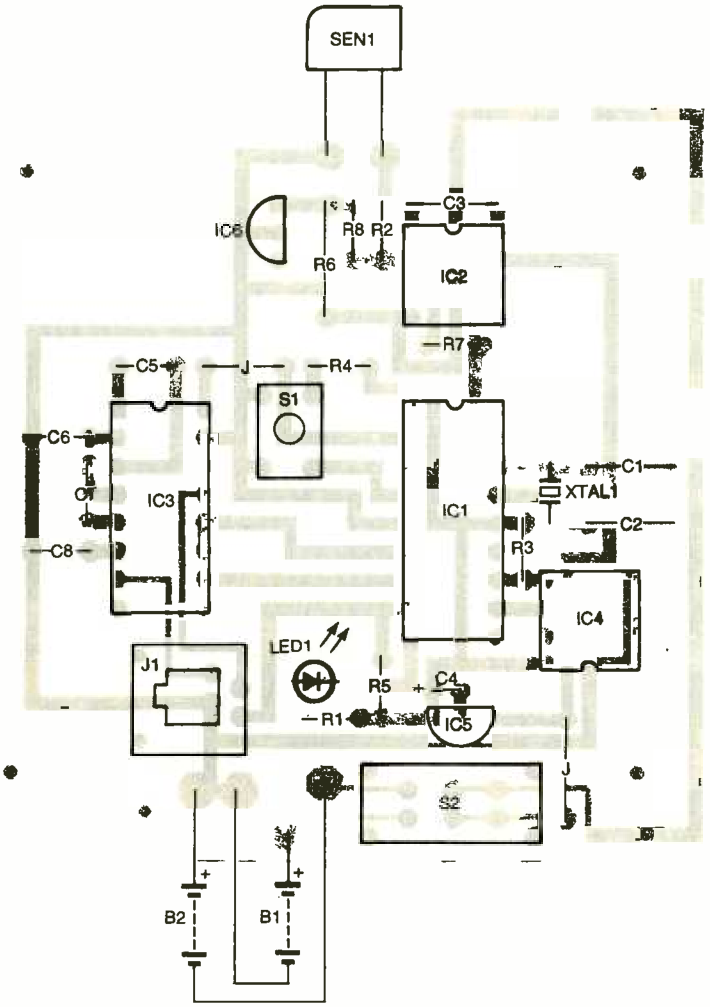


Fig. 3. The Seismic Detector is a simple circuit that fits on a small single-sided board. Only two jumpers are needed.

between 0 and 127; positive voltages will be between 129 and 255.

The frequency of XTAL1 was chosen so that together with the software that is programmed into IC1, precise timing lengths can be generated. For example, IC1 samples its analog/digital converter 16 times per second. If the reading is less than 123 or over 133, the software turns on LED1, which will flash every 15 seconds. One minute's worth of readings are stored in IC4, a serial memory chip. After a total of eight events, the system is set to "go to sleep" without taking any more readings no matter what happens. Due to the nature of how IC4 stores information, no data will be lost if power is lost. However, the unit will not take any more readings even if power is restored.

A bi-polar power supply is needed because of IC2. The positive side is supplied by four D-size batteries and is regulated to 5 volts by IC5, a low-power voltage regulator. A set of four AA cells provides the negative voltage for IC2.

Communications to a PC is handled by IC3, an RS232 interface chip. To conserve power, IC1 only activates IC3 when an adapter cable is plugged into J1. That adapter cable, shown in Fig. 2, shorts pins 3 and 4 of J1 together; IC1 watches for that condition. The Seismic Detector uses a 9600-baud rate to keep it compatible with the oldest of PCs.

Construction. The Seismic Detector's circuit is simple enough to build on a piece of perfboard using standard construction techniques. However, using a PC board makes for a neater appearance and eliminates most wiring errors.

If you choose to use a PC board, a foil pattern for a single-sided board has been included here. Alternatively, an etched and drilled board is available from the source given in the Parts List.

Before beginning assembly, note that IC1 must be programmed with the software that runs the Seismic Detector. The software for the Seismic Detector can be downloaded from the Gernsback FTP site (ftp.gernsback.com/pub/EN/seismic.zip). If you do not have access to a PIC programmer, a pre-programmed chip can be purchased from the source given in the Parts List, but download the software anyway. That package includes the PC software for reading back the information that the Seismic Detector has collected.

Start construction by placing the D-cell battery holder upside down with the wires to the left. Mount the AA-cell battery on the right side of the D-cell holder using double-sided tape or other suitable adhesive; the wires for both battery holders should face the same way.

Place the PC board on the left side of the D-cell battery holder. Mark the four locations where screws will hold the PC board to the holder. Drill those holes in the holder and set it aside.

If you are using a PC board that has been purchased from the source given in the Parts List or have etched one from the foil pat-

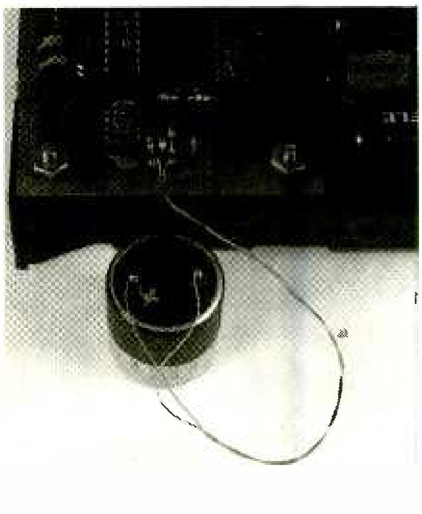


Fig. 4. The Seismic Detector relies on a vibration sensor that is used by the oil industry for exploration.

Fig. 5. The completed Seismic Detector is a compact, self-contained unit.

tern, use the parts-placement diagram shown in Fig. 3 to locate the various components. Note that there are two jumpers; they can be made from scrap pieces of component lead. In general, start with the smallest components and work your way up to the larger devices. Before soldering any polarized components, be sure to double-check their orientation. Burned semiconductors let you know that they have been installed backwards by releasing a puff of smoke and a unique odor that is unlike any other smell on Earth. Electrolytic capacitors, when installed the wrong way, have a way of failing that is—in a single word—"thrilling!"

A pair of square wire-wrap posts should be installed where SEN1 will be connected to the board. The integrated circuits can be soldered directly to the board; sockets can be used, but they might cause reliability problems after the Seismic Detector has been out in the field for several months exposed to extremes of temperature and humidity. Note the orientation of IC4; it is the reverse of the other chips.

You might want to consider a socket for IC1, especially if you are using the re-programmable version and might replace the program with one of your own design. Again, reliability and upgradability are the two features that you must choose between when it comes to the use of IC sockets.

When the board is done, look over your work carefully for poor soldering or missing, backwards, or misplaced components.

Note that there is a large strain-relief hole next to J1. Run the battery wires through that hole and solder them to the appropriate pads. The red wire from the AA batteries goes to ground and its black wire to the negative-voltage input. On the D-cell wires, the red goes to the positive-voltage input and the black to ground.

The transducer is connected to the board in a similar way; a strain-relief hole is next to the pads for the transducer wires. That hole is much smaller—use two different colors of wire-wrap wire. Twist the leads together and keep their length less than 12 inches to prevent any electromagnetic interference (EMI). The wiring method used in the author's prototype is shown in Fig. 4.

Mount the board to the back of the battery holder using standoffs, screws, and nuts. That completes assembly of the Seismic Detector itself.

Cut one end off of a modular 4-conductor telephone handset cord. Strip and tin the wires on the cut end. Following the schematic diagram shown in Fig. 3, connect the wires to a 9-pin connector. Use an ohmmeter or continuity tester if you are unsure as to which wire goes to which connector pin. The transmit line goes to pin 2 and the receive line to pin 3. Twist the ground and RS232 sensor wires together and solder them to pin 5.

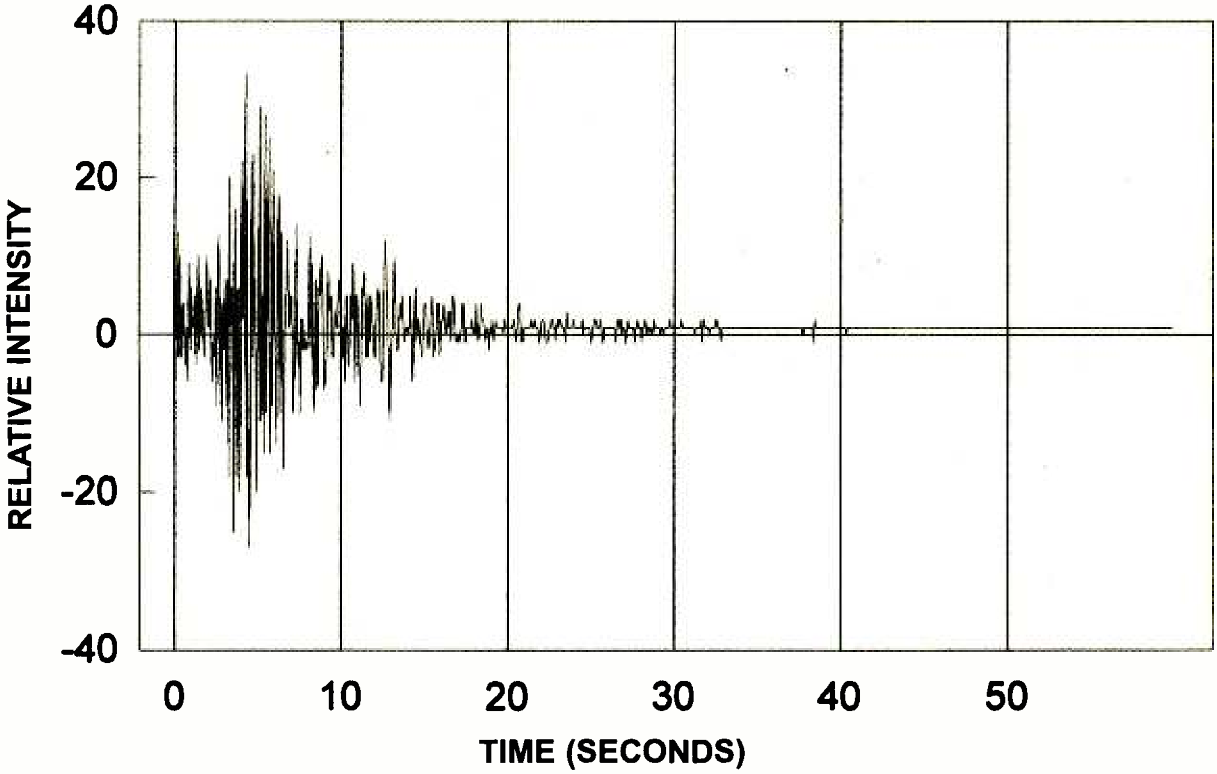


Fig. 6. An example of recorded data from the Seismic Detector is this plot of an earthquake that occurred in Carson City, NV on October 30, 1998.

PARTS LIST FOR THE SEISMIC DETECTOR

SEMICONDUCTORS

IC1—PIC16C71 microcontroller, integrated circuit
IC2—LT1077CN8 op-amp, integrated circuit
IC3—LT1181ACN RS-232 driver, integrated circuit
IC4—24C65 serial EEPROM, integrated circuit
IC5—LT1121CZ-5 low-power 5-volt regulator, integrated circuit
IC6—LT1004CZ-2.5 micropower 2.5-volt reference, integrated circuit
LED1—Light-emitting diode, red

RESISTORS

(All resistors are ⅛-watt, 5% units.)
R1—470-ohm
R2—1000-ohm
R3—4700-ohm
R4, R5—10,000-ohm
R6–R8—100,000-ohm

CAPACITORS

C1, C2—18-pF, ceramic-disc
C3—33-pF, ceramic-disc
C4—1-µF, 16-WVDC, electrolytic
C5–C8—0.1-µF, polyester

ADDITIONAL PARTS AND MATERIALS

B1, B2—6-volt battery
J1—modular telephone connector, PC-mount
SEN1—Seismic vibration transducer (see text)
XTAL1—4.194-MHz crystal
9- or 25-pin connector, four D-cell battery holder, four AA-cell battery holder, wire hardware, etc.

Note: The following items are available from Tahoe Chemical R&D; Tel: 702-885-8842; E-mail: sjnewt@aol.com: Pre-programmed IC1, $10; etched and drilled PC board, $15. Please add $5 for shipping and handling within US and Canada. NV residents must add appropriate sales tax.

SEN1 is available from: All Electronics, PO Box 567, Van Nuys, CA 91408-0567; Tel: 800-827-5432; item GP-1; and from Geo Space Corporation, 7334 N. Gessner, Houston, TX 77040; Tel: 713-939-7093; Web: www.geospacecorp.com; item GS-20DM.

If you need to use a 25-pin connector, pins 2 and 3 are reversed; pin 7 is used for ground.

As a final touch, put a drop of red fingernail polish on the side of S2 next to the battery wires. That will be a reminder as to which position is the "on" position. The completed Seismic Detector, with batteries loaded, is shown in Fig. 5.

Testing. One of the files in the download package is seismic.exe; that is the PC program for setting up and collecting data from the Seismic Detector. It is a DOS-based program; it will run under Windows95 and Windows98; compatibility might be a problem with other operating systems

such as WindowsNT, Windows2000, and OS/2. At any rate, running the software from a plain DOS prompt is best to avoid any interference Windows might cause while accessing the serial ports.

Make sure that S2 is off; place the batteries into their holders. With the Seismic Detector resting on a table, turn it on; LED1 should light. Connect the adapter cable to J1 and the serial port of your computer. The LED should turn off. Start the seismic.exe program and select the serial port that you have the Seismic Detector connected to.

Once you reach the main menu, type "C" for real time. Tap the table and you should see the data change. When SEN1 is at rest, the data should be centering on 128.

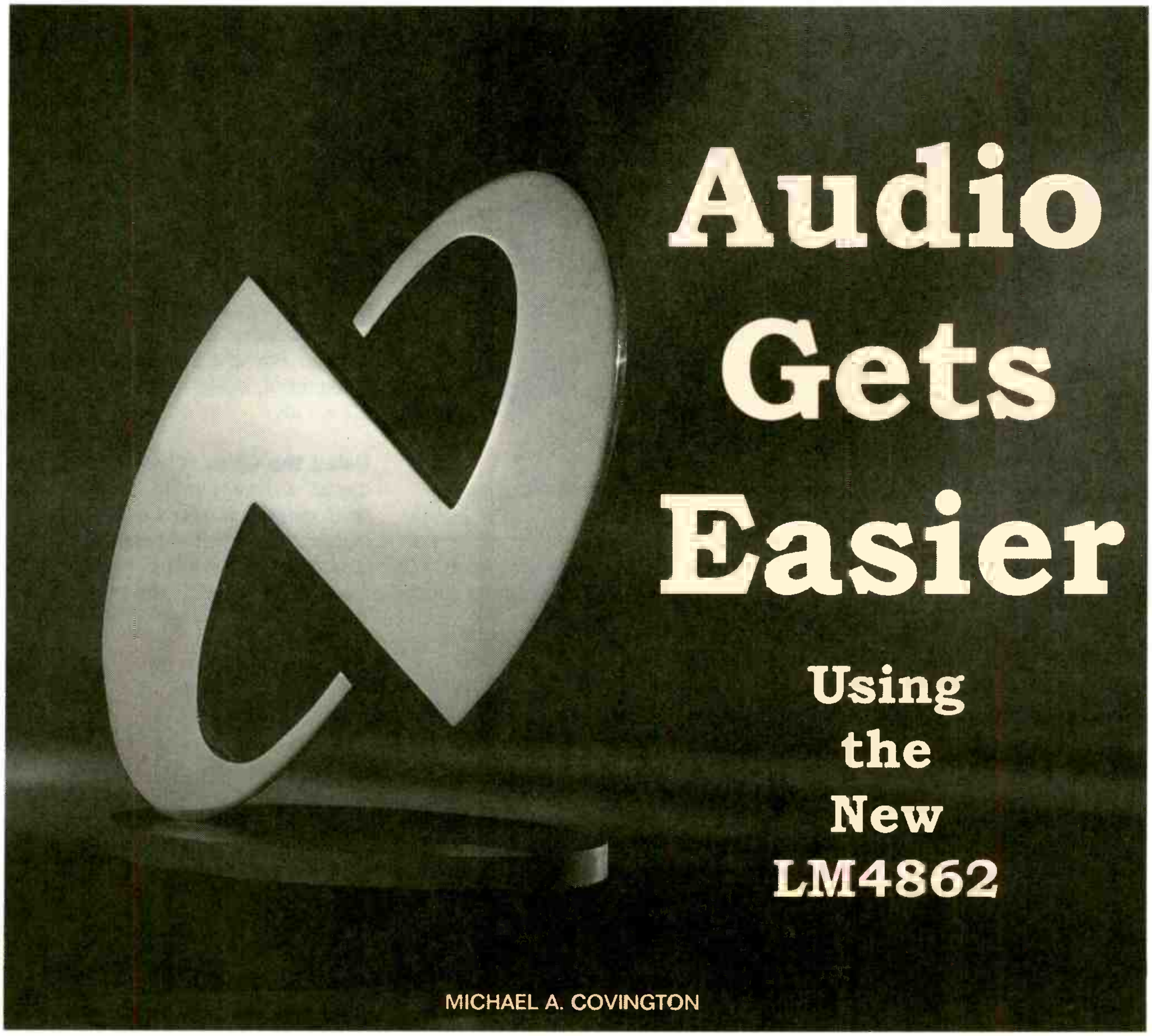
Now we'll test the unit's recording ability. Type "D" to clear the Seismic Detector's memory, and then type "E" for field recording. Hit the enter key to accept the default delay of one minute. Note that the Seismic Detector can be set for a delay of up to 255 minutes—that's four hours and 15 minutes, the approximate driving time between Boston and New York! Remove the cord from J1 and LED1 should blink on and off indicating that it is arming. Once LED1 goes out, it is armed. Tap the table and LED1 should go on indicating that it is taking data. Tap the table several times for about one minute. You can turn S1 off; the unit will retain its data.

Downloading. Plug the adapter cable into J1 and turn the unit on. At the main menu of the PC program, type "B" to choose the store-to-disk option, then type "A". Collection will automatically stop when all of the available data is downloaded. Once you are satisfied that you have stored the data you want, you can erase the memory as detailed above.

The data files can be read into any spreadsheet. Both Lotus 123 and Excel work well. The first large number is the date and its decimal is the time that the seismic event took place. The following data is seismic data. Use the spreadsheet's graphing function to display the data. An example of graphing a seismic event is shown in Fig. 6. That event took place in Carson City, NV on October 30, 1998 at 1:53 AM. That data file, as well as a text file with further information on using the Seismic Detector, is a part of the full software package that you downloaded.

Field Use. For simple seismic sensing in a building, set the unit down on its D batteries on a concrete floor in an area where it won't be disturbed. Place SEN1 next to it. The unit can be turned off without disturbing SEN1.

When studying volcanoes or doing other outdoor work, place the unit into a plastic container with a waterproof screw or snap cover. Fix SEN1 to the bottom using double-sided tape; hold the batteries in place with rubber bands or foam rubber. Bury the container to prevent vandalism and retrieve the data later. Remember that when you go back to dig it up, the shovel will cause the last recorded event! Don't forget to turn off the power when transporting the Seismic Detector. Ω



Audio Gets Easier

Using the New LM4862

MICHAEL A. COVINGTON

This new "Boomer" audio amp from National Semiconductor is easier to use, offers better performance, and needs fewer bulky external components than anything previously available.

Any electronic device that makes sound in a speaker—at least if the sound is more than digital beeps—needs an audio amplifier. Until now, the most popular IC for driving small speakers has been the LM386, introduced in 1975 by National Semiconductor. Figure 1 shows a typical circuit. Compared to the discrete-component circuits that preceded it, the LM386 was a godsend; it could deliver 0.2 watt into an 8-ohm speaker from a 9-volt supply without an output transformer.

But the LM386 wasn't perfect. As Fig. 1 shows, it requires large electrolytic capacitors, which add bulk and cost to the circuit and can distort the sound as they age. Further, the input impedance of the LM386 is very high, making it prone to oscillation if the inputs aren't carefully separated from the outputs. Its voltage gain of 20 (or 200 with one capacitor added) is a bit too high for line-level input (1V RMS) and contributes to the oscillation problem.

Twenty years went by, and National Semiconductor has recently introduced a new line of easy-to-use "Boomer" audio amplifiers. The handiest of these is the LM4862, which is available in both surface-mount and DIP packages with the same pinout (LM4862M and LM4862N respectively). It can deliver 0.675 watt into an 8-ohm speaker at 1% total harmonic distortion. (At slightly lower power levels, distortion is appreciably less.) What's more, it has automatic thermal shutdown to protect it from damage if overloaded, and it operates from a single 5-volt supply. The input impedance is relatively low and user settable, so the risk of oscillation is much lower.

Inside the Chip. Figure 2 shows what's inside the device. The LM4862 drives the speaker differentially, applying opposite waveforms to the two terminals—a configura-

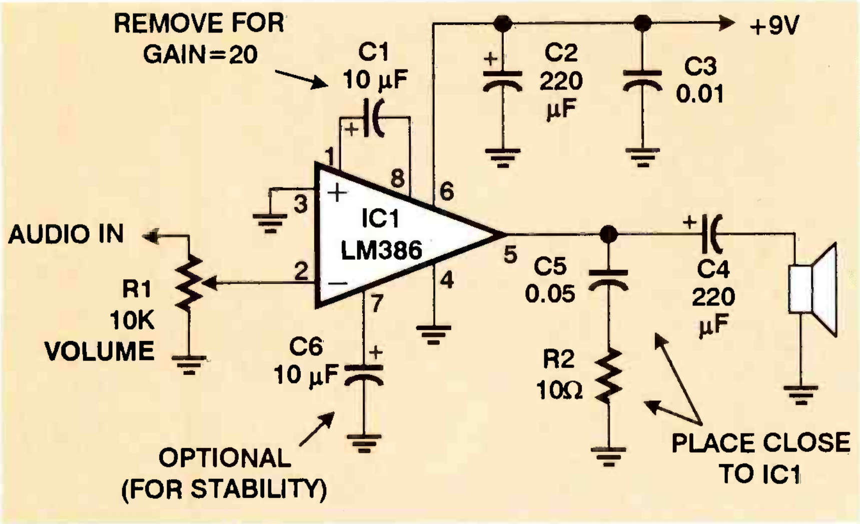


Fig. 1. The classic LM386 audio amplifier needs six capacitors, three of them electrolytic.

tion often called BTL (bridge-tied load). Either side of the speaker can go to +5V, while the other side goes to 0V. Thus, the amplifier can produce 10 volts of swing from a 5-volt supply. That's enough for room-filling volume with a 4-inch full-range speaker.

The supply voltage can range from 2.7 to 5.5 volts; naturally, the amplifier can deliver more power if the supply voltage is near the high end of the range. You can power the LM4862 from two or three 1.5-volt cells or a regulated 5-volt supply. (Do not use a 6-volt battery; it exceeds the maximum rating.) Total current consumption ranges from 5 mA when quiet to about 250 mA at maximum volume. Power-supply ripple rejection is excellent, better than 50 dB when C2 = 1 µF.

Using the Chip. A typical amplifier circuit is shown in Fig. 3. It's simple and does not require electrolytic capacitors; that keeps the cost down and ensures high-fidelity audio. Actually, C2, the bias bypass

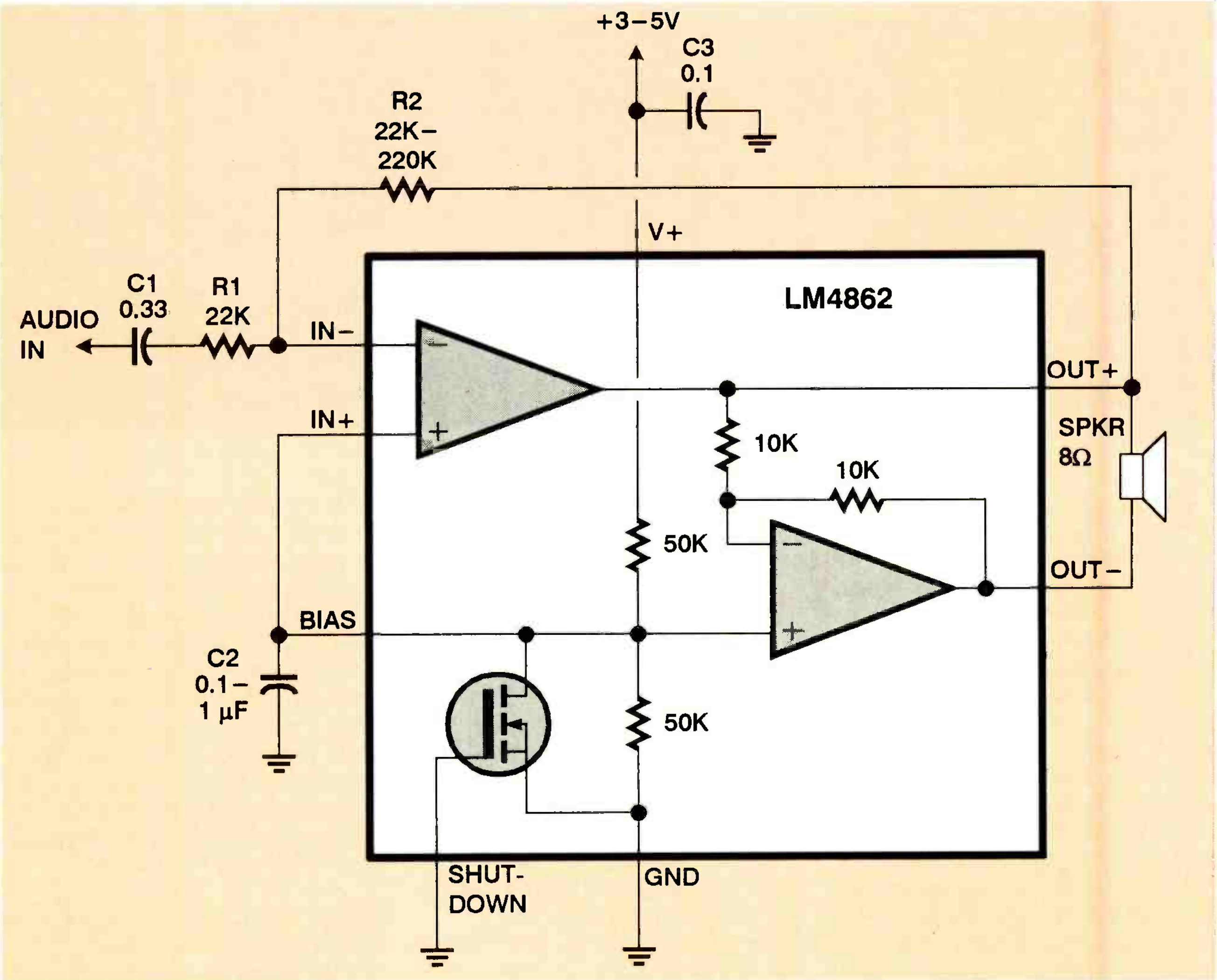


Fig. 2. The new LM4862 needs fewer external components and is less prone to oscillation than the LM386.

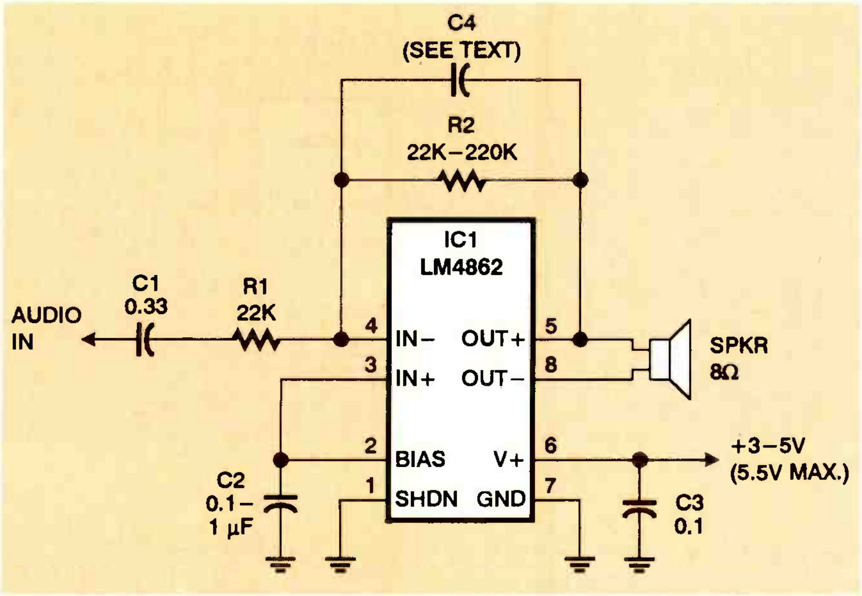


Fig. 3. A typical circuit using the LM4862. Place C3 as close to the IC as possible.

capacitor, can be a tantalum electrolytic; the audio signal doesn't pass through it. Also, a 100-µF electrolytic in parallel with C3 is a good idea when using batteries or a poorly regulated power supply.

The voltage gain is equal to 2(R2/R1) and should not exceed

	HIGH FIDELITY (20–20,000 Hz)	POWER SAVING (150–20,000 Hz)
LOW GAIN (A_V = 2)	R1 = 22K R2 = 22K C1 = 0.33 C2 = 1.0 µF C4 OMITTED	R1 = 22K R2 = 22K C1 = 0.05 C2 = 0.1 µF C4 OMITTED
HIGH GAIN (A_V = 20)	R1 = 22K R2 = 220K C1 = 0.33 C2 = 1.0 µF C4 = 22 pF	R1 = 22K R2 = 220K C1 = 0.05 C2 = 1.0 µF C4 = 22 pF

Fig. 4. Here are some component values for variations of the circuit in Fig. 3.

20; sound quality is best when R2 = R1 and the gain is 2. (That's exactly what you need to drive a speaker from 1-volt line-level or headphone-level audio.) When the gain is higher than about 5, R2 should be bypassed by a small capacitor (C4) to prevent oscillation. A 5-pF capacitor will do the job, but a 22-pF capacitor will probably be easier to find; do not use values larger than 32 pF. If the input signal is coming from a low-impedance source, you can use smaller resistors, such

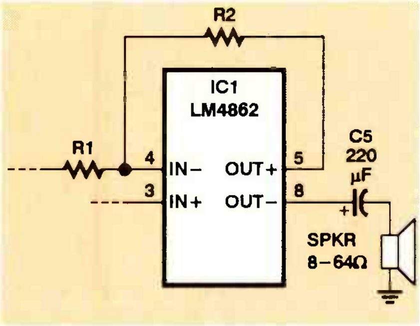


Fig. 5. How to drive a grounded circuit. The balance of the circuit is shown in Fig. 3.

as R1 = 4.7K and R2 = 4.7K to 47K.

Figure 4 gives component values for some typical amplifiers. Note in particular that you can save battery power, as well as component cost, by cutting the bass response when driving a small speaker that wouldn't reproduce low frequencies anyhow.

The speaker impedance must be at least 8 ohms. You can use a 16-, 32-, or 64-ohm speaker, but you'll get considerably less power out. If you must ground one side of the speaker, drive the other side through a capacitor as shown in Fig. 5; you'll get only a quarter as much power as if the speaker were driven differentially.

The shutdown (SHDN) pin disables the amplifier, bringing both outputs low and cutting power consumption to less than 1 micro-ampere (yes, microampere), when connected to +5V. The shutdown pin is grounded in normal use. You can use it to implement a "mute" button without putting a switch in the signal path, or even wire it to a headphone jack to silence the speaker when headphones are plugged in.

The bias pin is the output of a voltage divider built into the chip. Its purpose is to hold the positive inputs of both op-amps at half the supply voltage so that they can operate with a single supply. You can also use the bias pin to bias one or two additional op-amps as shown in Fig. 6.

The bias pin should be bypassed to ground by a capacitor between 0.1 and 1.0 µF. Larger values improve ripple rejection and suppress the "thump" when the amplifier is turned on.

Some Applications. The LM4862 teams up well with other low-voltage ICs. For example, Fig. 7 shows an experimental AM radio based on the Plessey (formerly Ferranti) ZN414 TRF receiver chip. On the breadboard, this circuit gave high-fidelity

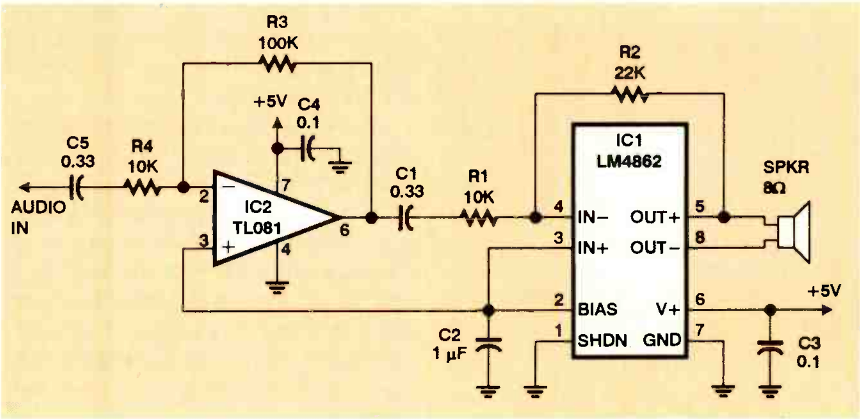


Fig. 6. You can use the bias pin, pin 2, to bias one or two external op-amps as shown here.

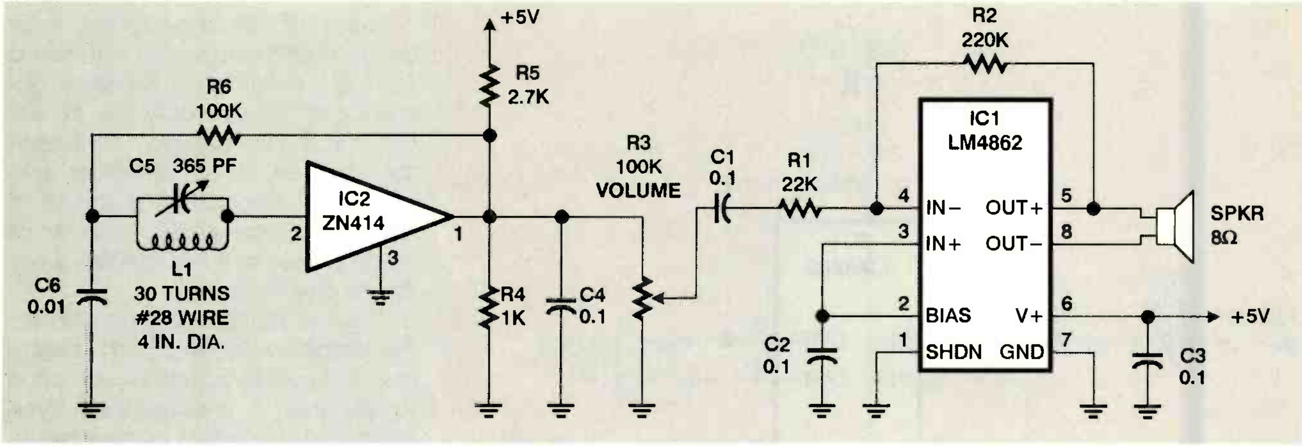


Fig. 7. When the LM4862 is combined with the Plessey (Ferranti) ZN414 receiver chip, the result is a simple, high-quality AM receiver.

reception of local AM stations.

Like other amplifiers, the LM4862 makes a fine oscillator. Figure 8 shows a classic op-amp square-

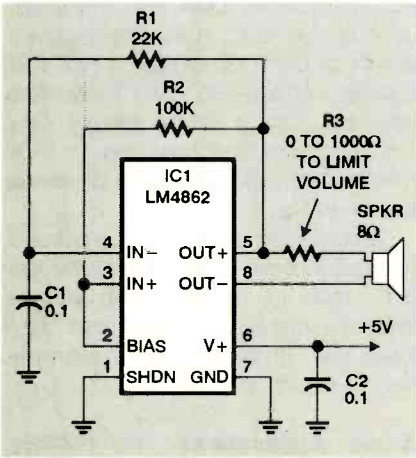


Fig. 8. This squarewave oscillator produces a loud 1-kHz tone in the speaker.

wave oscillator that can serve as a loud siren—at least twice as loud as any conventional 5-volt circuit.

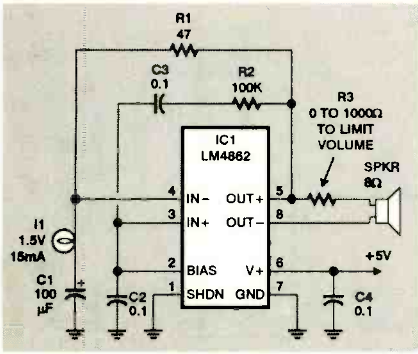


Fig. 9. A tiny "grain-of-wheat" light bulb is the feedback regulator in this circuit for a Wien-bridge oscillator.

Figure 9 shows a Wien bridge that produces a low-distortion sine wave.

In the last circuit, a 1.5-volt, 15-mA light bulb (RadioShack 272-1139)

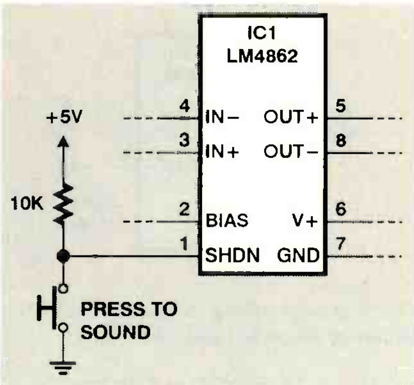
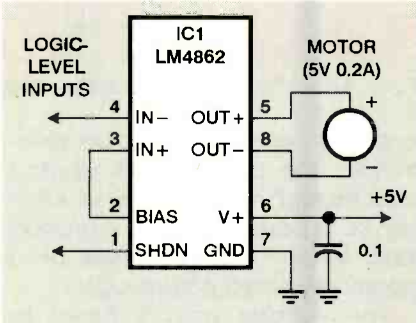


Fig. 10. The oscillators in Figs. 8 and 9 can be pushbutton controlled as shown here.

serves as the regulating element in the feedback loop. As current increases, the bulb heats up and its resistance increases, cutting feedback and stabilizing the oscillator. The bulb does not actually glow visibly in normal operation. Resistor R1 is closely matched to the bulb and will require a different value if a different kind of bulb is used.

To make either of the oscillators sound at the press of a button or to use them for Morse code practice, add a momentary-contact switch that grounds the shutdown pin as shown in Fig. 10. The 10K resistor is needed because the shutdown pin has no internal pull-up; if unconnected, it "floats" to a random voltage and the LM4862 operates very erratically.

Finally, a speaker isn't the only



INPUTS		MOTOR ACTION
SHDN	IN−	
+5V	ANY	STOP
0V	0V	RUN FORWARD
0V	+5V	RUN BACKWARD

Fig. 11. Using the LM4862 as a bi-directional motor controller.

thing the LM4862 can drive differentially. It also makes a fine full-bridge bi-directional driver for small motors. Figure 11 shows a circuit that was breadboard-tested with a 6-volt tape-recorder motor (running on 5 volts, of course). In this circuit, the inputs of the LM4862 are compatible with CMOS logic outputs, making computer control easy to implement.

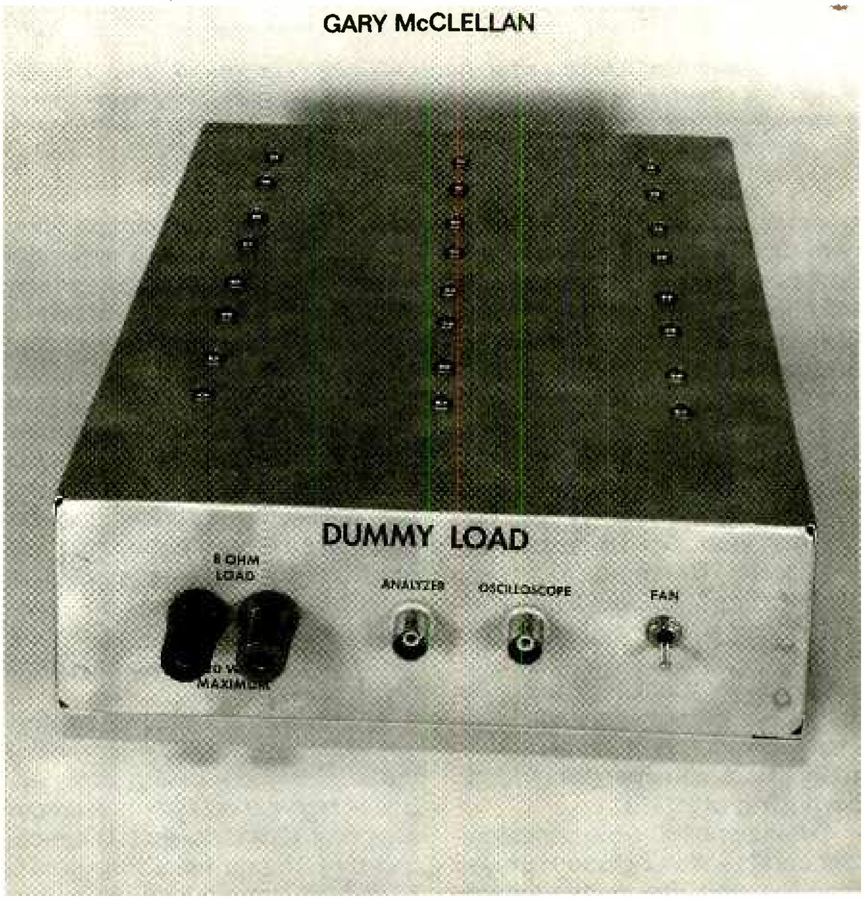
Availability. One potential problem with the chip for hobbyists is that it is not that widely available. National does provide free samples to engineers and sometimes others. For more information, see their Web site at www.national.com. It is also available from traditional full-line distributors such as Newark Electronics (www.newark.com). Ω

Test Equipment for Audio Technicians:

Precision Dummy Load

Spruce up your test bench with a dummy load for testing amplifiers without the need for speakers.

GARY McCLELLAN



If you work with consumer-audio, musical-instrument, or professional-sound equipment, you probably know that good test equipment makes your work easier and faster. The ability to do a repair job quickly and efficiently is especially important if you are being paid for your efforts. The ability to service more audio equipment faster translates into making more money.

Unfortunately, most of the really helpful audio test equipment is hard to find because only a few specialty stores offer it—if it is made at all Once such piece of gear is an eight-ohm, 320-watt dummy load. As you probably know, a dummy load is temporarily connected in place of speakers for testing an amplifier. A dummy load offers a safe, practical way to test for power output, distortion, and hum or noise output after the amplifier has been repaired. It can accommodate anything from a simple five-watt guitar amplifier to the 300-watt units used in professional sound systems.

Obviously, a dummy load is a useful test-bench accessory. The funny thing is that if you want one, you'll have to build it: for some reason, commercial dummy loads are not available as off-the-shelf products. Thankfully, the parts are readily available and the work is easy.

How It Works. The Dummy Load is a simple device, as you can see from the schematic diagram in Fig. 1. It uses a series/parallel combination of 16 power resistors to make up a value of 8 ohms. Using 20-watt units, the Dummy Load has the ability to dissipate 320 watts of power. To calculate the resulting value of a series/parallel resistor network, first add all of the series-resistor values together, and treat those results as large resistors in parallel. In the Dummy Load, the four strings of series resistors configuration takes advantage of low-cost, widely-available resistors. Consider the alternative of obtaining two 250-watt resistors and connecting them

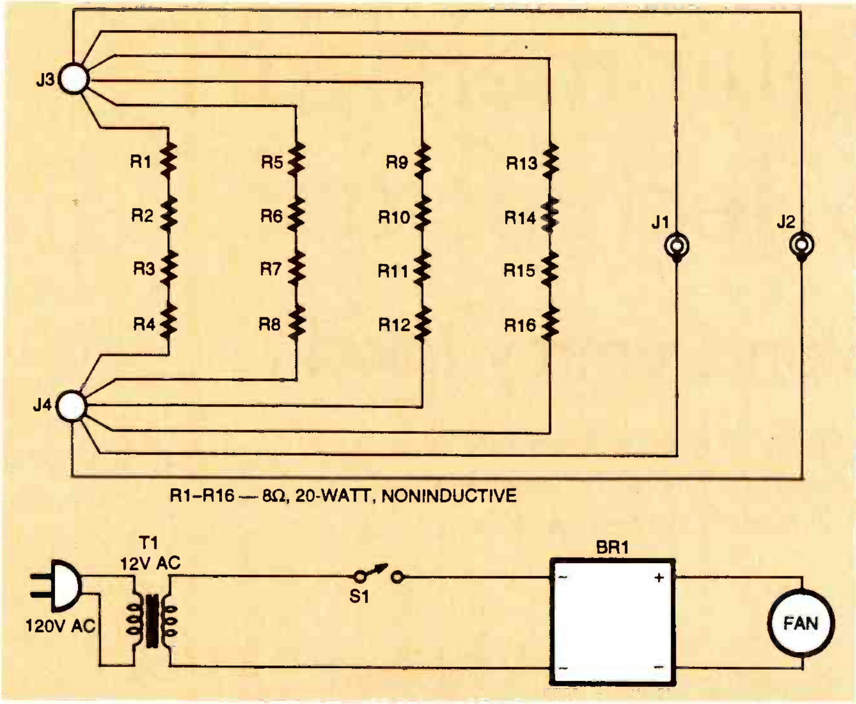


Fig. 1. The Dummy Load is simply a set of resistors that dissipate energy while testing an amplifier under load without having to hook up a speaker—a much noisier option! Using several resistors in a series/parallel arrangement lowers the cost of the unit as well it increases the accuracy; multiple resistors tend to cancel out tolerance differences between different resistors.

in series: a pair of Vishay/Dale 4-ohm 250-watt resistors currently cost over $108 from industrial distributors. Not only is that cost prohibitive, it is almost impossible to acquire the components if you are a hobbyist. The cost of the resistors in the Dummy Load is only about $24, and they can easily be found locally.

Note that the resistors specified are non-inductive units that are specifically designed for audio applications. The special construction of those devices insures that the load impedance doesn't rise with frequency, which would affect the power output of the amplifier. That consideration is especially important if you are going to do any testing at 20 kHz.

Other benefits of the series/parallel configuration include improved precision and reasonably fail-safe protection. Resistance errors tend to average out, resulting in a total value closer to 8 ohms when compared to a single resistor. For example, the author's prototype measured 8.06 ohms. In terms of fail-safe protection, consider what would happen if a single resistor burns out. If that happens, the load increases to 10.6 ohms but it doesn't go open circuit. That feature is essential when testing tube amplifiers where an open circuit at full-power output will destroy an expensive output transformer.

A pair of banana jacks, J3 and J4, is used to connect the Dummy Load to an amplifier. Additional monitoring jacks (J1 and J2) are provided for a distortion analyzer and oscilloscope. Note that the ground sides of those monitoring jacks are connected to J4; keep that in mind when you are connecting the Dummy Load to a piece of equipment.

At high power levels, the resistors get quite hot. A built-in fan keeps the resistors cool during any periods of high-power testing. A simple source of 12-volt power (T1) is rectified by BR1 and used to power a 12-volt DC "boxer"-type fan. Switch S1 turns the fan on and off.

Building the Dummy Load. The Dummy Load is easy to build. With a little bit of luck, you might have all of the necessary parts available in your "junk drawer." Here are some suggestions for "fine-tuning" the Dummy Load to better suit your needs and available parts.

If you don't need the 320-watt power-handling capability, you can use three rows of three resistors; the power rating will be 120 watts—fine for the majority of consumer stereo and musical-instrument amplifiers.

Any case can be used that's large enough to hold all of the parts and is made of metal. A metal cabinet is required for fire-safety reasons. An example of using a suitable cabinet comes from one technician who used the finned-heatsink cabinet from an old automotive stereo amplifier. The internal circuitry was removed and a new end panel made from scrap aluminum.

If you are using resistors from your junkbox or other surplus source, you might have to spend some time with a hand-held calculator until you find a series/parallel combination that yields 8 ohms. It's important to use power resistors marked "non-inductive." However, if you are not overly concerned with qualitative measurements as done by high-end testing labs, conventional resistors don't have enough inductance at the standard 1-kHz test frequency used in most service facilities to cause serious errors.

If you can't find the screw-mounted insulated posts that will hold the resistors in place, use terminal strips. Do not mount the resistors on a PC board; the board could burn and produce dangerous fumes. The fan is a common unit that can be removed from an old personal-computer power supply.

The author's prototype is shown in Fig. 2. As you can see from the photo, the resistors are arranged in

PARTS LIST FOR THE DUMMY LOAD

BR1—50-volt, 6-amp bridge rectifier
J1, J2—BNC jacks, panel-mount
J3, J4—Banana jacks or 5-way binding posts
R1–R16—8-ohm, 20-watt non-inductive resistors
S1—Single-pole, single-throw switch
T1—12-volt AC, 400-mA transformer
12-volt DC fan, aluminum case, rubber feet, wire fan guard, insulated tie points, rubber grommets, wire, hardware, etc.

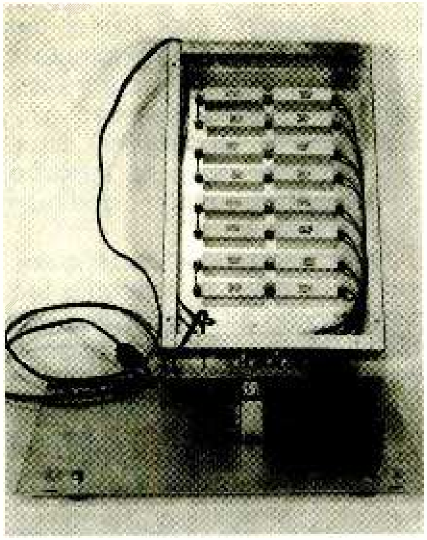


Fig. 2. The Dummy Load is built in a metal housing with a fan for forced-air cooling. Each resistance string is wired to the output jacks individually.

eight rows of two resistors per row. Space the rows at least 1 inch apart. Drill mounting holes for the insulated mounting posts that will hold the resistors in the top of the case—24 are needed. The jacks as well as S1 are mounted on the front. A suitable hole for the fan's power-supply cord is needed in the back of the unit. The back of the case will also need several ventilation holes. The fan and its power supply are mounted on the base plate near the front.

Once all of the holes are drilled or cut and deburred, clean the cabinet, paint it, and apply labeling as desired. The author's unit sports a "distressed" finish that was done with a wire brush chucked in an electric drill then cleaned and coated with a clear lacquer spray.

When the case's finish is dry, install the components. Make sure that none of the jacks are grounded to the cabinet. Mount the 24 insulated posts or terminal strips. The fan should be positioned so that the airflow will draw cold air through the bottom of the cabinet and push it through the resistors and out the back of the unit. Finally, mount BR1 and T1.

When installing the resistors, be sure that the body is suspended in space between the terminals. That insures good airflow around the resistors, reducing heat buildup. Note how every other row is connected to its neighbor, resulting is a set of four resistors in series.

Wire J1 and J2 to J3 and J4 with short pieces of hookup wire. When wiring the resistors to J3 and J4, use heavy-gauge wire; 16-gauge should be considered a safe minimum. As suggested in Fig. 1, do not "bus" the resistor branches together and use a single wire to connect to J3 and J4; that will cause measurement errors.

Pass the power-cord wire through the grommet and wire the cooling circuit (S1, T1, BR1, and the fan). Leave about eight inches of wire between S1 and T1 so that it is easier to work on the Dummy Load when it is opened up.

With construction complete, check your work for errors and correct any that are found. Mistakes to watch for include unsoldered connections, cold-solder joints, shorts between adjacent connections, and incorrectly installed parts. Close the case and the Dummy Load is ready for testing and use.

Testing the Dummy Load. Before using the Dummy Load, it is wise to make a few tests. Plug the unit in and verify that the fan runs when S1 is closed. Measure the resistance across J1, J2, and between J3 and J4. The reading must be 8 ohms. Measure the resistance between the cabinet and either J1 or J2; those jacks must be completely isolated. If those checks pass, the Dummy Load is ready for use. If not, recheck the wiring and repair any faults.

You might want to make some patch cables for easy connection between the Dummy Load and the amplifier under test. A four-foot length of 12-gauge two-conductor power cable makes for a rugged test lead. If you work with musical-instrument amplifiers, attach a 1/4-inch phone jack to one end and suitable connectors for mating with J3 and J4 on the other. You can make several types of patch cables for whatever type of equipment you'll be working with; for example, heavy-duty spade lugs for professional equipment or stripped and tinned wire ends for consumer audio equipment. It is a good idea to color code the two wires so that you can tell which lead should be connected to J4, and in turn to the measuring equipment's ground.

Basic Amplifier Testing

Although amplifier test methods are beyond the scope of this article, here is a simple continuous-power-measurement procedure to get you started:

1. Increase the audio oscillator level until a slight flattening of the waveform peaks appears. That point represents roughly 3% Total Harmonic Distortion (THD). Record the voltage across the load on the analyzer's AC voltmeter. Turn the oscillator level to zero immediately after you finish the measurement.
2. Calculate the power output using the formula P=I × 28. Subtract 10% from that value. Record that value as the rated power output.
3. Adjust the oscillator level for the rated power output and measure the distortion. Record the distortion and voltage across the load. Turn the oscillator level to zero.
4. If desired, you may measure hum and noise by disconnecting the audio oscillator, shorting the amplifier input, and noting the voltage reading on the analyzer's AC voltmeter. Then calculate the difference in dB using the formula:

dB(loss)=20 Log E rated power/E hum noise

Using the Dummy Load. The Dummy Load is easy to use once you understand some of the basics of testing amplifiers under load. Connect the amplifier output to J3 and J4 with appropriate patch cables. Be sure that the ground connection on the amplifier goes to J4. If you are testing an amplifier with a bridging output, you *must* isolate the distortion analyzer and oscilloscope from ground. Otherwise, one side of the amplifier will be shorted to ground through the instrument power cords, damaging the amplifier. Use ground-isolated or battery-operated instruments. Alternatively, you can temporarily install 3-wire adapter plugs on the instrument power cords to "float" their grounds.

Connect a distortion analyzer to either J1 or J2 and an oscilloscope to the other BNC jack. Turn on the fan and power up the amplifier. Adjust an audio oscillator for 1 kHz and turn the output level to zero. Connect it to the amplifier's input. You are now ready to measure power output, distortion, and hum or noise levels.

While the Dummy Load is a simple and rugged instrument, a few suggestions are in order to help you get a long life out of it and to avoid costly equipment mishaps. When testing solid-state amplifiers, check the output with a DC voltmeter before connecting the Dummy Load. If the reading is over 200 mV DC, correct the problem before going any further. When testing tube amplifiers, always connect the Dummy Load before turning on the power. If you don't, there is a possibility of damaging the amplifier's output transformer—a rather costly mistake! Be sure to use the 8-ohm tap on the amplifier for maximum power output.

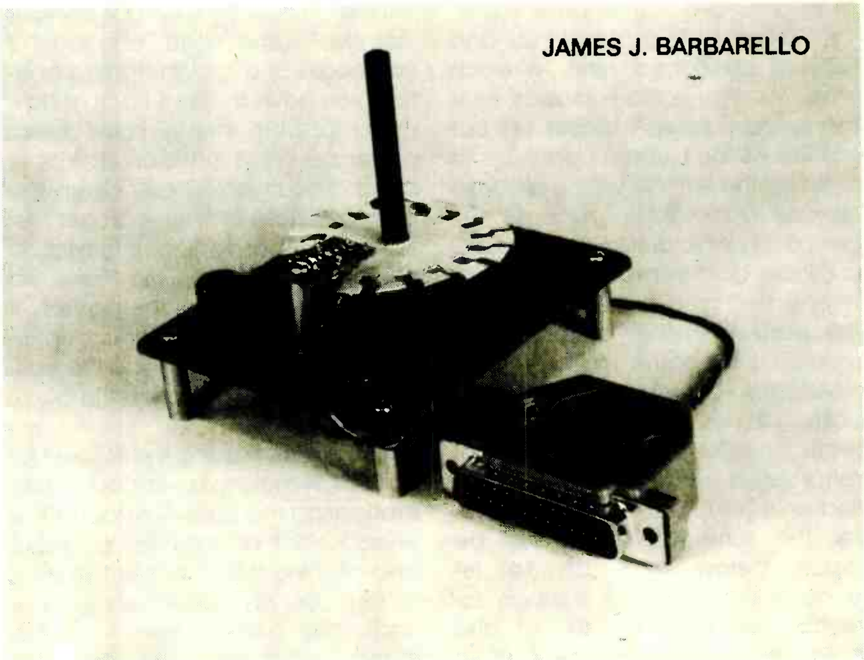
If you use a digital multimeter as an AC voltmeter instead of a distortion analyzer, be aware that the accuracy on most units degrades above 500 Hz. That will be a problem if you try to perform frequency response testing on the amplifier. Check your DMM manual to be sure.

Finally, remember that the Dummy Load is intended for short-term testing. Do not run the unit at full power over 5 minutes at a time, or any time with the fan turned off. If you do, the resistors might overheat, change value, and burn up. Ω

AN INFRARED-BASED ROTARY ENCODER

Measure the position of any rotary shaft.

JAMES J. BARBARELLO



There are times when you need to know the position of a rotary device like a potentiometer or a wind vane. You could do that by linking the device's shaft to a commercially-available encoder, but that approach has some drawbacks. The mechanics of connecting the encoder and shaft might be awkward or difficult; in some cases, it's impossible. Encoders are not the easiest components to find, and they are a bit pricey when you do.

Luckily, there's another approach that's mechanically simple and uses readily available, cheap parts. That approach uses an Infrared (IR) LED as a light source and an IR phototransistor to detect the IR light. The theory is simple: point the source at the detector. The IR energy from the source will cause the base-emitter junction of the detector to conduct. If the IR is blocked, the detector shuts off. Slipping a perforated piece of common paper (which, by the way, doesn't transmit IR energy) on the shaft that we want to monitor together with the encoder electronics creates a simple and low-cost rotary encoder. Any PC can read both the position and direction of a shaft. What's more, we're not restricted to rotary position sensing, as you'll see.

Theory of Operation. Figure 1 shows the schematic diagram for the IR Encoder. The circuit requires 5 volts DC, which is provided by IC1. That regulator can be eliminated if you have an available source of regulated 5-volt power. As shown, any unregulated 8–13-volt DC source, such as a 9-volt battery or a DC wall transformer, can be used. Capacitors C1 and C2 provide filtering.

Resistors R1 and R4 feed infrared sources D1 and D2 respectively. The current, set by the resistors, is about 11 mA. Their outputs physically shine on detectors Q1 and Q2. Pull-up resistors R2 and R3 have the same function as a standard inverting transistor stage.

The key to making such a simple circuit into an accurate position and direction encoder is the encoder disk's cutout pattern. Shown in Fig. 2, it creates four dis-

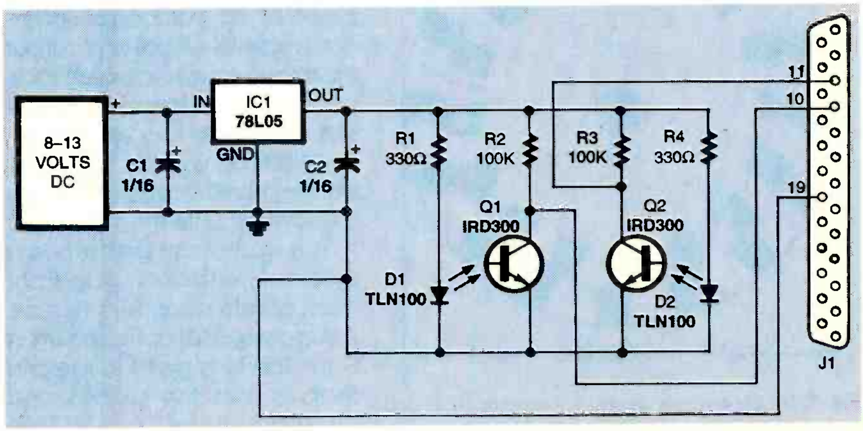


Fig. 1. The Infrared Encoder circuit is very simple. An infrared diode shines on a phototransistor. Anything opaque that blocks the infrared light turns the transistor off.

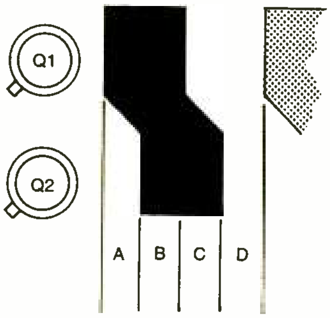


Fig. 2. The pattern for the encoder disc is divided into four "zones." The pattern is shaped so that only one sensor changes state at a time.

tinct zones. Note that both Q1 and Q2 are positioned next to each other. As the pattern passes over the sensors, zone A blocks Q1 but not Q2. As the pattern continues to move to the left, Q2 will be blocked as well (zone B). In zone C, Q1 becomes unblocked. Finally, zone D unblocks both sensors. The pattern is repeated at a similar spacing to the pattern shape; all four zones should be the same width.

Another important aspect of the pattern zones is that they are correctly sized to the diodes and phototransistors being used. The specified units have a 0.125-inch diameter. The zone size should not be much below 0.08-inch to let enough infrared light through for reliable sensing. You should also have enough length to the pattern in order to compensate for any misadjustment; double the sensor's diameter should be plenty.

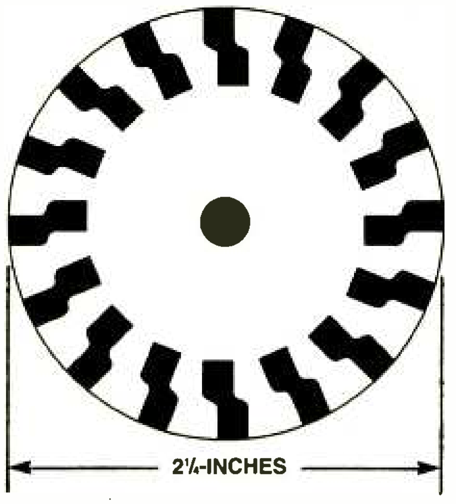


Fig. 3. Here is a sample pattern for the encoder disc. It is designed to fit onto a /-inch shaft. Any stiff paper or index card will work well, as long as the chosen material blocks infrared light.

The shape of the pattern is key to determining in which direction the pattern is moving. Let's say that both Q1 and Q2 are blocked (zone B). If the pattern moves to the left, Q1 becomes unblocked first; Q2 will be first if the pattern moves to the right. At any "starting" position, it is easy to determine which direction the pattern is moving by simply noting which sensor changes state. If you open up an old computer mouse, you'll find that the sensing technique is similar.

Positioning, on the other hand, is "relative" rather than "absolute." If you begin at a known starting position, you have to keep track of how many pattern pulses have been generated and in which direction; not a difficult job for any computer program. Note that we can get four times the positioning information out of the pattern since there are four distinct zones to the pattern. If we have an encoder disc with 16 patterns, we can determine the position of the disc to one part in 64.

Construction. Building the IR Encoder consists of making an encoder disc, fabricating the circuit, installing the encoder disk on the device's shaft, and aligning the circuit to the disc.

You can lay out your own encoder-disc pattern from the information provided above, or simply make a photocopy of Fig. 3. The disc should be 2¼ inches in diameter. The center shaft-mounting area is designed for a ¼-inch shaft, but it can be adjusted to suit the shaft on which it will be installed.

Paste the disc pattern on a piece of stiff cardboard (index-card material will do) and cut out the sixteen equally-spaced black-pattern areas with a pair of scissors or a sharp modeller's knife. The shaft hole should be cut a bit smaller than necessary to allow for a press fit onto the shaft.

The circuit can be built on a piece of perfboard using standard construction techniques. A suggested layout is shown in Fig. 4. The only point to keep in mind is that the diodes and phototransistors should be aligned so that they point at each other. Be careful to

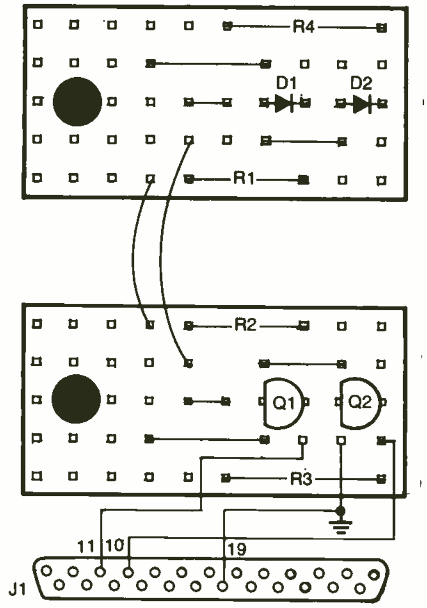


Fig. 4. The two boards for the IR Encoder can be built from perfboard; the positions of D1, D2, Q1, and Q2 should be the same on both boards.

check the polarities of the semiconductors before installing them; if one device is installed backwards you will have fits trying to figure out why the circuit doesn't work!

You can check out the operation of the diode by connecting it in series with a 330-ohm resistor to a 5-volt DC source. You should be able to measure a 1.2-volt drop across the diode. If not, reverse the diode and try again. To test the transistor, connect a 100,000-ohm

PARTS LIST FOR THE IR ENCODER

SEMICONDUCTORS

IC1—78L05 5-volt regulator, integrated circuit

Q1, Q2—IRD300 infrared phototransistor (Jameco 112176 or similar)

D1, D2—TLN100 infrared diode (Jameco 112150 or similar)

RESISTORS

(All resistors are ¼-watt, 5% units.)

R1, R4—330-ohms

R2, R3—100,000-ohms

ADDITIONAL PARTS AND MATERIALS

C1, C2—1-µF, 16-WVDC, electrolytic capacitor

J1—25-pin male connector

8–13-volt DC power supply, wire, index-card material, hardware, etc.

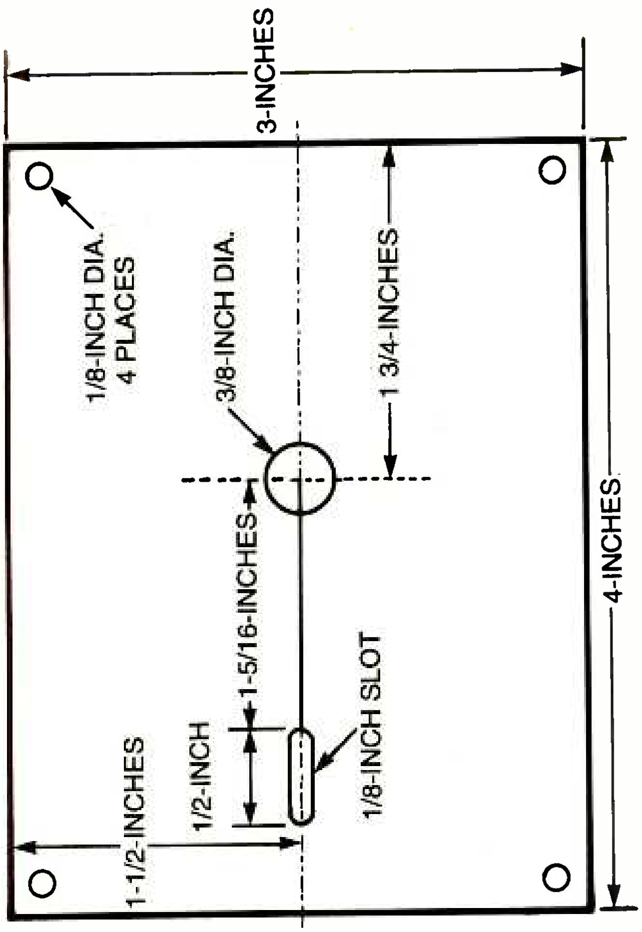


Fig. 5. The IR Encoder should be mounted on a plate for testing. An old potentiometer is mounted in the center hole; it makes an inexpensive shaft on a bearing.

resistor between 5 volts DC and the transistor's collector; connect the transistor's emitter to ground. Monitor the voltage across the transistor's collector-emitter leads; it should be at least 4 volts. When an energized diode is pointed at the phototransistor at a distance of about $^1/_8$ inch, the collector-emitter voltage should drop substantially. Depending on how you are holding the two devices, the voltage drop can be anywhere between 0.1 and 1 volt. If you don't get those results, reverse the transistor leads and try again.

If you want to start by building a "demonstrator" unit before incorporating it into another project, a simple mounting base made from Masonite or another suitable material should be used. Suggested dimensions are shown in Fig. 5.

A $^1/_2$-inch threaded spacer for a 4-40 machine screw secures the two boards together and keeps them a fixed distance apart. One of the screws goes through the slot in the mounting plate. Use a non-conducting washer to keep the lower board off of the mounting plate. With the two boards assembled, carefully adjust the position of each diode and transistor to make sure that they are not skewed to the left or right with respect to each other. Each diode and transistor should be as vertical as possible. The final assembly should look like Fig. 6.

Connect the circuit to a suitable power supply and wire up a connector as shown in Fig. 1. The connector wires should be long enough to reach your PC's parallel port.

Mount any standard potentiometer in the $^3/_8$-inch hole so its shaft is on the top of the base. For a more effective demonstration, disassemble the potentiometer and modify the inside so the shaft can turn continuously. Push the encoder wheel onto the potentiometer's shaft. Adjust the position of the circuit boards so that the diode/transistor pairs are in the same relative position as shown in Fig. 2 and the unit points directly at the shaft.

Testing. A test program has been included in Listing 1; it is designed to run under Qbasic or Quick Basic. Connect the IR Encoder to your PC's parallel port and power supply. Position the potentiometer shaft so that a portion of the encoder disc is blocking the diodes. Run the application. The program will say that it is "Waiting...". When you move the potentiometer shaft so that a cutout is directly over the diode/transistor pairs, the "Waiting" message will be erased and one of the 16 position markers will change to a large white rectangle. As you rotate the shaft, the computer's position indicator will follow suit.

Understanding the Software. The program in Listing 1 is liberally commented to help make its logic understandable. Let's focus on a few of the more important portions.

Loop01 waits for the encoder disc to be positioned so that both transistors are conducting. When that condition is been met, loop02 is entered. There, the status of the module is obtained and stored in variable x. If there has been no change (x = xold), execution jumps to loop03 where the keyboard is checked to see if the user wants to exit the program. If no keypress is found, execution loops back to loop02 for another look.

When a change has been detected, the program looks to see if the previous value was 128 (indicating the previous sample was a

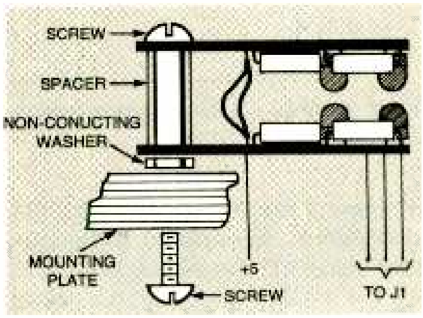


Fig. 6. Mount the two boards together with a threaded spacer and screws. The diodes and transistors need to be aligned with each other exactly. Note that the bottom screw mounts the Encoder to the mounting plate.

LISTING 1

```
REM ** Encoder Demonstration
REM ** ENCODER.BAS
REM ** V990222
REM
CLS : DEF SEG = 64: DEFINT P, X
ad0 = 888: ad1 = 889
DIM x(16), y(16)
LOCATE 1, 15: PRINT "ENCODER MODULE DEMONSTRATION (Press ANY Key to Exit)"
LOCATE 2, 1: PRINT STRING$(80, 220)
'
'Define the X and Y Locations of the Encoder's Rotary Display.
x(1) = 7: y(1) = 40
x(2) = 8: y(2) = 47
x(3) = 10: y(3) = 52
x(4) = 12: y(4) = 54
x(5) = 14: y(5) = 55
x(6) = 16: y(6) = 54
x(7) = 18: y(7) = 52
x(8) = 20: y(8) = 47
x(9) = 21: y(9) = 40
x(10) = 20: y(10) = 33
x(11) = 18: y(11) = 28
x(12) = 16: y(12) = 26
x(13) = 14: y(13) = 25
x(14) = 12: y(14) = 26
x(15) = 10: y(15) = 28
x(16) = 8: y(16) = 33
'
'Poff is Lower Case "o". Pon is a Graphics Block.
'
poff = 111: pon = 219
'
'Display the 16 Points of the Rotary Encoder Disk.
'
FOR i = 1 TO 16
 LOCATE x(i), y(i): PRINT CHR$(poff);
NEXT i
'
REM***** Logic For Obtaining Position and Direction.
REM
REM Pin 10 is INP(AD1) AND 64.
REM Pin 11 is INP (AD1) AND 128 (with Pin 11 response inverted).
REM So, get INP(AD1) AND 192, which is the combination of both. Then,
REM Marker = 128. To Left of Marker = 192. To Right of Marker = 0
REM In-Between Encoder Disk cutouts = 64
'
LOCATE 14, 35: PRINT "Waiting...";
loop01:
REM***** Loop Until Marker (128) Found.
a$ = INKEY$: IF a$ <> "" THEN END
x = (INP(ad1) AND 192): IF x <> 128 THEN GOTO loop01
LOCATE 14, 35: PRINT SPACE$(10):
LOCATE x(1), y(1): PRINT CHR$(pon);
xold = 128: positionold = 1
'
loop02:
REM***** Main Loop
'
'Get A Sample
'
x = (INP(ad1) AND 192)
'
'No Change from Previous Sample. Go Back for Another.
'
IF x = xold THEN GOTO loop03
'
'If Previous Sample Was the Marker, Determine Which Direction
'
IF xold = 128 THEN
  direction = 0
  IF x = 0 THEN direction = -1
  IF x = 192 THEN direction = 1
END IF
'
'If Current Sample is Not the Marker, Try Again.
'
IF x <> 128 THEN xold = x: GOTO loop03
'
'Marker Found.
'
' If Previous Sample Was To the Right of Marker (0), and
'   Direction is Clockwise (1), Increment Position by 1.
'
IF (xold = 0) AND (direction = 1) THEN
  position = positionold + 1: IF position = 17 THEN position = 1
'
'  Otherwise, if Previous Sample Was To the Left of Marker (192),
'  and Direction is CounterClockwise (-1), Decrement Position by 1.
'
ELSEIF (xold = 192) AND (direction = -1) THEN
  position = positionold - 1: IF position = 0 THEN position = 16
'
'    If Neither Condition Exists, No Movement In Position.
'
ELSE
  xold = x: GOTO loop03
END IF
'
'Store Sample As Previous and Re-Draw Circle and Block
'
 xold = x
 LOCATE x(positionold), y(positionold): PRINT CHR$(poff)
 LOCATE x(position), y(position): PRINT CHR$(pon)
 positionold = position
'
loop03:
'
'Check For Keypress Signaling Desire to End
'
a$ = INKEY$: IF a$ <> "" THEN END
'
'No Keypress, so Go Back for More.
'
GOTO loop02
```

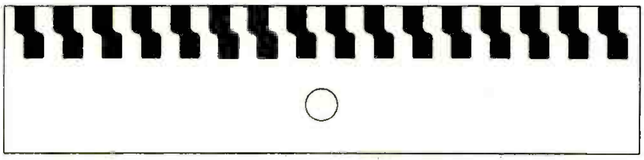


Fig. 7. The IR Encoder is not restricted to rotary applications; this pattern can be used for a linear arrangement.

marker). If that condition exists, the direction is determined. If the current value is 0, the direction is set to −1. If it is 192, the direction is set to +1. If that condition doesn't exist, then the current value is stored as the previous value and the program again goes to loop03 to check for a keypress.

If the current value is 128 (indicating a marker) and the previous value wasn't, the program proceeds to the code following the "Marker Found." remark. The IF... THEN... ELSE statements identify in which direction the shaft moved and increment or decrement accordingly.

The complete source code (less remarks) is only 55 lines long. Without setting up variables for displaying the position on the screen, the code that remains is only 35 lines long. You can use that code as the basis for your own applications.

Obviously, the results that you get depend strongly on the alignment of the diodes and transistors, and the position of the module on the base. Experiment with all of those variables for the best results. In actuality, there's no reason why the encoder has to be used with a round encoder disc. You can use the same cutout areas spaced linearly to make a linear movement encoder "strip." Such a strip is shown in Fig. 7.Ω

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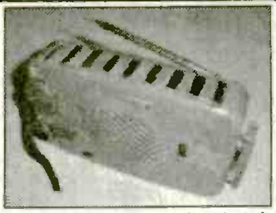
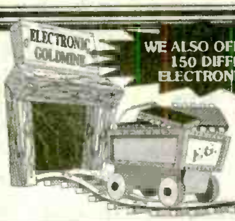


This radio is great for emergencies, camping, vacation travel, remote living, etc. It does not require batteries to operate because it has built in nicad rechargeables that can be recharged by the sun or a built in hand crank. The sound from the built in speaker is good quality and has room filling volume. These are blue in color and feature a tuning LED, power LED, charge switch, built in dynamo crank, built in solar panel, AM/FM switch, tuning control knob, volume control, carry strap, built in extendable antenna and a battery compartment for 2AA batteries (not included and not needed–for backup use only). Brand new in retail box–nothing else to buy. Makes a great gift for anyone!

G1539 $29.95 ea.



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METAL LOCATOR COIL ASSEMBLY

Unique

This is the coil head assembly from a small metal locator. It consists of a 7 1/16" plastic head which has a coil assembly inside connected to a 4 lead + shield flexible insulated cord. Head has a 16" aluminum pole attached by means of a wing nut. Sorry, no specs or data available. Removed from new equipment by a manufacturer who only wanted the metal locator main circuit board and case.

G1543 $6.00 ea.

DELCO AUTO SPEAKER

Made for use in many cars, this speaker features a built in 220uF 25V bipolar capacitor to allow a certain frequency range to pass into the speaker (can be bypassed if desired). Features a 2 3/8" ceramic magnet and a 4" x 6" frame. Impedance 4Ω. Brand new with dust cover. Sorry, power rating unknown.

G1549 $2.00 ea.

AB MOD POT®

High quality Allen Bradley Mod Pots® with standard panel mount 3/8" bushing and panel mount nut. Features screwdriver, adjust shaft and gold plated pins for hookup. AB part # 70MIN024S.

MODEL 70MIN024S103U (10K) G1544 $1.00 ea.
MODEL 70MIN024S104A (100K) G1545 $1.00 ea.

GIANT T03 HEAT SINK

Perfect for high power audio amplifiers and high power transmitters or power supplies. Made of solid anodized (gold color) aluminum. Size is 8" Long x 4 3/4" Wide x 1 1/4" Thick. Predrilled for 6 T03 metal case semiconductors. Brand new!

G1547 $10.00 ea. **Wow!**

50FT ALL-WEATHER MARINE POWER CORD

High quality 3 conductor grounded 14 gauge heavy duty blue power cord made by West Marine Dockmates™. Repels moisture, is abrasion resistant and resists deterioration from the sun. Flexible high quality power cord for all dock-side power needs is rated AWG 14/3 SJTW-A 15amp 125V. Has 3 prong male on one end and 3 prong female on other. Brand new!

G1540 $15.95 ea.

SCHAFFNER FN2080-12-06 LINE FILTER

High quality heavy duty EMI filter is rated 110/250VAC 50-60HZ@12amps. Brand new. Size 5 1/8" x 2 3/16" x 1 3/4".

G1546 $3.49 ea.

SMALL 12VDC 10AMP RELAY

Small 12VDC relay by MSD Inc. features SPST 10amp 250VAC contacts. Size only 3/4" L x 3/8" H x 15/32" W. Sealed case. Brand new high quality.

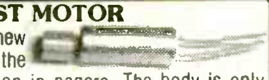
G1541 $1.95 ea.

RING SHAPED RARE EARTH COBALT SUPER MAGNET

This 11/16" Dia O.D. with 3/16" Dia. I.D. Super Magnet is only 1/16" thick yet is very powerful for its size. Worth much more than our price!

G1548 $1.50 ea.

OUR TINIEST MOTOR



These are brand new motors made for the "vibrator" function in pagers. The body is only 9/16" long x 1/4" dia. Attached to the shaft is a "D" shaped weight, which you can insert into the center of a small plastic wheel, and you have a drive unit for a tiny robot that you can power from a hearing aid battery, a solar cell, etc.

G1552 $1.49 ea. • 100/$100.00 **Wow!**

SAFETREE HEAT SENSOR ALARM ORNAMENT

This is one of the neatest products we have seen in years. This holiday ornament made by Quorum® is also a heat sensitive alarm that you can hang on your Christmas Tree. If there is a fire, the Safetree will emit a VERY LOUD (90 dBA per meter minimum) alarm when it detects a temperature above 122°F. The unit features very sophisticated IC and transistor circuitry driving a loud Piezo Buzzer. The Safetree Heat Sensor Alarm Ornament operates 24 hours a day for 21 days on one 9-volt battery (not included). This attractive ornament is the perfect addition to your home for this holiday season. The ornament is silver in color and is about 2 1/2" in diameter. Brand new in manufacturer's box, complete with instructions. We are offering this unique holiday item at an extremely low price. Hurry and get yours today!

G9880 ~~$5.95~~ ea. Sale! $2.95 ea.

Compare at $14.95

CALLER ID BLOWOUT

These are used, good condition caller ID units with a large LCD display which shows name and phone # of caller (Unless blocked or out of area). Stores info on up to 72 callers. Operates on one 9V battery (not Included). Call phone company to start caller ID service if you don't already have it. Hurry, don't miss out on this value!

G1550 SALE! $2.00 ea. **Wow!**

"AS IS" CORDLESS TELEPHONE WITH CALLER ID

High tech cordless phone stores up to 50 names and numbers on the built in caller ID display. We do not test them and we do not have any instructions for use so we are selling them "as is" only. Units are missing battery, phone antenna and a 9V 150ma adapter for the base unit. Please no returns. These were probably $200 phones!

G1551 White ~~$8.95~~ ea. SALE! $5.95

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CIRCLE 241 ON FREE INFORMATION CARD

World's Smallest TV Transmitters

We call them the 'Cubes'.... Perfect video transmission from a transmitter you can hide under a quarter and only as thick as a stack of four pennies- that's a nickel in the picture! Transmits color or B&W with fantastic quality - almost like a direct wired connection to any TV tuned to cable channel 59. Crystal controlled for no frequency drift with performance that equals law enforcement models that cost hundreds more! Basic 20 mW model transmits up to 300' while the high power 100 mW unit goes up to 1/4 mile. Audio units include sound using a sensitive built-in mike that will hear a whisper 15 feet away! Units run on 9 volts and hook-up to most any CCD camera. Any of our cameras have been tested to mate perfectly with our Cubes and work great. Fully assembled - just hook-up power and you're on the air!

C-2000, Basic Video Transmitter Cube $89.95
C-3000, Basic Video & Audio Transmitter Cube $149.95
C-2001, High Power Video Transmitter Cube $179.95
C-3001, High Power Video & Audio Transmitter Cube . . . $229.95

CCD Video Cameras

Top quality Japanese Class 'A' CCD array, over 440 line line resolution, not the off-spec arrays that are found on many other cameras. Don't be fooled by the cheap CMOS single chip cameras which have 1/2 the resolution, 1/4 the light sensitivity and draw over twice the current! The black & white models are also super IR (Infra-Red) sensitive. Add our invisible to the eye, IR-1 illuminator kit to see in the dark! Color camera has Auto gain, white balance, Back Light Compensation and DSP! Available with Wide-angle (80º) or super slim Pin-hole style lens. Run on 9 VDC, standard 1 volt p-p video. Use our transmitters for wireless transmission to TV set, or add our IB-1 Interface board kit for audio sound pick-up and super easy direct wire hook-up to any Video monitor, VCR or TV with A/V input. Fully assembled, with pre-wired connector.

CCDWA-2, B&W CCD Camera, wide-angle lens $69.95
CCDPH-2, B&W CCD Camera, slim fit pin-hole lens $69.95
CCDCC-1, Color CCD Camera, wide-angle lens $129.95
IR-1, IR Illuminator Kit for B&W cameras $24.95
IB-1, Interface Board Kit $14.95

Mini Radio Receivers

Imagine the fun of tuning into aircraft a hundred miles away, the local police/fire department, ham operators, or how about Radio Moscow or the BBC in London? Now imagine doing this on a little radio you built yourself - in just an evening! These popular little receivers are the nuts for catching all the action on the local ham, aircraft, standard FM broadcast radio, shortwave or WWV National Time Standard radio bands. Pick the receiver of your choice, each easy to build, sensitive receiver has plenty of crystal clear audio to drive any speaker or earphone. Easy one evening assembly, run on 9 volt battery, all have squelch except for shortwave and FM broadcast which has handy SCA output. Add our snazzy matching case and knob set for that smart finished look.

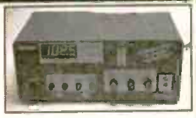
AR-1, Airband 108-136 MHz Kit $29.95
HFRC-1, WWV 10 MHz (crystal controlled) Kit $34.95
FR-1, FM Broadcast Band 88-108 MHz Kit $24.95
FR-6, 6 Meter FM Ham Band Kit $34.95
FR-10, 10 Meter FM Ham Band Kit $34.95
FR-146, 2 Meter FM Ham Band Kit $34.95
FR-220, 220 MHz FM Ham Band Kit $34.95
SR-1, Shortwave 4-11 MHz Band Kit $29.95
Matching Case Set (specify for which kit) $14.95

Tiny FM Transmitters

Gosh, these babies are tiny - that's a quarter in the picture! Choose the unit that's best for you. FM-5 is the smallest tunable FM transmitter in the world, picks up a whisper 10' away and transmits up to 300'. Runs on tiny included watch battery, uses SMT parts. FM-4 is larger, more powerful, runs on 5-12 volts, goes up to a mile. FM4,5 operate in standard FM band 88-108 MHz. FM-6 is crystal controlled in 2 meter ham band, 146.535 MHz, easily picked up on scanner or 2 meter rig, runs on 2 included watch batteries. SMT (surface mount) kits include extra parts in case you sneeze & loose a part!

FM-4MC, High Power FM Transmitter Kit $17.95
FM-5, World's Smallest FM Transmitter Kit $19.95
FM-6, Crystal Controlled 2M FM Transmitter Kit $39.95
FM-6, Fully Wired & Tested 2M FM Transmitter $69.95

Super Pro FM Stereo Transmitter



Professional synthesized FM Stereo station in easy to use, handsome cabinet. Most radio stations require a whole equipment rack to hold all the features we've packed into the FM-100. Set freq with Up/Down buttons, big LED display. Input low pass filter gives great sound (no more squeals or swishing from cheap CD inputs!) Limiters for max 'punch' in audio - without over mod, LED meters to easily set audio levels, built-in mixer with mike, line level inputs. Churches, drive-ins, schools, colleges find the FM-100 the answer to their transmitting needs, you will too. Great features, great price! Kit includes cabinet, whip antenna, 120 VAC supply. *We also offer a high power export version of the FM-100 that's fully assembled with one watt of RF power, for miles of program coverage. The export version can only be shipped outside the USA, or within the US if accompanied by a signed statement that the unit will be exported.*

FM-100, Pro FM Stereo Transmitter Kit $249.95
FM-100WT, Fully Wired High Power FM-100 . . . . $399.95

FM Stereo Radio Transmitters

No drift, microprocessor synthesized! Excellent audio quality, connect to CD player, tape deck or mike mixer and you're on-the-air. Strapable for high or low power! Runs on 12 VDC or 120 VAC. Kit includes case, whip antenna, 120 VAC power adapter - easy one evening assembly.

FM-25, Synthesized FM Stereo Transmitter Kit $129.95

Lower cost alternative to our high performance transmitters. Great value, tunable over FM band, plenty of power and manual goes into great detail about antennas, range and FCC rules. Handy kit for sending music thru house and yard, ideal for school projects too - you'll be amazed at the exceptional audio quality! Runs on 9V battery or power from 5 to 15 VDC. Add our matching case and whip antenna set for a nice 'pro' look.

FM-10A, Tunable FM Stereo Transmitter Kit $34.95
CFM, Matching Case and Antenna Set $14.95
FMAC, 12 Volt DC Wall Plug Adapter $9.95

RF Power Booster

Add muscle to your signal, boost power up to 1 watt over a freq range of 100 KHz to over 1000 MHz! Use as a lab amp for signal generators, plus many foreign users employ the LPA-1 to boost the power of their FM transmitters, providing radio service through an entire town. Runs on 12 VDC. For a neat finished look, add the nice matching case set.

LPA-1, Power Booster Amplifier Kit $39.95
CLPA, Matching Case Set for LPA-1 Kit $14.95
LPA-1WT, Fully Wired LPA-1 with Case $99.95

FM Station Broadcast Antenna

For maximum performance, a good antenna is needed. Properly tuned and matched antenna is fully PVC enclosed for weather protection and rugged use. Vertical or horizontal mounting, 'F' style connector, 5' long.

TM-100, Tru-Match FM Station Antenna Kit $39.95

AM Radio Transmitter

Operates in standard AM broadcast band, set to clear channel in your area. AM-25 'pro' version is synthesized for stable, no-drift frequency and is setable for high power output where regulations allow, typical range of 1-2 miles. Entry-level AM-1 has tunable transmit oscillator, runs FCC maximum 100 mw power, expected range 1/4 mile. Both accept line-level inputs from tape decks, CD players or mike mixers, run on 12 volts DC. Pro AM-25 includes AC power adapter, matching case and bottom loaded wire antenna. Entry-level AM-1 has an available matching case and knob set for a finished, professional look. High level modulation for low distortion.

AM-25, Professional AM Transmitter Kit $129.95
AM-1, Entry level AM Radio Transmitter Kit $29.95
CAM, Matching Case Set for AM-1 . . . . $14.95

RAMSEY

Binocular Special

Wow, did we nab a deal on these first rate binoculars! Absolutely identical to a famous big name brand here in Rochester, NY - but without 'their' name. Well made with fully coated optics, super nice rubber armored housing over hi-alloy aluminum, includes lens cleaner cloth, neck lanyard and carry case. 4 styles: roof prism 10x25 (10 power, 25 mm), 10x25 high performance roof prism ruby coated objective lens model for demanding use in bright sun, 10x25 high-end BAK-4 lens porro prism ruby coat with Tac-Grip housing, and Ultra-View 10x50 porro prism ruby coats. First quality, yet at a close-out price on the exact same units as the 'Trademarked' units - but at half price!

BNO-M, 8x21 Mini Monocular $14.95
BNO-1, 10x25 Roof Prism Binoculars $24.95
BNO-1EX, 10x25 Ruby Coated Porro Prism $29.95
BNO-2, 10x25 TacGrip Ruby Coat Porro Prism $59.95
BNO-6, 10x50 Ultra-View Ruby Coat Porro Prism $69.95

World's Smallest FM Radios

Everyone who sees one of these babies says they just gotta have one! Super cute tiny FM radios have automatic scan/search tuning, comfortable ear bud earphones and we even include the battery. The pager style unit looks like a shrunken pager and even has an LCD clock built-in. You will be amazed at the crystal clear amazing sound! That's a quarter in the picture for size comparison - pretty tiny, huh?

MFMT-1, World's Smallest FM Radio $11.95
PFMR-1, Pager Style LCD Clock & FM Radio $12.95

Speech Descrambler

Decode all that gibberish! This is the popular descrambler / scrambler that you've read about in all the Scanner and Electronic magazines. Speech inversion technology is used, which is compatible with most cordless phones and many police department systems, hook it up to your scanner speaker terminals and you're in business. Easily configured for any use: mike, line level and speaker output/inputs are provided. Also communicate in total privacy over telephone or radio, full duplex operation - scramble and unscramble at the same time. Easy to build, all complex circuitry contained in new custom ASIC chip for clear, clean audio. Runs on 9 to 15VDC. Our matching case set adds a professional look to your kit.

SS-70A, Speech Descrambler/Scrambler Kit $39.95
CSS, Custom Matching Case and Knob Set $14.95
SS-70AWT, Fully Wired SS-70A with Case $79.95
AC12-5, 12 Volt DC Wall Plug Adapter $9.95

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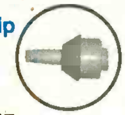
Swing Arm Magnifying Lamp

- Steel Shade supplied with a precise 3 diopter lens and a 22W fluorescent circling tube.
- Spring-Balanced 45° extension arm with 3 conductor
- Lamp included.

Color	Voltage / Freq.	Item #
White	120V / 60Hz	54-0120
Black	120V / 60Hz	54-0125

$34.95 Your Choice

Replacement Tip

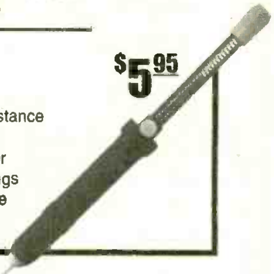


Replacement Tip for Solder Sucker (Item#51-2560)

$1.29

Item # 51-2565

Solder Sucker



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- Insulated vacuum pulse

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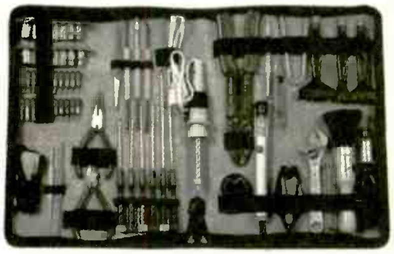

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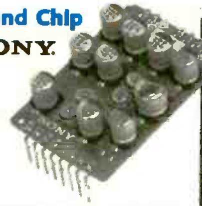

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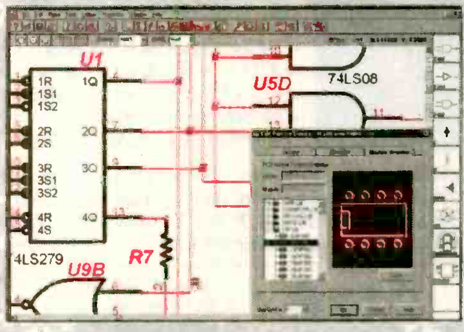

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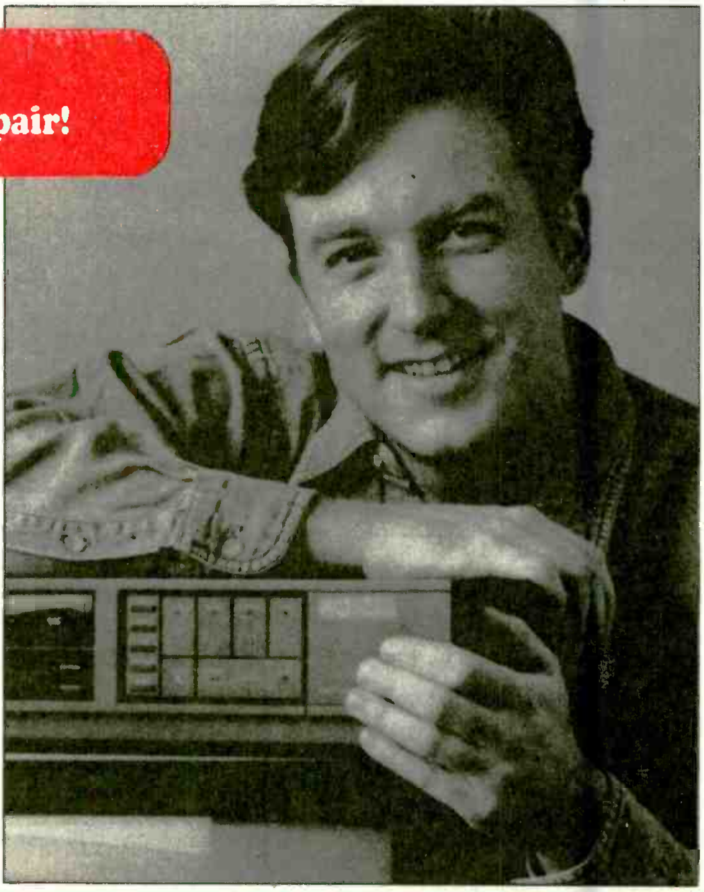
"I earned $1,000 on just 12 VCR repairs in one week"

A true statement by Paul B.* of San Pedro, California



How to cash in on skyrocketing field of VCR repair!

You too can earn up to $85 an hour, pocket $200 a day, double your income...in the high-profit field of VCR repair...part-time or full time. There are over 77 million VCR's currently in use in America today – a lot of business out there just waiting for you!

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It's easy to learn VCR cleaning, maintenance and repair at home in just a few short weeks through Foley-Belsaw's unique method which emphasizes the mechanics involved in 90% of all repairs, without dwelling on all the unnecessary basic electronics. This exclusive practical hands-on course was developed and proven over a long period of time in an actual VCR repair shop. It combines simple step-by-step lessons with easy-to-follow video cassette guidance. No special experience or electronics background is necessary. Just average mechanical aptitude and the ability to follow simple A-B-C repair procedures that are clearly outlined for you. And when you complete the course you will receive the School's official diploma attesting to your expertise.

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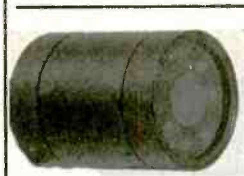

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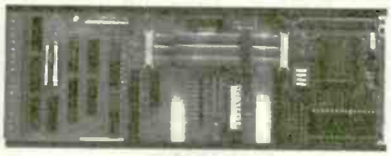

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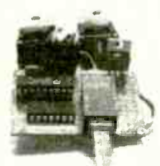

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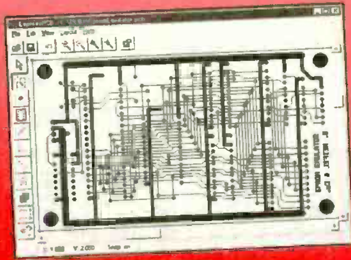

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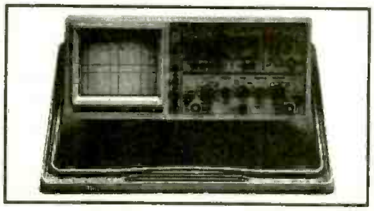

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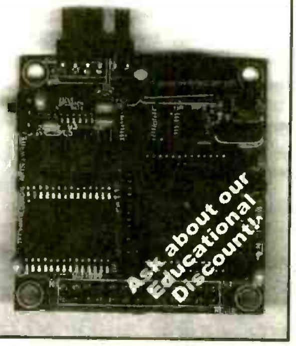

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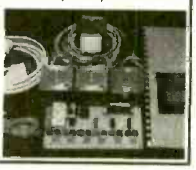

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We cannot bill for classified ads. **PAYMENT IN FULL MUST ACCOMPANY YOUR ORDER.** We do permit repeat ads or multiple ads in the same issue, but in all cases, full payment must accompany your order.

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DEADLINES

Ads not received by our closing date will run in the next issue. For example, ads received by November 13 will appear in the March issue that is on sale January 17. ELECTRONICS NOW is published monthly. No cancellations permitted after the closing date. No copy changes can be made after we have typeset your ad. NO REFUNDS, advertising credit only. No phone orders.

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17 - $42.50	18 - $45.00	19 - $47.50	20 - $50.00
21 - $52.50	22 - $55.00	23 - $57.50	24 - $60.00
25 - $62.50	26 - $65.00	27 - $67.50	28 - $70.00
29 - $72.50	30 - $75.00	31 - $77.50	32 - $80.00
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El Cajon, CA 90202

Electronics Plus, Inc.
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San Rafael, CA 94901

Electronics Warehouse
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Riverside, CA 92501

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HSC Electronics
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HSC Electronics
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Fullerton, CA 92631

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Garden Grove, CA 92643

Whitcomm Electronics
105 W. Dakota 106
Clovis, CA 93612

Colorado

Centennial Electronics
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Colorado Sps., CO 80909

Connecticut

Cables & Connectors
2198 Berlin Turnpike
Newington, CT 06111

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437 Washington Avenue
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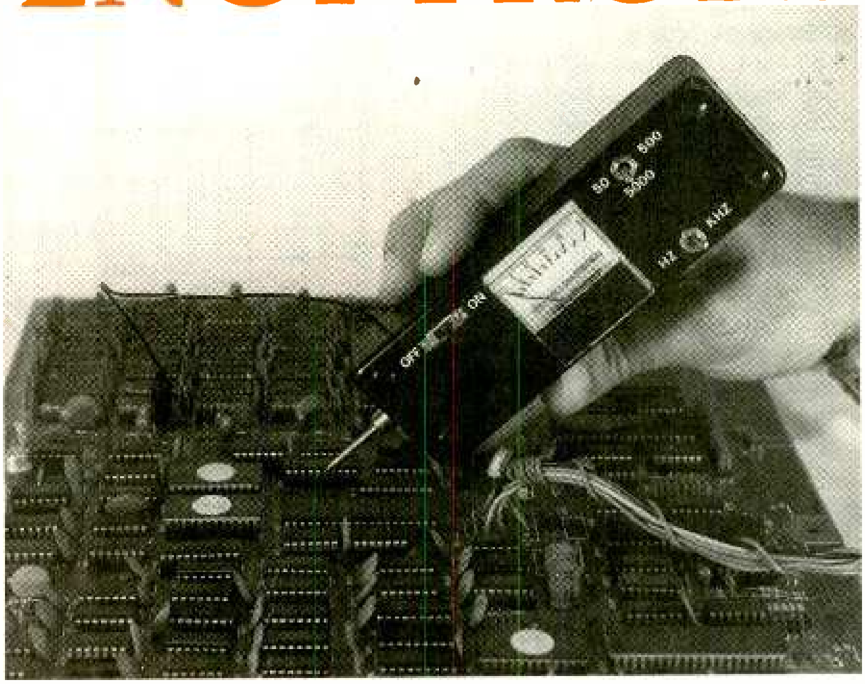
FREQUENCY PROBE



Build this simple analog instrument to test the frequency of almost any type of waveform

SKIP CAMPISI

Have you ever wanted to make a quick check on the operating frequency of a circuit but realized that it wasn't worth the effort to set up your multi-function frequency counter? Perhaps your counter can only handle 5-volt logic or small-signal RF waveforms, but nothing in between.

If you often find yourself in that situation, the Frequency Probe presented here is just the tool that you're looking for. This instrument is a handheld device that is powered by a single 9-volt battery and uses an analog meter as the display. Of course, you won't get the resolution of a digital display, but accuracy is better than 5%; more than enough in most situations. As a bonus, it is very economical and can be assembled for about $30.

This self-contained unit can measure the frequency of any type of waveform from about DC to beyond 2 MHz as long as the input waveform crosses the input threshold voltage (about 1.0 volt). The maximum swing on the input signal is 30 volts. Any waveform shape within that range can be read—including standard logic level signals.

The Frequency Probe has six basic ranges: 50 Hz, 500 Hz, 5000 Hz, 50 kHz, 500 kHz, and 5000 kHz. Small toggle switches are used to select the range; there is simply no room for rotary switches in a probe design of this type. The unit is constructed with standard, off-the-shelf components, available from many different sources such as Radio-Shack, Tech America, or Mouser Electronics, to name a few.

About the Circuit. Looking at the Frequency Probe's schematic diagram, shown in Fig. 1, note that only four ICs and a handful of passive components are used. Power from a standard 9-volt battery is regulated to 5 volts by IC2. The total current drain is about 10 to 15 mA.

An input signal applied to J1 is converted to a squarewave by IC1. Diodes D1 and D2 set the 1.0-volt threshold; D2 also provides reverse-voltage protection. A few millivolts of hysteresis provided by R2 helps yield a stable output from signals with a slow rise time such as ramps or sinewaves. Note that the specifications for the LM311 being used allow its inputs to swing above the power-supply voltage (up to 30 volts above ground) without damage to the device. That might not be true for devices made by manufacturers other than National Semiconductor—check before substituting a compatible part from another vendor.

The "heart" of the Frequency Probe is IC4, an LM2917N tachometer chip; it converts any input frequency to an output voltage. Because IC4 has its own built-in hysteresis "flip-flop" circuit, waveforms that are more or less symmetrical are best. Pulse inputs with a duty cycle of less than 10% or greater than 90% will have large output errors.

To cure that problem, IC3 is included to divide down the pulses depending on the settings of S2. With S2 in the "Hz" position, the signal is divided by two and by 2048 in the "kHz" position. No matter how short or long the duty cycle is, the input waveform to IC4 is always a squarewave, allowing a pulse train of any duty cycle to be measured.

The full-scale range (50, 500, or 5000) is selected by S3; S2 selects whether the scale is in Hz or kHz. The output voltage from IC4 is directly applied to M1 for frequency display. With an internal series resistance of 500 ohms on M1, the 2.5-volt full-scale output from IC4 will be at the meter's limit; R9 protects M1 from excess current in case of overload.

The value of C6 is a compromise between response time and output ripple. On the lowest settings, you

PARTS LIST FOR THE FREQUENCY PROBE

SEMICONDUCTORS

IC1—LM311 comparator, integrated circuit (National Semiconductor)
IC2—78L05 low-power 5-volt regulator, integrated circuit
IC3—CD4040 12-stage binary counter, integrated circuit
IC4—LM2917 frequency-to-voltage converter, integrated circuit
D1—1N4148 silicon diode
D2—1N5711 Schottky diode

RESISTORS

(All resistors are ¼-watt, 5% units, unless otherwise noted.)
R1—3900-ohm
R2—3300-ohm
R3, R5, R6—10,000-ohm
R4—1000-ohm
R7—150,000-ohm
R8—100,000-ohm potentiometer, single turn
R9—47-ohm

CAPACITORS

C1, C7—1-µF, 16-WVDC, solid tantalum, electrolytic
C2, C8—0.1-µF, ceramic-disc
C3—0.01-µF, polyester, 5%
C4—0.1-µF, polyester, 5%
C5—0.001-µF, polyester, 5%
C6—3.3-µF, 16-WVDC, solid tantalum, electrolytic
C9—10-µF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

B1—9-volt battery
J1—RCA phono jack, panel-mount
M1—Analog panel meter, 0–5 mA
S1—Single-pole, single-throw, switch
S2—Single pole, double-throw, toggle switch
S3—Single-pole, double-throw, center-off toggle switch
Enclosure, ground clip, battery clip, IC sockets, probe needle, wire, hardware, etc.

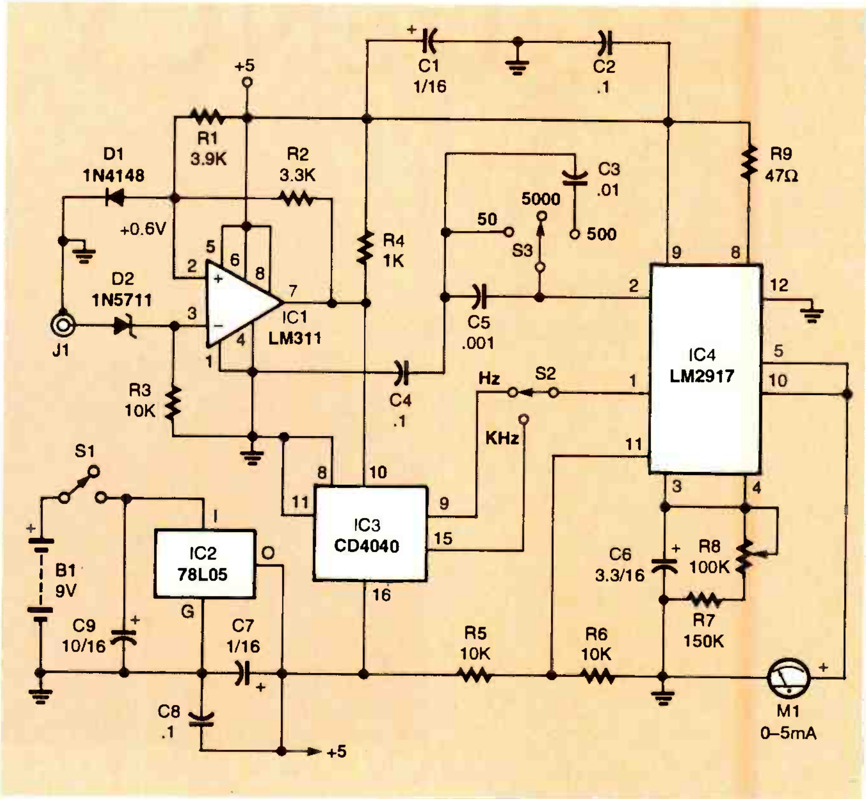


Fig. 1. The Frequency Probe changes any waveform to a squarewave and converts it to a current that is read out on a standard panel meter.

might see M1's needle vibrate slightly on readings below 5 Hz. If you want a more stable reading, you can increase C6's value for less ripple. Of course, that will increase the response and settling time of the Frequency Probe.

Calibration is set by R8, which alters the time constant of IC4's charge pump. The 2.4% error introduced by IC3 when in the "kHz" setting is just barely noticeable on the miniature 1-inch meter used for M1. To get the best overall accuracy, C3, C4, and C5 should be selected to match each other in exact decade multiples.

Construction Tips. Since the Frequency Probe is capable of measuring very high-speed input pulses, a compact and neat layout with short signal leads is not only recommended, but also almost mandatory. No foil pattern for an etched board is available; the Frequency Probe can be built on perfboard using standard construction techniques. To help you locate the components as close to each other as possible, Fig. 2 illustrates the component locations as used in the author's prototype. While you don't have to follow that suggested arrangement, it is known to give good performance.

Any probe-like enclosure that can hold all of the circuitry needed for the Frequency Probe can be used; just be sure that it is large enough. The internal arrangement of the author's prototype, shown in Fig. 3, uses a RadioShack 270-1804 project enclosure. It is a good idea to do all of the mechanical construction first before wiring the board. With the chassis laid out, it is much easier to locate and drill the mounting holes for the board before the components are installed and wired.

The probe needle itself is made from a ⅛-inch diameter piece of brass or steel rod that is 1¾-inch long. File one end to a point and round off the other end for easy insertion into J1. To do that quickly and easily, you can mount the rod in a power drill or lathe and grind it to shape. The finished probe tip should look like the one shown in Fig. 4.

Obviously, any signal being applied to the Frequency Probe must be referenced to the Frequency Probe's ground. A simple length of wire with a small alligator clip soldered to the end is connected to any convenient ground point on the Frequency Probe. A ground lug mounted in the case near J1 makes it easy to tie all of the ground wires together. You can attach the ground clip, the shield of J1, the negative side of B1, the negative lead of M1, and, of

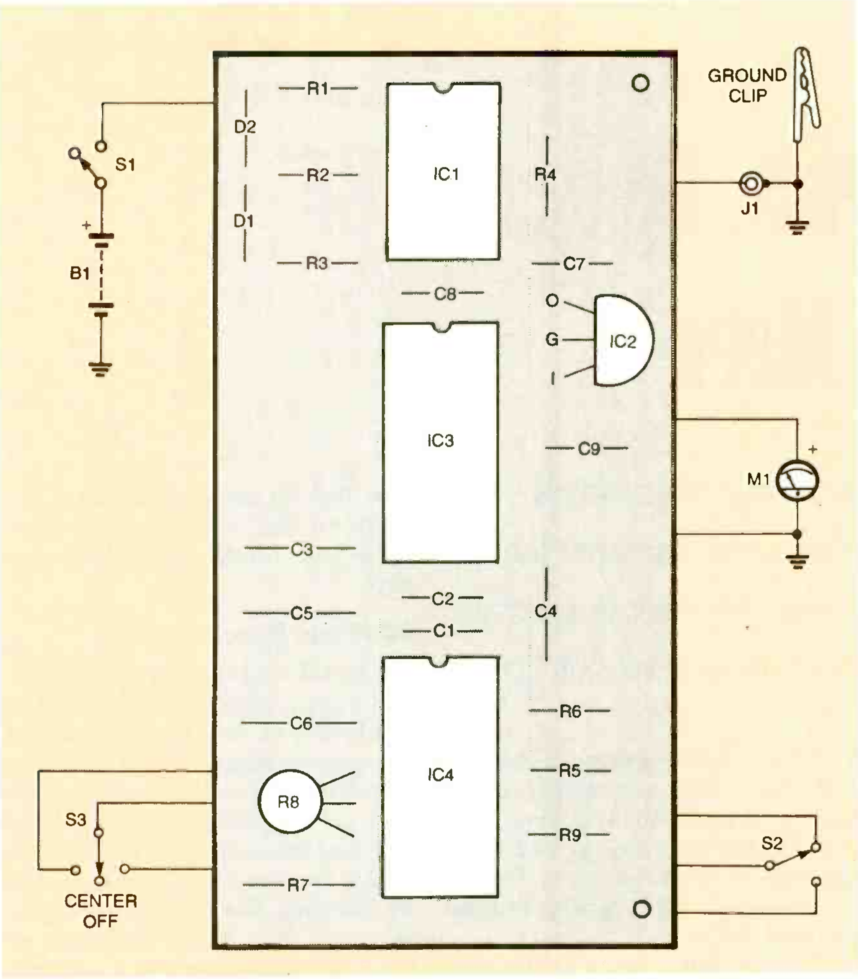


Fig. 2. While the Frequency Probe is a simple circuit, connections must be kept short. The author's perfboard layout shown here has resulted in a prototype that has a top end almost double the predicted results.

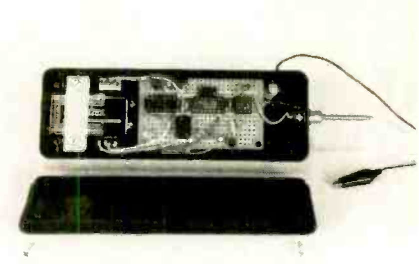


Fig. 3. With a properly-sized case, the Frequency Probe has a compact arrangement. Note how B1 is strapped down between two posts, S2, and S3. A ground lug near J1 makes a convenient point to tie all of the ground connections together—especially the external ground clip.

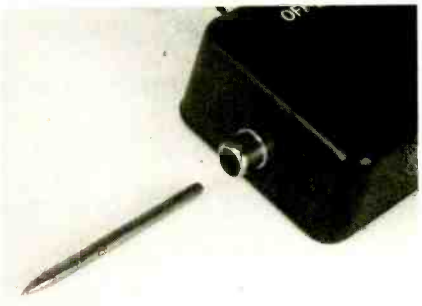


Fig. 4. A probe tip is easy to make by filing down a piece of 1/8-inch brass or steel rod. Rounding off the back end makes the probe needle easy to insert into J1. Not only does it fit securely into J1, it can be removed in order to make a direct cable connection to the Frequency Probe.

course, the ground connection from the board to that lug.

Once the Frequency Probe is built, inspect your work carefully for any errors. With the probe tip inserted into J1 and a fresh 9-volt battery installed, you're ready to calibrate the unit.

Set Up and Calibration. With power turned on with S1, use a voltmeter to check for +5 volts at the output pin of IC2. If you do not get that reading, shut off the power immediately and correct the problem. If that reading is within 10%, check for +0.6 volts at pin 2 of IC1 and about +2.5 volts at pin 11 of IC4. If those voltages are also within about 10% or so, the Frequency Probe should work properly.

Set R8 at about mid-position and apply a known input frequency that is within the Frequency Probe's range to J1. The frequency should be suitable for displaying a reading of between 40–80% of full scale on M1; the signal should have an amplitude that is between 1.0 and 30 volts. If you want, you can remove the probe needle and apply the signal directly through a coaxial cable with an RCA-style phono plug.

Set S2 and S3 to accommodate the input frequency and adjust R8 so that M1 displays correctly. You might want to try a few different frequencies in different ranges for best overall accuracy. The absolute maximum input frequency that the Frequency Probe can handle depends on the waveshape and the input voltage, which affects the ultimate speed of IC1. You can expect a display of about 2 MHz before response falls off at higher frequencies. The author's prototype is able to function reliably at about double that frequency. Of course it goes without saying, "Your mileage may vary!"

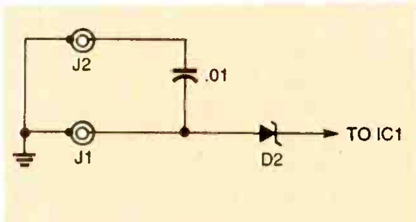


Fig. 5. By adding a second jack and capacitor, the Frequency Probe can sport an AC-coupled input as well as the standard input through J1.

The probe-needle/clip-lead input scheme works extremely well for most situations. If you need a direct cable input to J1, it is a simple matter to remove the probe needle and connect a length of coaxial cable (such as RG-58) with a shielded phono plug on the end. If your input signal is riding on a DC voltage outside of the triggering range (or over the maximum input voltage) of the Frequency Probe, use a 0.1-μF capacitor of suitable working voltage in series with J1. If you want, you can install a second phono jack next to J1 with that series capacitor installed in parallel with J1 for an optional "AC" coupled input. See Fig. 5. Ω

BY DON LANCASTER

Sub-Pixel Secrets, Diodes as RF Switches, and More

THERE SURE ARE SEVERAL LIVELY DISCUSSIONS NOW GOING ON IN THE SCI.ENERGY.HYDROGEN NEWSGROUP ON THE INTERNET. PROPONENTS FEEL THAT SOLAR ELECTRIC PANELS GENERATING COMPRESSED HYDROGEN GAS ARE THEIR way to go for "energy independent" personal vehicles. Sadly, they seem to positively refuse to look at all the fundamental numbers or even at the extensive work that has gone before, but accuse those trying to help of being "too negative" or "getting paid by the oil companies".

Well, in the first place, not one net watt of non-hydro solar electricity has ever been generated! The energy costs of the research, making up the cells, supporting the cells, interfacing them, and paying for your land, time, and labor involved have yet to even remotely approach break even.

The inherent low-efficiency limits of today's cells make hitting break even a daunting task. Only recently has the energy efficiency of cell manufacturing even been addressed. Thus, all of today's solar cells are paid for by oil or gasoline in disguise.

The magic break-even number is somewhere around a fully burdened eight cents per kilowatt hour. So far, solar electricity is far too valuable to waste on hydrogen apps. The energy in electricity is also of a much higher "quality" than in hydrogen because you can do more things with it and do so a lot more efficiently. Thus, changing from solar electric back to hydrogen can be a giant step in the wrong direction down the "energy" chain.

Further, there simply is not enough gross energy storage (3.5 watt hours per STP liter) in hydrogen gas to let you safely and cheaply gain enough vehicle range to be useful. You are talking hundreds of feet, not miles—at least when "unliquified" at sane pressures. Decent storage remains the crucially limiting hydrogen problem.

Two key points that I might have mentioned a time or two before: 1) An hour in the library (or on the Web) is worth a month of lab time. And 2) science works by standing on the shoulders of giants. So, ignoring what has gone before is sheer lunacy, especially in fields with hundreds of years of history.

Realistic personal transportation alternatives are now at www.rmi.org and maybe at www.homepower.com. More on hydrogen can be linked at my www.tinaja.com/h2gas01.html.

There is a very exciting new hydrogen storage development—one that just might make it all happen. We'll tell you where to find out more about it in our New Tech Lit section at the end of this article. But first, let's turn to some interesting "new" developments in video displays.

NEED HELP?

Phone or write all your US Tech Musings questions to:

Don Lancaster
Synergetics
Box 809-EN
Thatcher AZ, 85552
Tel: 520-428-4073

US email: don@tinaja.com
Web page: http://www.tinaja.com

Sub-Pixel Resolution

The old original Apple II computer used a sneaky display trick that could be called sub-pixel resolution to get double the apparent screen content in certain hi-res modes. For instance, a green half-pixel and a purple half-pixel could be combined into a full white pixel. Details on this could be found way on back in my *Enhancing Your Apple II, Vol I*, plus numerous other places. Variations on this trick have recently been rediscovered and promise to very much improve the apparent small text legibility of both laptops and dynabooks. In fact, sub-pixel positioning just may be the "enabling technology" to finally blow traditional print media out of the water, especially when it is combined with other tricks.

Microsoft calls their "new" take on sub-pixel tricks ClearType. The critics promptly re-labeled it HypeType. But you are certain to see lots of variants coming up. Apple II pioneer Steve Gibson has his outstanding tutorial and sample Web site up on sub-pixel schemes at grc.com/cleartype.htm, including freebie interactive software demos you can explore for yourself and links to other sub-pixel sites.

One older way of improving your display resolution is by anti-aliasing. With anti-aliasing as it typically is done, you create a weighted average of adjacent pixels using a low-pass filtering process. Replacing all the blacks and whites with varying gray levels allows the text to be shown in a more pleasing manner. The artifacts created by a sampling are usually at rather high frequen-

When **ANTI-ALIASING**, each pixel gets replaced with a weighted average of adjacent bits according to a rule matrix such as...

1/18	2/18	1/18
2/18	6/18	2/18
1/18	2/18	1/18

Anti-aliasing works quite well to remove the "jaggies" out of graphics, but tends to blur and lighten smaller text. Anti-aliasing is easily done late in the display process and is largely independent of content.

When **GRAYSCALING**, each pixel gets replaced with the amount of gray that each individual pixel represents. Special and often custom bitmapped fonts are required for the obvious grayscaling benefits.

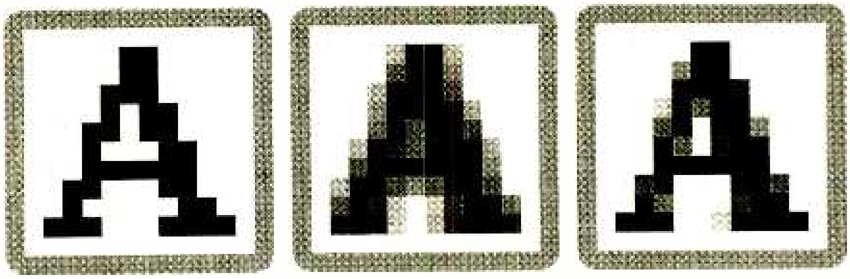


FIG. 1—ANTI-ALIASING AND GRAYSCALING are two older methods to improve small text appearance on most video displays.

cies. Spatial low-pass filtering thus favors the original content.

As Adobe Acrobat has shown us, an anti-aliasing often improves the legibility and appearance of smaller text, but often at the cost of getting somewhat gray and blurry. Figure 1 shows us the basics of anti-aliasing. In general, normal spatial low-pass anti-aliasing is great for taking the "jaggies" out of graphic images but only so-so and fuzzy for improving small text.

Grayscaling

There can be other sneaky ways to improve screen legibility. The main problem with anti-aliasing is that it is general spatial low-pass filtering after the fact. It's fast and cheap, but done late in the process, thus it always blurs and smears because no more information content is made available in the process.

But what happens if you instead match each pixel only to its wanted internal data beforehand—replacing each intended pixel with that fraction of gray (or other color) it is intended to optimally represent? Figure 1 also lets you compare that grayscaling alternative against bitmapping and after-the-fact low pass filter anti-aliasing. As you can see, the Palatino improvement at ten points is dramatic. But hand-crafted and bitmapped fonts are required for truly optimum results.

What got me started on this is that I was retouching a bitmap image for my new www.tinaja.com/barg01.html surplus bargain Web page and noted that the word PULL can be shown legibly with a 2×3 dot matrix! Start with an accurate character. To do grayscaling, optimally overlay the accurate character onto an n by m matrix. Calculate the exact energy in each matrix block. Replace that part of the character with the equivalent gray. Since the eye can resolve up to 64 bits of gray information, you are providing up to 64 times the information before quantizing into pixels. Your screen now has lots more information that it can work with.

Raw PostScript is amazingly adept at this sort of thing, especially its little known infill operator. The font capture and gray-scale coding can be automated, and this technique should work with most color combinations. Character sets will often have to be generated ahead of time to specific resolution sizes. One big advantage would be platform independence. This should work better with fonts optimized for low resolution screens—such as Stone.

Apparently I am not the only one playing with pixels. One grayscaling variant is known as hand anti-aliased fonts. Demos are at www.airwindows.com/shareware/fonts/index.html. There somewhat oversized fonts are retouched and then downcoded into appropriate grays.

Sub-Pixel Secrets

The "new" sub-pixel scheme in Fig. 2 can end up quite simple. If you have a display in which you can individually and separately address single and sequential red, blue, and green elements, and if you know the exact sequence of all those elements, then you can increase your apparent display resolution in one direction.

The sub-pixel trick works because the eye is much better at seeing detail than it is color. The small text-quality improvement on a typical laptop is stunning, though at the cost of display limits and special drivers.

As you can clearly see, combining sub-pixel techniques with grayscaling is a potent combination. But there are lots of "gotchas" to be aware of.

The idea applies mainly to LCD displays. No way is yet known to use a stock CRT monitor, nor is one likely to be found. Why? because the electron beam usually addresses many phosphor dots at once, and the multiple blue dots are not particularly left or right of the other colors.

You have to know the exact LCD color stripe sequence and match your software to it. Most LCDs are now RGB, but a few are BGR.

The resolution improvement only works in one direction. You'll want this to be horizontal, because most character details, bolding, italics, and kerning are all horizontal sensitive.

Thus, you are currently limited to landscape displays—unless someone builds a portrait-specific triad-rotated LCD display. You are also mostly limited to black text on a white background. There could be some color fringing, but it is apparently not too bad and almost certainly can be reduced by sneaky tricks or special displays.

You do not end up tripling the resolution because of positioning considerations. A doubling is more reasonable—but it sure looks better.

You are also restricted to specific text sizes that all must be carefully matched to the display resolution, at least for the finer print. But that is not necessarily a serious problem in a book-viewer type of machine.

Some color fringing is created by sub-pixel techniques. On the left side of each black font character in RGB sequence, chances are that blue may be weak or missing, thus giving you a possible orange fringe. On the right side, chances are that red is weak or missing, giving you aqua. Such modest LCD sub-pixel color fringing can probably be minimized by going to special displays whose color sequence shifts by one pixel on each horizontal line. Sort of a triple "super-PAL" mono mode.

Adobe has been strangely silent so far, but we can expect sub-pixel plug-ins for their Acrobat products. There is also an obvious but very expensive solution of increasing the display resolution, but it makes the most sense to make each portion of every pixel count the utmost before you demand more of them.

The PostScript code used to create these demos is up on my Web site (www.tinaja.com) in MUSE141.PSL You could easily explore these concepts further on your own. Consulting and code services are also available. See www.tinaja.com/info01.html.

ULTRASONIC BOOKS

1996 IEEE International Ultrasonics Symposium (FEFCS IEEE)
Clinical Sonography: A Practical Guide (Roger Sanders)
Diagnostic Ultrasound (Stewart Bushong)
Fundamentals of Ultrasonic Nondestructive Eval... (L. Schmerr)
Handbook on the Ultrasonic Examination of Aus... (Am Weld Soc)
Micromachined Ultrasound Proximity Sensors (Mark Hornung)
Nondestructive and Ultrasonic Testing for Aircraft (FAA Staff)
Piezolectric Actuators and Ultrasonic Motors (Kenji Uchino)
Power Sonic and Ultrasonic Transducer Design (B. Hamonic)
Three-Dimensional Ultrasound (Thomas Nelson)
Transducers for Sonics and Ultraso s (M. McCollum)
Ultrasonic Bioinstrumentation (Douglas Christensen)
Ultrasonic Communication by Animals (Gillian Sales)
Ultrasonic Instruments and Devices (R. Thurston)
Ultrasonic Liquid Atomization (Harvey Berger)
Ultrasonic Measurements for Process Controls (L. Lynnworth)
Ultrasonic Measurement Methods (R. Thurston)
Ultrasonic Methods of Non-Destructive Testing (J. Blitz)
Ultrasonic Motors: Theory and Applications (S. Ueha)
Ultrasonic Sensors for Chemical an Process... (R. Asher)
Ultrasonic Transducer Materials (Os r Mattiat)
Ultrasound: Biological Effects and Potential... (A. Williams)

For more details, see www.tinaja.com/amlink01.html

With **SUBPIXEL** techniques, each individual red, green, or blue pixel sub element gets treated as an individually addressable and position sensitive entity. As you can see, the apparent resolution improvement is dramatic. Especially when combined with custom grayscaled fonts.

The concept works because the eye is much better at resolving brightness than color. Subpixel techniques apply mainly to landscape LCD displays used for laptops and dynabooks. Exact color sequence must be known and matched.

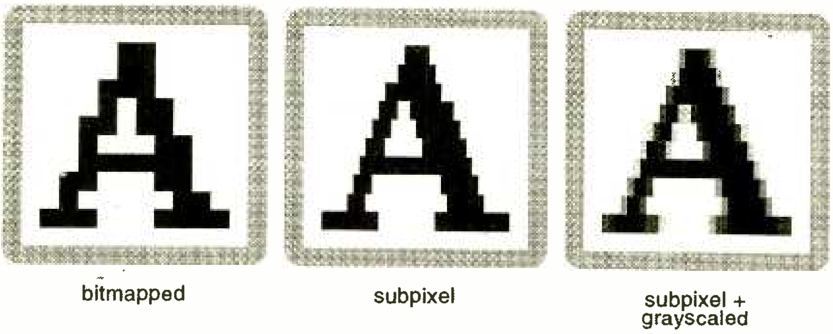


FIG. 2—"NEW" SUBPIXEL SCHEME promises to dramatically improve small text on certain LCD displays. Individually addressable color elements of a known sequence is required.

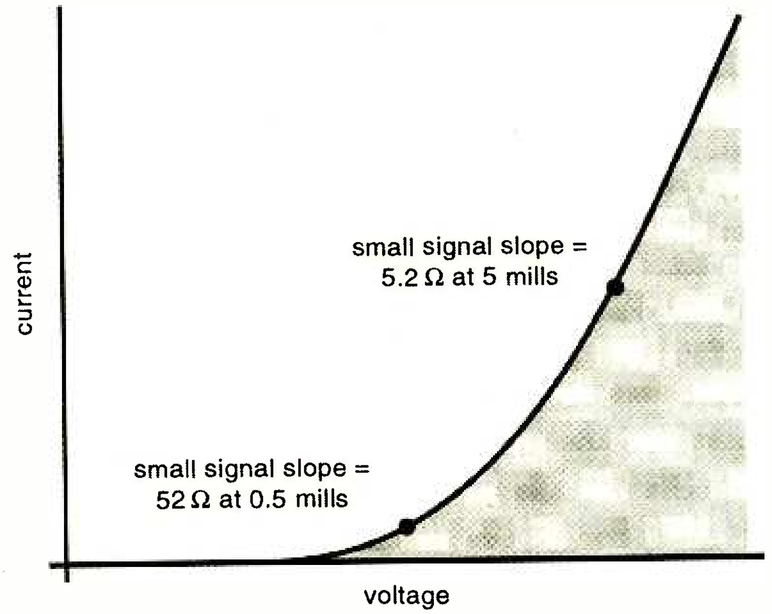


FIG. 3—ON ITS "KNEE", the slope of an ordinary diode is given by 26/i in milliamperes. Thus, a half mil DC current causes the diode to look like a 52-ohm resistor to very small RF signals.

Diodes as RF Switches

I've gotten several Help Line calls and e-mails on this topic, so it is time for an update and review. There's all sorts of times when you might like to turn a RF signal on or off, switch between two or more RF signals, activate a trap, change your channels or bands, or adjust RF-signal levels. These days, we have all sorts of options. Stock CMOS 4016 or 4066 analog switches can perform well at lower frequencies. Try my *CMOS Cookbook* or Maxim for details.

We also have new mid-frequency bus switch variations from Cypress, IDT, Pericom, Quality, and others. Get more info from www.questlink.com. Lots of ads for fancy and ready-to-go microwave switches and attenuators appear in trade journals such as *Wireless Product News, Wireless Design & Development, RF Design*, or *Microwaves & RF*.

But plain old diodes can also still be used here, as can their improved off-spring. Figure 3 shows us the forward curve of an ordinary silicon diode such as a 1N914. Since this is a plot of current versus voltage, the slope at any point will also be the equivalent resistance. At one mil, the equivalent small-signal resistance of a silicon diode is roughly 26/i where i is the current in milliamperes.

Thus, any DC current of half a mil makes a diode look like a 52-ohm resistor to very small AC signals. The higher the current, the lower the apparent RF resistance.

The trick is to set up two paths: A signal path that accepts low-level RF signals and is capacitively coupled, and a DC-coupled bias path that turns the diode on or off. Resistors or inductors are used in the bias path to only lightly load the signal path. Capacitors block the bias currents in the signal path. The diodes are largely "off" with zero current, and they act as fixed resistors with carefully set bias currents of a few milliamperes.

These days, there's an even better device known as a PIN diode. PIN diodes are diodes that are purposely designed to have exceptionally long carrier lifetimes and slow reverse recovery times. As such, they make useful current-controlled resistors for VHF and microwave apps. They are low in cost, and the bias current sets the resistance down to a fraction of an ohm. But do observe that PIN diodes are largely useless below 10 megahertz.

As with a regular diode, you set up an AC RF path and a DC biasing path. If you are sneaky, the diode's package capacitance can be resonated out or included as part of a filter.

Useful devices include the 1N5719 and others from Hewlett-Packard, or the BA582, BAT18, and friends from Infineon (who apparently used to be Siemens). With the BAT18 device, RF resistance at five mils is less than half an ohm. Recovery time is 100 nanoseconds.

Once again, the intentionally long PIN effective carrier lifetime does not change much on a RF cycle, making for a seemingly constant controlled resistance at RF, which is what PIN diodes are all about. Diodes may be combined into "L," "P," or "T" arrangements for more loss or better impedance matching. A simplified schematic for a multiple PIN-diode P attenuator is shown in Fig. 4. When properly designed, P attenuators offer a constant input and output impedance.

Use of two pairs of symmetrical back-to-back diodes can reduce the non-

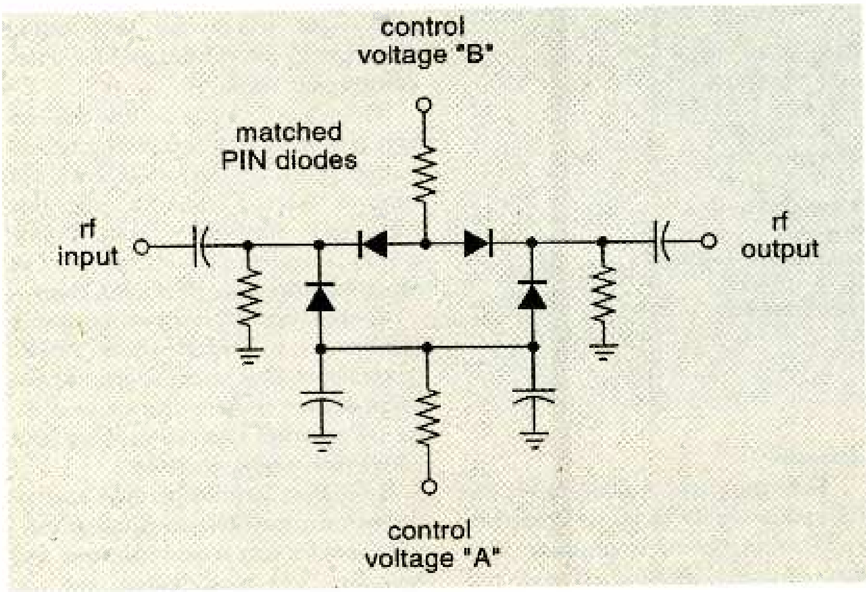


FIG. 4—SIMPLIFIED SCHEMATIC of a high-performance PIN-diode RF switch or attenuator. The P-network arrangement gives a constant input and output impedance. Control voltages must be carefully set for best results.

NAMES AND NUMBERS

AEMC Instruments
99 Chauncy St.
Boston, MA 02111
(800) 343-1391
www.aemc.com

Alpha Industries
20 Sylvan Road
Woburn, MA 01801
(781) 935-5150
www.alphaind.com

Cypress Semiconductor
3901 N First St.
San Jose, CA 95134
(408) 943-2600
www.cypress.com

Digital Content Creator
201 E Sandpoint Ave. Ste. 600
Santa Ana, CA 92707
(714) 513-8400
www.dccmag.com

Energy User News
1350 E Touhy Ave.
Des Plaines, IL 60018
(847) 390-2120
www.energyusernews.com

Hanser Gardner
6915 Valley Ave.
Cincinnati, OH 45244
(888) 527-8803
www.hansergardner.com

Hewlett-Packard
PO Box 10301
Palo Alto, CA 94303
(415) 857-1501
www.hp.com

IDT
2975 Stender Way
Santa Clara, CA 95054
(800) 345-7015
www.idt.com

Infineon Technologies
1730 North First St.
San Jose, CA 95112
(408) 501-6000
www.infineon.com

Maxim Integrated Products
120 San Gabriel Drive
Sunnyvale, CA 94086
(408) 737-7600
www.maxim-ic.com

Micro Plastics
Hwy 178 N
Flippin, AR 72634
(870) 453-2261
www.microplastics.com

JI Morris Co.
394 Elm St.
Southbridge, MA 01550
(508) 764-4394

Pericom Semiconductor
2380 Bering Drive
San Jose, CA 95131
(408) 435-1100
www.pericom.com

Pasternack Enterprises
PO Box 16759
Irvine, CA 92623
(949) 261-1920
www.pasternack.com

Pico Technology
149-151 St Neots Rd.
Hardwick, Cambridge CB3 7QJ, UK
44 (0) 1954 211716
www.picotech.com

Print On Demand Business
445 Broad Hollow Rd.
Melville, NY 11747
(800) 308-6397
www.podb.com

Quality Semiconductor
851 Martin Ave.
Santa Clara, CA 95050
(408) 450-8063
www.qualitysemi.com

Rohm Corporation
2150 Commerce Drive
San Jose, CA 95131
(408) 433-2225
www.rohm.com

Synergetics
Box 809
Thatcher, AZ 85552
(520) 428-4073
www.tinaja.com

linearity and distortion. Control voltages (and their diode currents) have to be carefully adjusted to work together to get the correct attenuation and impedance. The attenuation can range from very little loss up to 70 decibels. See the Alpha Industries application note *A Wideband General Purpose PIN Diode Attenuator.*

The same circuit makes a rather nice RF switch simply by going from minimum to maximum attenuation. Note that advanced construction and measurement skills are required for this simple and cheap circuit.

I have some great prices on digitally programmable 0.5 to 30 dB PIN diode RF atteunator blocks up at my www.tinaja.com/bargps01.html. These are a part of some specialized military *artery link* receivers. These also include multiple-stage broadband microwave amplifiers, analog PIN attenuators, and fiber-optic interface parts. These are real parts bonanzas and great project starters.

Some Books on Ultrasonics

I've gathered together a few useful books on ultrasonics as this month's resource sidebar. It seems there are great bunches of medical ultrasound books, so I've included only a modest sampling of these many titles. More details are up at www.tinaja.com/amlink01.html.

New Tech Lit

As promised at the beginning of this month's column, a major real-world breakthrough in hydrogen storage appears as "High H2 Uptake by Alkali-Doped Carbon Nanotubes under Ambient Temperature and Moderate Pressure" By Lin, Chen, Wu, and Ti in *Science*, Vol. 285, July 2, 1999, pages 91-93. The magazine's Web site is www.sciencemag.org. If you are not an AAS member, reprints are $5 per download. Or $10 for 24 hour guest access to their entire page full of reprints and abstracts.

Carbon nanotubes are very good at accepting and storing hydrogen. But keeping them stable and getting them to give most of their hydrogen back simply and safely have been huge problems. You might search the Web under "Rodriguez" and "Hydrogen" for interesting earlier work.

From Maxim, there's a new full-line data catalog CD on their analog switches, regulators, interface, A/D, D/A, and bunches more. Check out their new MAX1644 regulator. From Rohm, there's a similar CD on all sorts of intriguing consumer electronics chips.

A new line of current-measuring instruments is available from AEMC Instruments. One pricey source for just about any test cable, connector, or adaptor is Pasternack Enterprises. They have a free mini-catalog available.

From Pico Technology, there are free demos on virtual-instrumentation software used for data acquisition, temp and humidity, I/O conditioning, and for environmental monitoring.

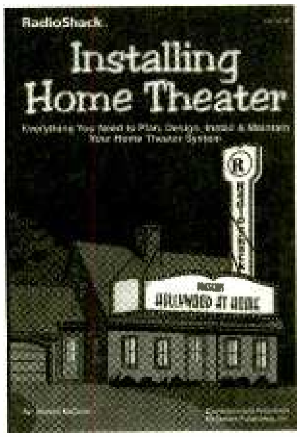
Insider technical books on plastics

(Continued on page 97)

NEW LITERATURE

Installing Home Theater: The Complete Guide to Buying, Installing and Maintaining Home Theater Systems

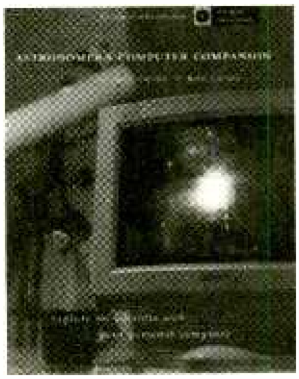
by Gordon McComb
Master Publishing, Inc.
7101 N. Ridgeway Avenue
Lincolnwood, IL 60712
Tel: 847-763-0916
Web: www.masterpublishing.com
$6.99
This easy-to-read book provides a complete guide to understanding all aspects of home theater. It begins by defining home theater, describes the components needed, what components can be reused, what needs to be new, and what equipment is necessary. In addition, the author covers the differences among TV sets and AV receivers and the latest advances in TV sets, including the transition to digital TV and the wide-screen format.



The sound system required for a true theater-like experience in the home is thoroughly explained—speaker types, where they should be in the room, and AV receivers. There are also useful diagrams on hooking components together, wiring tips, suggestions for room design and ergonomics, and guidance on home-theater equipment maintenance. Several easy-to-use charts help readers troubleshoot common problems from no sound to interference from outside sources. This book (#62-2319) is available at RadioShack stores nationwide and in Canada.

Astronomer's Computer Companion

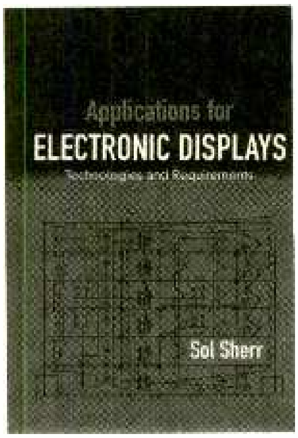
by Jeff Foust and Ron LaFon
No Starch Press
555 De Haro Street, Suite 250
San Francisco, CA 94107
Tel: 415-863-9900
Fax: 415-863-9950
Web: www.nostarch.com
$34.95
This first guide to locating and using astronomy resources on a personal computer introduces basic astronomy concepts. Simultaneously, it shows readers how to use computer-based resources to enhance their sky watching.



The authors sort through the "astronomical" number of Internet sites on the subject and present them in an organized and usable format. They discuss astronomy software and how to use it effectively. The book's included CD-ROM contains animations, shareware applications, astronomical images, plus a list of hardware and software resources and a list of Web sites for the amateur astronomer.

Applications For Electronic Displays: Technologies and Requirements

by Sol Sherr
Wiley-Interscience
John Wiley & Sons
605 Third Avenue
New York, NY 10158
Tel: 212-850-6366
Web: www.wiley.com
$69.95
Emphasizing the options that are available for finding the best match between application requirements and display technologies, this resource provides invaluable information and guidance. It is designed for everyone from manufacturers and design engineers to technicians in the computer and entertainment industries.

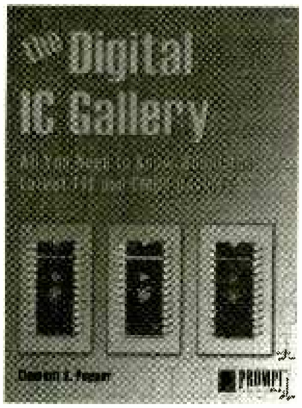


Key technical aspects are discussed. There is thorough coverage of display specifications; design, photometric, and visual parameters; and human-interface requirements. The author covers output devices and systems, including CRT and FPD monitors, hard-copy devices, and large-screen systems; and data-processing systems. In addition, he discusses computer graphics, CAD/CAE, multi-media, virtual reality, and entertainment applications, among other topics.

The Digital IC Gallery

by Clement S. Pepper
Prompt Publications
Howard W. Sams & Company
2647 Waterfront Parkway, East Drive
Indianapolis, IN 46214-2041
Tel: 800-428-7267
Fax: 800-552-3910
Web: www.hwsams.com
$39.95

As an experimenter or hobbyist, it is difficult to discover the full range of devices appropriate for your intended application. Vendor catalogs often contain only a partial listing, and often only the best sellers are shown. However, with this book in hand, readers can identify digital devices in the TTL and CMOS logic families.

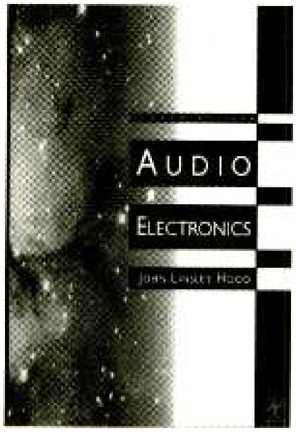


The author has compiled a comprehensive study of the latest semiconductors, complete with logic and connection diagrams, truth tables, functional descriptions, and performance data. Along with chapters on digital IC basics and gate logic, there's a glossary, as well as descriptions of the differing technologies used by various manufacturers. An appendix also lists numerous manufacturers' data books. If you work with or experiment with IC devices, this book will be very helpful on your workbench.

Audio Electronics

by John Linsley Hood
Newnes, Butterworth-Heinemann
225 Wildwood Avenue
Woburn, MA 01801
Tel: 800-366-2665 or 781-904-2500
Fax: 800-446-6250 or 781-904-2620
Web: www.bh.com/newnes
$39.95

Underlying audio techniques and equipment is a world of electronics that determines the quality of sound. Anyone involved in designing, adapting, and using digital and analog audio equipment needs an understanding of electronics for greater control over recorded or reproduced sound.

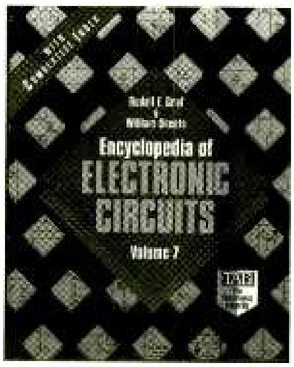


The second edition of this useful book includes new material in a wide-ranging survey of the field. The latest developments are covered: digital radio and TV, Nicam 728, and the latest Dolby noise-reduction systems. Numerous schematics and diagrams accompany the text.

Encyclopedia of Electronic Circuits, Volume 7

by Rudolph F. Graf and William Sheets
McGraw-Hill
1221 Avenue of the Americas
New York, NY 10020
Tel: 800-2MCGRAW
Web: www.book.mcgraw-hill.com.
$39.95

Designed for quick reference and on-



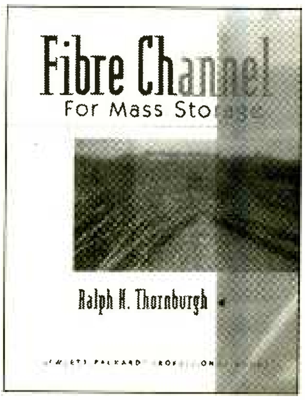
the-job use, this encyclopedia presents over 1000 state-of-the art electronic and integrated-circuit designs. Organized alphabetically by circuit type, this all-new collection includes the latest designs from industry leaders such as Advanced Micro Devices, Motorola, Teledyne, General Electric, and others.

Each circuit is accompanied by a brief explanation of its operation and other information regarding adjustments or alignment. Included are diagrams and schematics for circuits used in power supplies, computers, and amplifiers, among others. An invaluable reference tool, this book also offers a cumulative index that covers all the circuits presented here and in each of the previous six volumes.

Fibre Channel for Mass Storage

Ralph H. Thornburgh
Prentice Hall
One Lake Street
Upper Saddle River, NJ 07458
Tel: 800-282-0693
Web: www.phptr.com
$45

Mastering Fibre Channel enables users to scale storage systems from gigabytes to terabytes and to improve perfor-



mance simultaneously—all without disrupting systems or networks. This Hewlett-Packard (H-P) Professional Book (Web: www.hp.com/go/retail books) walks readers step-by-step through the basics of this next-generation technology and demonstrates how to deploy H-P's advanced Fibre Channel products to solve enterprise storage problems.

The author introduces H-P's state-of-the-art Fibre Channel product family, beginning with Tachyon, the industry's first Fibre Channel controller fully integrated on a single chip. H-P's adapters for K-, T-, D- and V-Class Enterprise Servers and parallel clusters; hubs; disk arrays; SCSI multiplexers; and more are thoroughly covered. There is also a preview of the future of Fibre Channel faster fiber rates, hunt groups, multicast groups, and classes of service. EN

TECH MUSINGS

(continued from page 94)

are published by the Hanser Gardner folks. Ultra-small nuts, screws, taps and dies can be found at J. I. Morris. Almost any variety of plastic fastener is sold by Micro Plastics.

Our featured trade journals for this month are *Digital Content Creator*, *Print on Demand Business*, and *Energy User News*.

For most individuals most of the time, any involvement with patents is virtually certain to end up as a net loss of your time, energy, money, and sanity. Find out why along with lots of proven real-world alternatives in my *Case Against Patents* package per www.tinaja.com/synlib01.html or my nearby Synergetics ad. Also check into my new Webmastering Secrets and similar InfoPacks.

Latest Web-site additions now up at www.tinaja.com include scads of GPS and navigation stuff, columns on new antenna resources, and more great surplus bargains. Besides great techie items, you will find everything from Micronesian flags to water-soluble swimsuits to Y2K wilderness survival land to Kinetron II medieval torture chambers to germ warfare kits. There are online auctions, too.

As usual, most of the referenced items are in our Names and Numbers or Ultrasonic Books sidebars. Always check those first before you call our no-charge US help line or e-mail me at don@tinaja.com as per the nearby box. Let's hear from you. EN

EQUIPMENT REPORT

(continued from page 4)

as is software for downloading images from the camera. All software supports both Windows and Macintosh computers.

This impressive list of features is packed into a digital camera that has a film-camera-like look and feel, with dimensions of 4.2 inches wide by 2.9 inches high by 2.6 inches deep and a weight of only 10.7 ounces. The C-2000 Zoom has a street price of $999, and lower.

P-330 Photo Printer

One of the nicest things about all Olympus digital cameras, including the C-2000 Zoom, is that they can print directly to the Olympus P-330 photo printer. Olympus' first-generation photo printer, the P-300, could connect directly to most Olympus digital cameras, without needing a computer, and print glossy 4- × 5.5-inch photos with the touch of a single button. The printer could also be connected to the parallel port on a PC to make prints from any digital images, including Internet downloads and images edited on a computer. The quality of the prints rivaled 35mm prints. The latest photo printer from Olympus, the P-330, produces the same great prints as the P-300, but with far greater flexibility.

The P-330 is a dye-sublimation printer that makes 4- × 5.5-inch prints only, in 24-bit color (16.7 million colors) at a rate of about 2 minutes per page. It can print up to 30 copies of a single image at once or print up to 16 thumbnails on a single sheet. The printer uses special ribbon cartridges and glossy printing sheets that come 60 to a pack along with a new ribbon cartridge for about $40, making these prints cheaper than Polaroids—and the quality is better, especially when you're printing the

2.1-megapixel source images provided by the C-2000 Zoom.

Like the P-300, the P-330 can print directly from Olympus digital cameras and from PCs through the parallel port and Macs through the serial port. But the P-330 photo printer also has a video output so that it can be connected to a TV set and a slot that accepts SmartMedia cards.

Now there is no need even to connect the camera to the printer, thus avoiding cables altogether. One simply removes the SmartMedia card from the camera and slips it into the P-330. Images are then reviewed on the TV screen and printed by pressing a button on the P-330. Images stored on a SmartMedia card can also be "dog-eared" while still in the camera, so that they will print on the P-330 without the user having to connect the printer to a TV set or needing to see them at all.

The P-330 printer is also a SmartMedia card reader, allowing images or other data stored on SmartMedia cards to be transferred to a PC via the parallel port, but only for Windows users. Another neat feature of the P-330 is that it has a video input. With the printer connected to a TV set, any frame from the incoming video signal can be grabbed and printed. This allows still prints to be made from videotape, a video camera, DVD or whatever. The P-330 costs $449.

For more information on the Olympus C-2000 Zoom digital camera or the P-330 digital printer, contact the manufacturer, Olympus America, Digital & Imaging Systems Group (Two Corporate Center Dr., Melville, NY 11747-3157; Tel: 516-844-5000 or 800-347-4027; Fax: 516-844-5262; Web: www.olympus.com/digital) directly or circle 15 on the Free Information Card. EN

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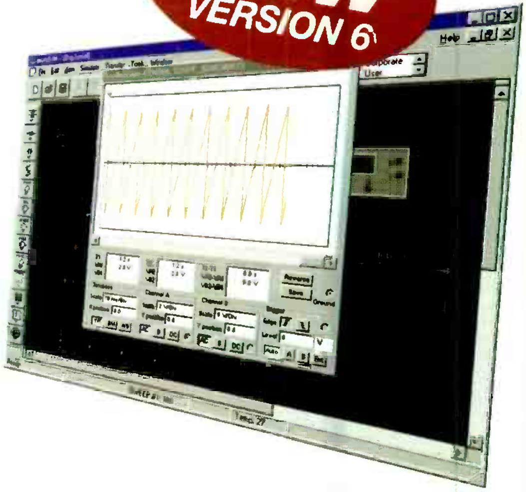

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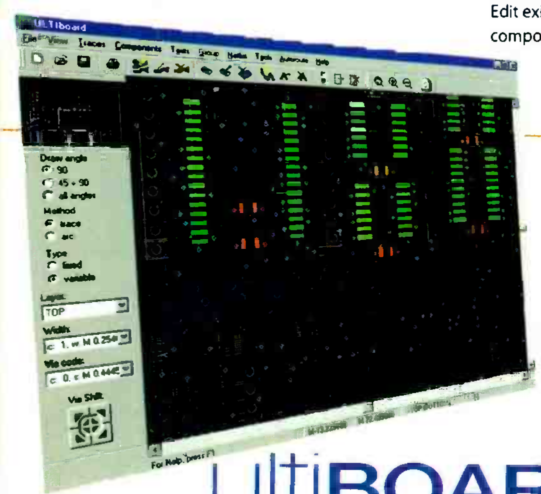

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