that I was simply in the right place at the wrong time: The band was dead. A quick check of local 10-meter FM repeaters showed that the antenna was working quite well. True to form, Murphy had helped me complete and install my new toy just in time for the band to go flat!

As time went by, I went on to happily use the 28HS2HB through many 10-meter openings to Asia, Europe, Africa, the Pacific, and Central and South America. I also contacted several US states! Scatter communications were also possible with the 28HS2HB—I sometimes heard scatter signals from 200 miles out or more.

The antenna exhibited good front-to-back, and front-to-side rejection. This was especially useful in picking an area of the globe that I wanted to work while rejecting strong signals from other directions. Although I expected an antenna of this design to have a fairly broad beamwidth, I found the 28HS2HB to be quite directional—enough to let me use the strength of other stations' signals to help me peak the antenna's heading.

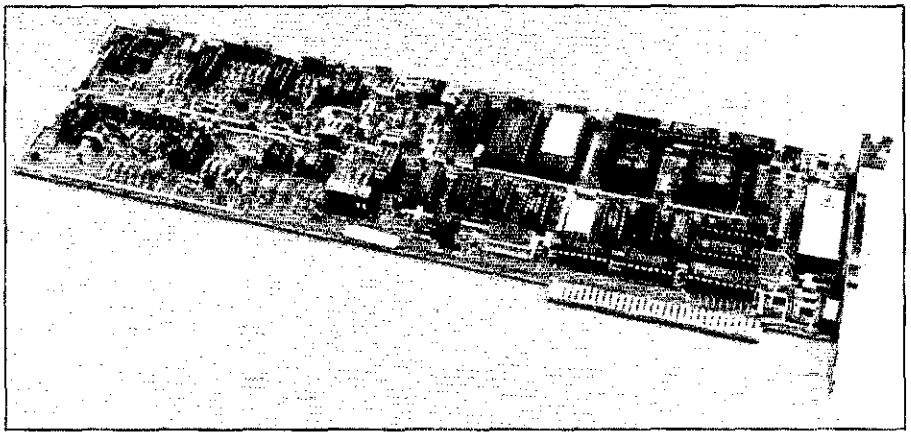
The 28HS2HB is rugged, and most of the its hardware resists oxidation and corrosion. I have, however, noticed rust on the nut and washer used in its RF connector assembly. Considering that my 28HS2HB has been in the air for just over three months, I recommend replacing these two parts with stainless-steel hardware before erecting the antenna for an extended period.

My Overall Impression

I've enjoyed using this antenna. With its small size, light weight, durability and pleasing performance, the 28HS2HB is a very desirable addition to my station. At this price, hams newly hooked on 10 will find limping along with a dipole hard to justify when they could move up to the 28HS2HB's directivity and gain. Retail price, $99.50 ($69.50 for the 6-meter 50HS2HB) from EasyTech, 2917 Bayview Dr, Fremont, CA 94538; tel 800-582-4044 or 510-770-2345; fax 800-582-1255 or 510-770-2346.

The HAL PCI-3000 Multimode HF Data Modem

Reviewed by Kirk Kleinschmidt, NTØZ



These days, the digital modes are gaining converts at an unprecedented rate. And the vast majority of today's RTTY ops (meaning non-packet, digital-mode operators) use computer-based, multimode HF data modems—not Model 28 electromechanical RTTY teleprinters. The competition for your HF digital dollars is intense, forcing manufacturers to position their products in different ways to secure their parts of the pie.

The most popular multimode communications processors (MCPs) take the "let's do everything" approach: A typical box sends and receives CW, RTTY, AMTOR, fax, packet, and so on, with receive-only capabilities for SITOR, NAVTEX and even SSTV (one even transmits SSTV after a fashion). Just add a computer or a terminal and you're on the air in a big digital way. Units of this type include the MFJ-1278, the Kantronics KAM and AEA's PK-232.

The remaining digital ops "make RTTY" with older, less-versatile computer-based units such as the Microlog AIR-1; commercial/military RTTY modems such as HAL's ST-6000; or commercial/maritime stand-alone units such as those in the Tono EXL-5000 series, which features built-in computers and video monitors. (During the review, in addition to having the PCI-3000 installed in one of my computers, I had a PK-232, a HAL ST-6000 and a Tono EXL-5000 hooked up to the receive audio for informal comparison purposes. It was RTTY Central in my shack!)

Enter the HAL PCI-3000 multimode HF data modem, a no-compromise, computer plug-in card aimed at providing RTTY/AMTOR/CW performance that exceeds the "do-everything" external controllers at a competitive price. (As I'll discuss later in the review, the complete PCI-3000 system sells for about $600—nearly twice as much as the popular MCPs, which sell for about $300, but far less than HAL's commercial/military modems, which sell for $1800 to $5500.)

So, a typical PCI-3000 buyer is someone who's willing to spend more than the low-cost price of admission to the digital game (presumably in exchange for better performance), who wants the convenience of a modem that plugs into an internal computer slot (IBM PC-compatibles only) and does not tie up a serial port, which might be needed to talk to a mouse or a packet TNC, control a transceiver, etc. The PCI-3000 buyer might also be a loyal HAL customer—something HAL's products and marketing seem to foster. What do PCI-3000 buyers, typical or otherwise, get for their money? Let's take a look.

The PCI-3000

The "basic" PCI-3000 is an HF RTTY/AMTOR/CW data modem configured as a standard, full-size plug-in card that fits IBM-compatible computers (XT through '486) running MS-DOS version 2.0 or later. The PCI requires at least two floppy disk drives (a hard drive is recommended) and a minimum of 512 kbytes of RAM. The software provided by the manufacturer, *PC-AMTOR*, is supplied on a 360k diskette.

The PCI sends and receives 100-baud AMTOR (ARQ, FEC, SELFEC and listen modes, with 4- and 7-letter SELCALs), Baudot (US or CCITT #2 alphabets at 45, 50, 57, 74 and 100 bauds), ASCII (45, 50, 57, 74 and 110 bauds) and Morse code (5-50 WPM, including prosigns and punctuation). The PCI's modem produces only 170-Hz shift, using the standard 2125/2295 Hz tone pair (the "low-tone" pair [1275/1445 Hz], used in Europe and elsewhere, is available on export versions). Also, the unit can't produce or copy 425- or 850-Hz shifts, or in-between nonstandard shifts, to the dismay of shortwave-RTTY listeners who would otherwise appreciate the PCI-3000. This harks back to the RTTY modems of yesteryear and is a feature (or a drawback, depending on your point of view) that runs counter to the "do-everything" philosophy. Most (all) of the other multimode boxes use a packet radio-based 200-Hz shift. The PCI, which was never intended to support HF packet, produces real 170-Hz shift.

The manufacturers of the "do everything" boxes assert that the interoperability difference between stations using 200- and 170-Hz shifts is insignificant. The engineers at HAL think that the difference is significant, especially when maximum performance is required. The shift dif-

ference is one reason why someone might want to buy the PCI-3000 instead of one of the units offering more shifts and modes.

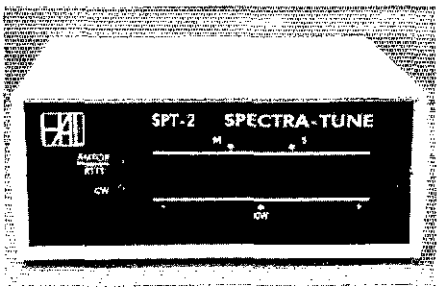
Other reasons include the SPT-2 and the FIL-1, two accessories that round out the PCI-3000 system. The SPT-2 SPECTRA-TUNE is an LED bar-graph RTTY/CW tuning indicator that connects (via a standard 25-pin serial cable) to the back panel of the PCI-3000 plug-in card and functions as a simple, but accurate, audio spectrum analyzer. The SPT-2's 30-LED display covers a range of 600 Hz (1910 to 2510 Hz for RTTY/AMTOR, 500 to 1100 Hz [centered at 800 Hz—a bit high for my taste] on CW). This equates to 20 Hz per LED. The SPT-2's documentation states, however, that because the transition between any two illuminated LEDs is gradual, a visual frequency resolution of 5 Hz or less can be achieved with the display.

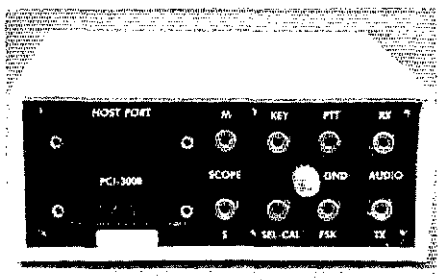
It's easy to tune RTTY signals with the SPT-2: Just line up the mark and space LEDs, and you're right on frequency. It's not quite as handy as a "crossed banana" oscilloscope display (the HAL ST-6000 has one built in), but it's a lot easier, faster and more precise than the tuning displays used on the less-expensive MCPs. After becoming familiar with the SPT-2, I could easily tune in RTTY stations in a second or less. No fiddling around, tuning back and forth, and so on. Its display works well, even when the bands are crowded with contest stations.

Visual CW tuning with the SPT-2 is similarly easy. (Whether your system includes the SPT-2 or not, you can make the PCI-3000 generate an 800-Hz sidetone, generated in step with the received CW signal, by pressing **Alt-C** on your computer keyboard. Turn on the sidetone, tune the incoming signal to match the sidetone pitch, and you're there. Hitting **Alt-C** again turns the sidetone off.)

You can purchase the PCI-3000 without an SPT-2, but sooner or later, you'll wish you had the tuning indicator. For me, the SPT-2 is a necessity. In addition to being an excellent tuning indicator, the serial cable that runs between the PCI-3000 and the SPT-2 also carries a bunch of other signals: Connectors for audio input, AFSK, PTT, FSK, CW key, oscilloscope, a SELCAL-activated switch to control external devices, and a DB25 serial connector to use the PCI-3000's "Host Mode" feature. All reside on the back panel, and all are phono jacks (except the serial connectors, of course, and a grounding post).

If you don't have the SPT-2, you'll have to make connections to the PCI-3000's 25-pin serial connector—and that's a pain, especially if you change rigs every now and then. Also, without the SPT-2, the PCI-3000 has no resident tuning indicator. With the SPT-2, making connections is a snap.





The PCI-3000's optional SPT-2 tuning indicator does more than help you tune: It also brings out to rear-panel phono jacks connections that you'd otherwise have to make via the PCI-3000's DB25 connector.

The SPT-2 makes the PCI-3000 a formidable HF digital operating system, and with the PCI's Host Mode (discussed later in the review), one that's very upgradable. Take my advice: If you buy a PCI-3000, buy the SPT-2.

The FIL-1 is an accessory audio filter that fits inside the SPT-2. It has a 500-Hz bandwidth that's centered around the RTTY tone frequencies and gives the PCI-3000's demodulator a shot in the arm, especially if your rig doesn't have passband tuning, IF shift or narrow IF filters.

Construction Quality

Because HAL is a small company that makes a lot of digital-mode gear for the military (ours and others), PCI-3000 owners get a pleasant, if unexpected, bonus: The PCI-3000—and all of its parts—are made to military specifications ("mil-spec"). Every PCI-3000 is checked by a government inspector at HAL's Illinois plant. I knew the PCI-3000 was of high quality the second I saw the glass-epoxy plug-in board. It *looks* high quality.

Setting up the PCI-3000

Getting the PCI system up and running is easy. Once you unpack it, you'll have the PCI-3000 plug-in card, an SPT-2 with its internal, already-installed FIL-1, one floppy disk, a serial cable, a 25-pin serial connector and three manuals, one for the PCI, one for the SPT-2 and one for the software, *PC-AMTOR*.

You'll need to install the card in a full-size expansion slot in your computer (make sure the power is off, etc). The PCI is configured to respond to a little-used interrupt, so it's unlikely you'll experience memory or device conflicts. (If you do, the PCI-3000's internal address and interrupt assignment can be changed.)

Next, connect the SPT-2 to the PCI board in your computer with the supplied serial cable. It's six feet long, so you can position the tuning indicator/breakout box at a convenient location.

Connections to your rig are made to the phono jacks on the rear panel of the SPT-2. If your rig also has phono jacks, hook-up will take only a minute or so. If you have to solder up a DIN plug, be sure to turn on some soothing background music....

Installing *PC-AMTOR* is simply a matter of inserting the floppy disk in the appropriate drive and typing **INSTALL**, which copies the software to your hard drive or another floppy disk. When installed, type **PCA** to load the software. You're all set.

The Software

PC-AMTOR is straightforward, no-frills RTTY/AMTOR/CW operating software. It covers all the bases, but it's not flashy. I used it during two RTTY contests, for casual operating and for SWLing on the utility bands.

For convenience, the software is menu driven. At any time, hit **F1** to call up the menus. To change modes, pull down the Code Menu and take your pick. To change data rates, use the Rate Menu. It's easy. Once you become familiar with how everything works, you can use keyboard shortcuts to save time.

One handy feature is HAL's Search Mode. Simply tune in your digital signal (CW included), enable Search Mode, and in a second or two, *PC-AMTOR* figures out the mode, data rate, tone polarity and so on. Search Mode is fast and accurate, but it can annoyingly hang in CW mode for a while when it's analyzing a received signal. Because of this, I wish Search Mode could exclude CW, but the delay is not a big deal.

PC-AMTOR features a standard split-screen format: top for receive, bottom for the transmit buffer. With the transmit function enabled, *PC-AMTOR* keys your rig's PTT circuit and starts transmitting as soon as you type characters (or words or lines, depending on your preference). It returns to receive a second or two after everything's been sent. With the transmit function disabled (both choices are in the Control Menu), you can type ahead and fill up the transmit buffer, even while receiving. When it's your turn to transmit, simply enable the transmit function to send what you've typed. (*PC-AMTOR* uses **Alt-F10** as the keystroke[s] to toggle transmit enable on and off. A single keystroke would be more convenient.) You can also transmit computer text files and save received data to disk.

To make operating a bit more convenient, *PC-AMTOR* has several program-

mable text memories that can store your call sign, the other station's call sign, your SELCAL, the other station's SELCAL and two "here is" message areas for contest exchanges, CQ messages or "brag tapes." I found that having only two general message memories to be somewhat annoying. I prefer at least five (hint, hint, HAL!).

PC-AMTOR really shines in its configuration menus. In addition to being able to set screen colors, time and UTC offsets and so on, each digital mode has its own user-defined default settings, such as line length, alphabet, CR/LF configurations, data rate and so on.

Other standard features include unshift-on-space (USOS), user-selectable synchronous idle (diddle), an on-screen clock and a status line that indicates mode, data rate and other information.

Overall, *PC-AMTOR* is effective and easy to use—it's the true "four-door sedan" of RTTY/AMTOR software. It's not glitzy, but it's not lacking, either. And it's the easiest to set up and use of any I've tried.

Using the PCI-3000

Everything about using and installing the PCI-3000 is straightforward, intuitive and enjoyable. Experienced users probably won't even need instructions (read yours, however).

During the review period I made about a hundred Baudot contacts (using FSK and AFSK), a few AMTOR QSOs (not one of my favorite modes, but one at which the PCI-3000 excels) and no CW QSOs. I did receive several CW stations, however, and the PCI-3000 copied them as well as expected: Machine-sent code prints well; hand-sent code, so-so.

One unusual feature emerges when the PCI doesn't recognize a Morse code string: it displays the offending dots and dashes graphically, in case *you* can! It looks weird at first, but it's quite helpful.

Performance Comparisons

So how did the PCI-3000 hold up against the competition in my home-grown, not-exactly-scientific comparative review? In a nutshell, very well.

As I hinted at earlier, the SPT-2's tuning indicator is excellent, coming in second only behind the HAL ST-6000's built-in tuning oscilloscope. The Tono EXL-5000 ran a close third with its accurate LED bargraph display (it's more precise than the SPT-2, but not quite as fast to use), and the PK-232 finished last.

In copying weak signals, the PCI-3000 again came in a close second to the ST-6000. (A friend who used the ST-6000 remarked, "Geez, it can copy RTTY so weak your ears can't even tell there's a RTTY signal there!") He's right—but the ST-6000 isn't as easy to use and set up, and you'll have to take your chances with a used one, because new ST-6000s cost about $1800—plus another $1000 or so for the AMTOR/SITOR accessory, not to mention software or a terminal unit. The Tono could detect extremely weak signals, but the PCI-3000 produced cleaner copy. The PK-232 came in a qualified last. It's important to remember that I'm talking about *really* weak signals here—the kinds useful for benchmark testing, but too weak for comfortable communications. Above a certain threshold, the PK-232 hung right in there, especially when I used the SPT-2 or the 'scope on the ST-6000 to tune PK-232 precisely.

When it comes to software and upgradability, the PCI-3000 is on a level with the other multimode boxes. Its firmware and software are upgradable. The ST-6000 has no firmware, but software that speaks 5-bit RTTY isn't exactly in vogue. The Tono comes in dead last here; it has its latest-version firmware, but there are no sources other than Tono (in Japan), and its software is definitely the least user-friendly!

Manual

Content-wise, the three user's manuals that accompany the PCI-3000 system components shine as examples of how user manuals should be written. They're complete (to an almost excessive degree!), easy to use and provide detailed circuit descriptions, exact schematics and precise alignment and troubleshooting procedures. There's an exhaustive, cross-referenced index, and a useful chart on how to interface the PCI-3000 with most late-model rigs for FSK.

Other Software

There's a "spare" serial-port connector on the SPT-2's rear panel that plays an important role for the PCI-3000 and its longevity. It's the Host Mode port, and it allows all of the PCI-3000's functions to be controlled by software other than *PC-AMTOR*.

A popular use for Host Mode is Vic Poor's *APLink* networking software. (Many *APLink* bulletin boards use HAL PCI-3000 systems.) Other programs that use the PCI-3000's Host Mode port include RTTY contesting/logging programs such as *CompRTTY*, and *WF1B*. There are even several public-domain programs that work with the PCI-3000 (try the one written by W9CD; it's available from HAL's BBS at 217-367-5547), and if you're an adventurous type, you can write your own. HAL provides all of the control codes and other information necessary to write custom programs for the PCI-3000.

Conclusion

Is the PCI-3000 a good value, and should you buy one, especially when the next generation of DSP-based super modems is just around the corner? Today's DSP RTTY boxes still cost more than the PCI-3000 system, but offer potentially better performance. If my information is correct, few, if any, analog-only modems will be able to hold their own performance-wise when DSP technology becomes inexpensive enough for the average ham to build or buy. But that's a few years down the road, and you're probably looking for an RTTY box *today*.

Here're some things to consider:

- The PCI-3000 is easier than the current crop of MCPs to set up, configure and use. *PC-AMTOR*, while not flashy, is capable and friendly. I agonized over setting up my MCP, with its unusual connectors and cables, its manually-set front-panel sensitivity control, its somewhat fussy tuning indicator and its cryptic packet radio-based commands. (I probably would have had an easier time if I had used dedicated software instead of a generic terminal program to talk to my MCP.) You'll have none of that with the PCI-3000. If your rig has phono jacks, the PCI-3000 system is virtually plug-and-play. You'd have to *try* to mess it up.
- If you're a gung ho RTTY or AMTOR enthusiast (and you don't need a board that offers packet), will the PCI-3000 perform better than the less-expensive MCPs? The answer is a qualified *yes*. Under certain conditions (and compared to certain MCPs) the HAL unit will significantly outperform its less-expensive counterparts. In other cases, the difference in performance is not monumental. (The PCI-3000's biggest performance edge is probably with Baudot RTTY, which has no error-correction scheme and depends on the modem to receive the information accurately the first time.)
- If you don't have an oscilloscope to dedicate as a tuning indicator, the SPT-2 is hard to beat. It's a lot smaller than most scopes, and it easily outperforms the tuning indicators on the multimode boxes. Your needs, operating habits and pocketbook will determine whether these differences are important.
- If serial ports are in short supply (and that's probably the case with most computers used for Amateur Radio), the PCI-3000 is advantageous. The HAL card needs no serial port—that is, unless you use the PCI's Host Mode, which requires a serial-port connection.
- The PCI-3000 comes with a one-year parts and labor warranty. HAL's service is top notch, so there's nothing to worry about there.
- There's a growing body of specialized (non-HAL) software for the PCI-3000, so your box won't be dead-ended down the road or shut out of specialized applications. (Most of the new software is available for the multimode boxes, too.)

So would I buy a PCI-3000? Sure, if I had enough excess cash (*there's* an oxymoron for you!). I have no interest in HF packet and I already have a VHF packet modem. The minor complaints I have about the unit mostly concern its software, and are potentially fixable. Performance-wise, I was quite happy with the PCI-3000, and I've dealt with HAL

enough in the past to know that I would be well cared for as a customer.

The biggest drawback for me is the price. Six hundred dollars isn't exactly petty cash. In a perfect world, the PCI-3000 system would cost about $400. (HAL Corp has never sold products on price; they've always emphasized performance, reliability and a long-term commitment to service and support. And for those, my friend, you pay! Besides, in the real world, $400 is virtually impossible when you consider that the unit is built in the US in a mil-spec shop.)

If you're looking for a high-performance RTTY/AMTOR/CW system that's notably easy to use and set up, has a superior tuning indicator, flexible software (and software options) and plugs into a computer slot, the PCI-3000 is a fine choice. It will more than hold its own until (or after) the DSP era is ushered in (and when it is, HAL will probably be right there with the DSP-3000, or whatever they'd call it).

If your HF digital operating needs are less demanding and you'd like your unit to cover HF packet—or if your budget is more restrictive—you can comfortably choose a less-expensive alternative.

Suggested retail prices: basic PCI-3000 (including *PC-AMTOR* software), $395; SPT-2, $169; FIL-1, $69.95; package price, $595. Manufacturer: HAL Communications Corp, 1201 W Kenyon Rd, Urbana, IL 61801, tel 217-367-7373, fax 217-367-1701.

Choosing a Digital Frequency Counter

(continued from page 44)

Higher sensitivity is not always better. A highly sensitive counter may be overly susceptibility to noise—extraneous pulses that the counter may mistake for input-signal cycles. For this reason, many counters, especially bench-top models, have provisions for limiting or controlling sensitivity.

Communications receivers are designed to have relatively good selectivity, but digital frequency counters generally aren't. Counter front ends usually consist of broad-band amplifiers that typically respond to all signals from a few hertz to several gigahertz. As a result, a counter usually responds to the strongest signal in its passband. Two or more similar-strength signals may confuse a counter and render its reading unreliable.

Input Impedance

Most counters have high- and low-impedance inputs, or allow switching a single input between either. An impedance of 1 to 10 megohms, shunted by 20 to 30 pF, is typical of counters' high-impedance inputs. *Low impedance* usually means *50 ohms.*

Overload Protection

Frequency counters are not intended to be directly connected to power lines or transmitter final amplifiers. Even so, accidents occur, so be sure to select a counter with input protection that's adequate for modest overloads. Counters generally provide varying degrees of protection for different input modes. For example, a rating of 100 V ac + dc in the high impedance (10 MΩ) mode but only 2 V ac + dc in the low-impedance (50-Ω) mode is typical.

Display

The display type, commonly LED, planar gas discharge (PGD), or LCD, may greatly affect a counter's ease of use. For example, in a bench-top environment with poor lighting, a bright LED or PGD display provides the best readout. LCDs are perfect for hand-held counters that are frequently used outdoors in bright sunlight; in high ambient light conditions, though, LED displays often appear washed out and difficult to read.

Counter displays may also include annunciators or subscales that indicate gating, external time base, input selection and signal amplitude. Gating indicators are useful in determining when the counter is actually measuring the signal frequency—a feature that's especially useful in situations where long gating periods (10 seconds or more) are used.

Accessories

Most digital frequency counter manufacturers offer accessories and add-ons that can make their basic units more useful. Accessories range from padded cases to high-stability TCXO time bases, NiCd batteries and specialized probes. In addition to providing some protection against impacts, cases can also hold probes, antennas, and other accessories. NiCd batteries and chargers are appropriate for frequently used hand-held counters.

Specialized probes and other input accessories can greatly extend and enhance the utility of a counter. For example, *attenuation probes*, which reduce signal level by a preset amount, can and should be used when severe noise is present, or when the signal to be measured may overload the counter. *High-impedance attenuation probes* are useful for connections to circuitry that a low-impedance probe would disturb. *Low-pass-filter probes* can allow you to measure low-frequency signals in the presence of high-frequency signals that would otherwise confuse the counter. *Preamplifier probes* amplify input signals that would otherwise be too weak for the counter to measure.

Convenience Features

Many frequency counters include convenience features that make counter use easier and more pleasant. *Autoranging*, in which a counter selects the most appropriate range (time base frequency and gating time) for the signal under test, is one of these. Other possible features include *touch hold*, in which the counter captures a reading and displays it from memory after you've disconnected the probes from the circuit; and *automatic clean dropout*, which monitors the counter input and causes an immediate zero readout whenever the input signal falls below the counter's input threshold. For the forgetful, *automatic shutoff* and *low battery indication* are valuable features, especially on hand-held models.

Don't Give Specifications the Benefit of the Doubt

Digital frequency counters vary considerably in features, ease of use, performance and price. It's all too easy to be misled by a counter's frequency range or number of display digits—you may assume an accuracy or precision beyond the capabilities of the instrument. In selecting a frequency counter, pay particular attention to advertised specifications. If you can't find the specifications relevant to your needs, it's safest to assume that the counter is inferior in those respects.

References

B. Bergeron and S. Locke, "Microcomputer-based instrumentation systems," *MD Computing*, Mar 1990, pp 178-184.

B. Bergeron, "A Surface-Mount Technology Primer," *Part 1*, *QST*, Dec 1990, pp 48-51; *Part 2*, *QST*, Jan 1991, pp 27-30.

B. Bergeron, "Hand-Held Digital Multimeters," *QST*, Jun 1991, pp 19-22.

Y. Efe, "Waveform Generators and Related Circuits," *Handbook of Modern Electronics and Electrical Engineering*, Belove, Hopkins, Nelson, Rosenstein and Shinners, eds (New York: John Wiley & Sons, 1986).

F. Harris, *Electrical Measurements* (New York: Wiley, 1952).

P. Horowitz and W. Hill, "Measurements and Signal Processing," *The Art of Electronics* (Cambridge, MA: Cambridge University Press, 1980).

J. Lee, "A Simple Secondary Frequency Standard," *QST*, Sep 1989, pp 29-33.

F. Thompson, "Measurement and Control Circuits," *Electrical Engineering Handbook*, Fink and Christiansen, eds (New York: McGraw-Hill, 1986).

M. Tooley, "GT200 Universal Counter," *Electronics and Wireless World* 96 (1655), pp 793-7, 1991.

J. Willson, "Precision Frequency and Time-Interval Measurement," *Evaluation Engineering*, Jun 1991, pp 42-51.