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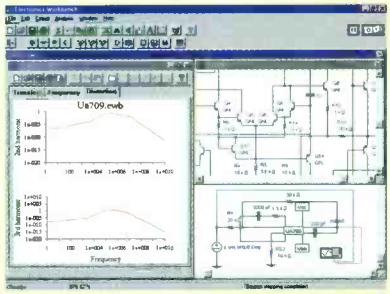

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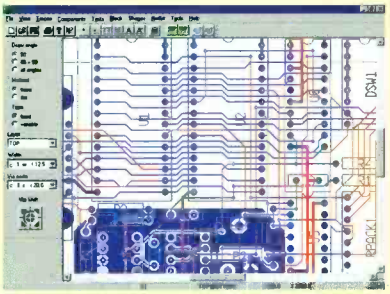

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COVER STORY

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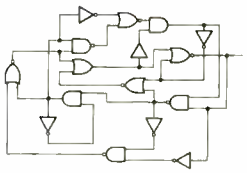
FEATURE



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PRODUCT REVIEWS

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ABC AUDITED

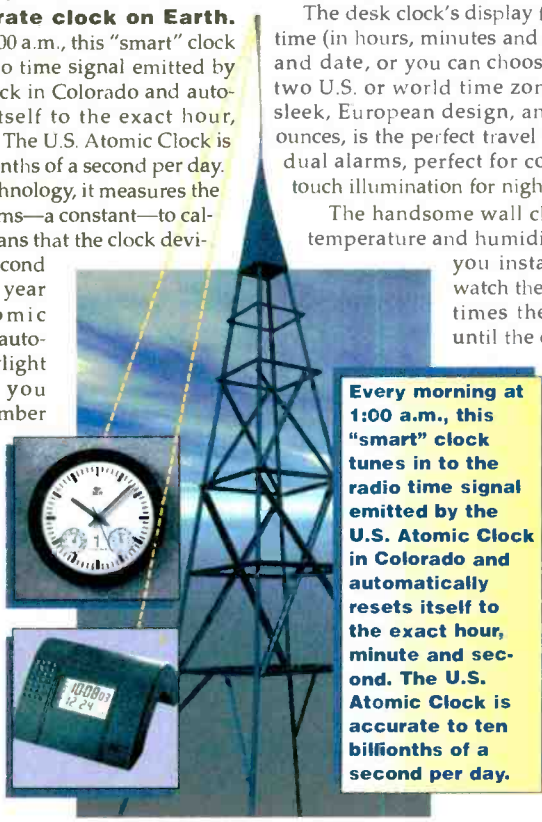
The U.S. Government always knows exactly what time it is...do you?

New clock from Arcron uses radio signals from the U.S. Atomic Clock in Colorado to display the precise time, within a billionth of a second.

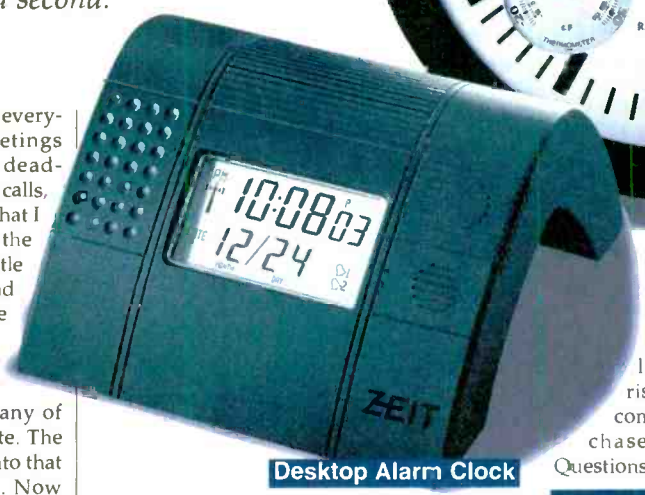
by Jake Prine

These days, timing is everything. Between meetings and appointments, deadlines and conference calls, my schedule requires that I know the time down to the minute. Even on weekends, I've got Little League games to coach, shows to tape and planes to catch. If I'm late, I'm sunk. The problem is that it's hard to be prompt if my clocks aren't correct. Even digital clocks can be inaccurate. Power outages, dead batteries, time changes...any of these can cause a clock to be inaccurate. The next thing you know, you're strolling into that important conference...an hour late. Now there's no need to worry, because advanced radio technology has produced a clock which gets the time directly from the U.S. Atomic Clock in Fort Collins, Colorado, the standard for time-keeping the world over. The Atomic Clock by Arcron is the most accurate, reliable and convenient timepiece you can buy.

The most accurate clock on Earth. Every morning at 1:00 a.m., this "smart" clock tunes in to the radio time signal emitted by the U.S. Atomic Clock in Colorado and automatically resets itself to the exact hour, minute and second. The U.S. Atomic Clock is accurate to ten billionths of a second per day. Using molecular technology, it measures the vibration rate of atoms—a constant—to calibrate time. This means that the clock deviates less than one second over a one million year period! The Atomic Clock even adjusts automatically for daylight savings time, so you don't have to remember to "spring forward" or "fall back." This clock is the only atomic clock with an internal calibrator that creates "intelligent" adjustments based on the latest signal readings. The desktop model is the only clock that will not lose time with low power or when you change its batteries.



Every morning at 1:00 a.m., this "smart" clock tunes in to the radio time signal emitted by the U.S. Atomic Clock in Colorado and automatically resets itself to the exact hour, minute and second. The U.S. Atomic Clock is accurate to ten billionths of a second per day.



Desktop Alarm Clock

An easy time. The most accurate clock in the world is of no use if it is difficult to operate. The Arcron Atomic Clock is engineered in Germany using the latest scientific technology. It comes in two styles, the wall clock and the executive desktop model. Both are designed to be functional *and* easy to use.

The desk clock's display features the exact time (in hours, minutes and seconds), month and date, or you can choose to display any two U.S. or world time zones. It features a sleek, European design, and, at only eight ounces, is the perfect travel clock. It also has dual alarms, perfect for couples, and one-touch illumination for nighttime viewing.

The handsome wall clock comes with temperature and humidity gauges. After you install the batteries, watch the hands spin at 20 times their normal rate, until the clock has adjusted to the precise time. Both the executive desktop and the wall model have an internal antenna for superior reception sensitivity, without unattractive wires.

The time to buy is now! Act now and you can own the world's most precise timepiece. Both the executive desktop and the wall model come with a one-year manufacturer's limited warranty and Comtrad's risk-free home trial. If you are not completely satisfied, return your purchase within 90 days for a full, "No Questions Asked" refund.

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Editorial

The Appliance Operator

In this month's issue, our cover story deals with putting together your own PC—at least the first part—the pros and cons of the selection of the necessary components. But you might ask, so why bother? The cost savings are not as great as they used to be. I can go down to my local computer store, or mail-order house, and pick up the whole computer system without knowing a blessed thing about motherboards, CPUs, DIMMs, SIMMs, expansion slots, and RAM. Nevertheless, the most compelling reason to put together your own system from scratch is that it will give you an education that only such a hands-on experience can provide. You can do upgrades, modifications, and repairs much more easily, and that's where the big savings come in.

Years ago, when I finally upgraded my CW-novice ham-radio equipment, the choice of many was to build equipment from a kit. Enter the era of *Heathkit*, *Johnson*, *Eico*, and countless other domestic kit manufacturers that, most unfortunately, have since gone out of business (it's a shame). The *Heathkit* SB301 and SB401 receiver and transmitter I finally built was my pride and joy. It took me months to put them together, but they were built to exacting standards with such pride and workmanship, unmatched by mass-produced standards. Fortunately I was not the type who expressed the "I want it now" attitude, so prevalent with today's youngsters—and I did not mind the time I spent reading the manual, rereading the manual, and only then soldering the wires. In fact, many of the DX hams I later worked (especially in the "Iron Curtain" countries), used "home-brew" equipment, which is at least an order of magnitude harder to put together than a kit. These dedicated radio amateurs had to scrounge up the parts, punch the chassis, and determine their own wire harnesses—all without the aid of the superb *Heathkit* manuals and pictorials.

Money-wise, by building my *Heathkit* equipment I probably saved about 25% over similar equipment with comparable features from other manufacturers, which came wired, tested and ready-to-go. Nevertheless the "real ham" looked down upon the "appliance-operator" ham, which was the term for operators who simply bought their rigs, turned on the power, cranked the knobs, and went on the air. Although 25% in cost was (and still is) a considerable savings, the main reason I put together my own ham equipment, was that afterwards I was not afraid to open up the rig, put in modifications, troubleshoot (which I am happy to say did not occur often over the 22 years I actively used the *Heathkits)*, and put in any improvements which came along. The same reasons exist today for putting together your own PC. Appliance operators may be in the majority, but although in the minority, those who build their own PCs experiment, explore, and in the process, learn.

Ed Whitman
Managing Editor

LETTERS

SIP UPDATE

For those of you who plan on ordering additional Single Inline Pin (SIP) module-types, described in the August 1998 feature article "Surface-Mount Audio Modules," Sescom Inc., *supplier of these SIPs, informed us that additional test equipment, such as an audio oscillator (low distortion), an audio voltmeter (reading to less than 10 mV), a distortion analyzer (reading to less than 0.1%), and/or an oscilloscope (reading to 5-mV levels)* ***may*** *be required for the following modules numbers: SIP-8, SIP-9, SIP-15, SIP-16, SIP-17, and SIP-23. This is necessary to adjust these modules for optimum performance after assembly. Consult* Sescom, *when ordering, to determine what auxiliary test equipment may be required for your module(s).*

*We recommend ordering their VHS video tape "*Sescom *Soldering," (described on page 34 of the feature) in order to learn how to assemble and handle these tiny surface-mount components.—Editor*

VENDOR UPDATE

The address of the source for more information in the "SCANeR and TRACS" feature (July 1998 —page 43) has been changed to ***French Technology Press Office****, One East Wacker Drive, Suite 3740, Chicago, IL 60601. The telephone and Fax number listed in the article are the same.—Editor*

AUTHOR'S COMMENTS ON E.Z. SIGNAL-GENERATOR PROJECT

I noticed an error that crept into "Build an E.Z. Signal Generator," (July 1998 issue), which may cause a problem for the builder. On page 64, in the "Setup and Calibration" section, the text correctly advises connecting the ×10 scope probe ground clip to the +1.9 volt bus. However, the text **incorrectly** states: "...check the **output** waveform of the circuit." This implies that the probe is connected to the output jack. It should read that the **probe** has to be connected to the **common lug of S2** for proper displays.

I also felt that the readers might be interested in a detailed description of the oscillator section operating theory. Integrated circuit IC1 (a *Linear Technology* LT1016) is a ultra-fast comparator with differential inputs and complementary TTL outputs. In the schematic, you will note the matched loading of both outputs—which essentially causes current to flow from one output through both loads to the other output—without flowing through the reference bus. At this load of about ±3 mA, the TTL output levels are about +3.5V (high) and +0.3V (low), when referred to ground.

To be able to use this circuit to drive integrator IC3 (the LM6361 op-amp), a bi-polar output is required. Thus, IC2 (the LF351 JFET) is configured to provide a low-impedance reference at a point 50% between the TTL levels, or about +1.9 volts. Referred to this level, the outputs are now ±1.6 volts. Resistors R3 (200 ohms) and R4 (330 ohms) provide positive feedback to pin 2 of IC1. The ±1.6V from pin 7 is applied to this divider and reduced to ±1.0V at pin 2. This is the reference level for the tri-wave amplitude.

Now let's assume that you have selected 1.0 kHz full-scale, with capacitor C11 (.05μF) selected via S1, and resistors R8/R14 at ×2 for maximum frequency on that scale. When power is applied, IC1 will be in either of two possible states: pin 7 low with pin 8 high, or *vice-versa*. Let's start out with pin 7 high. The output at pin 7 will be +1.6V, and +1.0V appears at pin 2, the non-inverting input. Thus, the outputs are now latched. Pin 8 is low at −1.6V, and this voltage appears across the series combination of R9 and R10, which is equal to about 4000 ohms when calibrated. Now we have about 400 μA flowing through capacitor C11, charging it in a linear fashion. The output of IC3 then ramps up in a positive direction.

As the output of IC3 is connected to pin 3 of IC1, the inverting input, when the ramp voltage reaches +1.0V, IC1's outputs reverse their states. Pin 7 will now be at −1.6V, and −1.0V will appear at Pin 2. Pin 8 will be at +1.6V, and −400 μA will flow through C11, causing it to discharge with IC3's output now ramping down in a negative direction. When IC3's output reaches −1.0V, the process starts all over again.

Thus, you can expect to see the following waveforms at the frequency selected on the following pins: ±1.6V square wave at pin 7 and pin 8; ±1.0V square wave at pin 2; and ±1.0V triangle wave at pin 3—all located on IC1. The time period of the waveform is determined by the formula: T = (C × V)/, where C = .05 μF, I = 400 μA and V = 4.0V (the total voltage excursion of the triangle wave.) Thus, T = 500 μsec, and $f = 1/T$ = 2000 Hz.

Hope this all helps our readers!
Skip Campisi
S. Bound Brook, NJ

OUR READERS REPLY

In response to G.L's "Haves & Needs" letter (July 1998) asking about "White's Radio Log," a publication which listed all the AM and FM stations in the U.S., the following online Web site is a good source: *http://www.inforamp.net/~funk/ page2.html*. I believe the original "White's Radio Log" ceased publishing in the early 1980s.
K. A.
Eau Gallie, FL

A listing of all the FM broadcasting stations in North America, entitled "FM Atlas and Station Directory" is available from Universal Radio, 6830 Americana Parkway, Reynoldsburg, OH 43068; Tel. 800-431-3939, Web: *www.universal-radio.com*. They also have available a similar AM station listing, "National Radio Club AM Radio Log."
D.S.
Piscataway, NJ

In response to George Wroe's "Haves & Needs" letter (August 1998) asking about programming a radio/tape recorder like a VCR, his VCR can be used to accomplish this. Since a VCR is essentially an oversized cassette recorder, only what is applied to it will be recorded. All Mr. Wroe needs to do is

use an *RCA-RCA* patch cord from his stereo tuner's output to the audio input of his VCR. Then remove the 75-ohm coax from the VCR and set record start and stop times as usual, ensuring that during the programmed times, the receiver is turned on and set to the desired station. Playback can then be made through the stereo by using the AUDIO OUT terminals from the VCR and the AUX/PHONO connection on the stereo.

If Mr. Wroe only has a radio with a headphone jack, the same procedure can be used with the appropriate patch cord. If a headphone jack output is used, some test recordings will have to be made to ensure that the audio preamp is not being overdriven. Without a stereo system, playback can be made using the 75-ohm coax to the television (just like playing back a recorded video). Although no video is recorded, audio playback should be as good as any standard cassette. I have used a VCR in this manner to record my band, by furnishing audio from our mixing console.

J.C.
Zephyrhills, FL

RADIO-CONTROLLED CLOCKS

I recently bought one of those radio-controlled clocks that is supposed to keep accurate time by tuning in on radio signals sent out from the *N*ational *I*nstitute of *S*tandards and *T*echnology (NIST) station WWV, in Fort Collins, CO. The signals are generated by a Cesium atomic reference that is located there. However, the clock I bought just hangs on the wall and refuses to do anything. I am in love with the idea of having an accurate radio-controlled clock in my house, and I think that the only thing that is wrong is that the low-powered radio receiver that is installed in the clock is just not sensitive enough to pull in the station's reference signal at my location. While I haven't inspected the insides of the clock, the whole mechanism is housed in a box not much larger than a pack of cigarettes. I believe that it uses a loop-stick antenna. I think that if I constructed a tuned RF amplifier, perhaps a superhetrodyne circuit, and piped the RF up to an antenna close to the clock, I may be able to solve the problem.

However, if I knew the frequency that they were using, I could measure the received signal strength at this location. It would also be important for me to know the method they use to modulate their carrier and the code arrangement used to control the clock. Do any of the **Popular Electronics** readers have any information on this? I would like to know what I can do to get this clock operating. There may be other people out there who are having a similar problem.

Bob Dinlocker
815 Shaw Avenue
Lansdale, PA 19446

HAVES & NEEDS

I have enjoyed reading **Popular Electronics** since 1994. I started to build a high-voltage power supply, but I'm stuck on the hook up of a fly-back transformer. I salvaged one from an old *IBM* monitor, with the part number MSH1FCT31. There are 13 pins at the base, and three wires—two at the top and one at the base. I have not been able to find any information on this part, and have no idea how to hook it up. Can any readers can provide a diagram of this part or any easy way of hooking it up to a power supply?

Karl Jondahl
305 Roger Street
Glasgow, MT 59230

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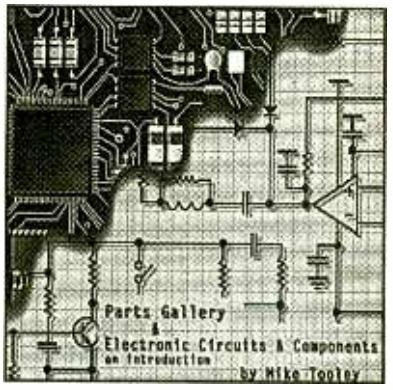

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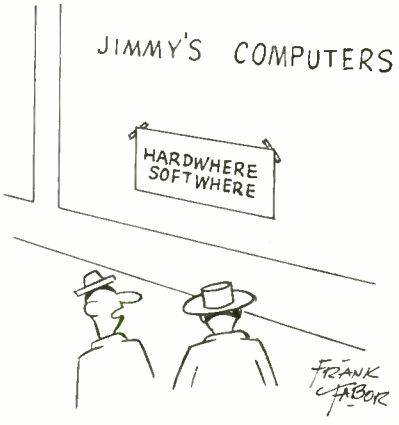
I do electric motor repair, and I need a low ohmmeter suitable for inductive circuits. I think an analog type is more suitable for this type of work. I would like to get instructions on how to build such a meter that can register one ohm or less full-scale.
A. Falcone
554 Union Blvd.
Totowa, NJ 07512

I am looking for schematics for a *Hewlett-Packard* 1220A oscilloscope and for a *Precision* VTVM Model 88—which are both in need of repairs. Any troubleshooting information on these two units would be appreciated.
Frank M. Cahn Montero
Diag 4C #27-98 Las Villas
Zipaquira, Cund.
Columbia

I recently resurrected my *Harmon Kardon*, Model 930 stereo receiver (vintage 1972) and have it working with the exception of a problem with the stereo-FM mode. The manufacturer could not supply a shop manual or even a schematic diagram of the unit, due to its age. Can any readers help me?
Skip Allen
11 Allen Farm Road
Barrington, NH 03825 ■



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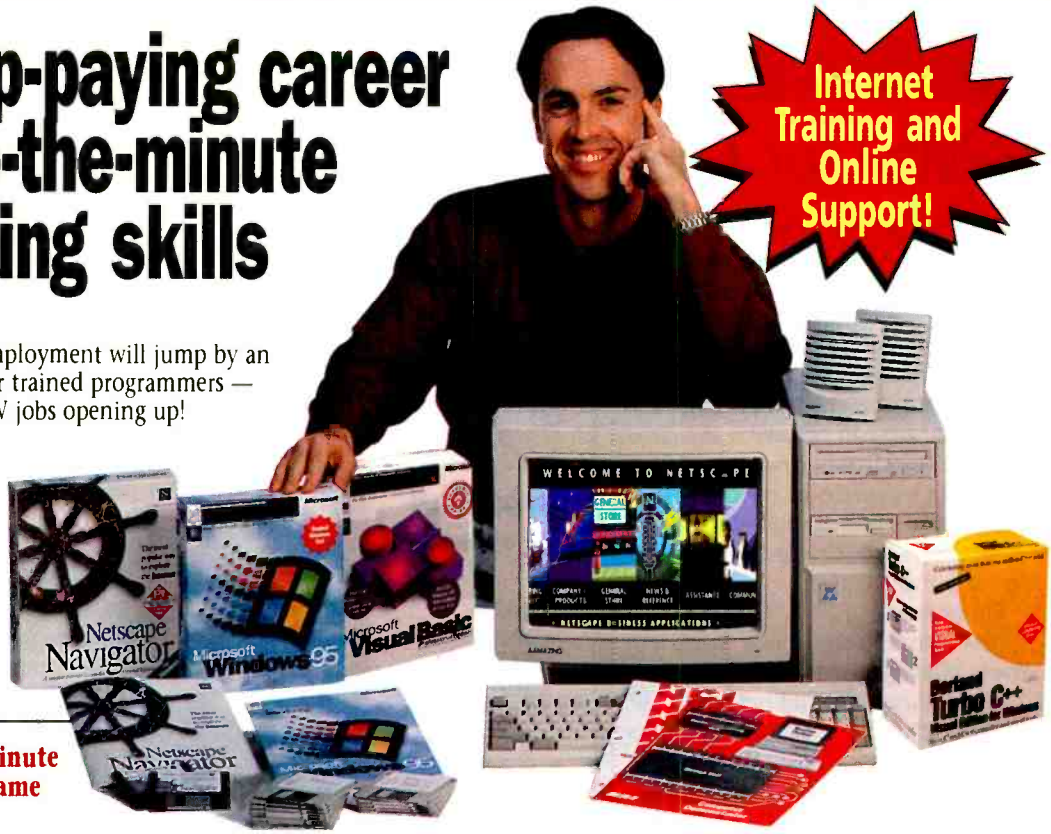

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NET WATCH

E-Mail for Free!

KONSTANTINOS KARAGIANNIS

Most of you reading this have noticed a growing problem with your home's "family" PC. As more people in the household begin to use the machine, more and more requests for personal Internet accounts start coming in. No matter how you try to explain that no two people can be online at a time with one machine anyway, and that sharing an account is a perfectly natural solution, you'll hear complaints like:

"But, Dad, I don't want Jenny reading my e-mail!"

Or, perhaps:

"But, Mom, I can never figure out which messages are for me."

Good arguments, but not every ISP supports multiple mailboxes for one account. And as you start to do the math in your head, paying an extra $20 a month for each household member can really add up. How do you satisfy each family member's need for an e-mail address without breaking the bank?

Simple—get free e-mail!

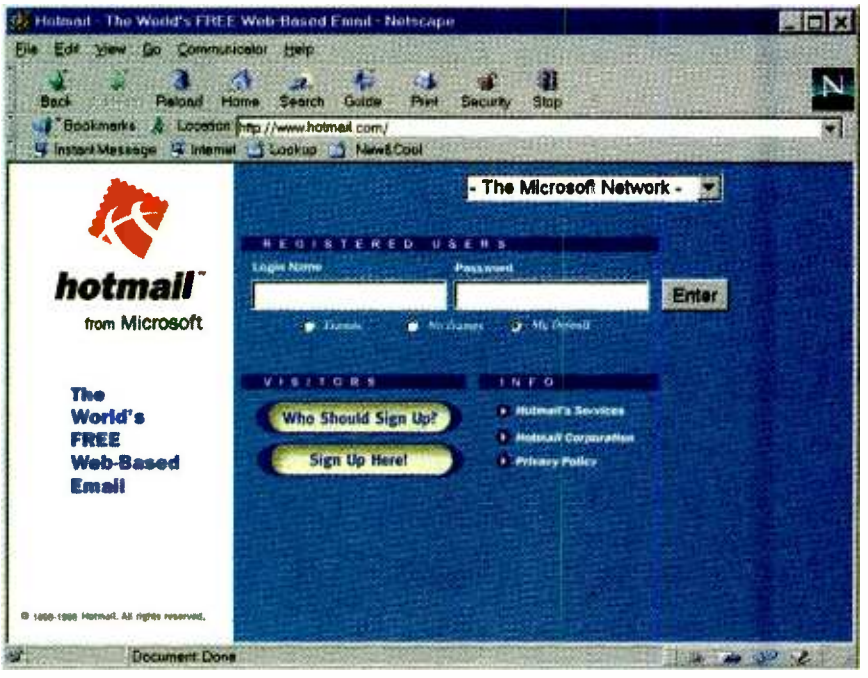
No, we're not talking about free Internet accounts. You'll still need a dialup account with an ISP to take advantage of that glorious Web whose praises we've been singing since this column's inception. However, the solutions here will make sure you have e-mailboxes galore and still be able to pay your mortgage.

Two of the solutions we look at are accessed through your machine's Web browser (hence the definite need for a dialup account). One of the free providers' offerings will only work through the use of a proprietary software package, and you have to dial in to the company's own access nodes. For those who don't want anything but e-mail (perish the thought!), you'll find this free solution the coolest of all.

What's that you say? Do we sense a cliché coming our way? Yes, you're right, you'll never be able to get a meal at noon without paying for it in some way. You will have to put up with a minor inconvenience when enjoying free e-mail: Advertising.

Is it really an inconvenience, though? Advertising is so common on the Web that most people have become used to it. Do you really mind ads in magazines? Most people don't. I've bought certain magazines just for the ads, especially when shopping around for a good price on something.

So if you can handle the aforementioned drawback and don't mind a slight delay in receiving your e-mail (it's not quite as fast as a standard POP3 e-mail account), this month's column may save you a fortune.



Hotmail, *run by software-giant* Microsoft, *is one of the true conveniences found on the Web. Sign up for a free e-mail account, and access it through any Web browser.*

HOTMAIL

It's no surprise that one of the most popular free e-mail providers, *Hotmail*, is a spawn of the world's largest software company. *Microsoft* has created a wonderfully easy-to-use and efficient service. Regardless of what some critics and the government might say about the company in general, *Microsoft* has, in our book, done no wrong with this site. But don't take our word for it, take a glance at the numbers. More than five million people use *Hotmail* regularly. We even know of quite a few small businesses that use accounts with *Hotmail* to cut down on expenses.

One of the nicest features of the service is that you don't have to pretend to be different people to get more than one free e-mailbox for yourself. *Hotmail* lets you have multiple accounts, and, get this, check them simultaneously.

Setting up an account doesn't take very long. Simply point your browser to the site, answer a few questions, and you're set. Each time you visit the site from then on, simply enter your login and password, and your mail will be exposed to your eyes only.

Those who are familiar with e-mail software will find that many popular convenience features are supported in *Hotmail*. For starters, you can "cc:" messages to up to 20 different addresses. This ensures *Hotmail* is a great solution for even business applications.

We were surprised to see that you can send and receive attachments. This is a feature we wouldn't have imagined was available to Web-based e-mail, but it is. The only limit is that a file coming in or going out can't be larger than 1 MB.

Speaking of file size, *Hotmail* lets you store up to 2 MB of received e-mails on its server. After that limit is reached, the service will delete old messages with new ones that come in. Don't worry—it will warn you in plenty of time to enable you to backup old e-mails to a disk (and how much old e-mail do you really need to keep, anyway?).

Something we should point out about this service and the other Web-based one that we'll get to later is that you can access your e-mail from ***any*** computer that has Internet access and a browser. This means that even if you don't have a laptop, you can still travel and find a business center or even public library and stay in touch with the world.

As with any e-mail account, in a matter of days you'll find yourself to be the target of junk e-mail. It's inevitable—people and companies sell e-mail addresses to direct marketers as fast as they can get them. To help you sort out some of the junk, *Hotmail* provides you with customizable filters. If you know that a particular e-mail address sends you nothing but junk, automatically get rid of messages coming from it—a nice touch for a free service.

JUNO

We've hinted at it, and a few of you were probably intrigued by the idea. Totally free e-mail, no Net account required. Even if you have an account, though, *Juno* might still provide the best solution for you. Let's say you have two PCs in your home, and you're online. If little Jenny from our earlier example wants to check her e-mail, you have to logoff so she can dial in, right? Not with Juno (we won't touch on the expense of the extra phone line you'd need for such a scenario).

Juno provides a free download of its software, or, if you aren't online, you can get it by calling 800-654-JUNO (the diskette, including shipping, costs $8.82). Once the software's installed, you have to go through a slightly arduous setup procedure. Composed of more questions than a standardized test in school, the setup is *Juno's* way of making you do its ad-sales staff's demographic homework for them. On the positive side, once you're done telling the service all about what makes you really you, chances are that a good majority of the ad banners you'll be stuck looking at will at least have something to do with your interests.

Juno *lets you have free e-mail access even if you don't have Web access. While the company's Web site lets you download its proprietary dialup software, you can also call up to get it.*

After visiting the most popular indexing site on the Web, Yahoo!*'s free e-mail service is only a click away.* Yahoo! Mail *even lets you access other POP3 accounts, making this site truly worthy of its exclamatory name.*

To access the service, you'll have to choose from one of 400 phone numbers. Odds are in your favor that you'll find one that is a local phone call. If not, you can always read and compose e-mail offline, only letting the toll charges add up while you're sending and receiving (which you may be able to do in under a minute).

A benefit of the *Juno* service and software is that e-mail is automatically stored on your PC. That means there's no limit to how much e-mail you're allowed to keep in your inbox. This makes *Juno* much more like a "normal" e-mail account.

On the flip side, it has a limitation that we just can't fathom. The software's on your machine, there's no

(Continued on page 30)

PRODUCT TEST REPORT

Samsung DVD905 Digital Versatile Disc Player

STEPHEN A. BOOTH

Samsung wasn't in the first wave ashore when Digital Versatile Disc (DVD) players were launched in April 1997. The South Korean electronics giant elected to design and build its own player, rather than source one from *Panasonic, Sony*, or *Toshiba*, as most other brands did. By sitting out the early innings, *Samsung* could study market evolution and develop features that would differentiate it from the competition. Besides, there was no great advantage to being first, as there wasn't a great deal of DVD software available to stimulate player sales. By the time you read this, about 1000 DVD titles will be available for sale or rental.

Although DVD players can be found for as little as $299, *Samsung's DVD905* stakes out the high ground—above $700—where *Sony* has enjoyed great sales success for full-featured, high-performance players. *Samsung*'s DVD carries a $749 sticker and a feature that is found nowhere else: RGB-type component video outputs that mate the player to high-end video projectors and monitors. Behind its distinctive pewter-finish, anodized-aluminum faceplate is another feature that designates high-end DVD players: built-in decoding for the format's *Dolby* AC-3 Digital Surround soundtracks.

DVD EXPLAINED

Multichannel digital audio is one standard feature of the DVD format. But digital video is what differentiates it from all that's come before. In case you missed the hype, here's some background on DVD. Unlike 12-inch video laser discs, which store images in analog format along with a digital soundtrack, DVD is all digital. It is a laser-read optical disc that's the same size as a compact disc (CD), but is capable of compression levels that yield a capacity of from 7- to 27-times greater than the roughly 650-megabyte limit of music CDs or computer CD-ROMs. DVD uses the MPEG-2 compression method—that's the same compression method that enables direct-broadcast satellite (DBS) TV systems, such as DSS and Echostar, to send so many high-resolution video channels down to a TV-set-top box.

DVD and DBS video have about the same horizontal resolution (480 lines) as most relatively new TV monitors. Compare that to about 425 lines for laser disc, 330 for a live NTSC broadcast, and 240 for VHS videotape. Its vertical resolution is also about 480 lines, which is converted within the player from progressive to interlaced scanning for display on NTSC televisions (or PAL/SECAM, where appropriate). For the record, the DVD players in computers retain progressive scanning for display on non-interlaced PC monitors; but when connected to TVs through the PC's video-out jack, the image is converted to interlaced scanning that TVs can display.

Like the laser disc, DVD can carry all manner of supplemental information about the program, and it is capable of various special effects including freeze-frame, slow-motion, random access to indexed "chapters," and more. It shares with laser disc the new *Dolby* AC-3 Digital Surround, by which the soundtrack is output as six discrete channels, including a subwoofer channel. For less elaborate home-theater systems, DVD also carries analog *Dolby* Pro Logic Surround—whose four channels are matrixed on the digital stereo soundtrack.

Where DVD leaves laser-disc audio in the dust is the number of soundtracks it can hold—up to eight in different languages, and as many subtitles for translation. In practice, though, discs now sold in the U.S. usually carry only English, French, and Spanish dialogue and subtitles. It can be different elsewhere in the world. (We'll explain why shortly.)

The new format is called digital "versatile" disc for good reason. Its current manifestation is DVD "video" for prerecorded movies. Eventually, there'll be DVD "audio," an improvement on CDs by virtue of higher-resolution sampling rates and discrete (rather than multiplexed) multichannel recording. Meanwhile, PCs with DVD-ROM (Read-Only Memory) already have arrived—the MPEG-compressed equivalent of today's CD-ROMs. Here's where DVD's roughly 5- to 18-gigabyte (GB) capacity can really be exploited. Recordable DVD is just emerging in the DVD-RAM (Random Access Memory) format, though storage is currently limited to 2.6 GB per disc side.

Generically, the DVD format can be single-sided or dual-sided—and dual-layered on either side. The latter feat is achieved by instructing the laser pickup (through on-the-disc coding) to shift its focus below the topmost layer of bits

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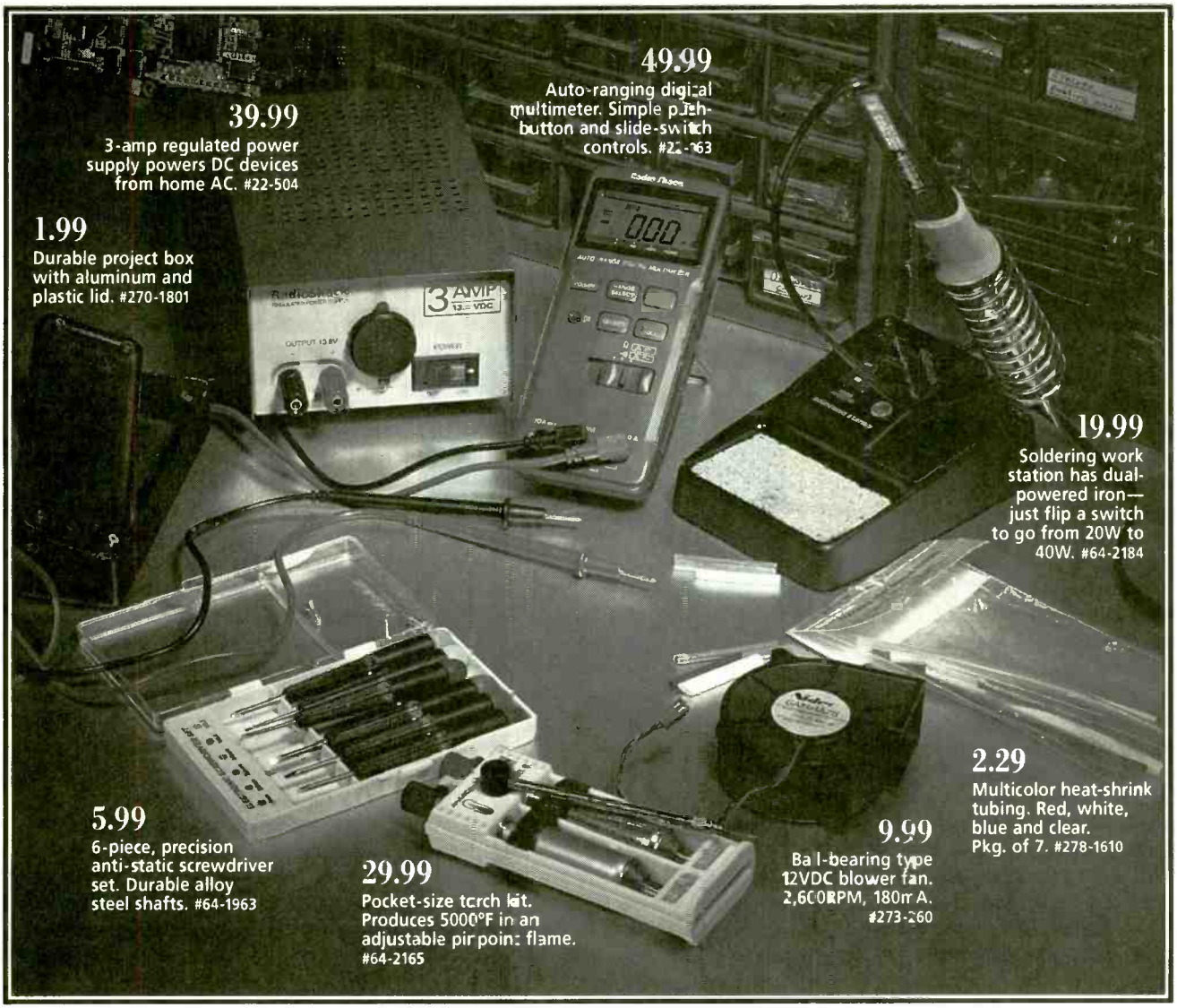

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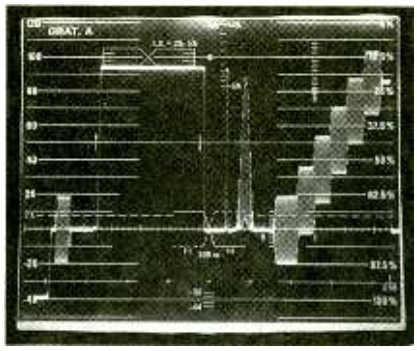
and bumps (with two-way mirror type reflectivity) to a subterranean level with sufficient reflectivity to bounce the ones-and-zeroes back.

At the time of this writing, there are dual-sided and dual-layered discs for movie DVDs, but no dual-sided dual-layered discs (*e.g.*, not both). There's little need for that. Most movies fit well within the 2-hours and 15-minutes capacity of a single DVD side. Meanwhile, most Hollywood studios are issuing their movies on a single DVD in both pan-and-scan (4:3 aspect ratio) and "original wide-screen" (read "letterboxed" of whatever ratio—16:9 or 1.85:1 or even wider *Panavision*) formats. They come either as dual-sided or single-side, dual-layer. If it's a dual-sided disc, you have to flip the disc manually because, at this time, there are no DVD machines that automatically reverse the optical pickup to play the flip side of the disc—an old feature in analog laser disc players.

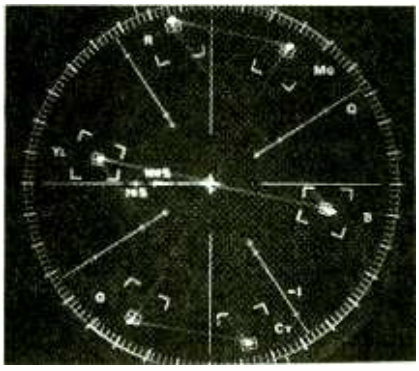
When buying a DVD player or discs, you ought to know that both hardware and software are regionally-coded for use together in different parts of the world. That means that a disc meant to be sold in one geographic region won't work on a player designated for use in another area. For example, the U.S. is Region 1, and players and discs sold here are clearly so marked. If you send friends in Ireland or Mexico a Region 1 DVD, it won't output any video (only audio) on their respective, Region 2 and 4 players. Ditto if you bring home some Japanese animation or Hong Kong martial-arts movies on those countries' DVDs—they won't compute on your U.S. Region 1 machine.

The reason for splitting the world into six regions is to protect the movie industry's distribution schedules. Frequently, a Hollywood film is released later elsewhere in the world than in the U.S.—by which time Americans can obtain a videotape (and now DVD) of the movie. By regionally-coding the DVDs, audiences elsewhere won't have access to the movie on video before it's shown in theaters in that region.

The reason the soundtrack is playable on any region's machines is because the DVD format was designed to be backward-compatible with music CDs. Every DVD player is also a full-featured CD player—older CDs have to be playable on the same machine as forthcoming DVD audio discs.



The SIN² Pulse and Bar measurements indicate that there's no significant over- or under-shoot in the way the player handles the relative timing of chrominance and luminance components.



When it comes to Color Purity, Samsung's DVD905 *is perfect—every color's dead-on; i.e., there's no shift in phase, no under- or over-saturation.*

EVALUATION

As in our earlier report on *Panasonic*'s DVD player (November 1997), we used the *Sony* DVD test disc (HLX-4001) for this report. When a more challenging industry-standard test disc becomes available from an independent producer, we'll try it. Meanwhile, we've added one measurement from the "DVD Spectacular" disc (DV7001) by *Delos International.*

A particular track on the disc tests for any video-signal leakage into the DVD's audio soundtracks. At just 210 microvolts, we found that the video leakage from *Samsung*'s player had no noticeable effect. As in the past, the lab used the *CBS* CD-1 test disc, which has been the industry standard for testing CD players for many years, to measure the DVD player's digital-audio functions.

Having said that, let's look at the numbers generated by the *Advanced Product Evaluation Laboratory*, our independent testing facility in Bethel, CT that performs the measurements. The player's frequency-response output is virtually ruler-flat, maintaining sharpness to the extent of the DVD format's inherent resolution. Meanwhile, as you'll see in the accompanying charts and graphs, the SIN² pulse and bar measurements indicate there's no significant overshoot or undershoot in the way the player handles the relative timing of chrominance and luminance components. When it comes to color purity, the *Samsung DVD905* is perfect. As the vectorscope shows, every color's dead-on: There's no shift in phase, and no under- or over-saturation.

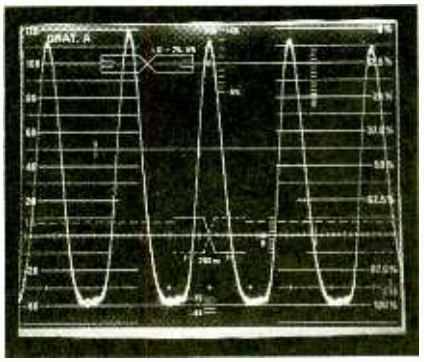
The unit's video signal-to-noise ratio is very good, as measured through the composite-video output jack. You won't find any analog video source with a measurement this good. It might have scored even better had we taken the reading through the player's S-video or component RGB video outputs. Each type sends luminance information to the monitor separately from the color, while component video refines the process by further splitting the red, green, and blue signals. At this time, few mainstream home TVs have component input jacks, and even for those that do, the industry has yet to settle on standardized connectors. S-video is more commonplace, although still not universal. Composite video remains the common denominator for all TV hookups.

Regarding stairstep linearity, this test measures how well the player resolves different shades of gray. The results are acceptable and might have been better if the measurements at each stage were either closer to 0%, or more consistent in their degree of deviation.

In most aspects of digital-audio performance, measurements for the DVD905 were very good to excellent. The results represent performance for the two-channel PCM linear stereo tracks, not the six-channel Dolby Digital Surround or four-channel analog Dolby Surround.

The frequency response showed no audible deviation through the audible range from 20 Hz to 20 kHz—off just insignificant fractions at the extremes. Total Harmonic Distortion (THD) was likewise negligible. As for the S/N ratio, dynamic range, and channel separation, they're acceptable, but not the best that the format can support. As stated earlier, the DVD905 has no significant leakage of video that could adversely impact the audio signal.

It's possible that audio performance



The DVD905's Stairstep Linearity (a measurement of how well the player resolves different shades of gray) is acceptable.

would be better in the *Dolby* AC-3 Digital Surround mode, because each of the multiple channels carries a discrete digital signal that's isolated from the other, compared with the multiplexed left and right channels for analog stereo. The DVD905 has a built-in decoder for *Dolby* digital, so you can send the six output channels directly to a six-channel amplifier, and then onto five speakers and a subwoofer. If your home-theater setup is limited to a four-channel *Dolby* Pro Logic amp or to conventional stereo, you'd simply connect the designated leads for these from the DVD player.

TABLE
TEST RESULTS—SAMSUNG DVD905

All electrical measurements were performed by the *Advanced Product Evaluation Laboratory* using the *Sony* HLX-4001 test disc for DVD-video performance, the *CBS* CD-1 standard test disc for digital-audio performance, and the *Delos* DV7001 test disc for video-noise leakage to the audio signal.

Brand: Samsung
Model: DVD905 Digital Versatile Disc Player
Price: $749

DIGITAL VIDEO MEASUREMENTS
Frequency Response
(Measured with a multiburst test signal)

Frequency (MHz)	Video Output (dB)
0.50	0.00
1.00	0.00
2.00	−0.06
3.00	0.00
3.58	0.00
4.20	−0.06

SIN^2 (squared sine-wave) Pulse & Bar
(Used to observe relative chrominance to luminance delay and gain

Color Purity
(Signal displayed on vectorscope as phase-angle relative to color reference-burst

Video Signal-to-Noise Ratio
(Luminance, 10 kHz to 4.2 MHz)

Level (IRE)	Video Output (dB)
100	51.0

Stairstep Linearity
(Measures how well the player resolves different shades of gray)

Step	Video Output (%)
1	−5
2	0
3	−4
4	−4
5	−6

DIGITAL AUDIO MEASUREMENTS
Reference Level (0 dB, 1 kHz):
2.14 volts
Frequency Response:
20 Hz to 20 kHz, +0.1 to −0.2 dB
Signal-to-Noise Ratio ("A" Weighted):
94.5 dB
Dynamic Range ("A" Weighted):
88.8 dB
Total Harmonic Distortion
Ref. 0 dB @ 1 kHz, including noise:
0.009%
Channel Separation
Ref. 0 dB @ 1 kHz
83.9 dB (left channel)79.0 dB (right channel)

ADDITIONAL DATA
Random Access Time:
0.75 seconds
Scan Time:
2.8 seconds
Power Requirements:
20 watts
Dimensions (H × W × D, inches):
$4\text{-}3/4 \times 16\text{-}1/2 \times 13\text{-}1/2$
Weight:
$10\text{-}1/4$ pounds

FEATURES
- DVD video player (MPEG-2)
- Video CD player (MPEG-1)
- Music CD player
- Dolby AC-3 Digital Surround decoder (6 channels)
- Dolby Pro Logic Surround mix-down (4 channels)
- PCM linear stereo mix-down (2 channels)
- Composite (2), RGB, and S-video outputs
- Audio phono-jack outputs (8 total)
- Optical digital audio-output
- Direct digital audio-out (bypasses internal AC-3 decoder)
- Front panel variable-brightness display
- Illuminated multifunction universal remote control

CONCLUSION

In hands-on evaluation of the DVD905 with a selection of DVD movies, the player performed as promised. Its illuminated remote control is a thoughtful touch, as people usually watch TV in subdued lighting. And as in many recent *Samsung* products, the onscreen menus are easy to understand and navigate.

DVD is still a relatively new format, though, with features that continue to evolve. So, if you're thinking of buying a player, it's best to focus on electrical performance compared with convenience features. Performance is important because your financial investment actually goes beyond the hardware. Until a large DVD rental market develops—it hasn't yet, though it's in the cards—you'll be buying DVDs at $20 to $30 each. Rentals notwithstanding, you'll probably buy some DVDs anyway as keepers for your home library—those movies which you've always admired and know you'll play time and time again.

With optical discs, your investment won't lose resolution over time, as is the case with magnetic tape. Consequently, buy the best-performing DVD player you can afford to get the most from your DVD collection.

For more information on the *Samsung DVD905*, contact *Samsung Electronics America*, 105 Challenger Road, Ridgefield Park, NJ 07660; Tel. 201-229-4000; *Web: www.sosimple.com*, or circle 100 on free information card. ■

"If there is a Microsoft scandal, will it be known as 'Gatesgate'?"

SCANNER SCENE

Great Diversion With Triple Conversion!

MARC SAXON

One of the ticklish problems that traditionally disturbs scanners is interference and image frequencies. *RadioShack's PRO-2041* desktop (and mobile) scanner fights back with its interference-reducing triple-conversion circuitry. Not that triple-conversion scanners have never before been seen, but it's a feature normally reserved for those priced at the high end. The *PRO-2041* signs in at a shade less than $300, which we'd say is a good price for such a unit.

The *PRO-2041* has 400 memory slots arranged in 10 banks. There are 10 priority channels, plus 10 additional monitor memory channels that allow you to temporarily store frequencies discovered in searches before you transfer them into the permanent memory. The Auto-Store feature allows you to store new frequencies easily and rapidly, even preventing the duplication of stored frequencies. Stored frequencies may be automatically arranged in consecutive order to facilitate scanning at the maximum speed of 25 channels/sec. It searches at 50 steps/sec.

There are 17 preset ranges for searching, or you can set up your own ranges anywhere within the *PRO-2041*'s generous tuning range. This range is 29–54, 108–174, 380–512, and 806–960 MHz (minus the cellular bands, which cannot be restored). Note that this includes the VHF aeronautical band.

This unit includes a power supply for AC operation, but you can also use it with an optional DC vehicle power cord. The *PRO-2041* is the closest to *RadioShack*'s top-of-the line desktop scanner, and yet it costs $100 less. That alone makes the scanner worthy of consideration by serious monitors with a keen eye towards a good deal.

CHANGES IN FREQUENCIES

The EPA's *National Vehicle and Fuel Emissions Lab* in Ann Arbor, MI, is changing frequencies. The frequency of 408.00 MHz will be replaced by 164.45, 173.375, and 173.9125 MHz.

The triple-conversion circuitry of RadioShack's PRO-2041 *desktop (and mobile) scanner fights interference—a feature normally reserved for high-priced units.*

New York City Police Department's highly complex communications system was recently reshuffled, and there's an entirely new frequency plan. You can check it out on your computer at: *www.radiotech.com/nypd.htm*. Some of the many notable new features include several local Staten Island special channels being simulcast with their citywide counterpart channels, including traffic and the *S*pecial *O*perations *D*etachment (SOD).

In Mansfield, MA, police set up on a new frequency of 159.675 MHz. Joining them there are several other MA towns like Oxford, Holden, Dartmouth, and Bellingham.

An Internet user reminds monitors that even though it didn't receive much hobby publicity, a few years ago the VHF aeronautical band was expanded beyond 136 MHz and now extends to 137 MHz. There's air traffic control activity on these expanded frequencies; also (on certain frequencies) you can hear airline company communications, similar to what many have long enjoyed monitoring, between 128.825–136.525 MHz. Other expanded band channels designated exclusively for airline company air/ground use are spaced at 25-kHz intervals between 136.5–136.975 MHz (*i.e.*, 136.5, 136.525, 136.55, 136.575 MHz, *etc.*).

TRAIN SCANNERS

A reader in Kansas asks about the odd data signals he often monitors on 457.9375 MHz. We wondered too, but recently learned that this is a popular frequency used nationally by many freight railroads for so-called EOTMs (*E*nd-*O*f-*T*rain *M*arkers). Personnel in the engine dial up a certain code number on EOT control equipment. This number matches the code number of the EOT unit located at the rear end of the train and activates the device. This device then transmits certain digital data that can be viewed on a screen in the engine cab. Data sent might advise when the brakes release, show the brake pipe pressure, tell whether or not the end of the train is moving, *etc.* EOT safety equipment is required because modern freight trains no longer have red cabooses, wherein once rode an employee who provided this information. The general opinion is that hobbyists can't decode these digital data transmissions.

MILITARY MONITORING

Someone once observed, "Monitoring is where you find it, so don't be afraid to search." How true! A reader in the National Capital area decided to see if activity might be found in the seldom-reported federal band lying between the high-frequency edge of the 2-meter ham band (at 148 MHz) and the low-frequency edge of the commercial VHF band (at 150.80 MHz).

What a pleasant surprise when plenty of communications were found on 148.68, 148.93, 148.95, 148.98, 149.00, 149.05, 149.0875, 149.10, 149.15, 149.30, 149.35, 149.40, 149.53, 149.54, 149.65, 149.84, and 149.875 MHz. These signals were from Navy, Air

(Continued on page 30)

GIZMO

TUNE IN, LOG ON, AUDIO OUT

MD-X8 MINIDISC MINISYSTEM WITH INTERNET AUDIO CAPABILITY. From Sharp Electronics Corporation, Sharp Plaza, Mahwah, NJ 07430-2135; Tel: 800-GOSHARP; Web: www.sharp-usa.com. Prices: MD-X8, $799.95; AD-AJ1 Digital Sound Card, $299.95.

What do you do when you want to tune into a favorite talk show or listen to some music? Where do you go to preview the latest music releases? Until quite recently, the answers would have been pretty straightforward. You'd have turned on your radio or CD player and taken a trip to your local record store. You probably wouldn't have thought to turn on your computer—even if it's equipped with a CD-ROM drive and satellite speakers—for the sole purpose of listening to music.

These days, however, there is literally a whole world of music, as well as other audio programming, available at your fingertips—if those fingertips happen to be resting on your PC's keyboard and that PC is connected to the Internet. On-line music marts offer audio snippets of new releases, tempting you to buy the latest CDs without leaving your desk. Don't want to spring for the whole disc? Some web sites let you purchase single tracks for as little as 99 cents each. You can listen to FM, AM, and shortwave radio stations from around the globe, and even tune in to scanner frequencies on-line. Want to keep up with your alma mater's sports teams? Tune into college radio stations for live, real-time broadcasts of games. Sample the music of struggling unknowns, or visit the web sites of big-name bands. For a more literary experience, you might want to download books-on-tape.

For more details on music and other audio delights available on the Internet, see the accompanying article, "Netmusic." Here, we'll show you one convenient way to save the music you download and to play it back anywhere, anytime, with CD-like quality.

Sharp's MD-X8 Computer Network MiniDisc (MD) Mini-System is not your typical bookshelf stereo. The MD-X8 is designed to allow direct recording of Internet audio to MiniDisc, using an optional digital sound card and connecting cable to link the stereo to a laptop or desktop PC equipped with a PCMCIA Type II slot.

Before we probe its Internet capabilities, however, let's take a look at how the MD-X8 performs as a stereo. It's a good-looking, compact unit, with an odd mix of futuristic and old-fashioned styling. The MD player/recorder, tuner, and three-drawer CD player, and its 80-watt (total power) amp are housed in a single $9^{1}/_{2}$-× $11^{-7}/_{16}$-× $12^{1}/_{2}$-inch unit finished in two contemporary shades of steel gray. Two speakers ($7^{-13}/_{16} \times 11^{3}/_{4} \times 11^{-1}/_{16}$ inches) feature silvery-gray grilles on wood-grain boxes that look somewhat anachronistic against all that metallic gray. The other throwback to yesterday's components is the large number of controls and inputs found on the front panel—a distinct contrast to today's trend toward streamlining—several of which are used for computer connections.

The front panel is divided into two distinct sections. The larger one (spanning about 7½ inches across) is on the left side and is finished in light gray. To the right is a 2-inch wide, darker-gray portion. The left side is home to the MD player/recorder, tuner, and CD player. The front-loading MiniDisc compartment occupies the top spot, surrounded, clockwise from the right, by the COMPUTER NETWORK, MD EJECT, MD RECORD, CD EDIT, CD TRACK SELECT, MD-MD EDIT and POWER buttons.

The CD player is found on the bottom portion. Three separate drawers are stacked vertically, each with an OPEN/CLOSE button to its right. Above the CD trays are controls for the tuner. Below them are a row of connectors: headphone jack, auxiliary input (and aux input level control), mic jack (and volume control), and PC and keyboard jacks.

The darker gray (right) side of the main unit features a vertical array of controls. From top to bottom, there are MD PLAY/PAUSE and MD STOP buttons; the VOLUME control; 3D SURROUND, X-BASS, and EQUALIZER buttons; a "multi control," whose up, down, left, and right arrows are used for a variety of functions; an ENTER button; three CD PLAY buttons (one for each tray); a SINGLE

PLAY/PAUSE button that will play all three discs in a row; and a STOP button.

The front panel's most prominent feature is an LCD that measures a whopping 5½ × 2 inches and is backlighted with a lemon-yellow glow. It's easy to read the display from across a room, even without switching to quadruple-size characters, which is an option. In standard character mode, there are four lines showing disc name and track titles; in extra-large mode, only the disc name is displayed. "Big-screen" graphics indicate changes in the pseudo-surround settings and illustrate discs being loaded. The LCD also displays menus for the unit's MD-editing and timer functions.

Physical set up for strictly audio use is a simple matter of connecting the two speakers and AM and FM antennas to the main unit's rear panel. Other rear-panel connections include analog input and output jacks, optical and coaxial digital inputs, and phono input jacks, allowing you to hook up video gear and/or other audio components. The front-panel PC and keyboard inputs simplify computer connections.

Once the keyboard is plugged into the front-panel terminal, it can be used just as if it was connected to a PC—almost. First, not all the keys will be functional. You can use all the number and letter keys, as well as the space bar and the enter, shift, and delete keys. Most, but not all, of the punctuation signs are available for use. Only the left and right arrows will work.

Both the MD and CD players offer a host of playback features, including audible fast forward and reverse, direct track selections, and an automatic program search system that finds the beginning of each track. Automatic programmable music selection (APMS) is used to select specific tracks to be played on a MiniDisc or compact disc. For CDs, APMS selections can be made using either the remote control or the main unit; only the remote control can be used for MD APMS selections. Repeat and random modes can be used in conjunction with APMS.

When it comes to recording, the MiniDisc format is light-years ahead of cassettes, and not just in sound quality. Each digital disc contains a table of contents (TOC) of information on track numbers and recording areas. The player/recorder is able to read that information, and act upon it, for instance, to automatically locate the point at which a recording can begin and to keep track of (and inform you of) the remaining recordable time before you begin recording. Track numbers are automatically inserted when recording on a MiniDisc. With digital recordings (from CD, DAT, or MD), track numbers correspond to those on the original recording. With analog sources, a pause of more than 1.5 seconds is seen as a space between tracks, and numbers are assigned accordingly.

The on-screen Sharp MD Controller.

If you're sitting at the computer within arm's reach of the MD-X8, and you've got the remote control on hand, most of those features are redundant. But when it comes to recording from the Internet, and editing/titling Internet or any other recordings, this is the way to go. If you're familiar with working in the Windows environment, you'll have no trouble erasing, moving, or dividing tracks; or creating MD labels.

When you use the MD-X8's MD portion to record programming from the built-in radio, the entire recording is considered a single track. It is possible, however, to divide the recording into two tracks, perhaps to separate two different performers in a live concert, or back-to-back talk shows. When recording talk shows, you can double the disc's recording time by selecting monaural long-play mode.

One of the most convenient features about the MD-X8—one that's lacking in most modern audio systems—is its built-in timer. Particularly in light of the unit's MD recording capability, whether the source be standard radio or Internet broadcasts, including a timer allows you to timeshift recordings. For instance, there's a show called *Hour of the Wolf* that airs on a local non-commercial radio station at the ungodly hour of 5:00 on Saturday morning. We enjoy the sci-fi short stories that are read, as well as the musical selections played. With the MD-X8 we can set the timer to record the show, and listen to it on a portable MD player at our leisure (on the train, in the car, or while walking). Time-shifting is similar to setting a VCR. Using on-screen menus, you select timer record, enter the start and stop times, the source, (and for radio recordings) the station preset number. By setting the MD-X8 to mono long-play mode, we were also able to tape "As I Please," which comes on at 6 AM. (In LP mode, we could record a maximum of 148 minutes.)

Unfortunately, the timer can be programmed to record only one event. Although the MD-X8 knows what date it is, the timer doesn't understand dates. You have to set the timer and put the unit in timer standby—which, like in early VCRs, puts the entire stereo temporarily out of service.

When recording from CD to MD, the easiest method is called One-Touch Editing. Load the CD, insert a MiniDisc, and press the CD-TO-MD button, and the disc will be copied, track by track. For custom recordings, the MD-X8 allows you to record single tracks, a series of tracks that appear in succession on the CD, or a selection of tracks that have been programmed using APMS. You can enter track titles, artist name, and the like with either the on-screen keyboard or a PC keyboard.

MD-to-MD recording can be done by connecting a portable MD player to the MD-X8. To make a straight copy, press the MD-TO-MD EDIT button, and the audible and text information will both be copied. The copy-protection scheme known as SCMS will not allow you to copy from MD to MD if the original MD was *digitally* copied from a CD, however.

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Many of the MD-X8's features are commonly found on bookshelf MiniDisc systems, either because they're standard to the MD format, or because their inclusion simply makes sense. SRS 3D sound, a pre-programmed equalizer with six modes (flat, heavy-1, heavy-2, vocal, soft-1, and soft-2), and X-Bass low-frequency enhancer are all standard fare on good bookshelf systems. As we go to press, however, the MD-X8 is the only MD recording system to offer the PC connectivity that makes recording audio from the Internet a snap.

Such recordings require the purchase of the optional AD-AJ1 digital PCMCIA (PC-Card) sound card and cable. Also required is a computer running Windows 95, with a PC-Card Type II slot, a Pentium processor running at 75 MHz or better, at least 12 megabytes of memory, a hard disk with 2 megabytes or more, and a 1.44-MB floppy drive.

The sound card drivers and the MD controller are found on the included diskettes. The software must be installed before the hardware is connected. The sound card is inserted into the PCMCIA slot, the included cable connected to the card's 15-pin terminal, and then the cable's other end is plugged into the MD-X8's PC CNT input.

Because the sound card is Windows 95 plug-and-play compatible, installation went smoothly on our Compaq laptop. Once the drivers had been installed and the card inserted, the computer was able to download music from the Internet. The MD-X8 can record anything you can hear with your computer, including music stored in WAV or MIDI files, streamed audio from a RealPlayer, MPEG-2 and -3 encoded recordings, audio from a PC game or from a CD played in your CD-ROM drive, and input from a computer microphone. The soundcard converts the audio into a SPDIF digital signal that can be recorded on the Minidisc.

The type of file is selected from the on-screen Multimedia Properties menu. Playback is controlled with an on-screen Media Player, which features controls similar to those found on CD or MD player. Other options and settings are accessed via pull-down menus from the Media Player's tool bar. For example, you would select "open" from the file menu to open a file, and then use the play button to begin playback.

Of course, you're going to need some files to open before you can start playing them. Where can you find them? Well, you can go out to a computer or musical instrument store and buy MIDI files on disk. You can also find floppies and CD-ROMs that have MIDI data on them packaged as supplements in computer magazines. But by far the greatest variety and selection can be found on the Internet. The next article in this issue of "Gizmo" tells you what's available, where it can be found, and how to get it.

Once you've got it, what can you do with it? Well, with the MD-X8, you can record it to MiniDisc to enjoy at home or on the road (if you also have a portable MD player). The AD-AJ1 software serves a second purpose: It turns your PC into a controller for the MD-X8. The on-screen MD Controller application can be used to turn on the MD-X8, activate all MD playback functions, adjust the volume and recording levels, display the disc and track names and playing/recording time, and control recording and editing functions.

The on-screen MD Controller has a large display that indicates disc and track names, track numbers, and playing/recording time. It offers a mixer, volume control and level meter, STOP, PLAY/PAUSE, FF/REV, REC, and APSS (Auto Program Search System) controls; and a RECORDING MODE button, for selecting stereo or mono LP mode. Clicking on the SYNCHRO REC button puts the MD in the recording standby mode, so that it will immediately start recording when music begins playing. Pressing the AUTO MARK button instructs the MD-X8 to record as a single track all of the songs played by the computer. The TOC EDIT button is used when you want to write to the MDs TOC, and MD LABEL is used to create labels for the MD currently in the player.

Pressing the on-screen ACCESS button puts the MD-X8 into its *Computer Network* mode. Recording from the PC is as easy as putting the MD-X8 into synchronized record mode and playing the music you want to record.

Once a recording is made, the MD Controller simplifies editing functions, too. The PC keyboard (plugged into the computer, not the minisystem) can be used to enter disc and track names. The printer can then be used to output a hard copy of the MD label you've created, which is a definite improvement over trying to hand-print the names of all the songs that fit on an MD on a label small enough to be affixed to the disc!

The MD-X8 is a niche product that falls within a market niche. MiniDisc, while continually making inroads, has not yet gained mainstream status. It has found its greatest acceptance among young, on-the-go consumers. Internet audio has a long way to go before it even becomes noticed by the average consumer—so far, its biggest fans are computer-savvy young men. We suspect that there are a lot of college kids out there who would love to get their hands on the MD-X8 with its digital sound card accessory kit. The question is, can they afford it? Luckily for Sharp, the mini-system can stand well on its own, even without the Internet option, so its appeal should be widespread.

Netmusic

Tune into a world of audio programming—via the Internet!

We are firm believers in the individual's right to freedom of choice—but are well aware that most of the things we do in our lives are prescribed, or proscribed, by various factors. The society we live in, our socio-economic position, our level of education, our religious affiliation, our government,

and our families all strongly influence the choices we make. We're well aware, if not always on a conscious level, of the role those institutions play in shaping the way we decide to live.

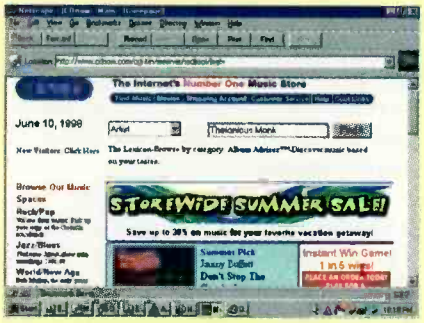
But there's another strongly influential factor in all of our lives: the technologies that are available to us. Of course, as technology opens new doors, old ones are slammed shut. Just try to get to the store by horse-and-buggy today. Unless you're living in Amish country, cars have effectively erased that option. And how about that box of $5^1/_4$-inch diskettes you have lying around? You won't find a computer that's compatible, except at flea markets or garage sales.

If we had to name any one technology that is most dramatically altering the way people work, play, and interact today, we'd have to say it's the Internet. Its impact has yet to be fully determined, but even in its formative years, its scope is remarkable and growing by the minute. Need to research a term paper, article, or a company that will be interviewing you for a job? Log on, search, and you'll be inundated with information. Want to network with working mothers, shortwave enthusiasts, stamp collectors, quilters? There's a chat group out there waiting with open arms. Need to make airline reservations, check the weather in Des Moines, find the lyrics to an old Steel Eye Span song, play a game of Scrabble, locate a copy of a video, an out-of-print book, or the latest CD? Try the Web.

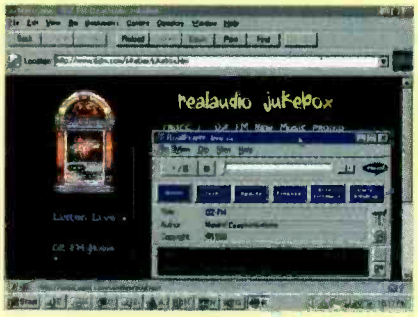
One thing the Internet seems destined to change is the way we produce, distribute, buy, and listen to music.

Taking advantage of today's multimedia home PCs, webmasters have been creating sites enhanced with graphics and sound. It stands to reason that a mainstream on-line music store would offer audible samples of the discs it's trying to sell. It's also not surprising that today's young, computer-savvy music fans would try to see just what they could get away with in terms of copying and distributing bootleg audio over the Net.

The world of Internet audio includes both those extremes, and everything in between. Anyone can log onto



Many Internt music sites are for-profit on-line record stores, such as CDNow.



The RealPlayer *can be used to stream audio from a variety of sites, including* Oz FM *(www.ozfm.com).*

cdnow.com and order CDs. If you want to penetrate the legally questionable world of bootleg music swapping, however, it will take some time and effort to locate the sites and to be admitted. We won't delve into that murky arena, but will focus on the above-board, legitimate sites that are offering a huge variety of music, talk, sports, and other programming over the Internet—usually with the intent of turning a profit.

In 1997, more than 30 million Americans used the Internet, either at home (about 60%) or at work. According to a WWW User Server survey from the *Graphic, Visualization, and Usage Center*, the average Internet user is 35.2 years old with a mean average household income of $58,000. More than half of those surveyed have college or advanced degrees, 33.41% are women and 68.7% are men. Another poll, conducted by *Dataquest*, found that the most popular uses of the Internet were research/education (42.4%) and surfing (30.5%)—and that only 0.5% of respondents spend time using real-time Internet audio.

That figure is bound to rise sharply over the next few years. Consider a few more stats: More than 26,000 Web sites already use audio; *Yahoo!* adds 31 new music sites every day; 34% of the sites visited by people surfing from their homes are music related; David Bowie's *Telling Lies* single was downloaded 450,000 times in one week, by people in 87 different countries; and more than 15% of U.S. broadcast radio stations have an on-line presence. One artist and composer, Todd Rundgren (*www.tr-i.com*) is trying to sell his forthcoming album in a unique way and solely over the Internet.

Want to get in on the Internet audio action? It's not difficult, and—unlike getting in on the ground floor with other audio formats—it probably won't cost you a thing.

There's a good chance you already have just about everything you need: a multimedia computer, with sound card, speakers or headphones, and a modem with a minimum speed of 28.8 kbs; an Internet connection; and a Web browser. The one remaining "component" is an audio player that—get this—is completely free of charge. The audio player is actually a software utility. It can be contained in a Web browser or it can be a stand-alone application.

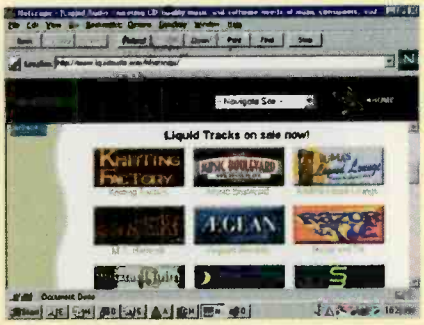
Several services have players available to be downloaded and installed, which is a mixed blessing. There's a lot of choice, but it can be a daunting task to learn the lingo and determine which is best for your listening style and tastes. But since money, for once, is no object, you can try out each one and use the one you like best, or keep several installed for when you might need them.

All of the audio available on the Net is, of course, in the form of digital data. The difference isn't in the data *per se*, but in the encoding and delivery methods.

The two most popular types of Internet audio delivery are via *streaming* and in file formats. Streaming audio is transmitted in close to real time. Packets of compressed audio data are sent to your computer, pass through a buffer (to minimize any interruptions caused by Net conges-

WHERE TO FIND INTERNET AUDIO

www.a2bmusic.com	AT&T's website features the company's own technology for downloading audio files.
www.audible.com	The site offers downloadable audio books, courses, and conferences. The company (Audio Web) also sells a device that records the programming from your hard drive so you can listen to it in your car.
www.audionet.com	This Internet radio network features music, audio books, sports talk, and the BBC.
www.cdnow.com	Four years ago, twin brothers just out of college started this virtual music store that's now making millions each year!
www.davidbowie.com	David Bowie is one of many popular musicians with his own web site. (Try www."yourfavoriteartist".com and maybe you'll get lucky!)
www.hardradio.com	The world's #3 audio site and largest online music station, this site offers 24-hour, commercial-free music sample, news, reviews, concerts, and online chats.
www.iuma.com (or try http://207.126.103.17)	The Internet Underground Musicians Archive site offers works by independent artists.
www.liquidaudio.com	Here's where to get the Web's most popular file-format audio player.
www.macromedia.com	Home of Shockwave, an audio streaming system that integrates with Macromedia's Director multimedia authoring program.
www.musicblvd.com	This online music emporium is run by N2K (www.n2k.com), a company that would like to see electronic delivery supplant physical media. Music Boulevard offers more than 200,000 titles.
www.musicmaker.com	Go to this site to create your own custom CDs, with prices beginning at $9.95 plus shipping costs.
www.real.com	Start here and download your RealPlayer 5.0!
www.rocktropolis.com	Here's where to find rock-n-roll.
www.thedj.com	Tune into any of this sites 60+ channels of non-stop music. If you hear something you like, link to CDNow to buy it!
www.towerrecords.com	The music retailer giant has a commanding online presence as well.
www.unc.edu	This classical music site offers many links to other sites.



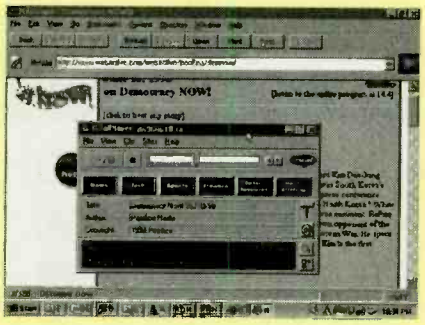
The tracks and discs on sale at the Liquid Audio *site can be downloaded directly to your hard drive.*

The LiquidMusicPlayerCD *streams music, allowing you to preview the music that's for sale.*

tion), and are played back. It's somewhat like listening to a radio or CD: Turn it on and music plays. When Internet audio is sent in a file format, such as .au, .wav, or .aiff, the data is reduced to allow quick transmission, the files are downloaded completely, and then they can be played back at any time. The fidelity is generally better than that of streamed audio, but downloading files doesn't offer the immediate gratification of real-time listening. It's also possible to download MIDI files, and there are some CD-quality digital audio files available to be downloaded to your hard drive—or recorded to cassette, CD-R, or MiniDisc.

The leading streamed audio format is *RealNetwork's RealAudio* (*www.realaudio.com*). An estimated 30 million *RealAudio* players have been installed, and the *RealAudio* Web site is among the top 10 most-visited sites. There are more than 450,000 hours of live audio content available over the Net every week. All different sorts of Web sites incorporate *RealAudio* files. You can find music to suit just about any taste, as well as sporting events, and radio broadcasts from around the world, static-free, and just plain free.

The *RealAudio* player is available at *www.realaudio.com*; the latest version is *RealPlayer 5.0*. Downloading and installing it is a simple matter of following on-screen instructions. After the file is downloaded, you close all open browser windows, launch the installation file, relaunch the browser, and you'll be ready to start listening (or, to be more accurate, to start looking for something to listen to—which we'll get to soon). The RealPlayer itself offers controls similar to those found on a CD player, with the addition of a viewing screen that can display



You can find all sorts of interesting radio programs on the Net, including Pacific Radio's "Democracy Now!".

promotional material, album covers, lyrics, and the like.

The technology behind the *RealAudio* player is scalable across various bandwidths. What that means to you is that, regardless of your Web connection (14.4-kbs modem or T1), you can receive audio programming in real time. That's not to say that you'll be hearing the same thing over a 14.4-kbs modem that you will over an ISDN or better connection. The audio quality is directly proportional to the speed of your connection. With our 28.8-kbs modem, the sound was decent. When the music began skipping due to overcrowding on the Net (actually, pausing to wait for the buffer to fill), we were advised to switch to a 14.4-kbs speed, and the drop in sonic quality was drastic. We wouldn't want to spend much time listening to music with such low resolution. For sampling new bands, however, or listening to international radio broadcasts, *RealAudio* was fine, even at the lower data rate.

Liquid Audio (*www.liquidaudio.com*) is to the distribution of file-format Internet audio what *RealAudio* is to streaming—the premiere Web site. In preparing music to be downloaded, *Liquid Audio* employs a suite of technologies, beginning with music mastering and software encoding, adding Dolby Digital noise reduction technology and watermarking tools to thwart would-be pirates and encryption technology. There is also *Liquid MusicServer* software, which delivers the audio files to your computers, and a Web-music player called the *Liquid MusicPlayer CD*. It resembles a CD player in that it provides the familiar PLAY, STOP, PAUSE, FF, and REV buttons. And, like the RealPlayer, it also offers a viewing window, with a row of buttons beside it, from which you can choose to see displayed such options as lyrics, cover art, track listings, and promotional materials. Finally, the *Liquid MusicPlayer CD* has buying buttons—click on one to purchase the track, and on the other to buy the entire CD.

Liquid Audio's intent is to serve as a link between the consumer and the world of commercial music production. Right now, the commercial end consists primarily of small, independent labels, but *Liquid Audio* is vigorously pursuing partnerships and alliances not only with more mainstream record labels and artists, but also with powerhouse *Microsoft*, *RealNetworks*, and the *American Society of Composers, Authors, and Publishers* (*ASCAP*). *Liquid Audio* recently announced plans to integrate support for *Microsoft NetShow 3.0* and to support the *Microsoft Advanced Streaming Format*, or ASF, which will allow music encoded for the *Liquid Music System* to be streamed by any ASF-compatible system. *Liquid Audio* also plans to make available a new *Liquid Music Player* media datatype for *RealNetworks* upcoming *RealPlayer G2*. So, in reality, it's not a matter of choosing between file format and streaming audio—the lines between the two are fuzzy, at best.

Liquid Audio uses streaming audio to allow you to preview music that you might want to buy. For instance, we logged onto *liquidaudio.com*, clicked on What's New, and learned of a CD set called *Jimi Hendrix: The BBC Sessions*, which consists of digitally remastered TV and radio performances recorded between 1967 and 1969 for the BBC by the *Jimi Hendrix Experience*. We were able to preview a few of the songs, view photographs and video (played at a very slow frame rate) of Hendrix and his band, and read the lyrics as we listened.

There's a plethora of music and other audio program out there, but finding what you want to hear can be a bit of a struggle. We've provided a list of several popular Internet audio sites in the box on page 25, but it's by no means all-inclusive.

We decided to dive right in and start surfing. On our first expedition, we located a great site that provided real-time audio—music, news, you name it—from radio stations around the world—Great Britain, India, Italy, France, and about a dozen more. Any recent immigrant would enjoy listening to the sounds of home while working or playing on a computer. And the site provides a convenient way to hear news from other countries, something that is sadly lacking on most American TV and radio news programs. Unfortunately, at that point we were just playing around; we did not jot down the URL, and we have not been able to locate the site again!

In our attempts to do so, however, we did come up with another good one: a shortwave radio page on the Southwest Missouri State University site (*www.smsu.edu.contrib/library/resources/swave.html*). That one offered links to shortwave radio stations just about everywhere. We tuned into the BBC's *Science in Action* program, and heard stories about "gene detectives" who were tracing the migrations of early humans, a telescope powerful enough to see men walk on the moon, and "identity-challenged neutrinos."

It's both fun and frustrating to search out Internet audio sites. We experienced frequent problems—everything from a site not recognizing that we had downloaded the latest version of the *RealAudio* player to audio dropouts caused by Net congestion. We got "object not found" and "This server has reached its capacity for the requested URL" messages. But we kept on going and found some good stuff for our efforts.

Will the Internet supersede other ways of buying and listening to music? Not anytime soon, as far as we're concerned. There's been a lot of talk about convergence—the merging of home computers with home entertainment—but so far the PC seems to be staying put in the study, the TV and stereo in the family room. Will there come a day when everyone has an Internet connection in every room of the house?

When wireless, portable PCs become small and cheap enough to compete for listeners with the Walkman and the car stereo? Perhaps. But for now we're just glad to find a new place to search for interesting radio broadcasts, hear new bands, and shop for CDs without dragging a three-year-old through Tower Records.

Outdoor Listening

OPTIMUS PRO-LS3 INDOOR/OUTDOOR SPEAKER SYSTEM (Cat.No. 40-4079). From RadioShack, A Division of Tandy Corporation, 700 One Tandy Center, Fort Worth, TX 76102; Tel: 800-THE-SHACK. Price: $200/pair.

We love to spend time outdoors in our yard in the spring, summer, and fall, puttering around the garden, reading a book, or just hanging around. The sounds of the wind rustling through the maples, birds calling, squirrels chattering—it's peaceful and relaxing.

Who are we kidding? Here on Long Island, whispering winds and singing birds get a lot of competition. There are lawn mowers and leaf blowers; airplanes, auto traffic, and the Long Island Railroad rumbling by; kids fighting or playing, but shrieking in any case; and their parents yelling at them to be quiet.

Then, just when we were about to retreat indoors, close the windows, and turn on the air conditioner to avoid hearing a simultaneous medley of that inescapable song from *Titanic*, something unintelligible from Busta Rhymes, and "Don't Sleep in the Subway," *the Optimus PRO-LS3 Indoor/Outdoor Speakers* arrived from *RadioShack*. We decided to stand our ground, and see if they could help us reclaim our outdoor aural environment.

The PRO-LS3 speakers have a power-handling capability of 75 watts rms and are said to be able to handle peaks of 150 watts. Each speaker's 11-× 7-× 6-inch cabinet houses a 5-inch polypropylene woofer and a $^1/_2$-inch ferrofluid-cooled tweeter. Designed for indoor or sheltered outdoor use, the cabinets are weather resistant to protect them from the elements, but they're not waterproof. When used outdoors, they should be placed in a protected spot.

Set up can be a breeze or a real headache, depending on where your source is located. There's nothing tricky about the supplied mounting brackets, and hanging the speakers is a straightforward affair. Running the wires can be difficult, especially if the source equipment is on the other side of the house. In our case, we snaked it from the living room down through the basement, out a hole drilled in the basement wall (for a previous outdoor-equipment installation), and back up from under the deck. The manual recommends using 18-gauge speaker wire for runs of up to 25 feet and 16-gauge wire for longer runs.

The second story of our home (/office) is cantilevered out two feet beyond the first floor, creating an overhang that was ideal for sheltering the PRO-LS3s. A large deck spans most of the back of the house, with 6-foot lattice privacy fences on the sides. We mounted one speaker at ear level (when sitting) in each of the two corners formed where the deck meets the house, about 24 feet apart. We used the corner placement to boost the bass, and the speakers were well underneath the cantilevered overhang.

The manual recommends using one pair of speakers for every 200-400 square feet of space. In a larger area, you tend to get hot spots of loud sound near the speakers when you turn up the volume loud enough so that it's audible over the entire space.

Even in our less-than-ideal mounting locations, the *Optimus* speakers performed admirably, and we have no hesitation recommending them for outdoor use. We tended to do most of our listening at low to moderate volume levels to preserve neighborhood harmony, and the background music provided by the PRO-LS3s was pleasing whether we were lounging on the deck or doing the ubiquitous yard work. For parties, we could crank them up with equally pleasing results.

We feel a bit bad about contributing to our neighborhood's noise pollution level—but, hey, if you can't beat 'em ...

Gizmo News

Sega Pins Its Hopes on Dreamcast

Sega Enterprises Ltd., whose *Saturn* game player was trounced in the market by *Sony's PlayStation* and *Nintendo 64*, has announced plans for a next-generation system. The new system, to be called *Dreamcast*, is based on *Microsoft's* Windows CE operating system, which provides an open, expandable architecture. Three other big-name partners have contributed to *Dreamcast*: *Hitachi* provided a cus-

tomized SH4 processor; *NEC* designed the PowerVR2 3-D graphics engine; and the XG sound engine came from *Yamaha*. *Dreamcast* also features two 64-megabit synchronous DRAMs, a 12x CD-ROM drive, and an internal 33.6-kbs modem.

NEC is hoping that its second-generation graphics device, the *PowerVR2*, which can process more than 3 million polygons per second—about twice the rate of today's arcade games—and boasts a pixel-fill rate of 200 million pixels per second, will attract the notice of PC manufacturers. Charles Bellfield, *NEC's* multimedia strategic business unit manager, pointed out that game titles written for *Dreamcast* will also run on a PC "or other platform."

Yamaha is positioning its XG 32-bit embedded RISC processor, capable of 64-channel adaptive differential pulse code modulation, as the next-generation sound source—MIDI's successor. The XG format is backward compatible with MIDI.

What does all that souped-up hardware mean to the gamer? Excellent graphics and sound-processing power. Dreamcast's image-processing capabilities include fog, anti-aliasing, bump mapping, environment mapping, alpha blending, and spectacular effects, both in real-time and interactively, in 16.8 million full colors, with VGA resolution. To further sweeten the deal, *Sega* will offer *Visual Memory*, a PDA-like accessory that will connect with the controller to serve as backup memory and as a personal viewer, showing information that other players can't see in games with more than one player. *Visual Memory* also can be used as a stand-alone portable gaming machine.

Dreamcast will make its Japanese debut in November, but won't be available in the States until late 1999.

FTC Report on Consumer's Online Privacy

According to the Federal Trade Commission, consumers have little privacy protection on the Internet. The FTC's *Report to Congress on Privacy Online*, the result of a three-year study in which more than 1400 Web sites were surveyed, concluded that "industry's efforts to encourage voluntary adoption of the most basic fair information practices have fallen short of what is needed to protect consumers."

Of the Web sites surveyed, only 14% provide any notice of their information-collection practices, and only 2% provide a comprehensive privacy policy. Of the 212 children's sites, 89% collect "personally identifiable information" directly from children, and less than 10% provide for some form of parental control over the information gathered from their kids.

The report noted four information practice principles that "are widely accepted as essential to ensuring that the collection, use, and dissemination of personal information are conducted fairly and in a manner consistent with consumer privacy interests." Those four principles are notice, choice, access, and security.

"The Commission's survey of Web sites tells us that industry efforts to encourage voluntary adoption of these principles has not met with great success," said FTC chairman Robert Pitofsky. "More incentives are necessary to encourage self-regulation and to ensure consumers that their personal information will be protected online. In fact, the online marketplace is unlikely to reach its full potential until consumers are confident that adequate protections are in place to protect their personal information."

The FTC recommends legislation for protecting children's privacy online, calling for laws that would require Web sites that are aimed at children and that collect personal identifying information from children 12 and under to provide actual notice to the parent and to obtain parental consent. In cases where that information would allow someone to contact the child off line, and when the information is to be publicly posted or disclosed to third parties, parental consent would be required before the information was collected. When a child's e-mail address is collected (such as to enter a contest), the site must notify parents and give them the opportunity to have the address removed from the site's database. When the children are older than 12, web sites would have to inform the parents that information was being collected from their children.

"The FTC's survey shows that many Web sites collect a variety of information from children, but that few take steps to provide for meaningful involvement from parents in the process," said Pitofsky. "That's why the Commission is recommending legislation that will put parents in control of information that is collected from their kids."

The FTC has developed a privacy web page called About Privacy (*www.ftc.gov*), where consumers can find information about how to protect their privacy online and off.

DVD-ROM Drives to Outsell DVD Players?

According the British market research firm *Strategy Analytics Ltd.*, over the next few years, shipments of DVD-ROM drives will far outpace those of DVD video players. The company forecast shipments of less than one million DVD players in the combined U.S. and European markets over the next two years, while the emergence of PCs with 400-MHz-and-faster processors, as well as MPEG-2 decoding software, will prompt sales of millions of DVD-ROM drives in the same time frame.

"The success of DVD hinges on the home-PC market," said Strategy Analytics analyst David Mercer. "DVD video is achieving modest success, but its potential is limited. By contrast, millions of home-PC buyers will choose DVD-ROM simply as a better CD-ROM." Mercer noted that the growing home-multimedia platform will encourage the development of DVD-ROM versions as enhancements to CD-ROM titles, which will eventually lead to improved "edutainment" and games offering full-motion, full-screen video, and 3-D graphics.

Strategy Analytics expects sales of DVD players in this country to level off at about 500,000 units a year until DVD recorders become available (within ten years), allowing the digital format to replace VCRs. ■

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NET WATCH

(continued from page 13)

Web interface, yet you can't send and receive attachments. Isn't that odd? But still, free is free, and for some people, *Juno* will provide a nice way to interface with the digital world, yet not shell out any cash to do so.

YAHOO! MAIL

No we're not just making an exclamation about the word "mail." *Yahoo! Mail* is a Web-based, free e-mail service from the Web's most popular site-indexing presence: Yahoo! This company wants you visiting its popular page as often as possible, and has found another way to keep Web surfers coming back on a regular basis.

Like *Hotmail*, *Yahoo! Mail* can be accessed from any machine that's connected to the Web and has a browser installed. However, it's not a clone of *Hotmail*. There are a couple of features that make *Yahoo! Mail* stand out.

For starters, the site you use to access your mail is directly linked to *Yahoo!'s* popular Four11 directory lookup engine. This can be handy if you forgot an e-mail address. If you know the address and details of the person you want to get in touch with, then why not keep track of him or her digitally? *Yahoo! Mail* provides a secure personalized address book that makes it easy to bring your contacts with you, without actually carrying them.

Now, let's mention a really incredible feature: You can access non-*Yahoo!* e-mail accounts! That's right, if you have a standard POP3 account, *Yahoo!* will allow you to check it and send mail through it. The convenience of this feature alone makes *Yahoo! Mail* worth the advertising you'll have to put up with.

Currently you can send or receive up to three attachments of 500K each in any e-mail message. The site claims that in the future this size may increase. As for regular e-mail size, you can store up to 3 MB of data on the *Yahoo!* Server—not bad at all. As with *Hotmail*, customizable filters are available, so you can cut down on which messages you receive in the first place.

How do you sign up? We give, in "Hot Sites," the URL for the standard *Yahoo!* page. Click on the *Yahoo! Mail* link to sign up. The reason we didn't provide a direct URL is that *Yahoo!* made it (probably intentionally) impossibly long and full of symbols. The company wants to increase its site traffic, after all, and making you visit its base site first is a good way to do so. Of course, one extra click is no big deal, and if you want, you can bookmark the actual e-mail site the first time you visit.

Well, I guess that about does it for this month. Until we meet here again, send me e-mail with your new free account here at netwatch@comports.com, or a traditional USPS letter to *Net Watch*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

HOT SITES

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SCANNER SCENE

(continued from page 18)

Force, Marine Corps, Air National Guard, MARS, and Army Engineers units. Monitoring in LSB and USB modes also netted satellite activities on 149.91, 149.94, 149.97, 149.98, and 149.99 MHz.

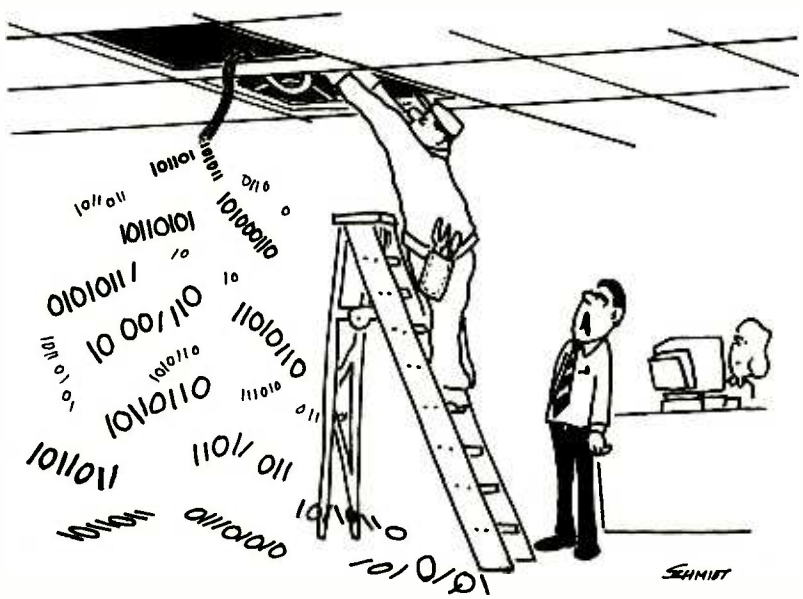
Readers from all areas keep reporting hearing two-way military traffic smack in the middle of the 46-MHz cordless telephone band. Crazy, but not quite as weird as it seems. For a great explanation, check out the "Editorial" section that you can access at *www.crbbooks.com*. Good stuff and scanner links there, too!

BITS 'N PIECES

Ever see those electronic monitoring ankle bracelets worn by prisoners who serve their time confined to their home? If the prisoner strays outside the boundaries of his home, the loss of the ankle bracelet's radio signal on a receiver placed in the home causes it to notify police. The confidential frequencies used by most of the electronic monitoring prisoner bracelets are 168.898, 168.922, and 314.40 MHz.

Did you see the film *Tornado*? How about that two-way radio system used by the tornado chase vehicles? If you live in Tornado Alley (the Midwest, Kansas, Oklahoma, or Texas), punch frequency 165.4375 MHz into your scanner. It's the primary repeater frequency used by the tornado-chase teams from the *National Severe Storms Laboratory*. The repeater is located in an aircraft, providing coverage over a wide ground area. Another channel is 163.10 MHz, which is for direct car-to-car communications.

Keep in touch with us! Our e-mail address is: Sigintt@aol.com. Or, write to us at Scanner Scene, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■



"Be careful up there—you just cut the LAN cable..!"

PUTTING TOGETHER YOUR OWN COMPUTER—FROM ATX TO ZIF

Building your own PC has never been easier and less expensive than it is today. Here is some advice on determining the selection of each major component in your computer, as well as some of the pros and cons of the many decisions you must make.

Although advances in the personal computer appear to be reaching consumers at a breakneck pace, the knowledge needed to build your own PC is not as complicated as the engineering behind the latest developments in computer hardware. In fact, building your own computer has never been easier than it is today. It has also never been less expensive. However, those are not the only reasons to build your own computer. With the price of a fully loaded system under $1000, the savings are not what they used to be. The most compelling reason to build your own system from scratch is that it will give you an education only such a hands-on experience can provide. By learning the techniques involved in building a PC, you can do upgrades and repairs much more easily, and that's where the big savings come in.

You may decide that a simple replacement of the motherboard and CPU is all that is needed. All other components from your old system

RAFAEL AVILA

may still be usable. If this is the case, you can bring your computer up to current cutting-edge speeds for less than one-quarter of the price of buying a new system.

This article provides commentary and step-by-step instructions on how to put together your own computer quickly and easily. Each major component in the computer is dealt with individually, and some of the pros and cons of the many decisions you must make are addressed. I do not recommend any specific make or model. However, at the end of each section, I have described the exact make and model that I chose for the construction of my system. This ensures that ***Popular Electronics*** readers are able to see what I did and to create their own up-to-date, powerful, working PC.

In The Beginning... Let's assume that you are starting out with nothing, nada, zippo! Here are the components you will need:

- Case and Power Supply
- Motherboard
- CPU
- RAM
- Hard Drive
- Floppy Drive and CD-ROM
- Video Card
- Sound Card/Speakers
- Modem
- Keyboard and Mouse
- Monitor
- Printer, Scanner, *etc.*

The first decision you need to make is whether to buy a kit or to pick and choose each of the major components. Many companies sell kits or bare-bones systems that you can assemble yourself (companies such as *CDW, MicroWarehouse, TigerDirect, et al.*—see Vendor List). The only disadvantage to a kit is that you may be limited to the hardware sold by the vendor. However, this is usually not a problem, as the better kit vendors allow you to swap hardware from among the products in their catalog, as long as you pay the difference in price for more expensive items. In addition to the valuable package-deal savings you get, there are other advantages to buying a kit from a good hardware vendor. One is that kits are generally very inexpensive compared to buying each individual component. Another benefit is that you don't have to worry about whether the components will work together. For example, one of the most embarrassing mistakes an amateur PC builder can make is to order a motherboard that doesn't fit the case. Make sure that the two are compatible. On the other hand, a good kit vendor will already have done that for you. Often these vendors will also offer 90-day depot warranty, besides telephone support. There are a few other similar considerations to take into account, which we will get into later. While we are on the subject of compatibility, let's start there—with the case, or chassis, as it is sometimes called.

Case and Power Supply. Cases and power supplies are most often sold together as a unit. While they can be purchased separately, it is usually less expensive and less troublesome to buy them together.

Case—When you choose a case or any other computer component, it's a good idea to think ahead. Consider not only the amount of desk or floor space available for the case, but also think about how you will be using your system in the future. Will you require many peripheral components, like a modem, a sound card, or a scanner? Usually, the more peripherals you intend to install, the more expansion slots you will need. Your case, therefore, should have enough bays to accommodate the number of expansion slots for the components you want to install. Keep in mind that your choice of motherboard also hinges on the number of peripherals that will be added, and it must have an appropriate number of expansion slots for your needs.

Choosing among the most popular case models is fairly simple, because there are only two that fit most people's needs: the AT (and baby-AT) and the ATX designs. While the overall size of the case can be either mini, mid, or full, the AT and ATX categories dictate the position of expansion slots, mouse, video, serial and parallel ports, and most importantly the mounting holes. The AT design is generally larger, older, and more appropriate for use where space is not a concern. It may also be okay for a person who foresees the need to add on many peripherals, as AT cases often come with ample expansion slots. For those who have limited space and little need to add peripherals, there is the more compact "baby-AT" case design.

However, by the time this article is printed, there may be no choice at all. Improvements, like better power and port connectors, can be found in the newer ATX design, which is quickly replacing the ATs and baby-ATs. The ATX is more efficient with its use of space, and it often accommodates more ISA and PCI slots for a greater number of peripheral components. It is also the design to which most computer hardware manufacturers seem to be switching. In addition, most ATX cases can accommodate any AT, baby AT, or ATX motherboard, leading to fewer logistical problems.

Power Supply—Your choice of power supply is also fairly simple. The choice depends on the amount of internal hardware that you intend to

ACRONYMS

AGP—Accelerated Graphics Port
BIOS—Basic Input Output System
CD-ROM—Compact Disc-Read Only Memory
CPU—Central Processing Unit
DIMM—Dual In-line Memory Module
DMA—Direct Memory Access
DSVD—Digital Simultaneous Voice and Data
EDO—Extended Data Out
EIDE—Enhanced Integrated Drive Electronics
I/O—Input/Output
ISA—Industry Standard Architecture
ISDN—Integrated Services Digital Network
ISP—Internet Service Provider
MIDI—Musical Instrument Digital Interface
PC—Personal Computer
PCI—Peripheral Component Interconnect
PnP—Plug and Play
RAM—Random Access Memory
SCSI—Small Computer System Interface
SDRAM—Synchronous Dynamic Random Access Memory
SIMM—Single In-line Memory Module
SVD—Simultaneous Voice and Data
SVGA—Super Video Graphics Adapter
UDMA—Ultra-Direct Memory Access
USB—Universal Serial Bus
VGA—Video Graphics Array
XGA—Extended Graphics Array
ZIF—Zero Insertion Force

add to your system, like extra hard drives, floppy drives, CD-ROMs, tape or disk-backup drives, *etc.* The more power-hungry internal hardware you wish to add, the more power you will need. Because the price per watt is very cheap, it's always better to opt for more. Most fully loaded systems require no more than 200 to 260 watts. However, some voracious systems, like those with dual processors and many peripherals, can easily gobble up 300 watts or more. One important thing to remember is that a faulty power supply can literally fry some of the most expensive and irreplaceable pieces of hardware in your system. Therefore, choose a brand new power supply.

In purchasing the hardware for my system, I decided to go with a package deal from a mail order catalog company called TigerDirect, *for some of the major components. Tiger allowed me to choose a case, a power supply, and a motherboard from their catalog as a package. Purchasing this way was less expensive than shopping for each individual component, and it gave me the flexibility to choose from a variety of components. As for the other major components, described in the following sections, I decided to purchase them individually.*

In my system, TigerDirect's *ATX six-bay case comes with a 235-watt power supply. The six-bay (six expansion-slot bays) feature helps to alleviate my anxiety over running out of expansion slots. Another feature that sold me on this case was its three full and two half-height external-drive bays and one internal-drive bay, allowing me to install almost any arrangement of drives.*

Motherboard. The motherboard, as its name implies, is one of the most important components of a PC. Accordingly, your selection of the mother of all computer components should be undertaken with great care. As alluded to earlier, the dimensions of your motherboard should fit those of your case. Correctly matching a motherboard and case is a very simple task, because most makes come in both AT or ATX dimensions.

Now that you have matched your AT or ATX motherboard to an appropriate case, the next question you must ponder is, "What kind of physical performance do I want from my system?" Speed and other qualities do not only depend on the MHz value of the CPU, but also on such factors as cache, bus speeds, and quantity and type of RAM.

Cache—Cache on the motherboard refers to an area of memory where the CPU can temporarily store data for very quick access. Most motherboards today come with at least 512 kilobytes (kB) of cache. However, the newest motherboards designed for Pentium II processors may take into account that Pentium IIs have a quite sizable on-chip cache—eliminating the need for cache on the motherboard.

Bus Speed—Performance also relies heavily on the system bus speed. Bus speed can be thought of as the rate at which the CPU communicates with the rest of the system, through the motherboard. The higher the system bus speeds, the faster your computer will work. Currently most motherboards come set at 66 or 75 MHz. However, at such low bus speeds, the newest 400- and 500-MHz Pentium systems would be restricted to performance typical of current 300-MHz systems. To accommodate the latest Pentium II processors, motherboards now have system buses that run at 100 MHz.

RAM—Without getting into the technicalities of how RAM (*R*andom *A*ccess *M*emory) actually works, it will suffice to say that it is required in great quantities for the manipulation of large files. And more is always better (see the detailed section on RAM that follows).

My recommendation is to select a motherboard capable of accepting a variety of technologies. For example, almost all of them sold today are capable of using SIMM (*S*ingle *I*n-line *M*emory *M*odule) RAM. The newer DIMMs (*D*ual *I*n-line *M*emory *M*odules) are faster, which is why they are slowly replacing SIMMs. Most motherboard manufacturers are including both SIMMs and DIMMs slots, so that their customers can use one or the other or both. Your best choice is a motherboard that has both slots.

No matter what type of memory your motherboard accepts, it must match the actual memory modules you purchase. Older SIMMs come in two forms—non-parity and parity. However, newer motherboards are equipped to handle faster EDO SIMMs and faster still SDRAM memory modules. Be sure the motherboard you choose can handle the RAM modules you chose.

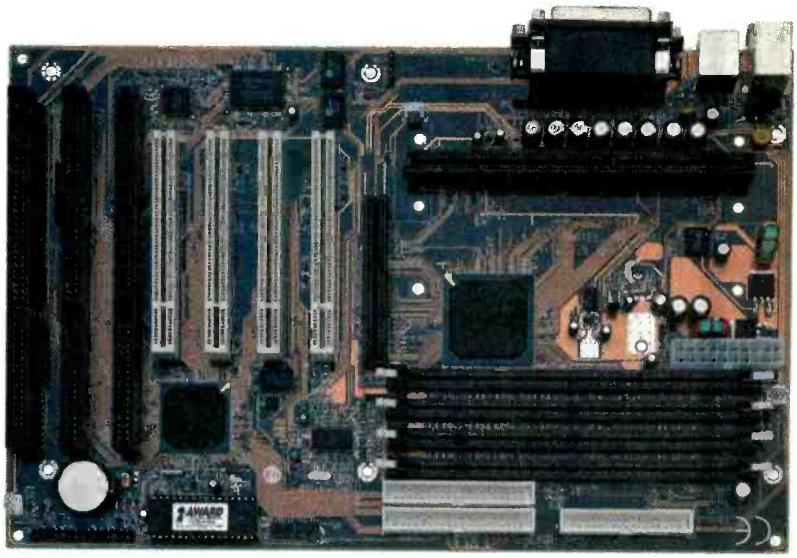
Expansion Slots—A similar consideration in selecting a motherboard hinges on whether or not you will be installing older peripheral components, like those you may have cannibalized from an older system. If you are buying new peripherals, like tape drives, a scanner, a MIDI-sound card, a modem, a video-input device, *etc.*, your choices may be somewhat easier than if you intend to install older devices. You would simply opt for a motherboard with expansion slots that are mostly, if not all, the faster PCI variety. On the other hand, you may be able to achieve excellent functionality and acceptable performance, while saving buckets of cash, by using older ISA-type peripherals, which require ISA expansion slots on the motherboard.

Let's assume you've decided to take the middle ground. You have some old ISA hardware you wish to use and some brand new PCI hardware you expect to purchase. You must now make a judgment call as to how many of the older type of ISA expansion slots, and how many of the newer type, PCI, expansion slots you want.

Whenever possible, you should opt for PCI components over ISA. PCI components can exchange 32 to 64 bits of information at a time, while their ISA counterparts can only send or accept 16 bits per parlay. On the other hand, with some components you may not notice a difference anyway. For example, a 28.8 kilobytes per second (kbps) or faster internal modem, hooked up to a standard non-ISDN phone line, will only be able to transfer data at a maximum of about 28 kb, due to the bandwidth limitations of common copper telephone wires. Limited at 28 kbps, an ISA 16-bit transfer will be able to transfer a signal equally as

fast as a 32-or 64-bit PCI card. In my experience, the difference in performance, especially on the Internet, is entirely negligible. If you know that faster phone line (e.g., ISDN) service is too costly, and is likely to remain so, an older ISA internal modem may be right for you. Otherwise, it is always best to view your future system with optimism and opt for a PCI device.

Another component to consider in selecting a motherboard is the I/O controller. Short for *I*nput/*O*utput controller, this device enables your computer to communicate with various data storage and retrieval devices, like tape drives, and CD-ROM and hard disk drives. There are really only a few popular I/O conventions by which most disk drives operate, EIDE (*E*nhanced *I*ntegrated *D*isk *E*lectronics) and SCSI (*S*mall *C*omputer *S*ystem *I*nterface—pronounced "skuzzy"). Enhanced IDE technology took the older IDE convention and removed the controller from the actual hardware device. EIDE technology uses an IDE-controller built into the motherboard to run the hardware. The result is much better, faster, performance. Let's limit this trade-off to EIDE I/O controllers and devices because, although slightly faster, SCSI devices are less popular among home PCs, and they are also somewhat more expensive. When purchasing a motherboard, make sure that there is an onboard EIDE controller and at least one EIDE socket. Otherwise you will have to use an expansion card I/O controller to connect your hard drive and CD-ROM. This would take up valuable expansion slots.



The MicroStar *MS-6111 is an ATX motherboard, which is designed to work with the Pentium II CPU and accepts four DIMM SDRAM memory boards.*

It is important to mention a new design trend that experts predict will replace the EIDE technology. It is called Ultra-DMA (UDMA), and it is considerably faster than the existing conventions. While EIDE has a 16-megabyte per second (Mbps) transfer rate, UDMA has a 32-Mbps-transfer rate. For those who always want to stay on the cutting edge, the UDMA is an absolute necessity on the motherboard. However, going with UDMA means spending a bit more for the motherboard, as well as

MANUFACTURER	MODELS	EXPANSION/ INTERFACE	MEMORY SOCKETS	FORM	PRICE
ASUS	TX97/TX97-X	4 EIDE 2 Floppy 2 Serial 1 Parallel Port	3-168 DIMMs	AT or ATX	$145
Tyan	TOMCAT IV Dual	4 EIDE 2 Floppy 2 Serial 1 Parallel Port	8-72 SIMMs	AT	$179
Super-Micro	P5MMA 98	4 EIDE 2 Floppy 2 Serial 1 Parallel Port 2 USB	4-72 SIMMs 2-168 DIMMs	ATX	$135
TigerDirect	A13-MB 21B	4 EIDE 2 Floppy 2 Serial 1 Parallel Port 2 USB	4-72 SIMMs 2-168 DIMMs	ATX	$209.99

Table 1. Motherboard Comparison Chart

for the UDMA devices. Luckily, some UDMA-equipped motherboards accept either UDMA or EIDE devices in the same socket, you can upgrade from EIDE to UDMA devices.

MicroStar *manufactured my choice of motherboard—their model MS-6111. This is, of course, an ATX Slot-1 motherboard, so it fits nicely into my ATX case, and also allows my power supply to snap right in with no problems. Designed to work with the Pentium II CPU, this motherboard is equipped with a Pentium II Slot-1, which holds the Pentium II CPU. It has four sockets, ready to accept four-DIMM SDRAM memory boards.*

Another important feature of this motherboard is the presence of three-ISA and four-PCI expansion slots. Since I will be using some older components, it is comforting to know that I have plenty of available ISA slots. And I still have four PCI slots for my newer devices. Furthermore, this motherboard has one Accelerated Graphics Port, slot, AGP, which holds an AGP video card. AGP video cards are superior to older video cards, which were primarily of the PCI variety. The newer video cards, based on AGP technology, can transfer 528 Mbps, which is ten times faster than a regular PCI video card.

Onboard dual-channel device controllers allow up to four EIDE devices, or the newer faster Ultra DMA devices like hard drives, CD-ROMs and some tape drives. In addition, there is an onboard floppy-drive controller, which can handle 5.25- inch and 3.5-inch floppy drives, including the most popular 1.44-MB drive and the newer 2.88-MB drive.

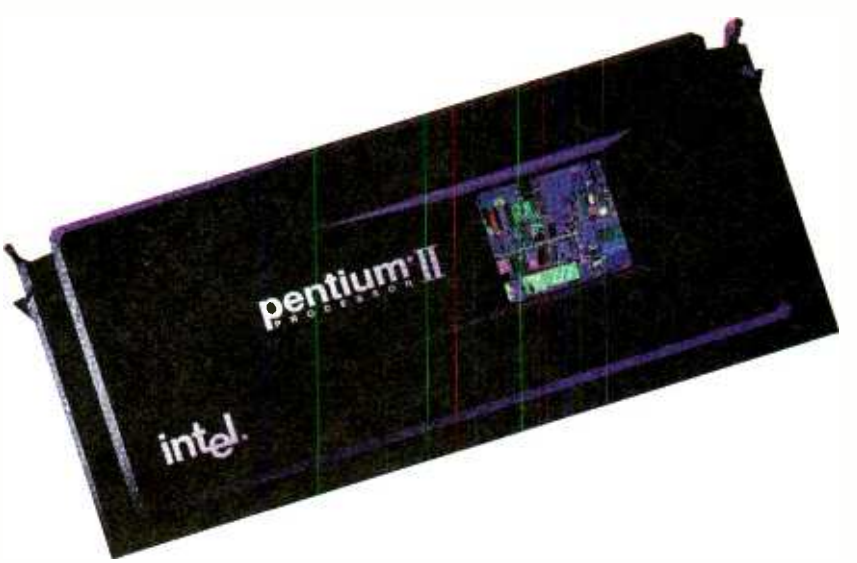
Several attributes that have not been described, but are nevertheless good to have on a motherboard are an Intel 44LX chipset, and an AMI BIOS, with plug-and-play (PnP) support and two Universal Serial Buses (USB). USB allows you to add up to 127-serial devices on each serial port. Therefore, in the future if I wanted to add 254 printers, scanners, or any combination of up to 254-serial devices, I would have no problem.

Shopping around for the best value is somewhat tricky, because there are so many components to keep track of. The data in Table 1 may come in handy when comparison-shopping for motherboards. Please note that by the time this article is printed, prices will surely have changed dramatically. You would do well to use Table 1 as a guide for filling in the data you collect from vendors and manufacturers. Note that although all the motherboards in the chart seem to match fairly well, the least expensive ones are missing features that the more expensive ones have. It is up to the buyer to determine whether or not those features are worth the extra money.

CPU. With the advent of *Intel's Pentium II* CPU, the general look of motherboards has once again changed dramatically. Until very recently, CPUs occupied a distinct square socket called a ZIF (Zero Insertion Force) socket (see motherboard section). Pentium IIs, however, have now been placed on a card which fits into a CPU slot, called Slot-1, which is similar in appearance to the SIMMs and DIMMs slots. In addition to taking up less space on the motherboard, the new design makes it impossible to misalign the CPU upon installation; older CPUs could be installed in three incorrect out of four possible orientations in the ZIF socket. Be aware that if you have chosen a Pentium II CPU, you must purchase a Pentium II motherboard with a Slot-1 CPU slot. Likewise, if you have purchased a CPU designed to fit into a ZIF socket, your motherboard must come equipped with a ZIF socket. (Please note that I use the term ZIF socket loosely here, meaning that the socket must be designed to accept the Pentium CPU. Not all Pentium and Pentium-like CPUs truly require zero force for insertion.)

For those willing to venture beyond the confines of *Intel's* wide CPU selection, there is much to be gained by purchasing competitive processors (not the least of which is a hand-full of greenbacks). Most people don't know this, but *Cyrix/IBM, AMD,* and a small number of other CPU manufacturers have been quite successful at eliminating compatibility problems, so that they now provide excellent substitutes to *Intel* products, at significant savings.

RAM. Measured in bytes, with current systems requiring 16 megabytes or more, RAM is used by your computer to load program instructions and store running files. The larger the programs and files one is working with, the more RAM one can expect to use. Thankfully RAM is recycled when a particular program no longer needs it, so we do not have to continuously fill up with RAM—like



The new Intel *Pentium II is the latest 400-MHz MMX "speedburner" CPU.*

we do with gasoline in our cars! However when almost all of the RAM is used or occupied by the data or code of program(s) running on the system, the computer must wait until more memory is recycled and available. Without enough RAM, this waiting time can make even the fastest systems seem extremely slow. Thus, it is always good to have plenty of RAM available. To ensure this, most PC builders are advised to have at least 16 MB of RAM. However, with the increased popularity of RAM-thirsty, multimedia applications, it is recommended that at least 32 MB of RAM be installed into the SIMMs or DIMMs slots on the motherboard. On almost all modern motherboards, both SIMMs and DIMMs must be installed two boards at a time. Therefore, if you wish to have 32 MB of RAM, you must purchase two 16 MB boards. Keep in mind that DIMM memory runs much faster than SIMM memory, and your allocation of RAM to either DIMMs or SIMMs slots should take this into consideration. If speed is most important to you, then you will want to purchase more DIMM memory for your available DIMM slots.

Two 32-MB SDRAM DIMMs boards were deemed satisfactory for the applications I intend to run on my system. I chose a reliable manufacturer called PNY Technologies *to ensure the proper functioning of both boards. Beware of some very inexpensive RAM boards, I've purchased quite a few duds that worked at as little as one half capacity.*

Hard Drive. When searching for a hard drive, there are several characteristics you should look at to suit your needs. They are capacity, seek time, and compatibility with your system.

When it comes to capacity, size definitely counts—don't let anyone convince you otherwise. The larger the hard drive the better. Although having six or more gigabytes (6 GB) of hard disk space may seem exorbitant, it isn't. You always seem to find yourself needing more space, as programs continuously increase in size. A small note of caution for anyone thinking about cheapening out on a small, less than 1-GB hard drive. To comfortably hold and use only ten of the most popular Windows 95 applications, like *Office 97, Corel DRAW, Microsoft Access, etc.*, your system can easily eat up over 500 megabytes, without saved data files. Your data files will gobble up even more hard-drive space.

As with every other component described in this article, compatibility is a major concern when it comes to choosing a hard drive. If your motherboard is equipped with an EIDE controller, you must choose an EIDE-compatible hard drive. Likewise, if your motherboard has a UDMA controller, you must choose a UDMA-compatible hard drive. Fortunately, many of the newer UDMA hard drives are backwards compatible. That is, they are capable of working with EIDE controllers. This is good news for anyone looking to purchase a new hard drive for an older motherboard.

Measured in milliseconds, the hard drive access time, also referred to as speed, is the time it takes a hard disk drive to locate and retrieve a sector of data. Naturally, the lower the access time, the faster the hard drive. Access times for very old hard drives were in the range of 100 to 85 milliseconds. Thankfully such dinosaur parts are no longer available. Currently EIDE hard drives generally have seek times in the teens, while the newer UDMA hard drives have seek times of less than ten ms. In actuality, there is a small but noticeable difference between the EIDE and UDMA hard drives. Depending on what your needs are, a less expensive EIDE drive may be satisfactory.

For my system, I purchased the Western Digital, *6.4 GB, UDMA hard drive. It has a seek time of less than 9.5 ms, and a transfer rate of 33 MB per second. The price was $230, from* TigerDirect's *catalog.*

Pictured here is Seagate's *Cheetah 9LP hard drive, which has the fastest average seek time of any Winchester-type disc drive, as low as 5.2 msec during read operations. The drive also delivers top performance with sustained data transfer rates reaching over 20 Mbps.*

Floppy Drive and CD-ROM. A floppy drive and a CD-ROM are two components that are essential for the setting up of your computer. Whereas in the past, only the floppy drive would have sufficed, nowadays such giant operating systems as *Windows 95* and applications such as *Office 97* are installed from a CD requiring that your system have a CD-ROM. While advances in computer technology have accelerated for the last decade, floppy drives have essentially remained the same. A standard 1.44-MB, 3.5-inch floppy drive will allow for the installation of small programs and transfer and storage of small amounts of data. Most motherboards have an on-

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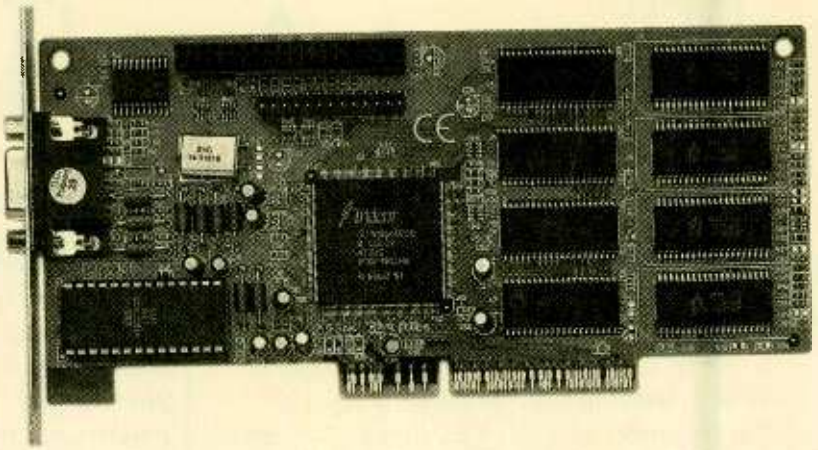
board floppy drive slot, which attaches a floppy drive to a built-in controller through a small ribbon cable. Since driver software is required to run a CD-ROM, you will need to install such software with the aforementioned floppy drive. For those anticipating running older programs or shareware software, a $5^1/_4$-inch floppy drive may also be necessary.

CD-ROMs, unlike floppy drives, have followed the industry's trend towards becoming faster. Only seven or eight years ago, CD-ROMs were at the 1× and 2× speeds, while today the current CD-ROM speeds are at 100×. While this may be good for some high-end graphics applications, the 24× CD-ROM suffices for most home applications. These CD-ROMs are usually of EIDE technology and connect to the motherboard's EIDE slot through an EIDE ribbon cable.

I chose a Mitsumi *standard 1.44 MB, 3.5-inch floppy drive, which sells for between $20–$30 in almost any computer-sellers' magazine. As for the CD-ROM, I chose* Creative Lab's *Soundblaster Vibra 24× for approximately $110.*

Video Card. The latest technology in video cards is the accelerated graphics port. AGP-video cards are superior to older video cards, which were primarily of the current PCI bus and ancient ISA bus varieties. The newer video cards, based on AGP bus technology, have transfer rates 10 times faster than regular PCI video cards. At up to 528-Mbps transfer rates, AGP cards are much better for multimedia applications, movie players, and 3-D video games. The all-important transfer rate is a primary indicator of performance; the higher this number is, the better performance you will see. Another factor in the performance is the amount of RAM the card itself holds. Just like RAM on the motherboard, more is better, and many current PCI and AGP cards allow you to add more RAM if you need it. Four to eight megabytes is sufficient for most common applications.

For my system, I purchased the ATI Technologies *XPERT XL, which uses AGP-bus technology and comes with 4 MB of RAM. Through Tiger Direct, this video-graphics card was $89.99.*



Video or graphics accelerators allow full-motion video playback, fast 3-D and 2-D graphics, 16.7 million colors (1280 × 1024), and up to a 200-Hz refresh rate.

Sound Card/Speakers. There are a great number of features that have been incorporated into sound cards, and your choice of features will affect the price. Thus, sound cards come in many flavors. Among the most important characteristics are the transfer rate (the rate at which the card actually communicates with the motherboard), and whether it supports duplex technology, whether it supports wavetable synthesis, and whether it is MIDI-capable. Let's first get into some definitions.

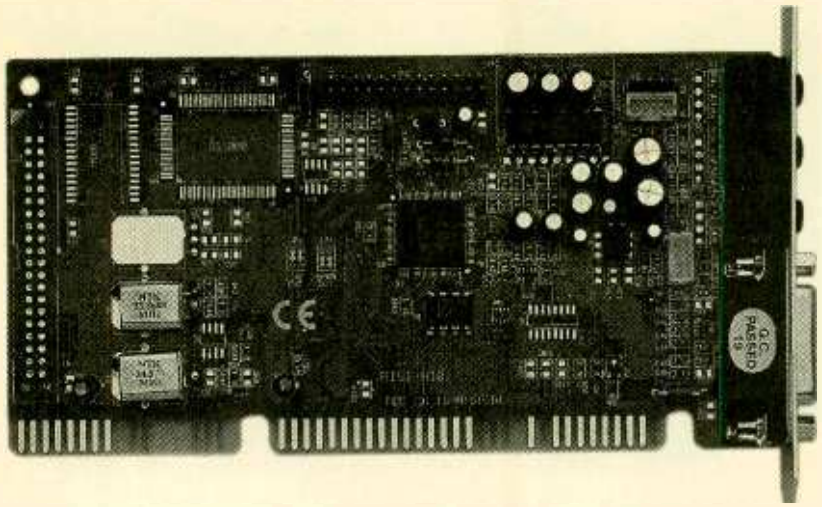
Transfer rate is very important when it comes to sound cards, because large amounts of information go into the generation of small amounts of complex music and sounds. As mentioned in the motherboard section, the architecture of the card, PCI, ISA, *etc.*, determines the rate at which the card can transfer information. Better sound cards will be of the PCI variety, meaning that they can transfer information 32 bits at a time. Some estimate that ISA sound cards transfer data at 25 to 50 percent of the speed of PCI cards.

Wavetable synthesis is very important for more discerning listeners, because it allows the sound card to draw from a set of previously defined sounds or voices. This technology, previously used only by those in the music industry, plays digital samples of actual musical instruments. The result is a more realistic sound. The number of voices in a sound card is important to those who take their PC's sound seriously.

MIDI input and output is a great feature of many multimedia applications. Short for *M*usical *I*nstrument *D*igital *I*nterface, this is an electronic format for defining the specific sounds that certain instruments make. It allows for far more compact storage of musical data. In order to convert such data into analog signals that can be played on your system's speakers, your sound card must be MIDI-capable. Also important for musicians is the reverse of this application. That is, some musicians require a sound card that is capable of translating analog sound from a microphone or other input device into MIDI data.

As far as speakers are concerned, the more watts, the more power you have when the volume is increased. Choosing speakers is like looking for a good stereo system. You can get monaural-types, speakers with woofers and tweeters—just about any combination that could whet the appetite of an audio *aficionado*. Since most computer speakers come with built-in audio amplifiers, which require a source of AC/DC power to operate, make sure your speakers come with an AC adapter. Also make sure they are magnetically shielded.

For $29.99, I chose the Hi-Val *Wave32 sound card, which uses 32-bit PCI technology. It is MIDI-capable and has a wavetable synthesis with 32 voices. The desktop speakers consisted of a*



Most of the newer sound cards use wavetable synthesis to digitally produce up to 128 instrument sounds, 132 percussion instruments, and 3-D sound—like a whole orchestra from your computer!

pair of JBL loudspeakers, model Media 100, which have a maximum audio output of 6 watts (12-watts stereo), a frequency range of 75 Hz–20 kHz, a 3-inch low-frequency woofer, a 1-inch high-frequency tweeter, and, of course, an AC adapter. Cost was $49.99 each.

Modem. With the growth in popularity of the Internet and the World Wide Web, the importance of a modem cannot be understated. Anyone who has any practical (or impractical) use for a computer can benefit from the wealth of resources available through a modem. As one would expect, the modem has experienced many technological advances over the years. As a result, there are a number of things to consider when choosing a modem.

The first thing is whether or not you wish to use an internal or an external modem. Aside from the issue of desk space, there may be some physical limitations that will push you toward one or the other. If you are considering an external modem, you will need to make sure that you have an available COM-port. Most motherboards come with an onboard COM-port. However, some systems either do not have a COM-port, or have only a single COM-port, which is devoted to another device. In such circumstances, one would have to install an additional I/O board that has a COM-port. Such a board must be installed into an expansion slot. For computer systems, which have no available expansion slots and no available COM-ports, a modem cannot be installed—much less an external modem. For internal modems, all that is required is an available expansion to hold the modem card (which is then identified by the system as a COM-port). A system with no available expansion slot, but which has an available COM-port, can only use an external modem. For the most part, though, internal modems are more economical, as you can generally get better performance for less money.

Before choosing your modem, a little history lesson is in order. Kilobytes per second is the name of the game, when it comes to modems. Thus, it is not difficult to track the recent technological advances in modem design and protocol. Just a few of years ago, circa 1990, (which is several generations in computer advances!) 14.4 kbps, or simply 14.4K, was considered a comfortable speed for a modem. (Anyone who uses the Internet a lot can tell you that there is no great speed for a modem, as anything shy of instantaneous is still not fast enough.). However, this number does not ensure that a modem will always operate up to its corresponding kbps rate, nor does it limit the speed at which a modem will operate. There are other factors that limit or enhance the actual throughput of a modem. One factor is the protocol that a modem employs to transfer data. The ITU-T (International Telecommunication Union-Telecommunication Standards) group, defines standards for modem protocols. Manufacturers configure their modems to accepted ITU-T protocols. (Though there are exceptions.)

The protocol for 14.4K-modems is called V.32bis. It is somewhat antiquated, but it does the job for 14.4 kbps transmission. With more modern 28.8-kbps designs, a new protocol called v.FC became the accepted standard. Here's where things get messy. The advent of 33.6K-modems saw the birth of the V.34 protocol, which, as one might expect, handles speeds up to 33.6 kbps. However, some manufacturer's 28.8K-modems are upgradable to newer protocols. Therefore, some 28.8K-modems have actual speeds of 33.6 kbps.

If the thought of a 28.8K-modem operating at 33.6 kbps is a little confusing, then consider the latest generation of modems, the 56K-modems. There are a number of protocols, some of which have not been accepted or endorsed by the ITU-T, (and none of which have reliably lived up to their 56 kbps designation). The protocols are K56 Flex, ×2, and V.90, which is scheduled to win ITU-T endorsement by the end of the year. Unfortunately, limitations of analog telephone lines restrict transmission, causing most 56K-modems to automatically drop down to the highest compatible protocol, which is usually V.34 at 33.6 or 28.8 kbps. It should be noted that only a pristine analog signal, with no noise, will allow the 33.6 kbps transmission. People who purchased 56K-modems may find that their analog line is so noisy that it only allows for 28.8 kbps transmission. It would be best for buyers to try out a variety of modems on their own telephone line to see if it can actually handle 33.6 kbps rates.

To add to the confusion, limitations on transmission rates over telephone lines are unequal between sending and receiving. That's because a modem sending over an analog line must perform an analog-to-digital conversion, which inherently introduces noise. This noise effectively brings the transfer rate

down to less than 35 kbps. However, most of the larger Internet service providers and net server, are directly linked to the nation's telephone infrastructure, which is entirely digital. Thus, an analog-to-digital conversion on the server side is not necessary, and noise can theoretically be eliminated. Without noise, a 56K-modem can theoretically receive data at 64,000 bps, which is accomplished by sampling at 8 bits per sample multiplied by 8000 samples per second. Unfortunately, the protocols and FCC regulations require that some of those bits be used to convey information about the transmitted information itself, and not convey true data. Thus transmission rates are effectively reduced to about 53 kbps even on the receiving end. Only time will tell which technology will come out on top. For now, if you know you can get a great deal on a 33.6K-modem it's probably your best bet.

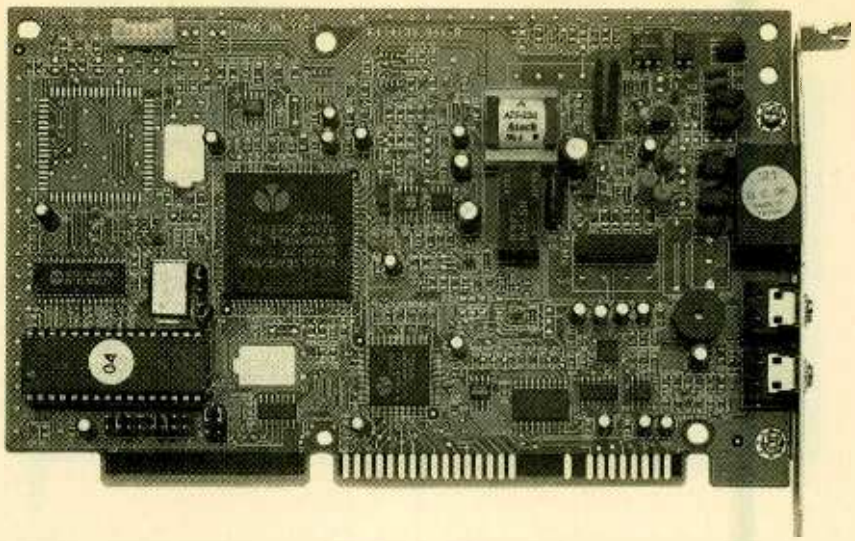
By the way, if you have an ISDN (Integrated Services Digital Network) telephone line, your digital 56K-modem will operate at 56 kbps or very close, because there is no conversion necessary between digital and analog lines.

Since almost all PC modems are Fax-capable, we won't get into the technicalities of Fax versus non-Fax capable modems. If you want to be able to Fax from your PC, make sure that you acquire a Fax modem.

As previously mentioned, it's a good idea to take an inventory of the ISA and PCI devices and available expansion slots in your system. Make sure that if you are purchasing a modem on a PCI card you have an available PCI slot for it.

I purchased a plain and simple U.S. Robotics *56K internal Fax modem with DSVD and speakerphone for $60. It supports V.34 data transmission at 33.6- and 28.8-kbps, and is backward compatible with ITU_T V.32bis standard at 14.4 kbps.*

Keyboard and Mouse. Selection of a mouse and keyboard is fairly simple because these two input devices follow a set of rigid conventions — at least when it comes to most current motherboards and systems. Before we get started on



The Amquest/KDS *56K modem is a fully compatible, hardware-controlled 56K modem, based on the legendary Rockwell Flex 56 technology. The modem features full duplex speakerphone, voice, data , Fax, SVD, Caller ID and V.80 video-conferencing capability.*

mice and keyboards, the issue of the *Windows 95* keyboard must be addressed. The *Windows 95* keyboard is no different than any regular PS/2 keyboard, with one tiny exception, the *Windows 95* key. This key is a nice feature for some *Windows 95* applications, although entirely unnecessary. Any *Windows 95* key function can be achieved through other keystrokes. Thus, if the keyboard you are considering purchasing comes with this feature, it's worth having as long as you are not paying any extra money for it. If your keyboard is missing the *Windows 95* key, you certainly should not lose any sleep over it.

Most PC motherboards come with an onboard PS/2 mouse port and an onboard PS/2 keyboard port. The PS/2 connector, which is at the end of the cable attached to the mouse or keyboard, is circular with six pins arranged concentrically inside the perimeter. For the easiest installation of a mouse and keyboard, one simply needs to make sure that both the keyboard and the mouse have PS/2 connectors, and that the motherboard has a PS/2 port for each. While these are certainly the easiest types of keyboards and mice to install, you may still come across an old mouse or keyboard that uses a serial port connection. Some not-too-old motherboards also come with a DIN port for the keyboard, even though it may be rare to find a keyboard with a five-pin DIN connector, as most ports are of the PS/2 variety. Don't worry; a simple "five-pin DIN to PS/2 adapter," available through any computer parts vendor, will make almost any keyboard work with a PS/2 keyboard port. In addition, older motherboards may come with no onboard PS/2 mouse port. Makers of such boards expect that the user can easily install a mouse through a serial port. Currently, mice can still be purchased with serial port connectors for just such circumstances. A serial-port mouse can be readily identified by the nine-pin connector, which has two rows of parallel pins. If the motherboard you have chosen has no mouse port, yet you have acquired a PS/2 mouse, not to worry. Just as there are DIN to PS/2 adapters, there are also serial to PS/2 adapters, which will allow you to connect your PS/2 mouse to your system through a serial port.

One additional note on keyboards and mice: Some of these devices come in unique shapes and sizes, the most popular of which are ergonomically designed. Some people love 'em; some hate 'em. The best advice is for you to try out any non-standard mouse or keyboard you are interested in, before you purchase it.

As you might have guessed, the components I have chosen are a standard PS/2 mouse and a standard PS/2 Windows 95 keyboard. Both are made by PC

Concepts, *and sell for $14.99 and $19.99 respectively.*

Monitor. Over the years, there have been many improvements made to computer monitor technology. However, for the past ten years, a common standard, called *S*uper *V*ideo *G*raphics *A*rray, or SVGA has dominated the computer industry. The SVGA standard is very similar to its predecessor, the VGA standard, which unlike any prior standards, uses an analog rather than a digital signal. VGA's analog technology appears to have been a great idea, since almost all subsequent standards, including SVGA, and XGA (*E*xtended *G*raphics *A*ssembly), are basically improvements on the same theme. Most important have been the improvements made to resolution and the number of colors a monitor is capable of displaying simultaneously. Table 2 summarizes video standards and their maximum resolutions. Note that on XGA and SVGA monitors, you are given a choice of lower resolution and more colors or higher resolution and fewer colors. You should choose whichever best matches your budget and needs. The resolution is given as number of pixels × number of pixels, and a pixel is the smallest element that can be drawn on a screen.

VIDEO STANDARD	RESOLUTION
VGA	640 × 480
SVGA	320 × 200
	800 × 600
	1024 × 768
	1280 × 1024
XGA	640 × 480
	1024 × 768

Table 2. Video Standards and their Maximum Resolutions

The ViewSonic *GS771 monitor presents sharper crisper images across its 17-inch screen. Exceptionally clear and bright colors are provided with its 0.27-mm true-dot pitch, which is matched with its 1024 × 768 resolution (maximum resolution of 1280 × 1024), and 87-Hz refresh rate.*

When purchasing a monitor, other factors to take into account are specifically screen size, dot pitch, and refresh rate. To some people, like artists and designers, as well as people who enjoy video games, screen size is very important. The important thing to remember is you always want to get the most out of what you pay for. Therefore, do not take screen size alone into account. For example, 14-inch and 15-inch screen size monitors both come in 800 × 600 pixel resolution. While the picture on such a 15-inch screen is slightly larger, it still has the same resolution and will only yield a slightly larger and equally less defined image.

Therefore, for most people, there is little to be gained by the extra inch. However, jumping to a 17-inch monitor, with a higher resolution of 1024 × 768 yields a larger image that is more defined. Larger and more defined still are the 21-inch monitors with resolution of 1280 × 1024 or better.

Because we are speaking strictly of color monitors, each pixel consists of a red, a blue, and a green dot, which, theoretically, can be illuminated in varying combinations to produce every color of the rainbow. Dot pitch is often used to describe an aspect of the definition or resolution of a monitor. Dot pitch is the size of the red, blue, and green dots on a screen that make up a pixel. The smaller and closer together these dots are, the sharper the image usually is, so a smaller millimeter dot pitch is always more desirable. Dot pitch values of current monitors range from 0.28 mm to 0.24 mm.

For the more discerning "comput-o-phile," there is another feature of monitors that is also very important, the refresh rate. The refresh rate is the rate at which the monitor repaints the entire screen. With the advent of multimedia, movie-viewing capabilities, and some of the newer high-tech 3-D video games, this feature has become far more important. One may have the fastest CPU, the highest bus speeds, the most RAM possible, and the best video-graphics accelerator card, but a monitor with a slow refresh rate will make your computer's moving images look as choppy as an

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Cyrix/IBM
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Web: *www.jbl.com*

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Web: *www.wdc.com*

old *Keystone Cops* film. Most current monitors have refresh rates ranging from 60 to 95 Hz. High-end monitors, which may be used for videography or other uses, may have refresh rates as high as 135 Hz or higher.

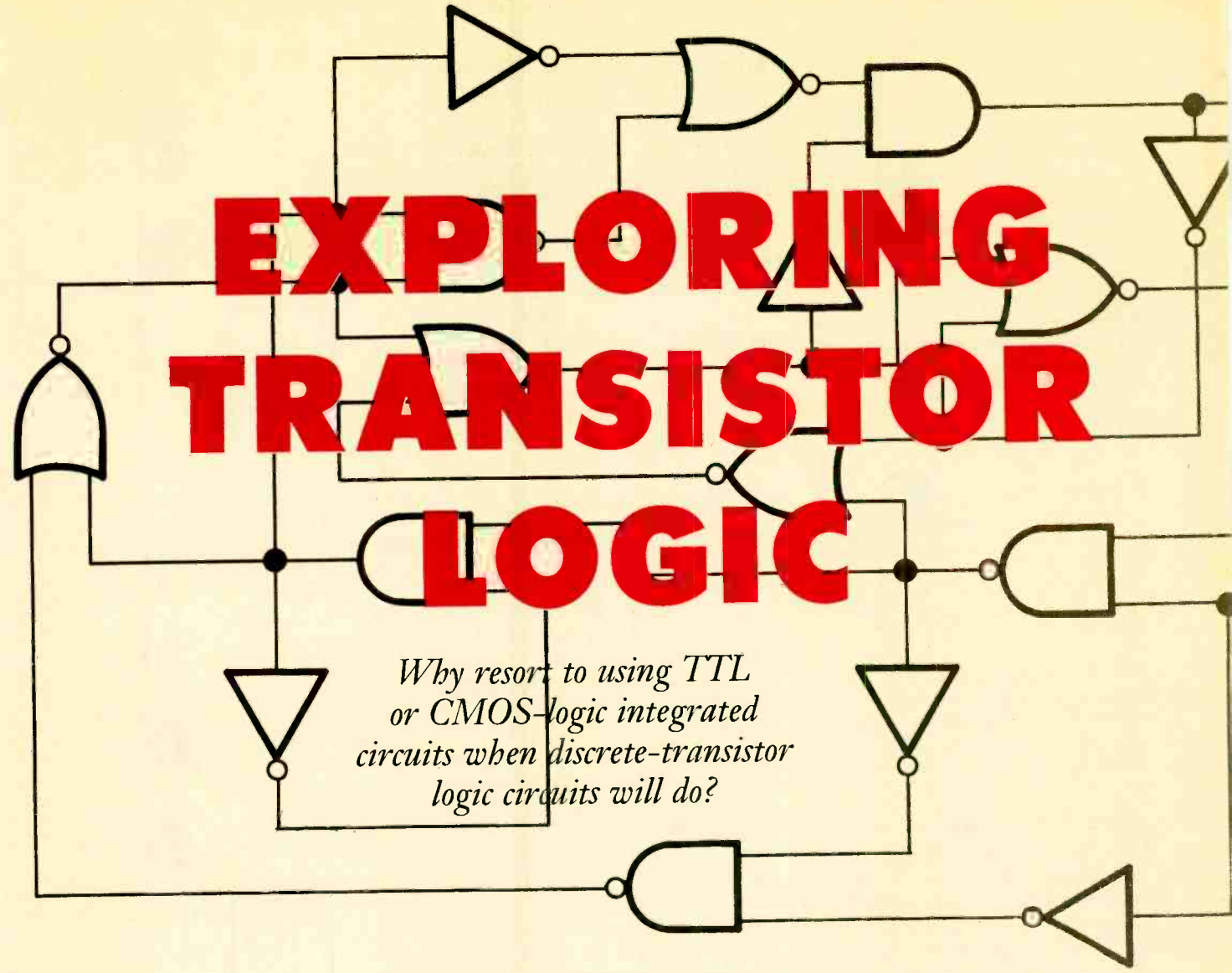
These features of monitors can be found in a wide range of combinations, some may be as small as 12.9 inches, selling for about $150, while others may be as large as 21 inches, for over $1300. Once again, the needs of the user must be weighed against the cost of higher performance. With literally hundreds of monitors on the market, there is surely a monitor for everyone's needs and budget.

For my system, I chose the ViewSonic, *model GS771, which has a 17-inch screen, a resolution of 1280 x 1024, dot pitch of 0.27 mm, and a refresh rate of 66 Hz. Cost was $429.99.*

Printer, Scanner, etc. Well, by this time you should have a good idea just what your computer system will consist of, and possibly where you are going to order it. But are we now through? NO—not by any means! This is only the beginning. The next logical step is to get a printer, so you can print out all those files, data, letters, and so on. But the wife wants a scanner so she can scan in all the great family photos for greeting cards; and the kids want you to put in a new video camera and a video-capture card. But what about Fax-capability, DVD-ROM drive, a removable storage drive, an uninterrupted power supply, voice-recognition capability...? The list of peripheral or auxiliary computer equipment is endless. The only limitations are your knowledge, and money (that's cash, not cache) in your pocketbook. We, at ***Popular Electronics***, can help with the former limitation, by presenting information on these topics in our monthly columns, such as *Multimedia Watch, Net Watch, Computer Bits, Gizmo, Product Test Report, etc.*, or in our special feature articles. Unfortunately, only you can provide the money to purchase these peripherals!

Having guided you through the purchase of the necessary compo-

(Continued on page 48)



EXPLORING TRANSISTOR LOGIC

Why resort to using TTL or CMOS-logic integrated circuits when discrete-transistor logic circuits will do?

STEVE WEISS

Certainly, no one disputes the value and usefulness of logic gates when it comes to performing or initiating various functions within many circuits. Logic gates are very useful for a variety of reasons. They come in handy during those times when a processor is not desirable for a project. At other times, the lack of the proper programming tools precludes the use of a programmable logic device. And then there are those times when the available voltage is insufficient to drive TTL or even CMOS ICs. That's especially true when it comes to battery-powered devices.

Of course, there's always the alternative 3-volt logic. However, they are not always readily available to the hobbyist or experimenter, and they do not perform below their specified limits (usually about 2.5 volts DC). A battery-powered project may only have room for one 1.5-volt battery. So what do you do? Transistors can substitute nicely for most logic gates. Usually only a couple of transistors are needed for any given logic gate, and only one transistor is necessary for a standard inverter.

FETs or Bipolar? Which is the best choice for low-voltage logic circuits—*F*ield-*E*ffect *T*ransistors (FETs) or bipolar transistors? FETs have the advantage of having an extremely low "on" resistance. They also require low gate-turn-on current. But in very low-voltage applications, they have one drawback. The average gate threshold is usually about one volt. And with a current-limiting or pull-down resistor connected to the gate, the available voltage can dip below the recommended operating conditions of the FET.

On the other hand, a bipolar switching transistor requires a mere 0.6 to 0.7 volt to turn on, thus giving such transistors an advantage in very-low voltage, single-battery applications. In addition, most off-the-shelf FETs (*i.e.*, those available in bubble packs at your local electronics retailer) are generally more expensive than bipolar transistors. In fact, for the cost of a couple of FETs, you can usually purchase a bulk pack of bipolar transistors. Further, handling FETs requires much more

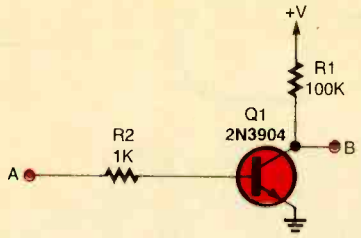


Fig. 1. One of the least complicated transistor applications is shown here. The switch, which can be viewed as being normally open, can be used as an inverter.

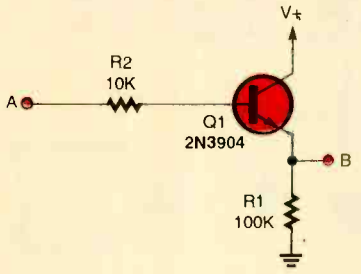


Fig. 2. Here is a variation of the Fig. 1 switching arrangement. By moving the output terminal and the load resistor to the emitter of the transistor, the circuit becomes a buffer amplifier (also known as a voltage follower).

attention than bipolar transistors. FETs are very susceptible to damage due to static and overall experimental abuse. A fun, productive evening of experimenting or designing can be destroyed by blown parts—not to mention the mental anguish of troubleshooting.

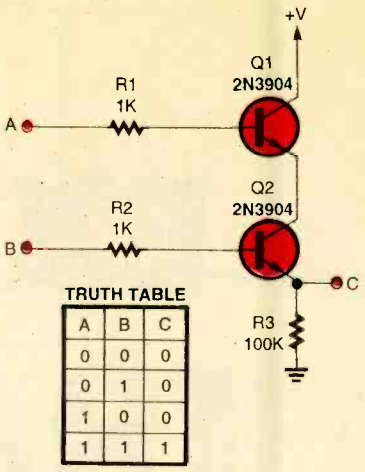
Switching Transistor Basics. For the following examples, bipolar NPN transistors are used—they're inexpensive and do not require special handling. However, proper precautions should be taken when hooking up your circuit so as not to cause damage to the device or its support components. **Note:** Although our circuits are built around *B*ipolar *J*unction *T*ransistors (BJTs) exclusively, the circuits could have just as well been based on FET technology.

One of the least complicated transistor applications is the lowly switch. Figure 1 shows a schematic diagram of the transistor switch. The switch can be viewed as being normally open or held low, depending on how it's used in an application. The simple switching arrangement shown in Fig. 1 (with its input at point A) functions as an inverter. The operation of an inverter is such that as long as no bias is applied to the base (point A) of the transistor (Q1), it remains at cutoff, so its output at point B is high or at logic 1 (close to V+).

However, when an appropriate bias is applied to the base of Q1, the transistor turns on, pulling the output of the circuit low or logic 0 (near ground potential). The transistor, Q1, is a 2N3904 general-purpose bipolar transistor, which is generally used in low-power switching and amplifier applications. Any similar transistor (such as the 2N2222, 2N4401, *etc.*) will do. The values of R1 and R2 were chosen for a balance of minimal current drain and commonality. All resistors used in the examples are $^1/_4$-watt, 5% units. The supply voltage can range anywhere from 1.4 to 6 volts DC. Note that by moving the output terminal and the load resistor to the emitter of the transistor, the circuit becomes a buffer.

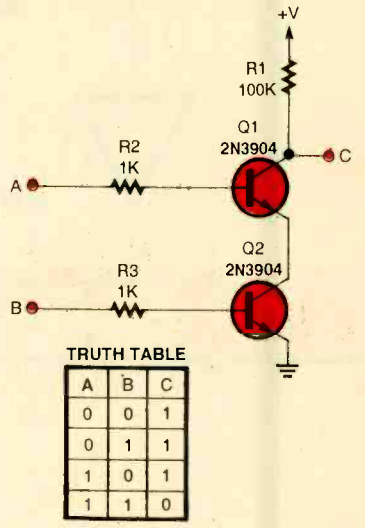
Figure 2 shows the schematic diagram of a similar switching arrangement—this one known as a buffer amplifier, or voltage follower. Note that the only difference between this circuit and the one in Fig. 1 is that the load resistor and output terminal have been moved from the collector of the transistor to its emitter. Moving the load resistor and output terminal to the opposite end of the transistor also "flips" its operation. That is, with no bias applied to the input of the circuit, the circuit's output is low; but when a bias of sufficient magnitude is applied to the input of the circuit, the output of the circuit goes high. (That's just the opposite of what occurs in the previous circuit.)

Logic Gates. Figure 3 is an example of how a pair of buffers (similar to that shown in Fig. 2) can be combined to form a simple two-input AND gate; the truth table for that gate is also shown. The truth table shows what the output should be for all possible input combinations. The input to the circuit is applied to points A and B, while the output of the circuit is taken from point C. Note from the truth table that there is only one set of input conditions that produces a logic-high output signal, while all other input combinations produce a logic-low output.



A	B	C
0	0	0
0	1	0
1	0	0
1	1	1

Fig. 3. Two or more switching circuits can be combined to form basic logic building blocks. Here a pair of switching transistors (setup in a buffer configuration) is used to form an AND gate.



A	B	C
0	0	1
0	1	1
1	0	1
1	1	0

Fig. 4. Shown here is a variation of the circuit in Fig. 3, along with its truth table. By relocating the output (point C) of the circuit and the load resistor to the collector of the upper transistor (Q1), the circuit becomes a NAND gate. The same effect can be achieved by feeding the output of the AND circuit to an inverter.

When the output of the Fig. 3 AND gate goes high, it hovers at just below V+. That's because of the voltage drop across the two transistors (Q1 and Q2). However, even with V+ at 1.2 volts DC, there is sufficient potential to drive another transistor.

Figure 4 shows a variation of the circuit in Fig. 3, along with its truth table. By relocating the output

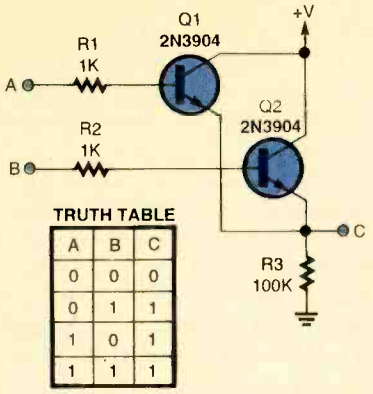


Fig. 5. A simple OR gate can be formed by combining the individual buffer circuits in an arrangement like this one.

(point C) of the circuit and the output resistor to the collector of the upper transistor (Q1), the circuit becomes a NAND gate. Since both Q1 and Q2 must be turned on in order to pull the low side of R1 to ground, the voltage drop at output C is negligible.

If more than two inputs are required for the transistor-AND or transistor-NAND gates, more than two transistors may be used or stacked in the configurations shown, to form three-, four-, etc., input AND or NAND gates. However, V+ should be increased proportionally to compensate for the voltage drops of the individual transistors.

Figure 5 shows another type of logic circuit called a two-input OR gate; the truth table for the OR-gate

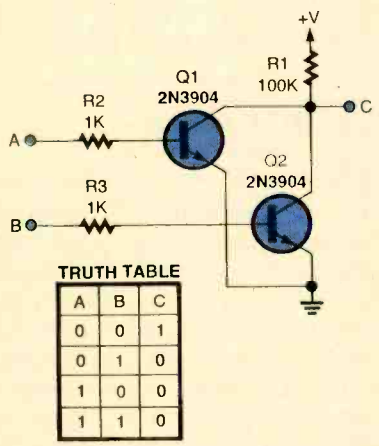


Fig. 6. Shown here is a variation of the circuit in Fig. 5—a two-input NOR gate. The relationship between OR and NOR circuits is similar to the relationship shared by the AND and NAND gates.

circuit is also shown. With either input A or input B pulled high, the output of the circuit at C is high, but because of the cascaded transistors, the voltage drop is close to half of a volt. Once again, with the values shown, there is sufficient voltage and current available to drive the next transistor gate.

The next gate on our "hit parade"—a two-input NOR gate, along with its truth table—is shown in Fig. 6. The relationship between OR and NOR circuits is similar to the relationship shared by the AND and NAND gates. All gates shown can provide sufficient drive to operate at least one or more additional transistor gates.

Transistor Logic Circuit Examples. Now armed with the most-common digital circuits, what do you do with them? Well, anything you would do with standard TTL or CMOS gates, but without the supply-voltage limitations. The following are a few examples of transistor-logic gates at work.

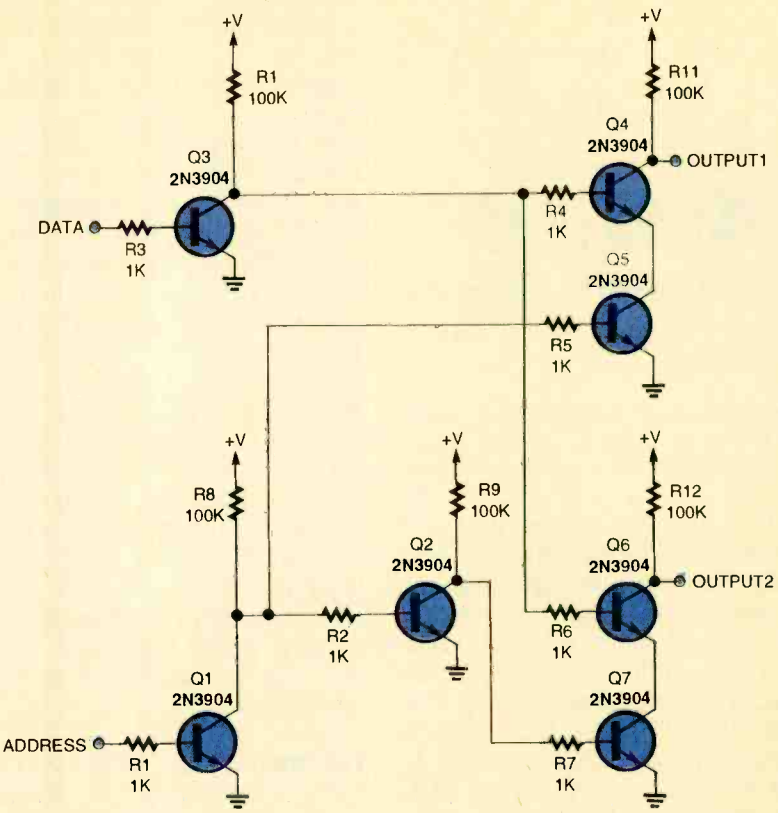


Fig. 7. The basic digital-logic circuits—AND, NAND, OR, NOR, and inverter—can be combined to form more complex circuits capable of performing more sophisticated operations. Here three inverters and a pair of NAND gates combine to form a 1-of-2 demultiplexer circuit.

Figure 7 shows a 1-of-2 demultiplexer that is comprised of three inverter and two NAND circuits. That type of circuit can be used to steer data to one of two outputs. The one bit "address input" is used to select the desired output: either OUTPUT1 or OUTPUT2, while the DATA input is where the information that is to be steered is applied to the circuit. The circuit performs best when the data rate is kept below 10 kHz.

The operation of the circuit is simple. Information is applied to the DATA input, causing it to turn on, inverting the input data. If the ADDRESS input is low (grounded or no signal is applied), the output of Q1 is forced high (inverting the address signal). The high output at Q1's collector divides along two paths. In the first path, the output of Q1 is fed to the base of Q5 (one leg of a two-input NAND gate), causing it to turn on, effectively "enabling" the NAND gate comprised of Q4 and Q5.

At the same time, the high out-

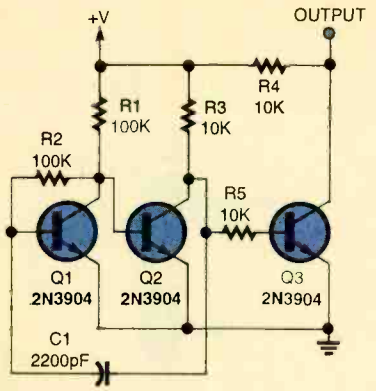


Fig. 8. Timing or clocking applications can also be satisfied by combining inverters to form oscillator circuits, like the one illustrated here.

put of Q1 is fed to the input of another inverter (Q2). The output of Q2 (after going through a double inversion) is low. That low is fed to the base of Q7 (one leg of a second NAND gate, comprised of Q6 and Q7), effectively disabling that NAND circuit. Under those conditions, any information applied to the DATA input appears at OUTPUT1. If, on the other hand, the signal applied to the ADDRESS input is pulled high, the opposite occurs. That is, the Q4/Q5 NAND gate is disabled, while the Q6/Q7 NAND gate is enabled, causing any information applied to the circuit to appear at OUTPUT2.

Our next circuit, shown in Fig. 8, is an example of a simple clock generator (better known as an oscillator) that is comprised of three standard inverters (one of which is biased via a feedback resistor, R2, which puts it into the analog region). The third inverter (Q3)—which provides the complement to the oscillator output—was added to square off the output. To adjust the operating frequency of the circuit, the value of C1 can be raised or lowered. With the component values shown, the output signal has a frequency of approximately 7 kHz with V+ at 1.5 volts DC.

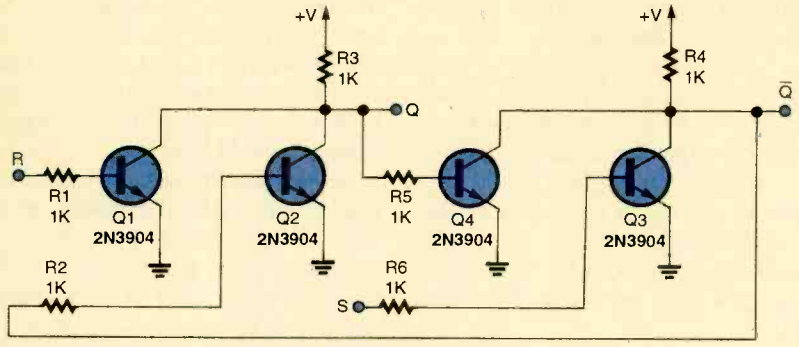
Our final circuit, see Fig. 9, is an RS latch, which is composed of two NOR gates. Resistors R3 and R4 were changed to 1k-units to insure a healthy output drive at the Q and $\overline{Q}$ outputs. The truth table for the RS latch is shown next to its schematic diagram. Those are just a few examples of the many reliable, low-voltage, digital, logic-gates circuits that can be fabricated from discrete transistors.

Too Many Parts. All of those low-voltage logic circuits can be used to solve a lot of problems—but, using such circuits in quantity can create another problem. If the project you are designing has a lot of gates, the number of components can grow quite large, gobbling up precious real estate. One solution to that dilemma is to use transistor arrays (plastic-encapsulated multiple transistors) and SIP (*S*ingle *I*nline *P*ackage) resistors in place of the discrete components.

Such devices can save enormous amounts of real estate on a board, without any difference in performance compared to their full-sized counterparts. Transistor arrays are available in quad packs, in 14-pin through-hole, or surface-mount packages. They generally have a suffix before their number value denoting arrays. For example, a 2N3904 NPN transistor in a quad pack would be listed as a MPQ3904 from Motorola. SIP and DIP resistors come in virtually any value, and are available in three different configurations—networked (called dual-row termination), common bus, and isolated.

For most projects, the isolated type is recommended. Isolated integrated resistors make it easier to use the leftover resistors in a package if they are not connected to anything else. It is usually OK to mix transistor types within a circuit. However, it is suggested that the designer stick to one type throughout the entire project (*i.e.*, if you build a part of a gate with a 2N2222, use that type for the rest of the gate). The reason is that different types of transistors may have slightly different characteristics. One may have a slightly higher or lower average *beta* than another, or perhaps a higher or lower base turn on threshold. It is also less expensive to purchase a bulk pack of a particular part.

Keeping with the practice of using consistent components will not only increase the success of your circuits, it will also increase the overall satisfaction of the entire project. ■



TRUTH TABLE

R	S	Q	$\overline{Q}$
0	0	0	0
0	1	1	0
1	0	0	1
1	1	0	0

Fig. 9. An RS latch, like the one shown here, can be formed from a pair of NOR gates.

COMPUTER A TO Z

(continued from page 44)

nents, you are invited to compare and shop, keeping in mind that there are many compatible motherboards, hard drives, CPUs, *etc.*, which have not been mentioned here. Please feel free to investigate the merits of these other components, insuring that they are compatible with one another. Join us for the next issue of ***Popular Electronics***, where we will guide you step by step through the assembly of your system, and the loading of necessary software. ■

Multimedia Watch

Cameras, Cards, and CD-ROMs

MARC SPIWAK
ASSOCIATE TECHNICAL EDITOR
COMPUTER RESELLER NEWS

Olympus America has done it again. In its quest to dominate the digital photography market, *Olympus* has introduced yet another great piece of digital imaging equipment. The latest product is the *Olympus D-340L Digital Camera,* a small, but powerful digital camera.

The D-340L is packed with innovative features. Its maximum resolution is 1280 × 960, and it can focus to as close as four inches, take up to ten shots automatically in half-second intervals, electronically double image size, create panoramic images, and more. Like all *Olympus* digital cameras, the D-340L can be connected directly to *Olympus' P300 Personal Photo Printer*, a digital photo printer that makes album-sized prints that I can't rave enough about. You have to see the prints to believe them.

I recently spoke about *Olympus D-500L*, a digital camera with all the bells and whistles one could want, plus 1024 × 768 resolution. With its built-in motorized zoom lens, about the only complaint I could come up with concerning the D-500L was that it wouldn't fit in a jacket pocket. But the new D-340L does fit in my pocket, and it has an even higher maximum resolution, 1280 × 960, than the D-500L.

The D-340L also has a video output to connect to a TV or VCR for large-screen image viewing or storing images on videotape. A 4 MB SmartMedia card is included, and the memory is specially formatted to allow panoramic stitching of multiple images. The memory will hold between 9 and 60 images depending on the image-quality setting you select.

While the camera does not have an actual zoom lens, it has a digital telephoto/wide-angle mode that provides the functionality of a zoom lens in a sleek point-and-shoot camera. Inside is an all-glass, 5.5 mm, *f* 2.8 wide-angle lens with macro-mode, equivalent to 36 mm on a 35-mm camera. The camera's built-in 2-inch color LCD display automatically activates in the telephoto/wide-angle mode for through-the-lens composition. The D-340L weighs only 9 ounces and measures 5 inches wide by 2.6 inches high by 1.8 inches deep. A built-in lens shield doubles as a power switch.

The Olympus D-340L Digital Camera *has a maximum resolution of 1280 × 960, and it can focus to as close as four inches. It can also be connected directly to* Olympus' P300 Personal Photo Printer.

Other features include a flash with red-eye reduction, force-fill flash, automatic low-light and back-light mode, and force-off to accommodate all lighting conditions. The D-340L includes four AA Alkaline batteries, a strap, serial cable for Mac and PCs, video connection cable for TV or VCR, *Adobe PhotoDeluxe* image-editing software, *InMedia Slides & Sound* multimedia presentation software, and panoramic image-stitching software. The D-340L has a street price of $699.

Olympus also sent me a sample of its optional *FlashPath*, a 3.5-inch floppy-disk adapter for SmartMedia memory cards. SmartMedia cards slide into the adapter, which looks like a conventional floppy disk, and holds two thin button batteries. The floppy-disk adapter, along with the included software, lets users transfer images from their camera to any computer that has 3.5-inch floppy disk drive. I've never seen anything like it before!

LEXAR MEDIA DIGITAL FILM

While I'm on the subject of digital cameras and their memory, I might mention the SmartMedia cards available from *Lexar Media*. While they look the same as any other SmartMedia memory, Lexar's version of the memory is specially designed to be faster and to work more intelligently with digital cameras. Its intelligent capabilities, such as power management, are hard to see immediately. However, I've seen a demonstration that showed how a digital camera was ready to take another picture much sooner using Lexar memory than with the memory that came with the camera.

Digital cameras generally take several seconds to process and store an image before they can take another picture. And Lexar's "Digital Film" definitely makes cameras work quicker. The SmartMedia memory is available in 4-, 8-, 12-, 16-, 24-, and 32-megabyte capacities. Prices range from $59.99 (for the 4-MB capacity) to $179.99 for the 32-MB version.

BONNIE & CLYDE

I recently received a sample graphics accelerator card that is unlike any other I've ever seen. As you probably already know, the AGP (*A*ccelerated *G*raphics *P*ort) bus is starting to take off on the PC platform—most new PCs have an AGP graphics card. The problem facing consumers in need of a new graphics card is whether or not to buy the PCI (*P*eripheral *C*omponent *I*nterconnect) card they need for their system today, or to upgrade their motherboard as well, and go with an AGP card. *Jazz Multimedia's The Outlaw 3D—Bonnie & Clyde* is a unique solution for people in that situation. It is the first graphics accelerator to feature both a PCI and an AGP bus in a single card. One side of the card has a PCI connector and the other side has an AGP connector—you flip it over and move the card bracket to the other side to use either interface. Bonnie & Clyde is available with 4 or 8 MB of SGRAM (*S*ynchronous *G*raphics *R*andom *A*ccess *M*emory), and it's based on *Rendition's Verite 2200* chipset, which delivers good 2-D performance for business applications and hot 3-D graphics for games. The card offers resolutions up to 1600 × 1200 with 65,000 colors at a 75-hertz refresh. Bonnie & Clyde has a suggested retail

WHERE TO GET IT

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800-369-6736
www.acerperipherals.com
CIRCLE 60 ON FREE INFORMATION CARD

Enroute Imaging
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Palo Alto, CA 94303
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Hasbro Interactive
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Jazz Multimedia
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CIRCLE 65 ON FREE INFORMATION CARD

Ricoh Electronics, Inc.
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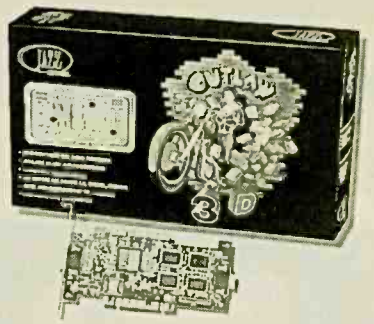
Tustin, CA 92780
714-566-2500
www.ricohcorp.com
CIRCLE 66 ON FREE INFORMATION CARD

price of $149.

ACER PERIPHERALS

I received some new peripherals from *Acer Peripherals, Inc.* recently, one a scanner and the other a CD-ReWrite (CD-RW) drive. The *Acer* Scan 610S is a full-featured 600-dpi, 16.7-million color flatbed scanner with a SCSI (*S*mall *C*omputer *S*ystem *I*nterface). This is all most people need in a scanner, and it's one of the most affordable flatbed units I've come across. It has a street price of under $300. The unit scans quickly and produces sharp, vivid scans. It also includes all the software you need to go along with a scanner, such as image-editing software and OCR (*O*ptical *C*haracter *R*ecognition) software that lets you turn scanned documents into editable text.



Jazz Multimedia's The Outlaw 3D–Bonnie & Clyde *features both a PCI and an AGP bus in a single card. Based on* Rendition's Verite 2200 *chipset, it's perfect for this transitional stage between PCI and AGP graphics.*

Acer's CD-6206A is a 6× Read/2× CD-RW drive. This is one of the next-generation CD recorders that can record, erase, and rerecord data on special blank CDs. It's also compatible with regular CD-R (*C*ompact *D*isc-*R*ead) blanks. The drive has a street price of under $300, so it's a bargain in the CD-RW arena. Disc-mastering software is included with the drive.

Speaking of recording on CD, I received a sample recordable CD-ROM—a blank disc, but not a re-recordable one—that ends people's concerns about the permanency of data stored on recordable CD-ROM. Unfortunately I can't prove it works for over 200 years. I'm talking about the *Ricoh Platinum CD-R*, a blank CD designed with higher than normal precision and a life of over 200 years. It is designed to have a low block-error rate; high resistance to light, heat, and humidity; and is optimized for recording speeds up to 8×. Street price for this CD is around $1.99.

A patented outer coating on the Platinum discs protects against peeling and other damage. That's important because it's much worse if the upper coating on a CD gets scratched or peels off than if the plastic underside gets scratched. Disc drives can often read through scratches and nicks, and sometimes the damage can be polished out. But the disc is ruined for good if the data-bearing metallic upper coating gets damaged. I've seen it happen to both factory and recordable discs.

NEW SOFTWARE

I've been using some pretty amazing software that's also amazingly simple to use. *Enroute Imaging's QuickStitch* software, bundled with digital cameras from *Olympus*, *Nikon*, and *Ricoh*, lets me turn multiple digital images of wide-angle scenes into a single, large image. Not only does it produce panoramic images, the technique effectively increases the resolution of a digital camera by allowing multiple images to form a single, larger one. All you have to do is select a group of image files that you want to stitch together, and then the software shows preview thumbnails of them. You drag and drop the images onto a 4 × 4 grid in the positions they should be in. From there the software does its magic, stitching the images together.

Now *Enroute Imaging* has introduced *QuickStitch 360*, which automatically combines overlapping photos into panoramic images up to 360 degrees. You can output the images to a graphics file or *QuickTime* VR movie, and then pan around the scene or zoom in for greater detail. *QuickStitch 360* automatically previews images, balances exposure, and stitches the images together. *QuickStitch 360* offers automatic or manual exposure and contrast correction, automatic cropping, choice of output resolution, and correction for ghost images. *QuickStitch 360* has a suggested retail price of $69.95.

New from *Hasbro Interactive* comes the *Tonka Garage* CD-ROM. This game lets children design, build, and customize their own *Tonka* vehicles. Once the vehicle is running, it's off to the gas station and then on to the test track. There's also a junk yard to explore, where kids can demolish vehicles, put them in a crusher, and melt them down to make new parts. Of course there's a paint shop, a showroom, and a printing center where kids can print out decals, ID badges, and more. *Tonka Garage* costs $29.95. ■

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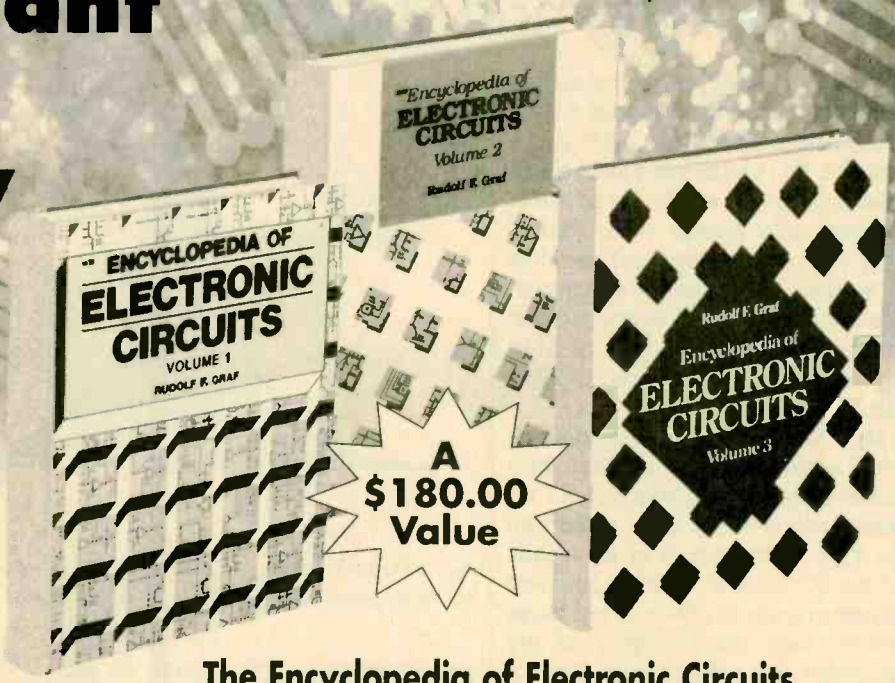

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HAM RADIO

QRP DXing and Boatanchors

JOSEPH J. CARR, K4IPV

In the late 1950s, when I first started in ham radio, we didn't have a lot of money and paper routes didn't pay a whole lot. So I had to find a lot of clever ways to get on the air. On the advice of my ham-radio mentor (Mac Parker, W4II), I put what money I did have into the receiver, rather than the transmitter. As a result, I managed to locate a war surplus *Hallicrafters* SX-28A for $140 (which was a lot more money in 1959 than it is today!).

My antenna system included a pair of half wavelength, more-or-less, horizontal dipoles. One was cut for 40 meters, which meant that I could also use it on 15 meters. The other was cut for 20 meters. I did experiment with other types of antenna, but those dipoles were the mainstay of my operations because of suburban lot restrictions.

There is one thing that characterizes all of the transmitters I owned in those years—low power output. My first transmitter was a single tube homebrew job that used a 6AG7 tube in a crystal-oscillator configuration. I built it from plans in an old *ARRL Handbook* with the help of W4II. It worked, "sorta." The next transmitter was a *Heathkit* DX-20 (50-watts CW, no AM), followed by a real powerhouse—a *Heathkit* DX-35 (90-watts CW, 65-watts AM). I also used an *E.F. Johnson* Viking Adventurer, which ran 50-watts input from an 807 power-amplifier tube.

Golly day, I was in ham heaven after graduating from high school and starting work in a radio repair shop (I didn't go to college until I was 23 years old). I was able to buy a *B&W* Model 5100, which ran 180-watts CW, 120-watts AM and 180-watts PEP on single sideband. I also picked up a ham-band-only receiver, a *National* NC-303. Although it worked quite well, I missed that ol' SX-28A (and am still looking for one for my collection) with its general coverage abilities.

The reason for this rambling personal history is to establish my credentials for a topic that we will deal with in future columns—QRP (ham talk for low power) operating. This month, we will discuss a little about QRP, and in subsequent months, we will look at some simple kit-built equipment that can be used for QRPing, mountain topping, or other low-power ham activities.

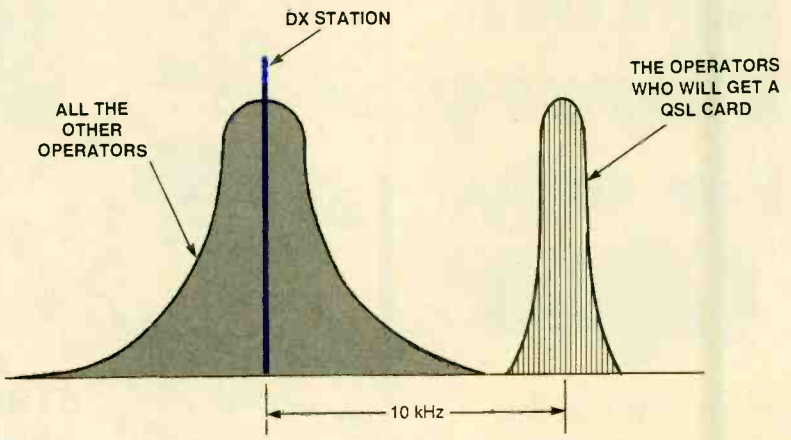

Fig. 1. The key to DX success: Find the frequency where the successful operators are transmitting—not the frequency where the DX station is transmitting.

Vic Clark, W4KFC, was also an early mentor. Vic was one of the big DXers in ham radio of that era, and a mainstay of the Potomac Valley Radio Club (one of the principal contesting and DXing clubs). He later became President of the *American Radio Relay League*. Vic used to pick me up at the house and take me to radio club meetings. He showed me a few things about DXing that helped both high-power and low-power operators.

One of Clark's ham activities was DXpeditions. He would go to some remote DX site (like Swan Island in the Caribbean) and, in a short period of time, work as many stations as he could. He taught me a method used by DX stations—they often answer stations that are on a different frequency than they transmit on. Figure 1 shows how this works in practice. The DX station transmits on the frequency indicated by the heavy dark line, but listens on a frequency about 10-kHz higher, or lower, than the transmit frequency (often this practice is called split-frequency operation).

Huge numbers of less skilled operators pile onto the DX stations transmit frequency, creating a huge "pile-up." There is a tremendous cacophony of stations calling the rare DX station, but getting no reply. Clark told me that his method of operating on DXpeditions was to set his receiver on the narrowest passband suitable for that mode (*e.g.* narrower for CW than for SSB). He would then work the stations that fell into the center of his passband at his designated DX split frequency.

What are the practical effects of this method? Having a lot of power into a high-gain beam antenna is always an advantage. But when the receiver selectivity skirts are relatively sharp, the advantage of the high power is diminished if your transmit frequency is not matched to the other operator's receiver frequency (simplex operation). The practical benefit goes to the operator who zeroes in on the DXer's receiver frequency, rather than his transmitter frequency.

Listening on a frequency that is *around* 10 kHz higher, or lower, than the DX station's transmit frequency will put the unsuccessful responding stations outside the passband of the DX station's receiver. Only those operators who zero-beat the receive frequency of the DX station are successful.

So how do you zero in on the other DX station's receiver frequency? After all, receivers don't emit a signal that can be zero-beat. The solution is to listen before transmitting and find the location of the stations who are working the DX station. Once you locate those signals, then zero-beat stations on *that* frequency, *not* the DX transmit frequency.

Some big DXers use two high quality communications receivers in their station. One will undoubtedly be the receiver section of their transceiver, while the other will be a high quality SWL receiver (or the receiver section of another transceiver). They use the "other" receiver to keep track of the DX station's signal, and the receiver inside the main transceiver to listen to the stations that are successful in making the contact.

PRACTICAL ZERO-BEATING

A lot of hams talk about "zero-beating" frequencies. So what does that mean? In the pure technical sense, it means adjusting a frequency source so that it has zero difference compared with another source. The process of heterodyning between two frequencies, f_1 and f_2, produces both sum ($f_1 + f_2$) and difference ($f_1 - f_2$) products. In zero-beating, we are concerned with the difference product. If, for example, one signal (f_1) is at 7001 kHz, and the other (f_2) is at 7002 kHz, then the difference is 7002 - 7001, or 1 kHz (1000 Hz). If you listen to the beat note, then you will hear a 1000-Hz tone.

In practical zero-beating, you adjust the procedure to the job at hand. In CW operating, for example, you should adjust your own transmitter frequency so that it produces the same tone beat note as the station you are listening to. The reason is that the beat frequency oscillator (BFO) or product detector (PD) in your receiver will beat against the raw CW signal (which sounds like a "thunka thunka thunkitty thunk" when the receiver is set for AM), producing the familiar beat note.

Most amateur radio operators go for a received beat note of 400 to 1200 Hz for most comfortable listening. Unfortunately, if the other station is using a narrow CW filter (*e.g.* 270 Hz), then zero beating on the BFO/PD beat note will put you outside the passband of his or her receiver. And that means no QSO. But if you set the beat frequency

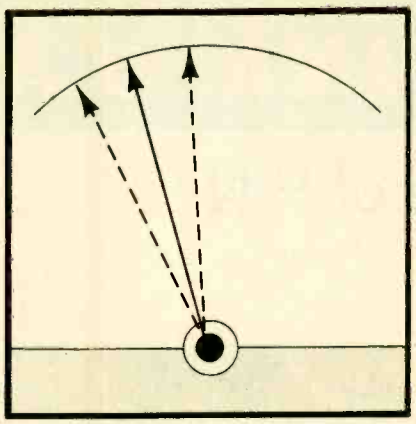

Fig. 2. Making accurate zero-beat measurements requires minimizing the swing of the S-meter needle as the two signals come together.

tone to about the same frequency as the tone coming out of the receiver, then you are on the same frequency (probably). Experiments show that the human ear can separate two tones within ± 50 Hz, which is certainly within requirements.

The fly in the ointment is that you have to be on the same side of the incoming RF. A superhet receiver with a BFO/PD can be set to either side of the frequency and still put out the same beat note. For example, suppose your receiver has a 9-MHz (9000-kHz) intermediate frequency (IF). A BFO set to 9001 kHz will produce a 1000-Hz beat note. But so will one set to 8999 kHz. Fortunately, whether you have a variable or fixed BFO/PD, it is usually fairly easy to ascertain which side of the IF the injection is on—and adjust your transmitter frequency from the same direction. Of course, if you use a transceiver this is done for you. In months to follow, we will look at simple QRP transmitters and receivers—and in such equipment you might not have that luxury.

The other situation where you will zero beat is when accurately measuring the off-the-air frequency of an incoming signal. The usual method is to use some accurate frequency source, and then zero beat it against the incoming signal. Unfortunately, there are two built-in limitations that might make it difficult to home in on the actual frequency. First, communications receiver audio sections usually have a 300- to 3000-Hz frequency response. The response of the audio amplifiers tends to drop off below 300 Hz, making it difficult to accurately see a zero beat in that region. Second, the human ear drops off rapidly below 40 Hz, so even if the receiver has a lower frequency response than usual, your ears do not.

So what's the solution? The most accurate frequency measurement occurs when the zero-beat condition occurs, *i.e.* when the difference frequency $f_1 - f_2 = 0$. There is a relatively simple solution to this measurement problem if the receiver has an S-meter. An interesting condition will be noted on the S-meter when $f_1 - f_2 \approx 0$. The needle on the meter will begin to bobble at a slow rate (Fig. 2) that is equal to the difference frequency. That means you can adjust the reference frequency to minimize the bobble rate, *i.e.* try to make the needle stand as steady as possible.

I first saw this method when a friend of mine competed in the *ARRL* Frequency Measuring Test back in the early 1960s. He had a very large *Hickock* vacuum-tube voltmeter that had originally been made for classroom use. The pointer of the meter was about nine inches long, so any bobble at the end actually swung over a relatively large distance even though the arc angle was small. He connected the voltmeter to the receiver automatic gain control (AGC) line, which is essentially what the typical S-meter reads. The frequency measurer could then count the needle swings over a known period of time, and then use that frequency to adjust the value read from the heterodyne-frequency meter. In another column, I will cover the details of heterodyne-frequency measurements.

CALLING ALL BOATANCHOR FANS!

The "BoatAnchors" Internet mailing list is devoted to the discussion of vintage communications equipment, fondly referred to as "Boatanchors" (which is where the name comes from). The central theme is vintage amateur radio equipment using vacuum-tube ("firebottle") technology. After all, "real" radio operators know that "real" radios glow in the dark. But they have been known to drift into discussions of such things as entertainment boatanchors, antennas, telegraph keys, classic electronic or radio books and radio history.

I recently signed up with BoatAnchors because of my intense interest in radio history, and collecting antique ham radio receivers and tele-

(Continued on page 57)

Think Tank

A Different Type of PIN

ALEX BIE

In our continuing review of semiconductor components, we come across another familiar device that finds multiple uses in a number of electronic circuits: namely the PIN diode. The PIN diode is widely used in radio-frequency circuits, since their construction enables them to perform well as switches and as attenuators. Apart from this, the PIN diode is also used in high power rectifiers, where its structure also enables it to withstand high voltages.

PIN diodes were first developed in the early 1950s in high power rectifiers. The first technical papers on their operation appeared in 1952, but it was not until 1958 that they started to be used in radio-frequency and microwave applications.

Diode Sandwich

The PIN diode consists of an intrinsic, or un-doped layer, of semiconductor sandwiched between P- and N-type layers. It is the intrinsic layer that gives the diode its unique properties. This layer has a low concentration of carriers (holes or electrons), and as such has a relatively high level of resistivity. Normally the intrinsic layer is quite narrow, typically between 10 and 200 µm. On either side of the intrinsic layer, the P-type and N-type semiconductor material are normally heavily doped (referred to as P+-type layers and N+-type) layers. Hence the name: *P*ositive-*I*ntrinsic-*N*egative, or PIN developed for this device.

The diodes are manufactured in two main forms—planar and mesa as shown in Fig. 1. For the planar structure, a substrate of heavily doped N-type (N+) substrate material is used. A layer of intrinsic material is then grown onto this and the heavily doped P-type region (P+) is diffused into this layer. For the mesa structure, the intrinsic and P+ areas are grown in layers onto the N+-type substrate. The outside layers are then protected with a layer of oxide.

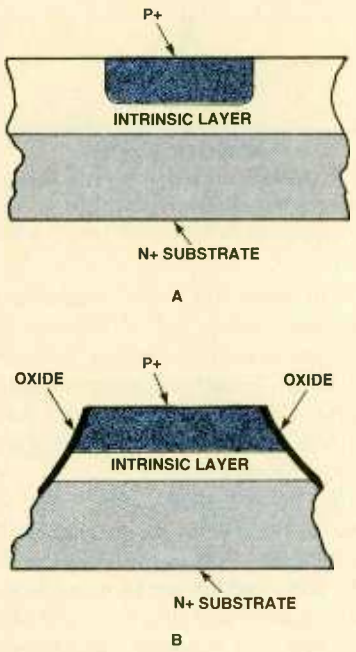

Fig. 1. There are two major structures for PIN diodes: the planar configuration shown in (A) and the mesa fabrication of (B).

For high-frequency operation, the mesa structure is better because the layer thickness can be controlled more accurately. This enables the intrinsic layer to be made very thin. In addition to this, levels of capacitance can be reduced and surface breakdown are less of a problem.

Operational Characteristics

The intrinsic layer performs a vital part in the operation of the PIN diode. It has virtually no carriers (holes and electrons) of its own, and at low levels of bias the carriers do not enter this layer. As a result, no current flows.

Under reverse bias conditions, the layer of depletion and the capacitance between the P- and N-type regions remains almost the same. Under forward bias conditions, a current starts to flow. The potential causes electrons to enter the intrinsic region. Further electrons enter the N-type region from the connection. Electrons are forced to leave the P-type region and flow into the external connection, creating holes. These holes migrate across the P-type region and enter the intrinsic region. The holes combine with electrons from the N-type region allowing further holes and electrons to enter the intrinsic region. The overall effect of this is that a current flows in the circuit.

One important characteristic of the PIN diode is that once it is forward biased it follows a very linear characteristic, being virtually resistive in nature. Unlike a normal PN junction diode, there is virtually no distortion or rectification.

There is a key frequency in the operation of the PIN diode, which we will call f_o, or cutoff frequency. At frequencies well below f_o, the PIN diode behaves as an ordinary PN junction diode. The RF signal on the diode is rectified and considerable distortion of the input signal occurs. In the vicinity of f_o, the diode begins to behave as a linear resistor with a nonlinear component. At frequencies well above f_o, the diode appears essentially as a pure resistance whose value can be controlled by a DC or a low-frequency control signal. As shown in the plot of Fig. 2, the diode resistance decreases almost linearly with increased bias current.

PIN Diode Usage

PIN diodes can be used in several areas. For amateur radio purposes, they are widely used as RF switches. When PIN diodes are forward biased they can be considered as a short circuit, although there is actually a small loss. When they are zero or reverse biased, they act as an effective isolator. For increased isolation, use is made of two or more PIN diodes in a series/shunt arrangement.

In the reverse-bias or zero condition, their capacitance is comparatively small because of the thickness of the intrinsic layer. This makes them superior to ordinary diodes whose capacitance is higher because the depletion layer (the

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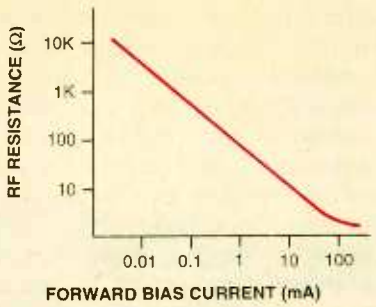


Fig. 2. A typical plot of RF resistance versus bias current of a PIN diode.

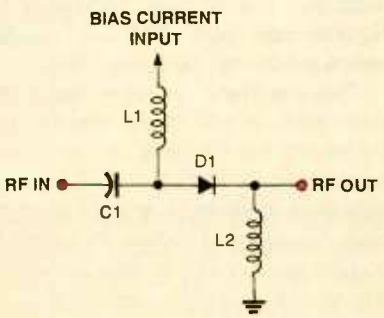


Fig. 3. A simple RF switching and attenuator circuit using PIN diode, D1. Note its linear relationship to the bias current.

layer around the junction which is depleted of holes and electrons because it is reverse biased) is not as thick. As a result, PIN diodes are often used as transmit-receive switches in transceivers. Here they are superior to electromechanical relays because they are more reliable, mechanically rugged, and operate far more quickly.

Diodes for use in the switching applications must be high-power varieties capable of carrying a few amps when forward biased and high voltages in the reverse-bias condition. The actual specifications are naturally dependent upon the power being transmitted.

PIN diodes are also used in voltage-controlled variable RF attenuator devices. They act as variable linear resistors, controlled by the level of bias, and as a result they can be incorporated into circuits to control the level of attenuation. With careful design, the impedance of the attenuator can be maintained within reasonable limits over the range of operation. At radio frequencies, the diode appears almost as a pure resistance, whose resistance value can be varied over a range approximately 1–10,000 ohms by a direct or low-frequency control current. When the current control is varied continuously, the PIN diode is useful for attenuating, leveling, and amplitude modulating an RF signal. When the control voltage is switched "on" and "off," or varied in digital steps, the device is useful for switching, pulse modulating, or phase modulating of an RF signal. A typical RF switching and attenuator circuit with PIN diode, D1, is shown in Fig. 3. Common inexpensive PIN diodes are the *Motorola* MPN3404 or the *Hewlett Packard* HSMS3800–HSM3900 series—just to name a couple.

Other than in RF applications, at frequencies well below cutoff, PIN diodes find uses as high-power rectifiers. PIN diodes used in these applications normally have a wide intrinsic layer, and this increases the reverse breakdown of the diode.

In next month's column, we will continue our "What is a ...?" series as we examine a widely used semiconductor device—the familiar light-emitting diode or LED. Now let's get to the readers' circuits.

PUMP CONTROLLER

A friend of mine, who owns a small pump (*Little Giant*), asked me to build an electronic pump-controller, which will be placed in a small cavity. I designed this controller around a 555 timer IC and other components (see Fig. 4).

When water reaches the probes, pin 2 of IC1 goes low, triggering the timer; pin 3 goes high and stays high for as long as the time-delay potentiometer, R1, is set above a triggering value. When this trigger value is reached, the IC switches the control voltage on the solid-state relay (SSR), tying its output pins together to provide power to the 117-volt receptacle, SO1, which powers the pump. Time delay on this circuit can be set from 1 to 90 seconds. The full-wave bridge rectifier is a standard 1A, 50 PIV-type (such as *RadioShack* part 276-1146), and the transformer, T1, is a 117 volt to 12 volt, 1A, step-down type. This circuit has been working over two years without a problem.

—Jiri Stuchlik, Edmonton, Alta., Canada

Nice circuit, Jiri. The SSR should be selected for your particular circuit application, but I am sure the RadioShack *part 275-310, which is rated at 3A, 125V, with a 1.2 VDC trigger voltage would be a good general-purpose relay to start with. As per our reader's comments in the September "Think Tank" Mailbag—don't forget to use stainless steel-type metal for the water-immersed probes.*

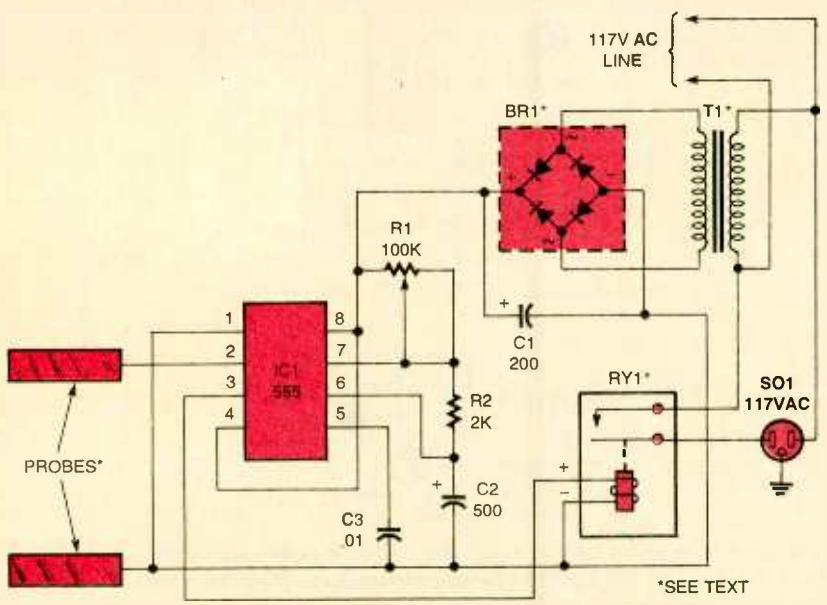


Fig. 4. This neat circuit is used as an AC controller for a water pump inserted into power outlet SO1; however, any device, which depends upon probes in a conducting medium to work, can be used in its place.

BETTER SIDE-TONE

This circuit was originally designed to replace the side-tone circuit (using the 555 timer, IC2) in Fig. 4 of the "Electronic Keyer," in the January 1998 "Think Tank" column, page 73, but as you will see it has other uses.

The new circuit (Fig. 5A) results in a more realistic and pleasing tone than

the original design with the 555 chip. This design is based around a *National Semiconductor* LM4861M audio power amplifier IC, using a phase-shift oscillator network consisting of capacitors C3–C5 and resistors R1–R3. Capacitor C2 serves as input coupling and R4 serves as overall feedback for the amplifier. Nominally the values of C3–C5 should be in the 6800-pF to 0.01-μF range, while R1–R3 are around 10 k. If you want to adjust the oscillator frequency, change the phase-shift oscillator components—use small value capacitors to raise the frequency, or larger value capacitors to lower the frequency. Their values can be determined from the equation

$$f = 1/2\pi RC$$

where R = R2 = R3, and C = C3 = C4 = C5. Make sure these components are as close to each other in value as possible. Use good quality mica capacitors, if available.

In Fig. 5B, the circuit is converted into a code-practice oscillator. Replace transistor Q1 and resistors R5 and R6 of Fig. 5A to use this stand-alone oscillator circuit.

—Craig Kendrick Sellen, Waymart, PA

Fine addition to an originally good circuit. Craig was wondering if any of our design buffs would be interested in modifying his phase-shift oscillator design with a Wien-bridge or twin-tee oscillator configuration—and comparing the performance. By the way, we checked with National Semiconductor, *and although the LM4861M IC is not that common, it is available from their major distributors.*

FLASHING-LIGHT ALARM CLOCK FOR THE HEARING IMPAIRED

How can a hearing-impaired person be reliably awakened by an alarm clock? This is a problem that I've struggled with for a number of years because my daughter is hearing impaired. And, while she hears fairly well when she has her hearing aids in and on, she obviously doesn't wear her aids when she sleeps. Since she suffers from a severe-to-profound hearing loss in both ears, even the "Super-Loud" alarm clock from *RadioShack* (part 63-741) did not have the ability to wake her up.

Recently, I noticed that when I turned on the light in my daughter's room prior to awakening her in the morning, she would start to move around a little bit. I am aware that hearing-impaired people are very visual, so I started to wonder if a flashing light might awaken a hearing-impaired sleeper. I found that I could awaken my daughter by turning the room lights on and off rapidly. This led me to consider modifying my daughter's alarm clock so that it would flash an external light in sequence with the pulsating alarm.

I didn't have a schematic of the *RadioShack* alarm clock. However, it was easy to find the alarm speaker and its associated wires. Using an oscilloscope, I was able to determine that the speaker was driven by a pulsating alarm tone (as opposed to being a self-contained alarm transducer driven by a pulsating voltage source). Now, if I could just find a way to use this tone to control a light.

This task turned out to be very easy. I found an AC solid-state relay (SSR) in the *RadioShack* catalog (part 275-310). A DC current of around 30–50 mA will cause this solid-state relay to switch up to 3 amps of current at 117 VAC.

The circuit I finally came up with is shown in Fig. 6. I simply rectified the alarm signal and applied it to the control pins on the solid-state relay. All components except the solid-state relay are mounted on a 5-lug tie-point *RadioShack* part 274-688. Number 4 hardware is used to mount the tie-point and the solid-state relay to the cover of the alarm clock. I also added [illegible] on/push-on switch [illegible] as shown in the photos, to turn the lamp on and off. This switch [illegible] across the solid-state relay. I used *Digi-Key* part 508PB-ND because I had one; however, *RadioShack* part 275-694 rocker switch would also be perfect here.

There is plenty of room inside the alarm clock to add all the circuitry and the switch. For the lamp socket, I used a pendant cable with a 117-VAC receptacle on it made from an old extension cord. Take care to ensure that there is no possibility of any shorts, especially around the 117-VAC circuitry. And, of course, **do not** work on the alarm clock unless it is disconnected from 117-VAC line!

To operate, plug a lamp into the 117-VAC receptacle and ensure that the switch on the lamp is turned on. Now, just set the alarm as usual. If you

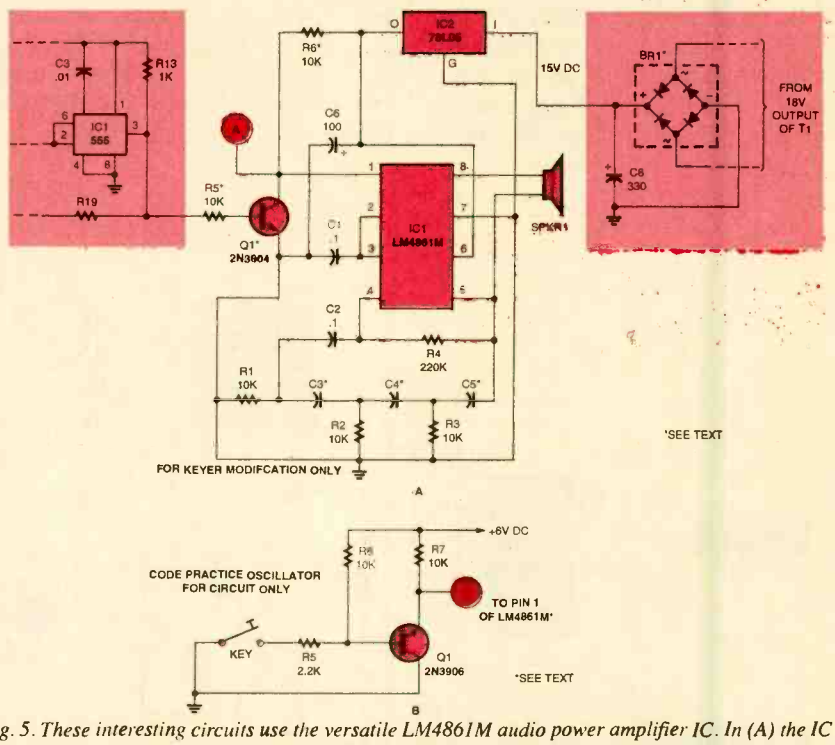


Fig. 5. These interesting circuits use the versatile LM4861M audio power amplifier IC. In (A) the IC is used in a modification to a previous **Popular Electronics** *electronic keyer circuit (January 1998, "Think Tank", and shown shaded). This circuit results in better tonal qualities for the generated side-tone. In (B) the oscillator is now used in conjunction with the LM4861M IC and provides an independent code-practice oscillator, which can be used to upgrade your CW skills.*

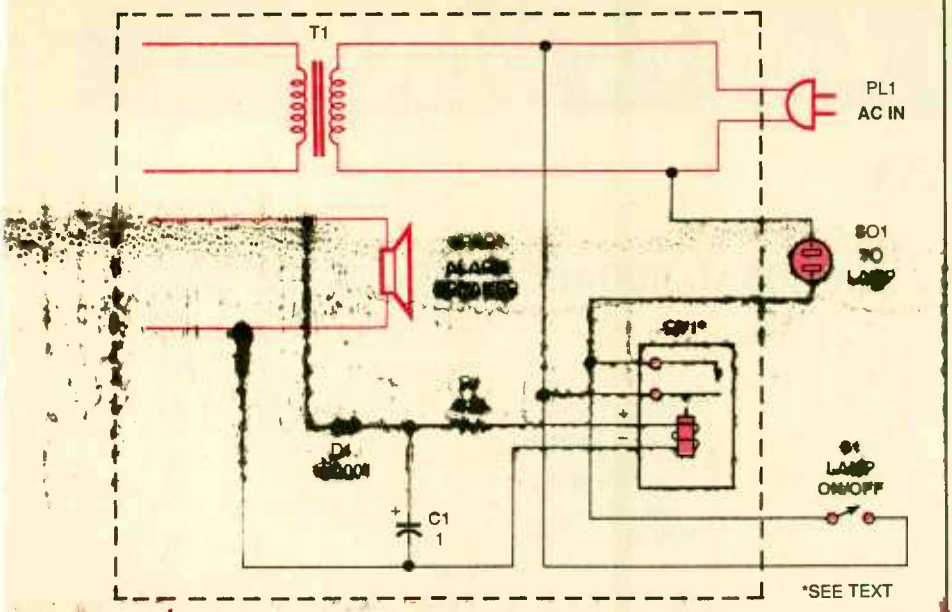
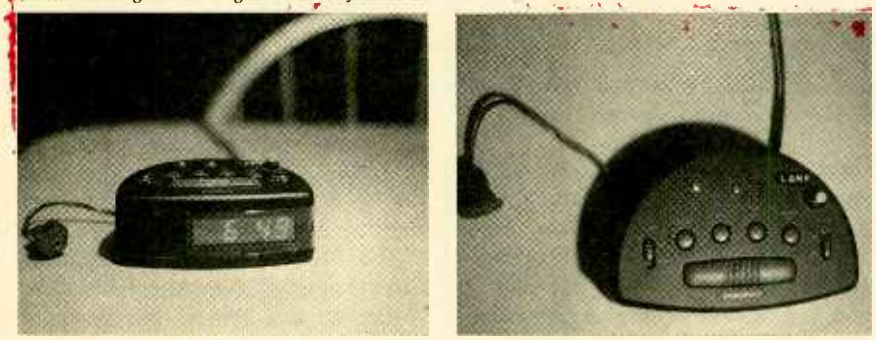


Fig. 6. Here is the circuit modification of an existing RadioShack *alarm clock to provide pulsing of an external light. The original circuitry is shown in color.*



Front view of the RadioShack *"Super-Loud" alarm clock showing the AC receptacle for the lamp, and the lamp-controlled push-button switch on the top right-hand side. In the top view you can plainly see the added push-button switch for controlling the lamp, independent of the alarm.*

want to turn on the lamp at any time, use the new lamp switch mounted in the alarm clock.

The flashing lamp worked beyond my wildest dreams. It reliably wakes up my daughter very quickly. As a matter of fact, it seems to wake her up faster than our audio alarm clock is able to wake up my wife and me! If you are hearing impaired, or know of someone who is, try this simple modification to this commercial alarm clock. You (or they) will be impressed as to how well it works!

—Phil Salas, Richardson, TX

That's a handy upgrade project with a happy ending, Phil. It's great when you modify a standard item and enhance it with features that makes its performance even more useful. I am sure that many of our readers can find novel uses for the circuit such as you described. Perhaps some enterprising manufacturer will incorporate such a feature into their product! ■

HAM RADIO

(continued from page 53)

graph keys. I received information from Jack, W4KH, the BoatAnchor Mailing List Archiver/Owner, and pass it along to you.

The members of the list have agreed among themselves to help defray the costs of the list and its distribution, through annual subscriptions, beginning 15 March 1996, with a modest annual fee. People on the list feel it is worth the effort and the fee to perpetuate the BoatAnchor's way of being, and generally regard the fee as "dues" for a club or as "electronic postage"—prepaid for a year.

You will, as a new subscriber, have a free "trial" subscription for about four weeks, which should give you plenty of time to look us over and make up your mind, as well as time to get your subscription in and processed. If you find the information and fellowship here useful and you want to do your part to ensure the continuation of "BoatAnchors," you will find the address for sending your subscription fee in the "Welcome" message.

Like nearly all decent list servers, the BoatAnchors people have a "terms of service" or "Netiquette" in place. Each subscriber must understand that the subscription does not give one the right to be disruptive on the list. Failure to observe common courtesy and consideration for your fellow subscribers or straying way off into non-BoatAnchor topics will result in your suspension or dismissal from the list, without recourse. Exercising good judgment and polite behavior will result in a most satisfying experience and an opportunity to buy, sell or trade vintage tube equipment and parts, and locate assistance from skilled engineers and experts in restoration.

If you would like to try out the BoatAnchors list, send the list owner a simple e-mail. It should include your real name (your e-mail address will be in the headers) indicating you understand the basics of polite societies such as exists on the BoatAnchors list, and they will subscribe you for a trial period.

Note that the BoatAnchors e-mail list is a "closed" list, and only subscribers may post. They have taken many steps to remove, block, and otherwise keep "SPAM" off the list. As part of that effort, they subscribe to the "RBL" real-time database of SPAM sites, and block all mail from those sites. Should your ISP become a "blocked" site, you will not be able to send mail to the list administrators, and you will not be able to post to the list itself. Your only recourse is through your ISP, in encouraging your ISP to change whatever is causing the site to be blocked. We do maintain a secondary address at *w4kh@hotmail.com*, which should remain open for e-mail in case mail is blocked by "theporch.com." Contact BoatAnchors at: *listown@jackatak.theporch.com.* I can be reached by snail mail at P. O. Box 1099, Falls Church, VA, 22041, or by e-mail at *carrjj@aol.com.* ■

DX LISTENING

New New Guinea

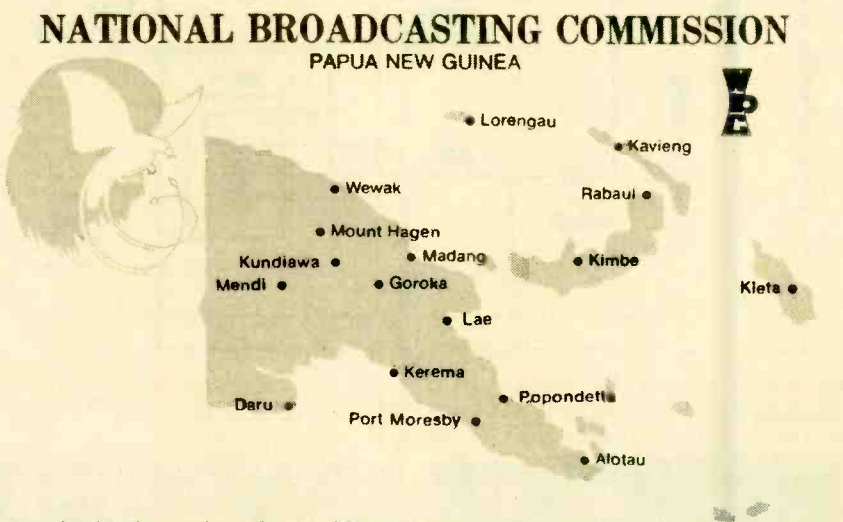
DON JENSEN

Quick! What is the second largest island in the world? The answer is New Guinea. (The largest, by the way, is Greenland). Now that the prime DX season of Fall is upon us, it's time to begin hunting those tough-to-hear stations that may have eluded you during the warmer months, when atmospheric noise and static obscured the weaker signals. And one particularly tempting target country for SWLs is the island nation of Papua New Guinea (PNG), which shares the world's number two island-size record with Indonesia. There are a surprising number of domestic SW broadcast outlets in PNG, none of them easy to hear, but most of them sometimes audible in North America at this time of year, given favorable reception conditions.

Papua New Guinea has an interesting history. In the 1880s, when European powers were busily grabbing chunks of overseas territory as colonies, one prime bit of real estate was the very large, lush island just north of Australia. To resolve conflicting colonial claims by imperial Germany, Great Britain, and Holland, New Guinea was divided into three parts.

The entire western half went to the Netherlands, and now it is part of Indonesia known as Irian Jaya. The rest was split between England and Germany. The southern quadrant, known as Papua, went to Great Britain, and, after the turn of the century, to Australia. Germany wound up with the island's northeast section, and a number of nearby small island groups. When Germany lost World War I, its New Guinean territories were mandated to Australia to administer. In the mid-1970s, the entire eastern half of the island gained independence as Papua New Guinea.

Even today, there still are parts of the interior of this island of jungle and jagged mountains that are, in truth, little removed from the Stone Age. In colonial days, Australia established shortwave services at Port Moresby, the capital, and at a number of small communities, both on New Guinea itself and on some of the outlying islands, such as New Britain, New Ireland, and part of the Solomons group.



A map showing the locations of some of Papua New Guinea's National Broadcasting Corporation (formerly Commission) shortwave stations.

With independence, nearly a quarter century ago, these SW outlets and some additional stations became part of the island's National Broadcasting Corporation (NBC) of Papua New Guinea. The NBC shortwave chain includes some 20 stations. However, Papua New Guinea is, after all, a Third World nation with limited resources, so some of these stations are frequently off the air for various periods of time. A recent check showed no sign of at least six of them, apparently shut down at least temporarily. However they may be back on, while others have gone silent, by the time you read this.

The key station, though not necessarily any more reliable than the local outlying outlets, is the National station at Port Moresby, which targets the entire population as well as serving, according to announcements, as "the Voice of Papua New Guinea throughout the Pacific." After a period of inactivity, the National station again has been heard on both 4890 and 9675 kHz.

The National station has 100-kilowatt transmitters; the other stations use 10-kilowatt units. Recent reception suggests that the former and a number of the latter probably are running less than peak power. The best time to hear any of Papua New Guinea's NBC stations is during the last hour or two before your local dawn.

The other NBC shortwave stations are targeted to local and regional audiences. Located throughout the Papua New Guinea-half of the big island are:

Radio Eastern Highlands at Goroka, on 3395 kHz; Radio Western Highlands at Mt. Hagen, on 3375 kHz; Radio Southern Highlands at Mendi, on 3275 kHz; Radio East Sepik at Wewak, on 3335 kHz; Radio Sandaun (Radio West Sepik) at Vanimo, on 3205 kHz; Radio Northern at Popondetta, on 3345 kHz; Radio Central at Boroko, on 3290 kHz; Radio Western at Daru, on 3305 kHz; Radio Madang at Madang, on 3260 kHz; Radio Milne Bay at Alotau, on 3365 kHz; Radio Morobe at Lae, on 3220 kHz; Radio Gulf at Kerema, on 3245 kHz; Radio Enga at Wabag, on 2410 kHz; and Radio Simbu at Kundiawa, on 3355 kHz.

CREDITS—Rich D'Angelo, PA; J. Findlater, CA; Bob Hill, MA; Fred Kohlbrenner, PA; David Krause, OH; George Maroti, NY; William McGuire, MD; Ed Newbury, NE; Jay Novello, NC; Denis Pasquale, PA; Bob Raymond, NH; Terry Wolf, OH; Dan Ziolkowski, NY.

On the outlying smaller islands of Papua New Guinea are Radio East New Britain at Rabaul, 3385 kHz, and Radio West New Britain at Kimbe, 3235 kHz, both on New Britain island; Radio New Ireland at Kavieng, 3905 kHz, on New Ireland; and Radio Manus, at Lorengau, 3315 kHz, on Manus Island in the Admiralty group.

PIDGIN PROGRAMMING

More than 30 ethnic languages are heard on the local and regional stations, and some English programming also is aired, especially on the National outlet station. But a particularly interesting language used by many of the NBC stations is Pidgin—formerly known as Pidgin English—which is understood in many parts of PNG.

Pidgin began in the 19th Century as a radically simplified version of English used by European traders to communicate with the diverse native peoples of New Guinea. Eventually, it evolved into a real and separate language with its own vocabulary, spelling, and grammar.

"Harim program bilong olgeta pipal ikam long NBC."

This identification announcement, put into something more like English would be "Hear him program belong all together he come along NBC, or, more freely translated, "Listen to the programs for everyone from the National Broadcasting Corporation of Papua New Guinea."

In Pidgin or the King's English, that's good advice for any SWL!

PACIFIC PARADISE

Long a favorite station of many DX listeners, the *Societe Nationale de Radio Television Francaise d'Outre Mer* shortwave outlet on Tahiti has had a rocky couple of years. RFO, for short, had an old and truly unreliable shortwave transmitter near Papeete, capital of French Polynesia. When it was on the air, and usually it was not, reception was very poor.

This was a shame, too, since the programming, often wonderful island music with its pulse-racing Tahitian drumming, was among the most exotic-sounding to be heard on shortwave. It was enough to send your imagination winging across the thousands of blue ocean miles to this paradise.

The good news, though, is that RFO seemingly has a new transmitter and again is being heard with regularity and vastly improved signals. The frequency is 15170 kHz, Look for this one with local Tahitian and French programming—with French news, a satellite feed from Paris, on the hour—until 0600 UTC, when it switches to all French, the AM and FM domestic France-Inter network, also fed by satellite.

CHILE TODAY

A new station, which should be fully operational by now, Radio Vision Cristiana promises to do for Chile what longtime religious broadcaster HCJB has done for Ecuador—make an otherwise not-so-easy South American SW country a simple catch.

Like HCJB, Radio Vision Cristiana is a Christian radio station. Two years ago the British religious organization, Christian Vision acquired a series of high powered 100-kilowatt shortwave transmitters, formerly used by the Chilean government Radio Nacional de Chile, long off the air. After applying for a license to broadcast from Santiago, Radio Vision Cristiana began testing on one frequency, around 21550 kHz, earlier this year.

Chief engineer Andrew Flynn, who formerly was assigned to another Christian Vision shortwave outlet in Zambia, southern Africa, said that programming in Spanish will be directed to listeners from Mexico to southern South America, with Portuguese programs for a Brazilian audience. It seems likely that there also will be some English, if only identifications.

In time, Radio Vision Cristiana will use more and different frequencies. To check on this, you can e-mail the station at vozcrist@interaccess.cl or check out its Web: *www.christian-vision.org/*. The mail address is Radio Vision Cristiana, Box 490, Santiago 3, Chile.

DOWN THE DIAL

Why not drop a note with details on the interesting SW stations you've come across. Be sure to include the time and frequency and some notes on what you heard, particularly if you liked or disliked the programming. Send along any questions you may have about SWLing, in general, or about particular stations or countries broadcasting on shortwave. I'll try to answer them for you.

The address is: Don Jensen, c/o DX Listening, ***Popular Electronics***, 500 Bi-County Blvd., Farmingdale, NY 11735.

In the meantime, here are some SW targets to tune for:

ALBANIA—7160 kHz, Radio Tirana is on this frequency with political news and identification in English around 0245 UTC.

ICELAND—5055 kHz, Riksutvarpid, the national broadcasting service in the capital of Reykjavik transmits here in Icelandic. It was noted with a sermon at 1834 UTC, with a parallel transmission on 9275 kHz. These transmissions utilize the upper sideband mode. The station also has been heard on 11402 and 13650 kHz, around 1950 UTC.

LATVIA—5935 kHz, Radio Latvia in Riga has been heard with English language programming until sign off at 2135 UTC.

MEXICO—9705 kHz, Radio Mexico International has an English program called "Antenna Radio Summary," at 0415 UTC, followed by English news and identification.

NIGERIA—7255 kHz, Voice of Nigeria in Lagos has English programming from after 0500 UTC until 0700 UTC, when the schedule switches to French. Programs include news and rock music with an African beat.

PAPUA NEW GUINEA—4890 kHz, the National station is logged here at 0920 UTC, in English, relaying a program from Radio Australia. This was followed with local news and popular music.

PHILIPPINES—9670 kHz, Radio Veritas Asia, a Roman Catholic SW outpost in the Philippines, is heard at 1200 UTC with programs in the Lao languages, preceded by an English identification.

SUDAN—9200 kHz, Republic of Sudan Radio operates on this frequency around 1900 UTC. It has been heard with long programs in Arabic, with mention of the Sudanese city of Omdurman.

TURKEY—7300 kHz, Voice of Turkey has Turkish music and a folklore program in English after 2330 UTC.

UGANDA—3340 kHz, Radio Uganda is noted here from around 0400 UTC with lively African highlife music. At 0420 UTC it was heard with English news on another frequency, 4976 kHz.

UNITED ARAB EMIRATES—15395 kHz, Dubai's SW outlet is observed signing on with Arabic programming, music and recitations from the Holy Qu'ran, at 1500 UTC. ■

ANTIQUE RADIO

Radio Repair for Dummies-2

MARC ELLIS

Last month, I began a series on basic antique radio repair. It is aimed at those of you who are either new to the hobby or who are just beginning to think about working on some of the acquisitions you have been collecting. I plan to present strategies to use to return many sets to working condition, even if you don't yet have a lot of technical expertise.

Before going on, I need to mention that the discussion so far is slanted towards AC sets (the ones that plug into the wall socket). Though much of what has and will be said also applies to the earlier battery models, I'll add some specific tips for them at the end of the series.

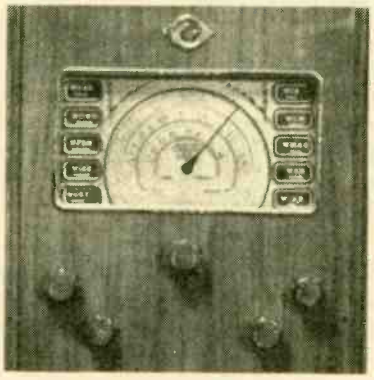
In our first installment, I discussed some basic tools and resources that should be on a restorer's workbench. Then a first inspection of a radio to be restored was done, using no tools but eyes and ears to search for clues to component failures and other problems. Finally, it was time to begin actually working on the radio—doing an initial clean-up and removing the tubes.

TUBE SHIELDS

To continue on the subject of tubes, it's important to bring up the often-neglected subject of tube shields. If your radio happens to be equipped with metal tubes, which are self-shielding, you won't have to worry about this. But sets with glass tubes will almost invariably have tube shields installed at certain critical locations.

Tube shields may be straight and cylindrical. Or, in the case of the tubes with "double dome" (type-ST) bulbs, the shields may be made in two halves shaped to the contours of the glass. Locked together with a snap ring, the halves snugly enclose the bulb. Regardless of design, the shield must make contact with one or more "wipers" mounted on the chassis so it can be effectively grounded. It may also have a separate "hat" piece to cover the top of the tube.

Later tubes with the small cylindrical "bantam"-type bulbs were fitted, when necessary, with simpler cylindrical shields—usually one-piece—which slipped over the glass and made contact with the chassis as already described. The still later baseless miniature tubes were also fitted, when necessary, with similar shields.



Make sure your set is fitted with all of the shields it was designed to have. If necessary, find replacements on a "junker" chassis.

Tube shields prevent electronic feedback and other undesirable interactions that can take place in sensitive circuitry carrying radio-frequency energy. The shielding system installed by the radio's manufacturer must be kept intact, otherwise the set may squeal, motorboat, or develop some other type of annoying and difficult-to-correct oscillation.

If your radio has some shielded tubes, note the fittings installed on the chassis to contact the shields. Then see if such fittings are installed in other locations currently without shields. If so, you'll need to replace these. "Junker" radios obtained at flea markets are your best source.

ELECTRICAL CLEANING

Once the tubes and shields are removed, check to see if there are any other "plug-in" components such as loudspeakers, loop antennas, and pilot-lamp assemblies. Cautiously remove the plugs, being careful not to force them in cases where contacts seem to be "welded" by corrosion. Use a gentle rocking motion to loosen the contacts, and then ease the plugs out little by little.

Your next job is to clean all of the electrical contact points in the radio. This includes tube and plug pins, tube and plug socket contacts, and surfaces where tube shields mate with each other or the chassis. Spray a good brand of contact cleaner/lubricant on the pins and contacts; then gently work the tube or plug in and out of its socket several times. Examine the pins carefully, and use fine sandpaper or steel wool to remove any remaining corrosion. Also spray the mating surfaces of the tube shields, as well as their chassis contacts, following up again with light sanding or light cleaning with steel wool.

Each of the controls in the radio will require individual attention. For potentiometers such as the volume and tone controls, use the extension straw on your aerosol cleaner can to squirt the solvent inside the metal cover. You can usually squirt through the crack where the cover wraps around the terminal strip. Then work the control back and forth through its full range several times so that the solvent will have a chance to cut though any deposits on the wiping contact or resistance element.

Treat all switches the same way. Band switches usually have open contacts, which make it easy to apply the cleaner. Also be sure to clean the tone control, station selector, and other switches. Enclosed slide-switches, if present, can be handled just like potentiometers: Find a crack around the switch terminals through which to squirt enough cleaner to do the job. Also look for wiping contacts on the tuning capacitor, spray them liberally with cleaner, and work the control through its range several times.

TUBE TESTING

"But I don't have a tube tester," you say. "I'm just getting started!" Well that's the point. You don't have to worry too much about testing tubes. It's

amazing how rare it is for a tube problem to be bad enough to stop a set from working. Even a set with one or more tubes rated as "weak" on a good tester will often run just fine, pulling in a good selection of stations with no trouble at all. Of course, a tube that doesn't light (open heater) will definitely silence any radio.

If your set is transformer-powered and has glass tubes, you can easily spot an open heater. When you are ready to turn on the radio for the first time, just observe it in dim light and make sure all the tubes glow. If the set has metal tubes and will not operate, you can feel the tubes to see if one is not heating up.

You could also use the "ohms" scale of your multimeter (lowest resistance range) to check for continuity between the filament pins of each of the tubes. Your tube manual will tell you which pins they are. Recommendations about multimeters and tube manuals were made in last month's column.

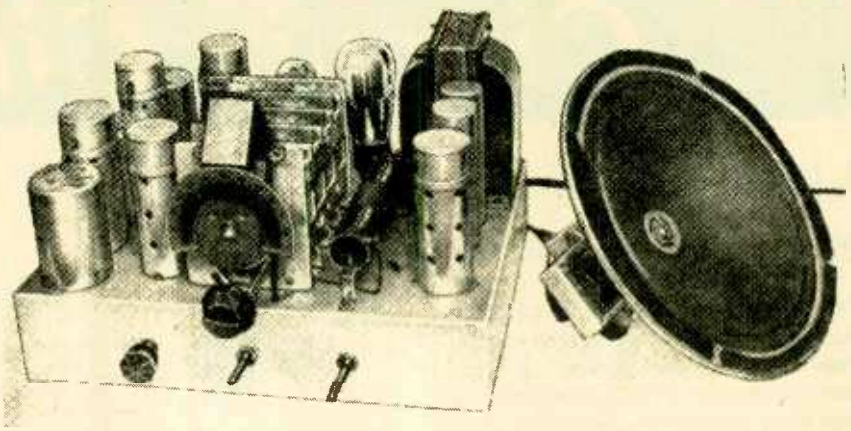
The AC-DC radio, as described in last month's column, is quite prone to open-heater tube problems. The circuit design is such that the heaters glow brightly, operating on more than their rated voltage, for a few seconds after the radio is first turned on. Because of this, heater failure is much more common than in transformer-powered sets.

And there's an additional complication. Since the heaters of AC-DC sets are wired in series, the failure of one heater will cause all to go out—just like with an inexpensive Christmas light set. In a way, this simplifies troubleshooting. If the tubes refuse to light when you are ready to power up the set for testing, the problem that caused the set to fail is likely to be a burned-out heater. Use your ohmmeter to find out which one.

Never fail to ohmmeter-check and (if necessary) replace the pilot light on an AC-DC set. For reasons we won't explore right now, operating some AC-DC sets with a burned-out pilot light can lead to premature rectifier tube heater failure.

THE SMOKE TEST

If the radio you are trying to coax into life is one that you plan to use or demonstrate frequently, you should strongly consider replacing all of the paper and electrolytic capacitors with new ones. This will eliminate a lot of problems that could be waiting in the wings to keep your radio from operating. It will also provide insurance against short circuits that can lead to failure of other components that are very difficult to find replacements for, such as power-, IF-, or output-transformers. Such capacitor replacement, which will be discussed in the next installment, is well within the capabilities of even a neophyte restorer.



Behind almost every knob on the set you are restoring will be a potentiometer or switch in need of cleaning and lubrication.

However, if the radio is not one of the showpieces of your collection, and will be turned on only occasionally, it's not unreasonable to consider a test with the existing capacitors. Providing, of course, that you've found no burned, melted, or charred components in your initial inspection. Most people won't want to expend the time or the materials to put every set in their collection in top working order.

If you discovered a brittle or broken line cord during your initial inspection, now is the time to replace it. As was discussed last month, replacing a line cord that contains a voltage-dropping resistance element (present as a third asbestos-covered wire) is beyond the scope of this series. It will have to be covered in a series on more advanced troubleshooting. Now is also the time to correct any corroded or loose grounds, or other questionable connections, you may have found during the inspection.

Before starting up your set, find an extension cord in good condition and cut one of the two parallel wires. Connect the free ends to an ordinary lamp socket. Screw the lowest wattage bulb you have available into the socket and plug the radio into the cord. The lamp will be in series with the line and the radio when you plug the extension cord into your isolation transformer (see last month's column). Connect your multimeter (on an AC range appropriate for 115 volts) across the line where it enters the radio.

With the radio's power switch in the "off" position, plug in the extension cord. Your multimeter should read the normal line voltage. Turn on the power switch and observe the meter reading. If it drops to less than about 50 volts, try the next highest wattage bulb. The idea is to start up the set at a very low voltage to give the long-disused electrolytic power-supply filter capacitors a chance to "re-form." "Forming" is the process by which the thin layer of electrolytic paste between the layers of foil in the capacitor, under the action of electric current, builds up its insulating properties.

On a more sophisticated workbench, start-ups on old sets are done with a continuously variable autotransformer such as a *Variac*. This allows the line voltage to be built up slowly and gradually to facilitate the forming process. However, this cruder method will work reasonably well.

When you get near a value of 50 volts, carefully remove the probes from the AC line and reset your multimeter to the 250-volt DC range. (About a 500-volt range if you are dealing with a transformer-powered set.) Connect the negative probe to chassis ground and the positive probe to one of the rectifier heater-socket contacts (either one). You should read a small DC voltage—perhaps 25–50 volts.

If not, the rectifier tube heater may not be receiving enough voltage for the tube to conduct and provide DC to the filter caps. Try a somewhat larger lightbulb wattage and see what happens.

(Continued on page 65)

CIRCUIT CIRCUS

Light it Up!

CHARLES D. RAKES

This session, the *Circus* is going to spotlight circuits using a very interesting and unique infrared light-to-frequency converter integrated circuit. The TSL245 IC, manufactured by *Texas Instruments*, converts light intensity to frequency without any additional components or circuitry.

A pictorial and functional block diagram for the TSL245 is shown in Fig. 1. Inside the three-legged CMOS chip is a silicon photodiode, encased in a visible-light cutoff filter, along with a current-to-frequency converter. The output is a true 50% duty cycle square-wave with frequency directly proportional to the light intensity hitting the photodiode. The photodiode responds best to infrared light in the wavelength range of 800 nanometer (nm) to 1100 nm, but is not blind to visible light (4000–7000 nm). *(The TSL230 and TSL235 devices have a response range in the visible spectrum—Editor).* The device operates on a single supply source of 2.7 to 6 VDC with low power consumption (5 mW) and is TTL compatible. *(Since this device is rather unusual and may be difficult to find at your local parts store, the sidebar lists several suppliers—including the author—who have this part available—Editor.)*

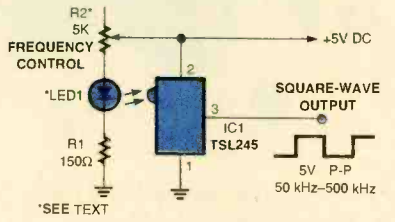


Fig. 2. Just apply some IR energy from the LED and a square-wave output will result.

PARTS LIST FOR THE LIGHT-VARIABLE SQUARE-WAVE GENERATOR (FIG. 2)

IC1—TSL245 infrared light-to-frequency converter, integrated circuit (see sidebar)
LED1—Infrared light-emitting diode (*Mouser* part 512-QED223; Tel. 800-346-6873), or similar
R1—150-ohm, 1/4-watt, 5% resistor
R2—5000-ohm potentiometer

LIGHT-VARIABLE SQUARE-WAVE GENERATOR

Our first circuit, see Fig. 2, is a variable-frequency square-wave generator that covers the frequency range of 50 kHz to about 500 kHz, using the potentiometer R2 as the frequency control. An infrared (IR) LED (with specified maximum output at 880 nm) is aimed at the input window of the TSL245 (that's the small domed-bulge on the front of the IC), with a spacing of about half inch.

The IR pair must be housed in a light-tight enclosure. This step is very important, because any outside light that reaches the photodiode will interfere with the circuit's operation. The circuit's lowest operating frequency is limited by the minimum amount of light that reaches the photodiode. In total darkness, the circuit's output frequency can be less than 1 Hz. The circuit's lowest operating frequency occurs when R2 is set to its maximum resistance value and the LED's light output is at its lowest level.

The square-wave generator circuit may be modified to operate in the audio frequency range by increasing the value of R2 to a 10k resistor or 20k potentiometer. If the circuit fails to operate at low frequencies, temporally remove power from the IR LED and check the output frequency. If it is above 50 Hz, there is a good possibility that outside light is reaching the photodiode. Shine a bright light at the circuit and check for a frequency increase. If no change occurs, the housing is light-tight. If an increase occurs, locate the light leak and provide cover.

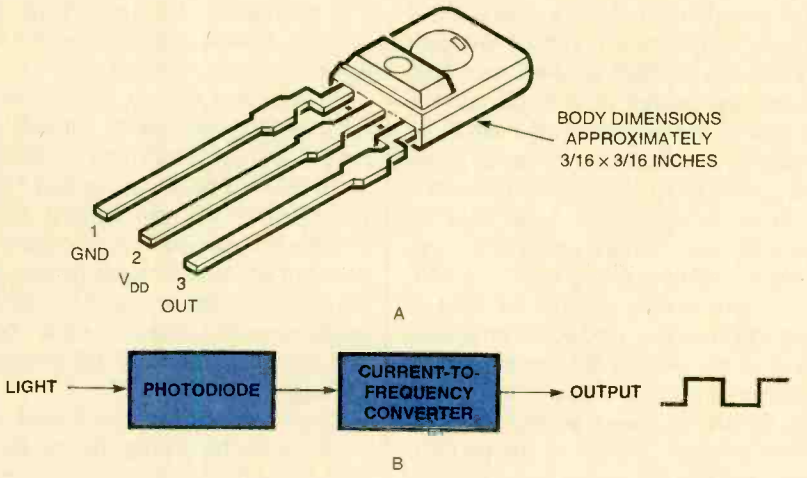


Fig. 1. The unusual TSL245 light-to-frequency integrated circuit is illustrated in A, while B shows a functional block diagram of the converter.

LIGHT-OPERATED VARIABLE-PITCH AMPLIFIER

Our next circuit, Fig. 3, places the TSL245 in a light-seeking circuit that produces an audible output tone in response to the level of IR-light hitting the IC. Even though the IC has a built-in IR filter, additional filtering must be used for the circuit to operate in the audio frequency range in normal ambient light. A suitable IR filter can be made from the unexposed and developed ends of 35mm, or similar type, film. The film ends will be very dark and may be stacked in as many layers as necessary over the front of the IC for the circuit to produce a 2- to a 8-kHz output tone in a room with normal light. The number of film layers used

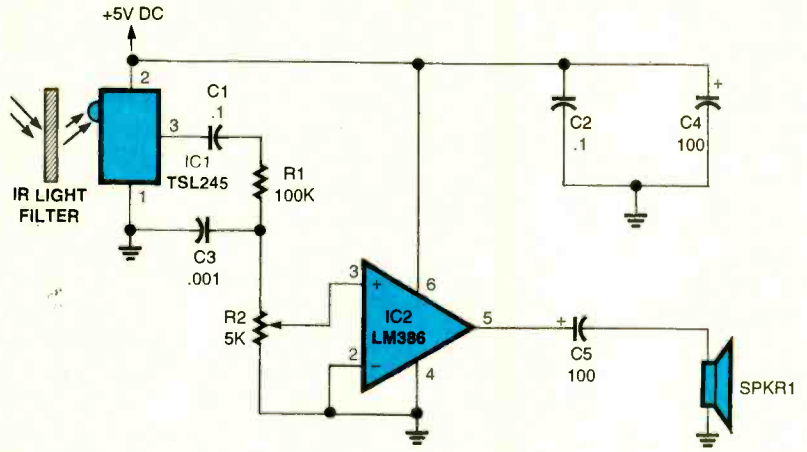


Fig. 3. This fun-circuit produces an audio output whose pitch is proportional to the light falling upon IC1.

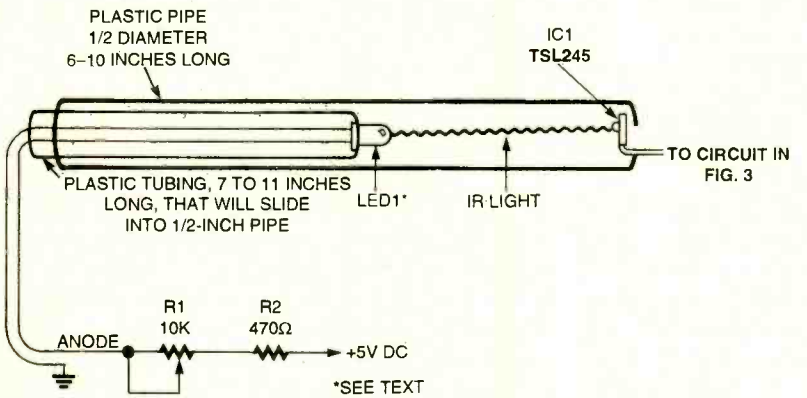


Fig. 4. Add this tube with an adjustable LED-to-IC positioner, and you have an electronic trombone.

will set the circuit's maximum operating frequency. The lowest output frequency will depend on the minimum amount of light allowed to reach the IC's photodiode.

Here's how the circuit operates and what you can do with it. The ambient light impinging upon IC1 causes the TSL245 to produce an output, which is coupled through C1, R1, and R2 to the input of an LM386 audio power amplifier IC. C3 bypasses the higher frequencies to ground. The amplifier drives a small 4-ohm speaker. If you want to change the output frequency, wave your hand over the TSL245 and the reduction in light will lower the oscillator's output frequency (or pitch). Block all of the light you can with your hand or any opaque object, and the tone will drop to it lowest frequency. If you're musically inclined, try varying the light level with your hand and see if you can play a simple tune.

ELECTRONIC-TROMBONE CIRCUIT

Let's get into the music-making mood and take a look at the circuit in Fig. 4—add it to the light-seeking circuit in Fig. 3, and you have a fun electronic-trombone circuit. The TSL245 is mounted in one end of a piece of $^1/_2$-inch plastic pipe facing toward the opposite end. The area behind IC1 must be sealed to prevent light from entering around the backside of the integrated circuit. The TSL245 connects to the circuit in Fig. 3, as IC1. An IR LED is mounted in one end of a plastic tube that snugly slides into $^1/_2$-inch pipe. As the LED moves in the direction of the TSL245, the output frequency goes up, and as the LED moves away from the IC, the frequency drops accordingly. The oscillator's frequency range is set with potentiometer R1—adjust it to operate within the audible frequency range. If too much ambient light enters the plastic pipe, try painting the outside with a flat-black paint.

PARTS LIST FOR LIGHT-OPERATED VARIABLE-PITCH AMPLIFIER (FIG. 3)

C1, C2—0.1-μF, ceramic-disc capacitor
C3—0.001-μF, ceramic-disc capacitor
C4, C5—100-μF, 25-WVDC, electrolytic capacitor
IC1—TSL245 infrared light-to-frequency converter, integrated circuit (see sidebar)
IC2—LM386 audio power amplifier, integrated circuit (NTE823, S9210, or equivalent)
R1—100,000-ohm, $^1/_4$-watt, 5% resistor
R2—5000-ohm potentiometer
SPKR1—4-ohm speaker
Miscellaneous—IR light filter material, *etc.*

PARTS LIST FOR ELECTRONIC-TROMBONE CIRCUIT (FIG. 4)

IC1—TSL245 infrared light-to-frequency converter, integrated circuit (see sidebar)
LED1—Infrared light-emitting diode (*Mouser* part 512-QED223; Tel. 800-346-6873), or similar
R1—10,000-ohm potentiometer
R2—470-ohm, $^1/_4$-watt, 5% resistor
Miscellaneous—plastic pipe, *etc.* (see text)

LIGHT-OPERATED THEREMIN INSTRUMENT

Our next circuit, Fig. 5, adds a phototransistor to the basic circuit in Fig. 3, turning it into a simple light-operated Theremin. For those not familiar with this term, a Theremin is an unusual musical instrument that is played without touching or contact; merely waving your hand near the circuit changes the pitch and volume of the output.

The phototransistor, Q1, is connected in a voltage-divider circuit between the output of IC1 and the input to IC2. The ambient light level on Q1 sets the pitch output level (when Q1 is dark or covered, this minimum light level sets the maximum tone output). Light variations on IC1 determine the volume of the output level.

Separate Q1 and IC1 by about ten inches and use one hand to control the volume and the other for the tone. Adjust potentiometer R1 for the best volume operating range. If too much light is getting to the phototransistor, place some IR filters over it, and adjust the number of filters for the best high/low pitch operating range. A similar procedure may be required for the control of volume determined by IC1.

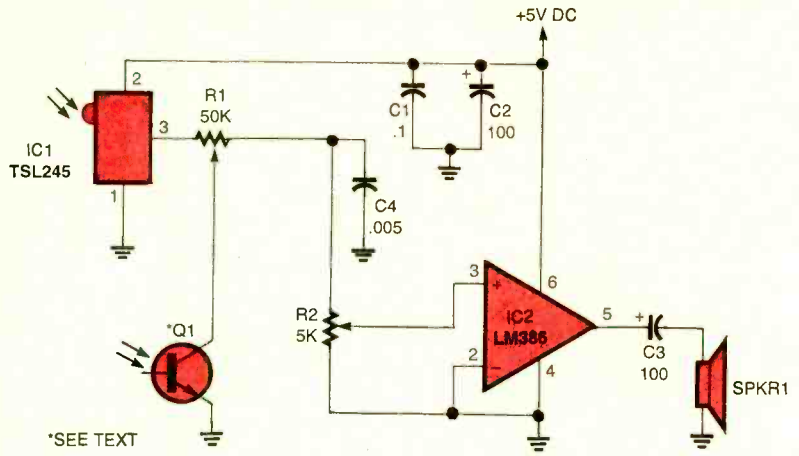


Fig. 5. This unusual circuit functions as a light-operated Theremin musical instrument. Varying the light upon the phototransistor and IC1 sets the pitch and volume, respectively, of the output.

PARTS LIST FOR LIGHT-OPERATED THEREMIN INSTRUMENT (FIG. 5)

C1—0.1-μF, ceramic-disc capacitor
C2, C3—100-μF, 25-WVDC, electrolytic capacitor
C4—0.005-μF, ceramic-disc capacitor
IC1—TSL245 infrared light-to-frequency converter, integrated circuit (see sidebar)
IC2—LM386 audio power amplifier, integrated circuit (NTE823, SK9210, or equivalent)
Q1—IR phototransistor (*Mouser* part 512-QS0723; Tel. 800-346-6873), or similar
R1—50,000-ohm potentiometer
R2—5000-ohm potentiometer
SPKR1—4-ohm speaker

AUDIO-SWEEP GENERATOR

Our next entry, see Fig. 6, places the TSL245 in a light-driven audio-sweep generator circuit. The IR LED and TSL245 are located about $^1/_4$-inch apart face-to-face and housed in a light-tight enclosure.

The circuitry following IC1 is essentially the same as was used in Fig. 3, but in this circuit we're supplying a varying IR light source to control IC1's output frequency. IC3, a 555 IC oscillator/timer, is connected as a low-frequency oscillator circuit operating at about 1 Hz. Transistor Q1 is connected in an emitter-follower circuit that offers isolation between the high-impedance saw-tooth waveform output generated at IC3's pins 2 and 6, and the low input resistance of the IR LED. As the voltage across capacitor C6 increases, the current through LED1 rises, producing more light that in turn causes IC1's output frequency to increase. The sweep generator's frequency is set by R4, the square-wave output frequency range is controlled by R5, and the amplitude by R6.

This audio-sweep generator can be used to plot the output curve of an audio filter, response of an amplifier to a square-wave input, and in any other test arrangement that requires this type of signal. Also there is a fun side to using this circuit. You can play around with the settings of potentiometers R4 and R5 and make the generator sound like a number of different electronic siren circuits.

AUDIBLE LIGHT COMPARATOR

Our last design for this visit is an audible light comparison circuit shown in Fig. 7. This circuit operates somewhat like the old beat-frequency metal locator's circuits that were popular in the 1960s. The two TSL245 outputs are connected together through two 10k isolation resistors and then through a common 10k mixing resistor. The mixed signal output is tied to the high

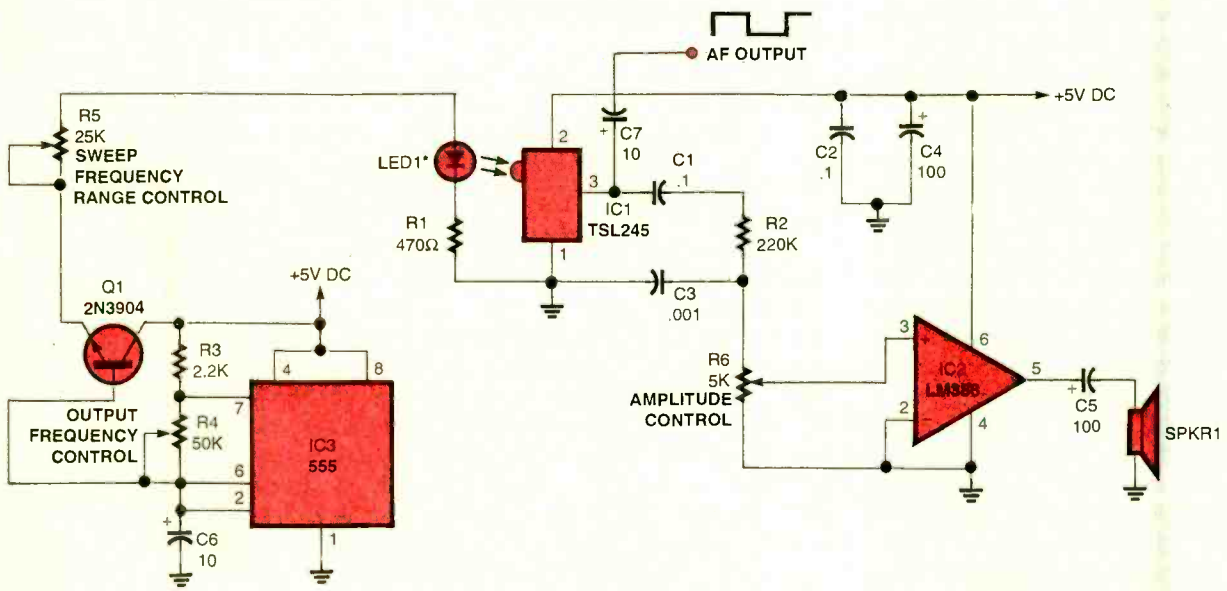


Fig. 6. In this circuit, the TSL245 IC is configured to produce an audio sweep generator—complete with frequency, range, and amplitude controls.

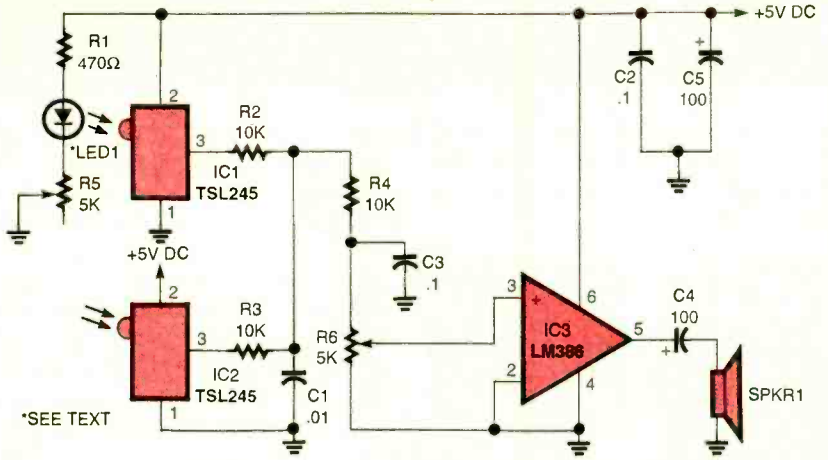


Fig. 7. Here two TSL245 ICs are arranged in an audible light comparator circuit. Any difference in light upon the photodiode area of these ICs will produce a notable audio signal from the speaker.

PARTS LIST FOR AUDIO-SWEEP GENERATOR (FIG. 6)

C1, C2—0.1-μF, ceramic-disc capacitor
C3—0.001-μF, ceramic-disc capacitor
C4, C5—100-μF, 25-WVDC, electrolytic capacitor
C6, C7—10-μF, 25-WVDC, electrolytic capacitor
IC1—TSL245 infrared light-to-frequency converter, integrated circuit (see sidebar)
IC2— LM386 audio power amplifier, integrated circuit (NTE823, SK9210, or equivalent)
IC3—555-oscillator/timer, integrated circuit (NTE955M, SK3564, or equivalent)
LED1—Infrared light-emitting diode (*Mouser* part 512-QED223; Tel. 800-346-6873), or similar
Q1—2N3904 general-purpose NPN transistor (NTE123AP, SK3584, or equivalent)
R1—470-ohm, 1/4-watt, 5% resistor
R2—220,000-ohm, 1/4-watt, 5% resistor
R3—2200-ohm, 1/4-watt, 5% resistor
R4—50,000-ohm potentiometer
R5—25,000-ohm potentiometer
R6—5000-ohm potentiometer
SPKR1—4-ohm speaker

SOURCES FOR THE TSL245 IC

Charles D. Rakes
P. O. Box 445
Bentonville, AR 72712
Please send $2.80 per device to cover part plus shipping

Newark Electronics
Tel. 800-463-9275
Equivalent part number:66F4572

Wyle Electronics
Tel. 800-414-4144

PARTS LIST FOR AUDIBLE LIGHT COMPARATOR (FIG. 7)

C1—0.01-μF, ceramic-disc capacitor
C2, C3—0.1-μF, ceramic-disc capacitor
C4, C5—100-μF, 25-WVDC, electrolytic capacitor
IC1, IC2—TSL245 infrared light-to-frequency converter, integrated circuit (see sidebar)
IC3—LM386 audio power amplifier, integrated circuit (NTE823, SK9210, or equivalent)
LED1—Infrared light-emitting diode (*Mouser* part 512-QED223; Tel. 800-346-6873), or similar
R1—470-ohm, 1/4-watt, 5% resistor
R2, R3, R4—10,000-ohm, 1/4-watt, 5% resistor
R5, R6—5000-ohm potentiometer
SPKR1—4-ohm speaker

end of the 5k volume-control potentiometer. Capacitors C1 and C3 filter out the high frequency signals that are above the hearing range. If the two TSL245s are receiving the same light intensity from the IR LED light source, LED1, their output frequency will be very close, and the difference frequency from the mixer will be low and easily heard coming from the speaker. If something partially blocks the light from either of the light detectors, the output of the partially blocked IC will go down in frequency, and the resultant audio-output pitch will go up in frequency by the same amount.

The circuit may be used to compare and match various types of light filters. Initially position the IR LED so both of the TSL245s are receiving the same light input level—this will produce the same output frequency. The circuit is now in the zero-beat mode of operation, and no output tone will be heard. Place a filter between each of the TSL245s and the IR LED, and any difference in the two filters will be indicated by the audio output tone.

It looks like we're about out of light at this *Circuit Circus* visit—so tune in next month at the same time for more circuitry. ■

ANTIQUE RADIO

(continued from page 61)

When you do succeed in measuring some voltage at the tube pin, let the set sit in that condition for five or ten minutes. Then try yet a larger bulb to increase the voltage still more—allowing the set to operate at the higher level for another few minutes.

If your old filter caps decide to fail, shorting out the power supply, the light bulb in the extension cord should suddenly increase in brilliance, warning you of the problem and absorbing power that would otherwise be destructive to the set. Then your only recourse would be (at the very least) to install new filter capacitors. But if no shorts develop, disconnect the extension cord, plug the radio directly into your isolation transformer, and tune around. Your set may now be alive!

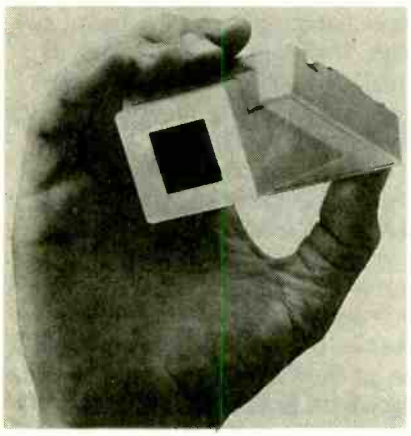
Come back next month for the final installment in "Radio Repair for Dummies," when we will talk about giving your radio a complete recap job. ■

"What do you think, Marvin, does that void the warranty?"

New Products

MINI-CAMERA

The *CW-350* is an ultra-miniature ceiling/wall camera so small it can fit in the palm of your hand. Measuring only $2^1/_4$- × $1^3/_4$- × $3^1/_4$-inches and weighing less than two ounces, this discreet camera is designed to replace bulky, hard-to-mount ceiling cameras. The design of this small lightweight camera makes it easy to mount on ceilings or walls, and it blends inconspicuously into any decor.



The camera provides over 425 lines of resolution and only .02 lux sensitivity. It comes standard with a built-in electronic shutter and a 4mm wide-angle lens. Other lenses are available as well: 2.5-, 6.5-, 8-, and 12-mm. There is also an optional audio capability.

The suggested retail price is $251.30. For more information, contact *CCTV Corporation*, 280 Huyler Street, S. Hackensack, NJ 07606; Tel. 800-221-2240 or 210-489-9595; Fax: 201-489-0111.

CIRCLE 80 ON FREE INFORMATION CARD

CALENDAR/ TEMPERATURE CLOCK

Visible from 15–20 feet away, the *MFJ-119 GIANTdisplay 24/12 Hour Calendar/Temperature Clock* lets you know the month, date, day, and UTC time at a glance. Measuring $8^1/_2$ by 9 inches, this white and silver speckled clock has an easy-to-read LCD display with $2^1/_4$-inch tall time characters.

Users can select either a digital calendar display with year shown, or a UTC or local time clock with time shown. In either selection, month, date, day, and temperature are displayed. The settings are easy to program, and the batteries are included. The clock sells for $49.95

For more information, contact *MFJ Enterprises, Inc.*, P.O. Box 494, Mississippi State, MS 39762; Tel. 800-647-1800 or 601-323-5869; Fax: 601-323-6551; E-mail: mfj@mfjenterprises.com; Web: *www. mfjenterprises.com.*

CIRCLE 81 ON FREE INFORMATION CARD

DIGITAL STILL CAMERA

Designed for business and graphics users, *Sony's DSC-F1* is the first digital still camera with a built-in infrared transceiver. This transceiver allows the camera to wirelessly transfer images to an IrDA-equipped PC in seconds. Images stored in the camera can be downloaded individually, enabling selected pictures to be stored in the computer or output directly to the printer. The *DSC-F1* can connect to a PC or Mac via a serial port and to a TV or video monitor via a standard video jack for playback.

The *DSC-F1* camera features 4 MB of flash memory built-in, a rechargeable lithium-ion battery, a 1.8-inch LCD screen, and various recording modes. *Sony* includes a progressive scan, 350K square-pixel, *C*harge-*C*oupled *D*evice (CCD) that enables the *DSC-F1* to capture sharp, high-resolution images. It captures the images in JPEG format and stores them in memory at 640 × 480 resolution with 24-bit color—ideal for computer input. Users may select any of three different compression levels, resulting in 30, 58, or 108 pictures. It provides excellent color fidelity and blur-free, full-frame image reproduction.

Lightweight and sleekly designed, the *DSC-F1* camera measures 4- by 3- by 1.6-inches and weighs only 10.6 ounces, fitting easily into a pocket, briefcase, or purse. Its small size makes it suitable for those who need instant image capture and/or playback capabilities. The camera's built-in video output and capability of transferring pictures (including graphics, charts, and text) back and forth from camera to PC allows the camera to be used for portable presentation, as well as an input device. It comes bundled with ARCSoft PhotoStudio DSC software, a photo-editing program that offers easy-to-use features for photo-enhancement and -manipulation.

A variety of recording modes are available. Continuous mode allows the recording a series of pictures in succession (four frames per second), ideal for capturing action sequences. The Time Machine feature uses a buffer memory to record images prior to pressing down the shutter. Multi-Screen mode divides a single picture into nine separate sections, recording the sections in a $^1/_{30}$ second interval. This mode is appropriate for showing a thumbnail view of a series of images. Similar to a 35-mm camera, the *DSC-F1* camera also includes a self-timer. The date and time of captured pictures are automatically recorded digitally.

In the playback mode, users can view images forward, backward, in a continuous loop (Slide Show mode), as thumbnail images (Search mode), and

(Continued on page 68)

Microcontrollers VI

JEFF HOLTZMAN

Let's continue our exploration of *Atmel Corporation's* AVR series of microcontrollers. In this issue, we'll look at implementing precise timing delays. For a sample program, we'll create a scrolling display that sequentially lights each LED on the Atmel development board for a precise period of time.

The entire program is shown in Listing 1; occupying only 22 bytes of code, it's deceptively short and simple. Conceptually, what the program does is shift a bit through a register, light the corresponding LED, wait half a second, shift, light, wait, and loop.

The first few lines of the program are three assembler directives, that tell the AVR assembler which chip it is assembling for, and where in the chip's code-execution space to start assembly. Then come several lines defining user-friendly names for the output port (B), and timing-loop constants. ILC is the *I*nner *L*oop *C*onstant, and OLC is the *O*uter *L*oop *C*onstant.

Program execution begins at the line labeled RESET. The first two lines there set up Port B for output by writing all 1s to the data-direction register. The value 255 decimal equals the value $FF hexadecimal and the value 11111111 binary.

We use register 16 (r16 in the listing) as the container for the bit-shifting process. Whenever we want to light an LED, we must write a 0 to the corresponding bit of the output port. So to light a single LED, what we do is load the shift register (r16) with one zero and seven ones. To start the process rolling, we load the register with $FE, which is 11111110 in binary. In other words, we turn the right-most LED on first. Then we continue shifting the zero leftward, as follows:

```
11111110
11111101
11111011
11110111
11101111
11011111
10111111
01111111
```

Then we're ready to recycle:

```
11111110
```

Now let's examine the code. First we load register 16 with $FE, which as we just saw will turn on the right-most LED. Then we set the carry flag, delay for half a second, shift the bit, and continue. First we'll discuss the shift process, and then the delay.

Why do we set the carry bit? Where is the shift instruction? What does "rol" do?

SHIFT VS. ROTATE

As a matter of fact, we're not actually shifting the bit, we're rotating it. What's the difference between shift and rotate? When you shift, you stuff a 0 into one end of the register, let whatever is in the opposite end of the register fall off into cyberspace, and move everything else over one position. By contrast, when you rotate, you don't stuff anything at one end or let anything "fall off." Instead, it's as if we connect one end of the register to the opposite end *through the carry flag of the CPU.* That last point is important. That's why we set the carry flag at the instruction labeled LOOP. Doing so ensures that we shift a 1 into the low bit of r16.

For the test program, we chose to rotate left. If we used the instruction

LISTING 1

Bit Rotation Test Program for Atmel AVR Microcontrollers

```
.device   AT90S1200
.cseg
.org 0

.equ      DDRB =  $17
.equ      PORTB =$18
.equ      OLC =    0              ; outer loop count for delay routine
.equ      ILC =    156            ; inner loop count for delay routine

RESET:  ldi       r16, 255
   out    DDRB, r16          ; set port B for all outputs

   ldi    r16, $FE           ; initially enable just the lowest bit
LOOP:   sec
   out    PORTB, r16         ; turn on one LED

   ldi    r17, 5             ; wait 0.5 sec
LP1:    rcall     DELAY
   dec    r17
   brne   LP1

   rol    r16                ; rotate the bit
   cpi    r16, $FF           ; if all bits not set
   brne   LOOP               ;  ... continue
   dec    r16                ; else set just the lowest bit
   rjmp   LOOP               ; loop forever

DELAY:  ldi       r22, OLC ; delay for 1/10th second
DL1:    ldi       r23, ILC
DL2:    rcall     DUMMY              ; waste 7 cycles
   dec    r23
   brne   DL2
   dec    R22
   brne   DL1
DUMMY:ret
```

TABLE 1

Basic Equations

$Ici = 10 \times (ILC - 1) + 9$
$Ico = ((Ici + 4) \times (OLC - 1)) + (LCI + 3)$
$clks = Ico + 8$
$time = clks/f$

Example
$f = 4 \times 10^6$
$ILC = 156$
$OLC = 256$
$Ici = 10 \times (156 - 1) + 9$
$Ico = ((1559 + 4) \times (256 - 1)) + (1559 + 3) = 400,127$
$clks = Ico + 8 = 400,135$
$time = clks/f = (400,135)/(4,000,000) = 0.100003375$

Calculating time delays can be tricky, but it helps if you break things down into chunks as shown here. ILC and OLC are constants; Ici stands for Loop Count Inner, and Ico stands for Loop Count Outer.

"ror," what do you think would have happened? Bingo! The bit, hence the lit LED, would move right. Do we gain anything by doing a rotate instead of a shift? That's for you to find out!

DELAY

Depending on the needs of your application, producing precise time delays in this type of device can be tricky. The technique used here is about as simple as you can get, but you lose several things in the process. Basically we just get the CPU to spin its wheels, waste time, do nothing. It works like this. Look at the line of code labeled DELAY.

The routine uses two registers, r22 and r23. One (r22) holds an outer loop count; the other (r23) holds an inner loop count. First we load the loop count registers with constant values; we'll show how to calculate the values momentarily. At the point labeled DL2, we start decrementing the inner loop count register (r23). Each time r23 goes to a value of zero, we decrement the outer loop count register (r22). Finally, when it hits zero, we return to the calling routine.

Note the instruction: "rcall DUMMY." What it does is call a "routine" that simply returns. In other words, we just waste time. We could insert NOP (no operation) instructions, but they take only one clock cycle apiece. By doing the dummy call/return, we use seven clock cycles in only two bytes of code.

How do we know how long an instruction takes? We get the number of clock cycles from the data book. Of course, the actual amount of time taken depends on the frequency of the clock. If an instruction takes one clock cycle (as do most AVR instructions), and if the clock runs at 1 MHz, then the time for one instruction is simply

$$1 \times (1/10^6) = 1\ \mu sec$$

In our case, the clock on the Atmel development board runs at 4 MHz, so the single-instruction time is

$$4 \times (1/10^6) = 4\ \mu sec$$

So what's the total time for the loop beginning at DELAY? As shown in Table 1, it is a smidgen over 1/10 second (0.100003375 to be exact). That's accurate enough for our purposes, but it might not be in all cases. For example, a real-time clock display would gradually run faster and faster.

MAKING IT BETTER

The code as shown works, but it could be better. First, there's an easy way to squeeze four bytes from the routine. Second, setting the carry flag just before calling a subroutine, and expecting it to return unscathed, is ... well ... not the safest type of coding. If we changed the delay loop to include some arithmetic instructions, the carry flag could easily be affected.

I'm going to have a contest. Whoever can come up with the cleanest, shortest, most flexible, most accurate, *safest* cycle-flipping AVR delay routine is going to achieve everlasting fame in the pages of this magazine. Send your entries directly to me—and don't worry about the interrupt problem discussed below.

INTERRUPTS

Another thing to consider is interrupts. We're not dealing with interrupts yet, so we don't have to worry about them. However, take a minute to consider what would happen if an interrupt occurred in the middle of the DELAY loop. Depending on how much time it took to service the interrupt, the delay could be seriously affected. For example, like the return from subroutine ("reti") instruction, a return from interrupt ("reti") takes four clock cycles. The AVR chips have built-in timer counters. The AVR chips have power-down and sleep modes. Hmmmm...

See you next month and send your delay-routine entries to jeff@ingeninc.com. ■

VENDOR INFORMATION

Atmel Corporation
2325 Orchard Parkway
San Jose, CA 95131
Tel. 408-441-0311
Web: *www.atmel.com*
Part Numbers:
AT90S1200-16PC is the 16-MHz 1200 in a 20-pin DIP package.
AT90S8515-8PC is the 8-MHz 8515 in a 40-pin DIP package.
ATMCU00100 is the evaluation board.

Arrow/Schweber Electronics
Tel. 800-833-3557

AVROne
Web: *www.avrone.com*

DonTronics
Web: *www.dontronics.com*

Marshall Industries
Tel. 800-833-9910
Web: *www.marshall.com*

Pioneer Standard Electronics
Tel. 216-587-3600
Web: *www.pios.com*

NEW PRODUCTS

(continued from page 66)

as magnified 2× on the camera's LCD screen. In the editing mode, users may choose to delete, protect, or transfer images between the camera and a PC or printer.

The camera has automatic white balance, adjustable exposure control (±2 steps), and manual shutter control between 1/7.5 to 1/1000 frames per second. The *DSC-F1*'s camera lens and flash are located on the upper portion of the camera body, and they pivot to allow shooting in a variety of angles. It includes a wide-angle lens, as well as a macro setting that focuses as close as three inches from a subject. The camera sells for $499.

For more information, contact *Sony Electronics, Inc.*, Information Technologies of America, 3300 Zanker Road, San Jose, CA 95134; Tel. 800-352-7669; Web: *www.sony.com/image.*

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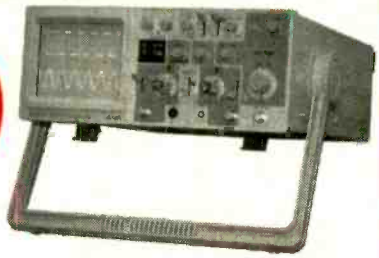

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DMM-89S ($179.00): true rms, AC/DC (V,A), Ω, bar graph, freq, capac., dBm, logic, diode

DMM-88S ($149.00): AC/DC (V,A), Ω, bar graph, freq, capac., logic, diode

DMM-20 ($74.95): AC/DC (V, A), Freq, cont., Capac, Induct., Ω, hFE, diode, duty cycle

DMM-22 ($89.95): 4000counts, bar graph, Freq, AC/DC(V,A), Ω, Capacitance, diode, contin.

DMM-23T ($99.95): 4½ digit, true rms, high resol. (10µV, 10nA, 10mΩ), hFE, diode, contin.

DMM-10 ($19.95): 3½ digit, DC/AC V, Ω, hFE, diode, signal output(+3V,-0.5Vsq.,50%duty)

DMM-113 ($24.95): Pocket Size, DC/ACV, Ω, diode, Continuity beeper

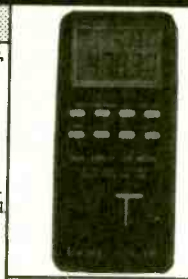
DMM-120 ($24.95): economy type, DCV,ACV, DCA, Ω, hFE, diode

DMM-122 ($59.95): DC/AC(V,A), Ω, hFE, diode, capacitance, freq, logic, continuity

DMM-123 ($44.95): DMM + capacitance, DC/AC(V,A), Ω, hFE, diode, continuity

DMM-124 ($69.95): Electrical+Temp,DC/ACV, Ω, capacitance, freq, 3 phase, diode, contin.

DMM-125C ($54.95): Autorange + bar graph, DC/ACV, Cap,Ω, diode, continuity beeper



LCR METER

CAP-15 *($49.95)*: 3½ digit, 0.1pF-20mF, 9 Ranges, 0.1pF resolution zero adjustment.

LCR-24 *($139.95)*: 0.1µH-200H, 0.1pF-2000µF, 0.01Ω-20MΩ, diode test. *New Model.*

LCR-814 *($189.95)*: 0.1µH-200H, 0.1pF-20mF, 1mΩ-20M Ω, Q Factor, dissipation, zero adjust

LCR-131D *($229.95)*: autorange, 0.1µH-10kH, 0.1pF-10mF, 1mΩ-10MΩ, Q Factor, serial/parallel, 120Hz/1kHz testing mode.

FREQ. COUNTER

FC-1200 *($129.95)*: 1.25GHz Handheld, 8 digits display, 10ppm accuracy, sensitivity 5mV (130-350MHz), 30mV (440MHz), 22mV (800MHz), batteries or 9V adapter.

FC-2500 *($179.95)*: 2.5GHz Handheld, 8 digits display, 4ppm accuracy, sensitivity <50mV, batteries or 9V adapter.

FC-5270A *($349.95)* 1.2 GHz bench type, 8 digit, 10 ppm, 35mV sensitivity, 10Vp-p max. input, power by 9V adapter.

FC-5700 *($329.95)* 1.3GHz bench type, 8 digit, 1 ppm accuracy, 20mV sensitivity, period 0.1µs to 100ms. Ideal for test & repair of audio instrument.

FLUKE DMM

HandHeld		*Scope Meter*	
12B	$ 84.95	**92B-III**	$1,445
70-III	$ 85.00	**96B-III**	$1,695
73-III	$115.00	**99B-III**	$2,095
75-III	$139.00	**105B**	$2,495
77-III	$154.00	**123-III**	$945
79-III	$175.00	**863E**	$475
87	$289.00	**867B**	$650
87-III	$309.00		

SPECIALTY METERS

- Sound meter $169.95
- EMF Tester $69.95
- Conductivity $169.95
- Thermometer $69.95-$89.95
- Humid./Temp meter $169.95
- Press. meter $299.95
- Electr. scale $89.95
- Watt Meter $129.95
- High Voltgae Probe $59.95
- pH Meter $79.95
- Light Meter $80-$90
- Light Adapter $49.95
- Anemometer $179.95
- Anemometer adapter (And More) $89.95

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Dual Trace, Component Test, 6" CRT, X-Y Operation, TV Sync, CH2 Output, Graticule Illum, 2 Probes(x1;x10)

- PS-200 20 MHz Dual Trace $339.95
- PS-205 20 MHz Dual w/ Delay Sweep $429.95
- PS-400 40 MHz Dual Trace $494.95
- PS-405 40 MHz Dual w/ Delay Sweep $569.95
- PS-605 60 MHz Dual w/ Delay Sweep $769.95
- PS-1000 100MHz Dual Trace $999.95

Digital Scope:

- DS-303 30MHz Digital, 20 Samples/sec $849.95
- DS-303P RS-232 interface, 30MHz $1,049.95

Scope Probe:

HP-9060 (60MHz) $15, HP-9150 (150MHz) $22, HP-9250 (250MHz)$29, HP-9258 (250MHz,100:1)$39

AUDIO/RF/FUNCT. GENERATOR

RF Generator

- **SG-4160** ($124.95) 100kHz-150MHz sinewaves in 8 ranges, 100mV at 35MHz
- **SG-4162** ($229.95): same as SG-4160, plus 6 digits int/ext freq. counter (150MHz).

Audio Generator

- **AG-2601** ($124.95)10Hz-1MHz, 0-8Vpp sine, 0-10Vpp squarewave
- **AG-2603** ($229.95): same as AG-2601, plus 6 digits int/ext freq. counter (150MHz).

Function Generator

- **FG-2100A**($169.95).2Hz-2MHz,5mV-20$V_{pp}$
- **FG-2102AD** ($229.95) same as FG-2100A, plus int. counter and TTL, CMOS output.
- **FG-2103** ($329.95) *Sweep* 0.5Hz-5MHz, linear/log, VCG, GCV, 6 dig. int/ext counter

POWER SUPPLIES

Single Output DC Power Supplies

- Short Circuit and overload protected
- Constant current, constant voltage mode
- 0.02%+2mV line regulation; 0.02%+2mV load regulate

Analog Meters Display

PS-303 ($159.00) 30V/3A
PS-305 ($219.95) 30V/5A
PS-8110 ($289.95) 60V/3A
PS-8112 ($399.95) 60V/5A
PS-1610 ($289.00) 16V/10A
PS-8107 ($399.95) 30V/10A

Digital Voltage, Analog Current

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PS-8201 ($239.95) 30V/5A

Digital Volt & Current Display

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- Constant current & voltage mode
- Independent or Tracking

Dual Tracking (Analog V & I Displays)

PS-303D ($314.95) 30V/3A/30V/3A
PS-305D ($399.95) 30V/5A/30V/5A
PS-8108 ($549.95) 60V/3A/60V/3A
PS-8109 ($699.95) 60V/5A/60V/5A

Triple Output

- One fixed 5VDC, 3 Amp output
- Parallel to double current output (PS-8102 & PS-8103 only)

Triple Output (Analog displays)

PS-8102 ($399.95) 30V/3A/30V/3A
PS-8103 ($489.95) 30V/5A/30V/5A

Digital Displays

PS-8202 ($499.95) 30V/3A/30V/3A
PS-8203 ($549.95) 30V/5A/30V/5A

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OSCILLOSCOPE

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- Dual CH / Delay sweep
- **Readout & Cursor meas**
- Built-in delay line
- Z-axis input,CH1 output
- TV syn., trigger level lock
- 2 probes (x1, x10)

- Dual CH/X-Y operation
- 1 mV/div sensitivity
- Z-axis input,CH1 output
- TV syn., trigger level lock
- 2 probes (x1, x10)

OS-305 ($229.95) - 5 MHz One Channel
OS-310 ($324.95) - 10 MHz One Channel

DC POWER SUPPLIES

Triple Output

- 2 variable out 0-30V,0-3A
- One fixed 5V,3A output
- Auto track, serial, parallel
- Const. volt, current mode
- 4 analog or 2 digital display

PC-3030 ($499.95)
PC-3030D ($549.95)

Single Output

- Const voltage, current mode
- Voltage regulation ≤0.01%
- Current regulation ≤0.2%
- PS: 2 analog or 1 digital disp
- PR: 2 analog or 2 digital disp

Analog Meters Display

PS-1830 ($209.95) 18V/3A
PS-1850 ($229.95) 18V/5A

PS-3030 ($219.95) 30V/3A
PS-6010 ($209.95)60V/10A

PR-3060 ($329.95)30V/6A
PR-6030 ($329.95)60V/3A
PR-1810H($349.95)18V/10A

Digital Meters Display

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PS-1850D($254.95)18V/5A
PS-3030D($254.95)30V/3A
PR-6030D($399.95)60V/3A

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- 50point program(PPT ser.)
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PPS-6020G ($1,149.95)
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- Sine/Squ/Tri/pulse/Ramp

FG-8016G ($239.95)
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- Pulse, function generator

FG-8017G($249.95)Sweep
- Sine/Tri/Squ/TTL/CMOS
- 0.02Hz-2MHz, FM mod.

FG-8019 ($399.95) Sweep
- 0.02Hz-2MHz w/counter
- INT/EXT AM/FM mod

FG-8020G ($209.95)
- 0.02Hz-2MHz

FG-8050 ($499.95) Sweep
- 0.05Hz-5MHz w/counter
- INT/EXT AM/FM mod

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- Output: sine, tri., square, sync out, arb. waveform
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- 1000V, 20A, 0.5% accu.

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- ACV to 50kHz, true rms

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- 0.006% basic accuracy
- 1µV,1mΩ,1nA resolution
- dBm,auto,REL, min/max

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- Same funct. as DM-8055

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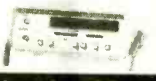
FC-8270 ($629.95)2.7GHz
UC-2010G ($294.95)



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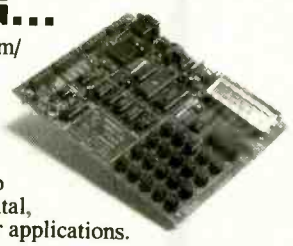

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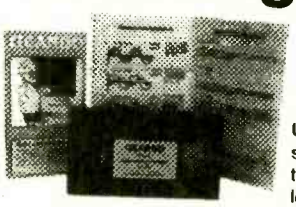

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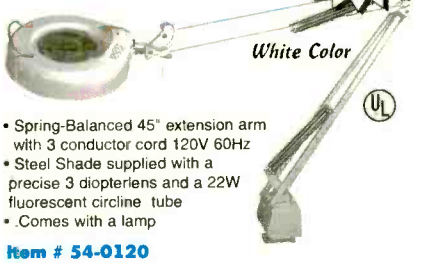

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277-015	MDT-30	49.90	47.50
277-020	MDT-33 Pair	199.90	195.50
277-025	MDT-10	35.50	33.90
277-030	MDT-20	42.50	39.90
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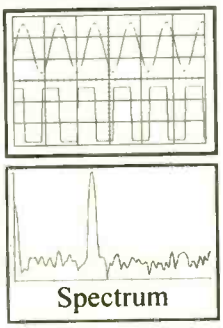

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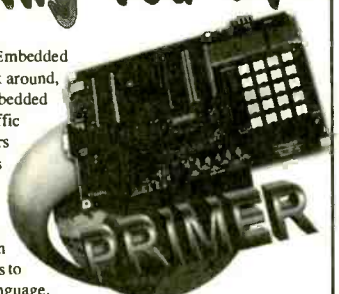

Are you interested in Microprocessors & Embedded Control Systems? If not you should be! Look around, just about everything these days has an embedded microprocessor in it. TVs, cars, radios, traffic lights & even toys have embedded computers controlling their actions. The Primer Trainer is the tool that can not only teach you how these devices operate but give you the opportunity to program these types of systems yourself. Examples & exercises in the Self Instruction manual take you from writing simple programs to controlling motors. Start out in Machine language, then move on to Assembler, & then continue on with optional C, Basic, or Forth Compilers. So don't be left behind; this is information you need to know!

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The PRIMER is only $119.95 in kit form. The PRIMER Assembled & Tested is $169.95. This trainer can be used stand alone via the keypad and display or connected to a PC with the optional upgrade ($49.95). The Upgrade includes: an RS232 serial port & cable, 32K of battery backed RAM, & Assembler/Terminal software. Please add $5.00 for shipping within the U.S. Picture shown with upgrade option and optional heavy-duty keypad ($29.95) installed. Satisfaction guaranteed.

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General

Display: 3-1/2 Digit LCD, 21mm Figure Height with Automatic Polarity
Overrange Indication: 3 Least Significant Digits Blank
Temperature for Guaranteed Accuracy: 23°C±5°C RH<75%
Temperature Ranges: Operating: 0°C to 40°C (32°F to 104°F) Storage: -10°C to 50°C (14°F to 122°F)
Power: 9V Alkaline or Carbon-Zinc Battery(NEDA1604)
Low Battery Indication: BAT on Left of LCD Display
Dimensions: 188mm long x 87mm wide x 33mm thick
Net Weight: 400g

DC Voltage (DCV)

Range:	Resolution:	Accuracy:
200mV	100µV	
2000mV	1mV	±(1%rdg+2dgts)
20V	10mV	
200V	100mV	
1000V	1V	

Maximum Allowable Input: 1000V DC or Peak AC.

DC Current (DCA)

Range:	Resolution:	Accuracy:
200µA	100nA	
2000µA	1µA	±(1.2%rdg+2dgts)
20mA	10µA	
200mA	100µA	±(1.2%rdg+2dgts)
10A	10mA	

Overload Protection: mA Input. 2A/250V fuse.

Resistance (Ω)

Range:	Resolution:	Accuracy:
200Ω	100mΩ	
2000Ω	1Ω	
20KΩ	10Ω	±(1.2%rdg+2dgts)
200KΩ	100Ω	
2000KΩ	1KΩ	
20MΩ	10KΩ	±(2%rdg+10dgts)

Maximum Open Circuit Voltage: 2.8V

Diode Test

Measures forward voltage drop of a semiconductor junction in mV test current of 1.5mA Max.

ohFE Test

Measures transistor hFE.
Frequency Range: 45Hz-450Hz
Maximum Allowable Input: 750V rms
Response: Average Responding. Calibrated in rms of a Sine Wave.

AC Voltage (ACV)

Range:	Resolution:	Accuracy:
200V	100mV	±(1.2%rdg+10dgts)
750V	1V	

CAT NO	DESCRIPTION	PRICE
9300G	Rugged High Quality DMM with Rubber Boot	$19.00

Positive Photofabrication Kit
Make your own PCB's

Kit includes the basic items needed to fabricate pre-sensitized printed circuit boards (does not include artwork). Also included is a basic process guide to assist the user in the basics of exposing, developing and etching a PCB. All items fit conveniently in the plastic development tray, and a tight fitting lid is included for handy storage. Additional recommended supplies for fabricating PCB's are: exposure bulb, etchant tank, eye protection, art-work, paper towels.

Kit Includes

- 1 each 3"x5" pre-sensitized single sided PCB
- 1 each 4"x6" pre-sensitized single sided PCB
- 1 each 6"x6" pre-sensitized single sided PCB
- 1 each 500ml developer liquid
- 1 each 500ml ferric chloride etching liquid
- 2 each foam brushes
- 1 each plastic development tray
- 1 each rubber gloves
- 1 each instruction sheet

new!

CAT NO	DESCRIPTION	PRICE
416-K	Photofabrication Kit	$27.95

Positive Photo Resist Pre-Sensitized Printed Circuit Boards

These pre-sensitized printed circuit boards are ideal for small production runs. They provide high resolution and excellent line width control. High sensitive positive resist coated on 1oz. copper foil allows you to go direct from your computer plot or art work layout. No need to reverse art.

Single-Sided, 1oz. Copper Foil on Paper Phenolic Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
PP101	100mm x 150mm/3.91" x 5.91"	$2.55	$1.90	$1.70
PP114	114mm x 165mm/4.6" x 6.6"	2.98	2.45	1.98
PP152	150mm x 250mm/5.91" x 9.84"	5.40	3.98	3.60
PP153	150mm x 300mm/5.91" x 11.81"	6.15	4.48	4.10
PP1212	305mm x 305mm/12" x 12"	12.78	10.65	8.52

Single-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GS101	100mm x 150mm/3.91" x 5.91"	$ 3.90	$2.98	$2.60
GS114	114mm x 165mm/4.6" x 6.6"	4.80	3.49	3.20
GS152	150mm x 250mm/5.91" x 9.84"	8.69	5.98	5.78
GS153	150mm x 300mm/5.91" x 11.81"	10.20	7.20	6.80
GS1212	305mm x 305mm/12" x 12"	18.88	15.73	12.59

Double-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GD101	100mm x 150mm/3.91" x 5.91"	$ 5.07	$3.68	$3.38
GD114	114mm x 165mm/4.6" x 6.6"	5.95	4.29	3.99
GD152	150mm x 250mm/5.91" x 9.84"	10.47	7.39	6.98
GD153	150mm x 300mm/5.91" x 11.81"	11.95	8.69	8.30
GD1212	305mm x 305mm/12" x 12"	22.09	18.35	14.68

Exposure System

Just place your presensitized board and artwork centered under the exposure fixture. Place the convenient acrylic sheet over the board and artwork to hold everything in place. Turn on light. Voila! Exposure takes about 5 minutes. Kit includes one fluorescent tube, stand and acrylic weight.

new!

Features

- Exposes boards in about 5 minutes!
- Convenient acrylic sheet to hold board in place during exposure (12.5" x 8.5")
- Fluorescent light fixture with plastic cover designed to aid in proper light refractions for even exposure

CAT NO	DESCRIPTION	PRICE
416-X	Fluorescent Exposure System	$31.95
416-B	Extra Replacement Fluorescent Tube	16.95

Etching Tank

This handy etching system will handle PC boards up to 8" x 9", two at a time. Ideal for etching your PCB's! System includes an air pump for etchant agitation, a thermostatically controlled heater for keeping etchant at optimum temperature and a tank that holds 1.35 gallons of etchant. A tight fitting lid is also supplied to prevent evaporation when system is not being used. Typical etching time is reduced to 4 minutes on 1oz. copper board!

REDUCES ETCHING TIME!

CAT NO	DESCRIPTION	PRICE
12-700	Etch Tank System	$37.95

Developer

This product is used as the developer on our positive photo-resist printed circuit boards. Includes instructions. 50 gram package, mixes with water, makes 1 quart.

CAT NO	DESCRIPTION	PRICE EACH 1	10	25
POSDEV	Positive Developer	$ .95	$ .80	$ .50

Etching Chemicals/Ferric Chloride

A dry concentrate that mixes with water to make 1 pint of etchant, enough to etch 400 sq. inches of 1oz board.

CAT NO	DESCRIPTION	PRICE EACH 1	5
ER-3	Makes 1 pint	$3.50	$2.75

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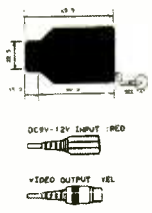
Color Weather Proof Bullet Camera

1/3" CCD with removeable rotation capable mounting bracket

Specifications

Image Sensor:	Interline transfer CCD 1/3" format
Effective Pixel:	512(H)x492(V) pixels/NTSC 512(H)x582(V) pixels/PAL
Scanning System:	2 : 1 interlaced
Sync System:	Internal sync
Sync Pulse:	15.734KHz +1%(H)/15.625KHz +1%(H) 59.94Hz +1%(V)/ 50Hz +1%(V) Sub-Carrier 3.57 MHz +30ppm
Resolution:	400 TV lines (H)
S/N Ratio:	More than 46dB (typ)
Gamma Characteristics:	0.45
Min. Illumination:	1 LUX (F1.2 10 IRE)
Video Out:	Composite video signal : 1.0Vp-p
White Balance:	Auto white balance
Electronic Shutter:	1/60 - 1/100,000 SEC(N) 1/50 - 1/100,000 SEC (P)
Power Supply:	DC 12V + 10%
Power Consumption:	240mA (typ)
Lens:	4mm (78 or 92 degree) F : 2.0
Ambient Operating Temp:	-5 deg. C +40 Deg. C
Ambient Storage Temp:	-10 Deg. C+50 Deg. C RH 95% MAX
Dimension:	2 1/8" (L) x 1 1/4" (D)
Weight:	3 oz.



CAT NO	DESCRIPTION	PRICE EACH 1	5
WDB-5407S	Color Water Tight Bullet Camera	$299.00	$269.00

(water tight for outdoor use, not suitable for sustained underwater use)

CCD Bullet Cameras

Available with standard or pinhole lens. Virtually indestructible bullet shaped casing. This sleek B&W camera can be mounted on walls or ceilings along narrow corridors or virtually any location for virtually any surveillance application. 0.5 lux minimum illumination with 380 lines of resolution. Even includes a built-in electronic iris for automatic light compensation.

Features

- Extremely low power consumption
- No blooming, no burning
- 0.5 LUX minimum illumination
- CCD area image sensor for long camera life
- Ultra small size allows for simple application and installation
- Built-in electronic auto iris for automatic light compensation
- Ultra compact camera

Specifications

Image Pick-Up Device:	1/3" CCD area sensor
No. of Pixels:	EIA = 512(H) x 492(V)
Pixel Pitch:	EIA = 9.6uM(H) x 7.5uM
Scanning System:	EIA=525 lines, 60 field/sec
Sync System:	Internal sync
H. Resolution:	430 TU line
V. Resolution:	400 TU line
Usable Illumination:	0.5 Lux F1.6
S/N Ratio:	More than 48dB
Gamma Characteristic:	0.45
Video Output:	1.0 - 1.1 up-p 75 Ohm
Electronic Shutter Time:	EIA=1/60 - 1/50,000 sec
Lens F No. Focal Length:	STD : 1.6 Open / 4.3mm(78 deg) Pinhole: 4.3 fixed/ 2.8mm(91.4 deg)
Power Consumption:	DC 9V (8-10V), 110mA
Operational Temp.:	-10 deg - +50 deg C RH95% max
Storage Temp:	-20 deg - +60 deg C RH95% max
Dimensions:	STD : 22mm(W) x 22mm(H) x 38mm(D) Pinhole: 22mm(W) x 22mm(H) x 30mm(D)
Weight:	35g max

CAT NO	DESCRIPTION	PRICE EACH 1	5
WDB-07S	Standard Lens Version	$144.00	$129.00
WDB-07P	Pinhole Lens Version	144.00	129.00
WDP-07S/water	Standard Lens Weather Proof	169.00	152.00

CCD Dome Camera with Audio

B&W DOME camera with integrated microphone. Ideal security system application. 12 VDC operation.

Specifications

Image Device:	1/3" interline transfer CCD
Picture Elements:	EIA=542(H)x492(V)
Scanning System:	2:1 Interlace
Synchronization System:	Internal
Horizontal Resolution:	380 TV Lines
Sensitivity:	Under 0.3 LUX
Electronic Iris (linear):	EIA = 1/60~1/100,000 sec
Video Output:	1.0vp-p, 75 ohm
S/N Ratio:	More than 50dB
Power Supply:	12V DC (±20%)
Gamma:	r=1
Power Consumption:	110 mA max
Operating Temp.:	-10°C ~ +50° C
Operating Humidity:	RH 95% Max
Weight:	100g
Applied Lens:	3.6mm -92°, 4.3mm -78°
AI/EE/Flicker Less/Mirror Image:	Jump soldering selection
Audio Pick-up Sensitivity:	-60dB (0dB=1V/ubar)
Audio Frequency Range:	20 Hz ~ 20 kHz
Audio S/N Ratio:	More than 40dB
Audio Output Level:	1Vp-p/600 ohm
Dimensions:	87 x 55.5mm

CAT NO	DESCRIPTION	PRICE EACH 1	5
WDDB-6500	B&W Dome Camera	$144.00	$129.00

1/3" CCD Board Cameras

Available with **PINHOLE LENS** with **AUDIO**; **STANDARD LENS** with **AUDIO**; and **STANDARD LENS** with **INFRA-RED and AUDIO**. These are the world's smallest commercially available CCD board cameras!

World's Smallest B&W Board Cameras


WDP-2000


WDS-2005


WDI-4000

Specifications

Image Pick-Up Device	1/3" CCD area Sensor
Picture Elements	EIA=512(H) x 492(V)
Pixel Pitch	EIA=9.6UM (H) x 7.5UM (V)
Scanning System	2 : 1 Interlace
Scanning Frequency	EIA=525 lines, 60 field/sec (II) 15.750 KHz x 60 HK
Resolution	430 Lines
Minimum Illumination	0.03 LUX
S/N Ratio	45DB
Lens Mounting	4.3mm standard, 5mm pinhole
Video Output	1.0 VP-P/750OHM composite signal
Power Requirement	8-12 VDC (9VDC standard)
Power Consumption	100mA
Operating Temperature	-20C -+ 70 C RH 95% Max
Storage Temperature	-40C -= 85 C RH 95% Max
Audio Pick-Up Sensitivity	-60 DB (0DB = 1B/UBAR. 1KNZ)
Audio Frequency Range	20 Hz to 20KHz
Audio S/N Ratio	More than 35DB
Audio Output Level	1VP-P/600 OHM

Dimensions

WDP-2000	30mm (H) x 30mm (W)
WDS-2005	30mm (H) x 30mm (W)
WDI-4000	44mm (H) x 30mm (W)

CAT NO	DESCRIPTION	PRICE EACH 1	5
WDP-2000	1/3" B&W Pinhole Lens with Audio	$89.00	$77.00
WDS-2005	1/3" B&W Standard Lens with Audio	89.00	77.00
WDI-4000	1/3" B&W Infra-RED with Audio	89.00	77.00
WDPH-55BW	Plastic Housing Option for B&W Board Cameras (WDP-2000 & WDS-2005 ONLY)	13.00	12.00

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Features

Fine Tune Temperature from 150° C (300° F) through 450° C (850° F) without unnecessary tip or heating element changes.
Precision "Tip Temperature" accuracy is mastered to within ±3° C (6° F) using state of the art circuit technology and a built-in P.T.C. sensor located at the top of each ceramic heater shaft for fail safe accuracy.
Fast Heat Up & Recovery. A long life Japanese made ceramic heating element facilitates fast heat up, fast recovery and exacting temperature control with minimal overshoot. Heat-up time to working temperature is attained in about 45 seconds.**Spike Free Circuit.** "Zero voltage" switching and fully grounded design meets military application standards for protection of electrosensitive devices against line transience and voltage spikes. Tip leakage is less than 0.4 mv or 0.5 ohm resistance.**External Calibration Port.** A calibration port is located on the face of the unit thus temperature adjustments are quick and convenient.
Lightweight Soldering Iron. Ergonomic mini handle that stays "cool". Handle assembly cord is made from silicone rubber that won't be damaged when coming into contact with high temperature irons.
Isolated Power Unit. The power unit is isolated from the AC line by a high quality transformer and only 24 Vac voltage is used to drive the heating element.
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Lock-Out Feature: Constructed with a lock-out feature to allow supervisors only to set and lock specific soldering temperatures. Accomplished via a special sized allen head screw located on the front panel.**Superior High Insulation** ceramic heater provides insulation rated over 100Mohms at 750° F. **Optional SMD Tip Series** for re-work applications. **Range of Interchangeable Tips Available** for maximum system flexibility.

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137ESD w/ Digital R/O

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CAT NO	DESCRIPTION	PRICE EACH 1	5
136ESD	Electronic Temp Controlled ESD Safe Soldering Station	$99.00	$88.00
137ESD	Electronic Temp Controlled ESD Safe Soldering Station w/ Digital Readout	129.00	114.00

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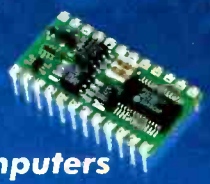

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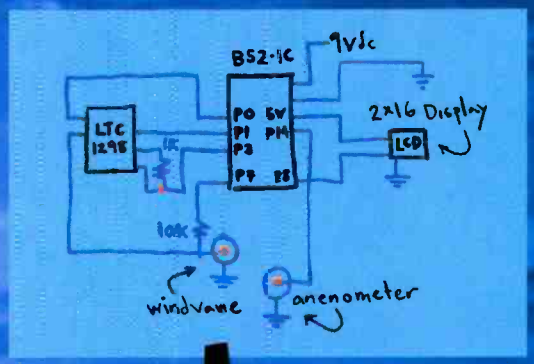
BASIC Stamp Computers

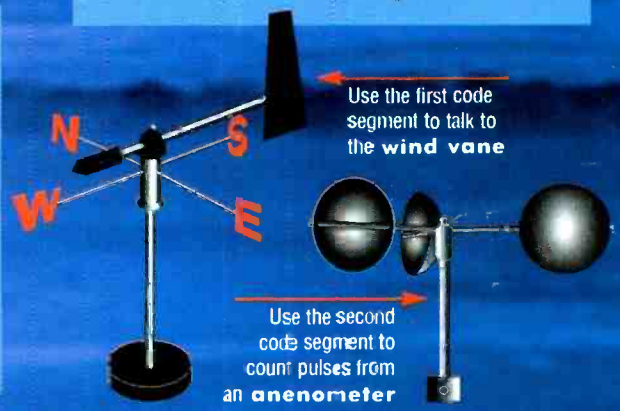
BASIC Stamps are a little solution for a big project. BASIC Stamps consist of a microcontroller, EEPROM, resonator and a few other components mounted on a small module the size of a postage stamp. The simple Parallax BASIC programming language commands include HIGH, LOW, INPUT, OUTPUT, IF, THEN, FOR, NEXT, TOGGLE, GOSUB, and GOTO. Check http://www.parallaxinc.com for a complete code listing and sample source code.

Build a Weather Station with your BASIC Stamp II

The following two code fragments show you how to measure wind speed and wind direction. Most anenometers produce a pulse with each rotation, and can be connected directly to a BASIC Stamp I/O pin. With 5 VDC applied to the wind vane, the 12-bit LTC 1298 A/D convertor (Parallax #27915 - $26) returns a 0 to 5 VDC value that corresponds to a wind direction. Schematics and source code are available at http://www.parallaxinc.com /stamps/anenometer.htm




```
Get_Direction:
        low CS                          ' Select A/D
        shiftout DAT,CLK,lsbfirst,[cfg\4]   ' Send configuration
        shiftin DAT,CLK,msbpost,[AD\12]     ' Receieve data
        high CS                         ' Deselect A/D
return
.
.
.
Get_Speed:
        high AN_PWR                     ' Turn on I/O pin
        count AN,2000,pulses            ' Count pulses for 2000 ms
        mph=pulses*/458/seconds         ' Calculate wind speed
        low AN_PWR                      ' Turn off I/O pin
return
```



BS2 Starter Kit Contents

BS2 Carrier Board (#27120 - $20)

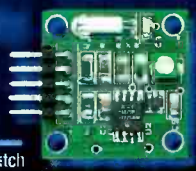
BS2-IC Module

BASIC Stamp II Starter Kit (#27203) $149

The BASIC Stamp II Starter Kit includes the BS2-IC module, carrier board, manual and application notes, software and serial cable. Free telephone and e-mail technical support is included with the purchase of every product.

BS2-IC Module (#BS2-IC - $49)

BS2-IC module has 16 I/O lines, 2048 bytes EEPROM (program and data), 500 instr. max program length, and 50k baud serial I/O. Command set includes LOOKUP, LOOKDOWN, READ, WRITE, plus those identified above.



2-line x 16 character Serial LCD Display (#27910) $54

LCD showing weather measurements

Use the BASIC Stamp's SEROUT instruction (requires one I/O line, ground and power) to communicate with the Serial LCD display.

Solutions Cubed Pocket Watch

Pocket Watch B (#27962) $27

Would you like to time-stamp your weather data? Try adding this realtime clock manufactured by Solutions Cubed. The Pocket Watch B uses a simple serial interface to communicate with the BASIC Stamp. Small size (less than 1.2" wide), 5-pin SIP package could plug right into a BASIC Stamp carrier board.

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