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Kenwood TS-950SDX MF/HF Transceiver

Maldol 28HS2HB Two-Element 10-Meter Beam

HAL PCI-3000 Multimode HF Data Modem

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Kenwood TS-950SDX MF/HF Transceiver

Reviewed by Rus Healy, NJ2L

It's natural to wonder how Kenwood revised the TS-950S platform to build their new top-of-the-line TS-950SDX. "It had better be something *really* special," you're thinking, "otherwise Kenwood would have a lot of explaining to do as to why they released this rig less than two years after its predecessor!" Well, the new '950 *is* really special. It retains all the basic radio performance of the TS-950SD, and Kenwood's digital signal processing has finally come of age in this product.

In developing the TS-950SDX, Kenwood substantially revised the TS-950S's front panel and operating software. Unfortunately for TS-950S/SD owners, Kenwood has no plans to offer an upgrade to the TS-950SDX. A physical upgrade is practically impossible; the new '950 is a completely different radio in most respects. It's *so* different, in fact, that after reviewing it, I'm surprised they didn't call it the *TS-960S*.

To get a better idea how the new radio differs from the old, and to see how their lab-measured performance compares, read the January 1991 *QST* TS-950SD review. Except where they differ, I won't discuss most of the features and controls the TS-950SDX shares with the TS-950S/SD.

What's New?

Here's a rundown of the more substantial changes and improvements:

Now Standard:

- The TS-850S's wonderfully quiet, nearly spur-free direct digital synthesizer, which can tune in 1-Hz steps.
- CW operation on either sideband and a **FINE** button, which gives 1-kHz-per-revolution tuning in CW mode, like the '850.
- The AGC control has an **AUTO** position in which the radio chooses AGC constants by mode. You select the default for each mode in a setup menu.
- Memory keyer with remote control. We've entered a new era in transceivers with the TS-950SDX: Its supplied wired remote is your *sole* access to the radio's standard three-memory keyer (and the optional DRU-2 digital voice recorder/player, if installed).
- A refined, useful second receiver.
- New DSP effectiveness and versatility.

No Longer Standard:

- 270-Hz and 1.8-kHz filters for the 8.83-MHz IF.

No longer is there a "base" TS-950S; the digital signal processing (DSP) unit is now so completely integrated into the radio that Kenwood decided to offer only one package.

Still Standard:

Excellent basic radio performance; 150 W output; fast, quiet automatic antenna tuner; simple VFO manipulation and split operation; 100 memories; RF-derived SSB monitor circuit; lots more.

Other Highlights

- The radio's improved software results in fewer front-panel controls and less clutter. The reworked panel is easier to navigate than the old one.
- The TS-850S-like Quick Memo function allows easy storage and recall of five frequency/mode/filter combinations. You can tune these memories in Recall mode.
- A widely variable display dimmer that lets you vary the intensity of every front-panel indicator.
- Menu-configurable IF-filter choices by mode. Why should you have to pass over a 500- or 270-Hz filter in SSB mode—or a 6-kHz filter in CW? Now you can deselect them to make filter selection more convenient.

The Bottom Line

Rich in features, this transceiver rewards top-dollar-radio buyers with top-shelf performance. It does a lot, but is somewhat complicated to use—as reflected by its manual, which is not up to the task.

Data-mode operation is quite straightforward with the TS-950SDX. In FSK, the radio ignores front-panel microphone input and works quite smoothly. Three DSP filter bandwidths are available in FSK, in addition to the CW IF filters and **VBT** controls. On the rear-panel data in/out jack (**ACC 2**), a pin can also be used to disable the microphone input for other modes (packet radio, AMTOR, etc).

You can connect an external keying source *and* a paddle to the radio at the same time, using the rig's internal keyer and external keying source with relatively little hassle. To do so, however, you have to wire an external adapter cable for the remote control, because both it and the external keyer connect via the **REMOTE** jack (see "Documentation").

In the different-but-not-better category: The traditional Kenwood 10/20/30 dB attenuator settings are gone. Now your choices are 6, 12 and 18 dB. I consider this a drawback. This radio is *so* sensitive that I often operate on 160, 80 and 40 meters using 18 dB of attenuation *and* the AIP circuit to keep signals to a reasonable level.

Kenwood has left behind the TS-950SD's bipolar output transistors in favor of FETs in the '950SDX. The new radio puts out just as much power as the old one, but its SSB IMD characteristics, although still very good, are actually slightly worse than the TS-950S—at least in the samples we've tested in the ARRL Lab. Kenwood says that the new FET final offers enhanced reliability.

Options

Filtering options for the TS-950SDX's

main receiver include 1.8-kHz and 270-Hz units for the 8.83-MHz IF, and a 250-Hz unit for the 455-kHz IF. For all but the most demanding contesting on crowded bands, the radio's stock 500-Hz CW IF filters, DSP low-pass filter and VBT controls do the job well. If you have a 40-meter beam, live on the East Coast (or in Europe) and spend a lot of your operating time in DX contests, you'll probably benefit from one or both of the narrower (sub-300-Hz) filters. For SSB contesting and DXing, the 1.8-kHz filter is valuable, but not absolutely necessary, thanks to the radio's other filtering functions.

User Interface Improvements

The TS-950SDX implements most user-definable functions via setup menus. In fact, there's now only one configuration switch on the radio: the external-amplifier control switch on the back panel. Most commonly changed functions (29 of them) are configurable at any time via the **MENU** key and sub display. Thirty other functions, covering everything from FSK shift to frequency- and channel-step sizes, can be reconfigured only at power-up.

Here's how the menu system works. Let's say you want to change the display brightness (when the display **DIM** switch is pressed). You push the **MENU** button and use the **M.CH/VFO.CH** knob to select the appropriate menu item—in this case number 02. As you turn the knob, you'll see the item numbers, brief descriptions of each function, and the current settings roll by. When you reach number 02, you'll see *Bright* on the sub display, followed by its relative setting. You can then choose any of eight display-brightness settings using the up- and down-arrow keys on the keypad. The brightness changes as you push these keys. Push **MENU** again and you're back to normal operation. While in **MENU** mode, the radio's main functions—tuning, AF gain, and so forth—remain usable.

The TS-950S/SD's top hatch is gone in the TS-950SDX, and the controls that were under it moved to the front panel. Bravo, Kenwood!

The New DSP System

Kenwood's first-generation TS-950SD DSP unit was rather unimpressive, mainly offering limited transmitted-signal processing functions. Its only receive function was a variable-bandwidth audio filter that didn't exactly revolutionize audio-filter performance.

One of the TS-950SDX's biggest improvements over the '950SD lies in its sophisticated, effective DSP receive functions. On transmit, the DSP unit still sets the high and low cutoff frequencies of transmitted AM and SSB audio, shapes the CW waveform and generates the FM carrier, but it's now also used for a variety of receive functions, such as SSB and CW *detection*, band-pass filtering on CW, FSK and SSB, and noise filtering on SSB.

In SSB and CW operation, the TS-950SDX's DSP detection makes for incredible elimination of the audio image ("opposite sideband")—even with low CW offsets and loud signals! The acid test was setting the radio's offset to 400 Hz and tuning in W1AW's S9+60-dB signal on CW. Using a 500-Hz filter and almost any other radio, you can tune such a signal on both sides of zero beat (the desired sideband and the audio image); in the '950SDX, *the audio image isn't there*—even with a 2.7-kHz filter in line! Of course, this works equally effectively on SSB. Kenwood has made quite a leap with digital signal processing in this area.

Another feather in Kenwood's engineering cap is its much-touted DSP *comb filter*, which you can toggle on and off via a menu item. Except on the quietest bands, the comb filter makes for a sometimes dramatic improvement in signal-to-noise ratio, though it does noticeably limit the receiver's audio response. The comb filter vastly reduces band noise—and operator fatigue—particularly in 40, 75 and 160-meter SSB operation.

Used in combination with the IF filters, SSB **SLOPE TUNE** controls and the variable-cutoff DSP low-pass filter (which also works very well on CW), the comb filter makes the TS-950SDX an exceptionally selective SSB radio—Kenwood's best ever. Between that, the radio's obliteration of the undesired sideband on receive, and Kenwood's traditional interference-reduction controls, the TS-950SDX is certainly one of the most capable SSB DXing and contesting radios ever made.

Enhanced Sub Receiver

The TS-950S's sub receiver was perhaps its least fully developed feature. It stuck you with an SSB-bandwidth filter, a small tuning knob and limited range (±500 kHz with respect to the main-receiver frequency). You had no choice but mixed audio, with the audio-output ratio and levels set by separate **AF GAIN** controls. In these limitations, the TS-950S's sub receiver significantly lagged its competition.

The '950SDX provides much more sub-receiver versatility. Thanks to the **M/S** (main/sub swap) key, no longer must we suffer by tuning the sub receiver with that little **RIT/XIT**-size knob! And the **RX <=> SUB** key lets you swap the two entirely, rather than just their controls, which is very useful in contest operation. The second receiver now has its own signal-strength meter: During sub-receiver operation, the transmitter's yellow ALC scale doubles as the sub-receiver S meter.

The **SUB** key also gives direct-frequency-entry capability and shows the selected IF filter (500 Hz or 2.7 kHz). Yes, the adio now comes with a selectable 500-Hz CW filter in the sub receiver! That's a big improvement. CW DXers may consider this feature the sub receiver's most significant improvement: It allows using the sub receiver on crowded bands—something very difficult to do with the '950S.

Stereo/mixed audio selections, invoked from the **MENU** key, are useful. You can select which receiver's audio goes to which ear in a stereo headset, or to internal and external speakers. But the radio still has two **AF GAIN** controls, making adjustment less quick and easy than a master AF gain and separate balance control.

Sub-Receiver Tidbits

- Its AGC is fixed at something close to the main receiver's **MID** constant.
- It's tunable ±1 MHz from the main receiver.
- It works only on CW, SSB and FSK, and you can't enable the sub receiver if the main receiver is in AM or FM.
- It's still restricted to the main receiver's mode.

On the Air

The TS-950SDX hits the mark in the most important ways: receiver dynamic range, transmitter cleanliness, CW wave shaping, and low phase noise.

On CW, the TS-950S was hard to improve on—except for its QSK transmission. If you wanted to use the TS-950S in QSK mode, you had to trade off optimum performance in semi-break-in mode. Not so in the 'SDX. As the keying photos and on-the-air use show, this radio does both very well, with external or internal keying sources. If you're using either radio in QSK mode, you'll definitely want to turn off the external amplifier key line, however; the relay used to switch this line is rather noisy.

The radio's low-pass DSP audio filter is always active; you set its cutoff frequency in the range of 400 Hz to 6 kHz in a menu. This filter lets you shape receiver audio response optimally for any mode. With this filter wide open, the receiver's AM-audio response is wonderfully wide. It's quite useful on CW, SSB and FSK, also.

Kenwood has kept its basic, proven IF-filter scheme, improving it with each radio generation. With variable-bandwidth tuning in the radio's audio and IF sections and wonderfully smooth AGC on all modes, the TS-950SDX is at least the TS-950S's equal. But with its cleaner synthesizer, DSP low-pass filter and improved user interface, the 'SDX is more effective and enjoyable to use.

Documentation

The 63-page TS-950SDX manual covers a lot of ground; it documents a very complex radio. It isn't up to the standards set by Yaesu, Ten-Tec and ICOM, however. I had trouble finding information I needed on numerous occasions. Although the manual does a pretty good job of describing what happens when you press a button or turn a knob, it gives very little *practical* information on how to use the radio's many functions, so it takes a lot longer to

learn to use this radio than you might otherwise require.

In some cases the manual is vague. For instance, it strongly implies that the DSP low-pass filter is only available in FSK; it's not—it works on FSK, CW and SSB. Only the band-pass selections are solely for FSK. I found only one error in the manual: A box on page 31, the section on SSB transmitting, contains this note: "The transmitter will not operate unless the **FULL/SEMI** switch is in the **FULL** position." This is not true.

The manual is also somewhat disorganized. The section on connecting accessories is near the beginning, just past the rear-panel jack descriptions. I wanted to connect a separate keying source (my computer) *and* a paddle for use with the radio's internal keyer. This *is* possible, as mentioned earlier, but the section on how to do it is buried in the option-installation section near the back of the manual, with no pointers from elsewhere. Descriptions of the radio's DSP functions are also widely scattered throughout the manual.

On the good side, the manual's sections on basic receiving and transmitting functions, accessory connections and option installation are concise and easy to follow. Three manuals are shipped with the radio: the instruction manual, the external control manual (which details computer-control operation), and a booklet of fold-out schematic diagrams—a nice touch. The radio also comes with a handy quick-reference card showing the functions accessible via the **MENU** key, their default settings, and summaries of what they do.

Odds and Ends

Kenwood has addressed a number of TS-950S owners' concerns in the TS-950SDX. For example, some users of the TS-950S (and other radios) have experienced high-SWR power reduction when

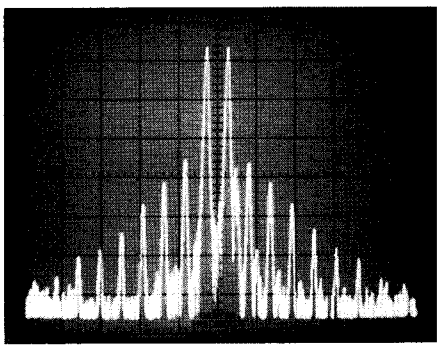


Fig 1—Worst-case spectral display of the TS-950SDX transmitter during two-tone intermodulation distortion (IMD) testing. Third-order products are approximately 35 dB below PEP output, and fifth-order products are approximately 41 dB down. Vertical divisions are 10 dB; horizontal divisions are 2 kHz. The transceiver was being operated at 150 W PEP output at 3.9 MHz.

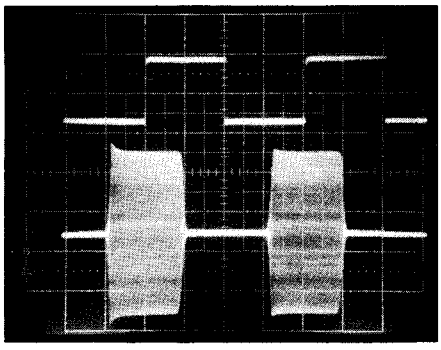
Table 1

Kenwood TS-950SDX MF/HF Transceiver, Serial no. 31200011

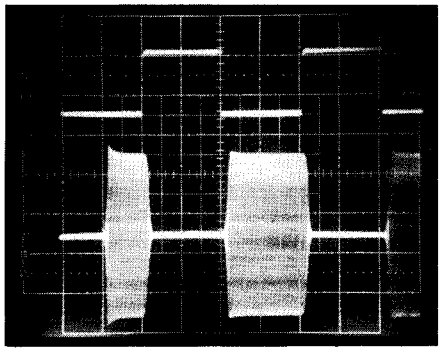
Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: Receive, 0.1-30 MHz, transmit, 1.8-2, 3.5-4, 7-7.3, 10.1-10.15, 14-14.35, 18.068-18.168, 21-21.45, 24.89-24.99, and 28-29.7 MHz.	Receive, as specified; transmit, 1.7-2, 3-4, 6.5-7.5, 10-11, 13.5-14.5, 18-19, 20.5-21.5, 24-25, and 27.5-30 MHz.
Modes of operation: AM, CW, FM, FSK, LSB, USB.	As specified
Power requirement: 120 V ac ±10% at 110 W on receive and 700 W max on transmit.	Not measured.
Receiver	*Receiver Dynamic Testing*
Receiver sensitivity (10 dB [S+N/N], bandwidth not specified, AIP off): SSB and CW: 0.1-0.15 MHz, 2.5 μV (−99 dBm); 0.15-0.49 MHz, 1 μV (−107 dBm); 0.49-1.7 MHz, 4 μV (−95 dBm); 1.7-30 MHz, 0.2 μV (−121 dBm).	Minimum discernible signal (noise floor) with 500-Hz IF filters: 1.0 MHz: AIP Off −121 dBm, AIP On −111 dBm 3.5 MHz: AIP Off −139 dBm, AIP On −127 dBm 14.0 MHz: AIP Off −138 dBm, AIP On −126 dBm 28.0 MHz: AIP Off −137 dBm, AIP On −127 dBm
AM (10 dB S+N/N, bandwidth not specified, AIP off): 0.1-0.15 MHz, 25 μV (−79 dBm); 0.15-0.49 MHz, 10 μV (−87 dBm); 0.49-1.7 MHz, 32 μV (−77 dBm); 1.7-30 MHz, 2 μV (−101 dBm)	Signal 30% modulated with a 1-kHz tone: 1.0 MHz: AIP Off −105 dBm, AIP On −96 dBm 3.8 MHz: AIP Off −122 dBm, AIP On −111 dBm
FM (12 dB SINAD, AIP off): 28-30 MHz, 0.5 μV. (−113 dBm).	29 MHz with 6-kHz filter: −118 dBm (AIP off); −110 dBm (AIP on).
Blocking dynamic range: Not specified.	Blocking dynamic range with 500-Hz IF filters:* 1.0 MHz: AIP Off 128.5 dB, AIP On 129.3 dB 3.5 MHz: AIP Off 131.5 dB, AIP On 133.5 dB 14.0 MHz: AIP Off 131.8 dB, AIP On 133.9 dB 28.0 MHz: AIP Off 135.4 dB, AIP On 138.4 dB
Two-tone, third-order IMD dynamic range: 108 dB (signal spacing and IF bandwidth not specified).	Two-tone, third-order IMD dynamic range with 500-Hz IF filters:* 1.0 MHz: AIP Off 83 dB, AIP On 87 dB 3.5 MHz: AIP Off 93 dB, AIP On 94 dB 14.0 MHz: AIP Off 94 dB, AIP On 95 dB 28.0 MHz: AIP Off 97 dB, AIP On 100 dB
Third-order input intercept:† Not specified.	AIP Off / AIP On 1.0 MHz: 3.5 dBm / 19.5 dBm 3.5 MHz: 0.5 dBm / 14.0 dBm 14.0 MHz: 3.0 dBm / 16.5 dBm 28.0 MHz: 8.5 dBm / 23.0 dBm
S-meter sensitivity (for S9 reading): Not specified.	At 14 MHz: AIP off, 59.5 μV; AIP on, 282 μV.
CW/SSB squelch sensitivity (1.7-30 MHz): Less than 0.5 μV.	As specified.
FM squelch sensitivity (28-30 MHz): Less than 0.32 μV	As specified.
IF notch filter attenuation: More than 45 dB.	29 dB.
Receiver audio output: 1.5 W into 8 Ω at 10% distortion.	2.3 W into 8 Ω at 10% total harmonic distortion.
Receiver IF/audio response: Not specified.	At −6 dB, with audio low-pass filter at 2.8 kHz: SSB (2.7-kHz IF filters), 282-2534 Hz (2252 Hz); CW (500-Hz IF filters, 500-Hz offset), 247-646 Hz (399 Hz).
Transmitter	*Transmitter Dynamic Testing*
Transmitter power output: Adjustable from 20-150 W on CW, FM, FSK and SSB; 10-40 W on AM.	Adjustable from 10 to 150 W (CW, SSB, FM—output varies slightly from band to band). AM as specified.
Spurious-signal suppression: >40 dB.	As specified. Meets FCC specifications for equipment in its power-output class and frequency range.
Third-order intermodulation distortion products: Not specified.	See Fig 1.
CW keying characteristics: Not specified.	See Fig 2.
Transmit-receive turnaround time (PTT release to 50% audio output): Not specified.	AGC fast: S1 signal, 25 ms; S9 signal, 23 ms.
Composite transmitted noise: Not specified.	See Fig 3.
Size (height, width, depth): 6 × 16.1 × 17.6 inches; weight, 51 pounds.	

*Blocking dynamic range and third-order IMD dynamic range measurements were made at the ARRL Lab standard signal spacing of 20 kHz. Also see Table 2.

†Third-order input intercept (dBm) = MDS (dBm) + 1.5 × third-order IMD dynamic range (dB).



(A)



(B)

Fig 2—CW-keying waveforms for the Kenwood TS-950SDX in the semi-break-in (VOX) mode (A) and the full-QSK mode (B). The upper traces are the actual key closures; the lower traces are the RF envelopes. Horizontal divisions are 10 ms. The transceiver was being operated at 143 W output at 14 MHz. In VOX mode, the first keyed element is shortened by about 5 ms; in QSK mode, no perceptible element shortening occurs. In both modes, the first element after key closure is slightly harder than the rest.

using them with external power amplifiers. When first keyed, some amplifier TR-relay contacts take long enough to settle that the radio sees a very high SWR for a few milliseconds and cuts back power accordingly to protect the final-amplifier transistors. When things have settled, the radio's output slowly rises. To alleviate this problem with amplifiers that use slow-settling relays, the TS-950SDX has a jumper you can cut that delays the radio's RF output by 30 milliseconds (instead of the default 15 ms) in semi-break-in mode. (QSK operation isn't affected.)

One rather annoying characteristic of the TS-950S/SD was display flicker. Whenever any part of the display changed, the entire display flickered. In the TS-950SDX, this problem is better, but not completely fixed. Now only when very loud signals "move the S meter" (illuminate its bars) over about S9 is flicker perceptible.

Decisions, Decisions

The TS-950SDX is a strong and worthy contender for your high-performance-radio dollars. With the TS-950SDX, it's more important than ever that you obtain a copy of the manual before making your buying decision. Because this radio is so complex and capable, a few evenings of studying the manual will reveal a great deal of useful information that will help you determine if this is the high-performance radio for you. While you're at it, study the competitors' manuals and *QST* Product Reviews of their radios to see how things compare. Above all, make a concerted effort to spend some time with every radio you're considering, even if it's only at a convention or dealer.

More than $3700 (a typical TS-950SDX street price) is a *lot* of money to spend on a radio. Do everything you can to make sure you pick one that's right for you.

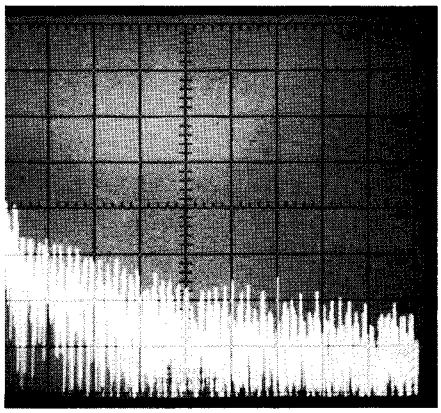


Fig 3—Spectral display of the TS-950SDX transmitter output during composite-noise testing. Power output is 144 W at 14 MHz. Vertical divisions are 10 dB; horizontal divisions are 2 kHz. The scale on the spectrum analyzer on which these photos were taken is calibrated so that the log reference level (the top horizontal line on the scale) represents −60 dBc/Hz and the baseline is −140 dBc/Hz. Composite-noise levels between −60 and −140 dBc/Hz may be read directly from the photographs. The carrier, off the left edge of the photographs, is not shown. These photographs show composite transmitted noise at frequencies 2 to 20 kHz offset from the carrier.

Table 2
TS-950SDX Sub Receiver Performance at 14 MHz

Category	*Measured in the ARRL Lab*	
	AIP Off	*AIP On*
CW Sensitivity*	−139 dBm	−130 dBm
Blocking Dynamic Range†	126 dBm	134 dB
Third-Order IMD Dynamic Range†	94 dB	96 dB
IF/audio response at −6 dB*	With 2.7-kHz filter, 158-2661 Hz (2503 Hz); with 500-Hz filter, 341-1035 Hz (694 Hz).	
S-meter sensitivity for S9 reading	AIP off, 28.2 μV; AIP on, 129 μV.	

Note: Sub-receiver AGC cannot be disabled.
*500-Hz IF bandwidth.
†20-kHz signal spacing.

Thanks to Dave Newkirk, WJ1Z, and Steve Powlishen, K1FO, for their contributions to this review.

Manufacturer's suggested list prices: TS-950SDX, $4500; YK-88SN-1 1.8-kHz IF filter, $85; YK-88CN-1 270-Hz IF filter, $84.95; YG-455CN-1 250-Hz CW filter, $160; MC-90 microphone, $220; VS-2 voice synthesizer, $63; IF-232C computer interface, $99; DRU-2 digital voice recorder/player, $122; SP-950 filtered speaker, $110; SM-230 monitor scope, $1000. Manufacturer: Kenwood USA Corp, 2201 E Dominguez St, Long Beach, CA 90801, tel 310-639-4200.

Maldol 28HS2HB 2-Element 10-Meter Beam

Reviewed by Bart J. Jahnke, KB9NM

The 28HS2HB caught my eye as I thumbed through *QST* ads. (I saw it in a spread for EasyTech, one of Maldol's US distributors.) For my station, the antenna's price, size (two elements on a 4-foot, 5-inch boom), and nondemanding installation (it can be rotated using a light-duty TV-antenna rotator) were highly attractive. Furthermore, with the influx of new hams who have 10-meter privileges and the resultant popularity of 10 meters, a monobander—however small—for that band was something I wanted to try.[1] The 28HS2HB looked as if it would give me the opportunity.

Specifications and Construction

The Maldol 28HS2HB's two elements are driven out of phase. One element is made shorter than the other to give the antenna directivity. For an SWR of 1.5:1 or less, the antenna's specified bandwidth is

[1]A 6-meter version, the 50HS2HB, is also available.

The Bottom Line

A compact, solid monobander, the 28HS2HB provides real directivity and gain on ham radio's most popular HF band at great price.

500 kHz—centered on the frequency for which the antenna is tuned. As with most HF antennas, initial frequency settings must be established during assembly.

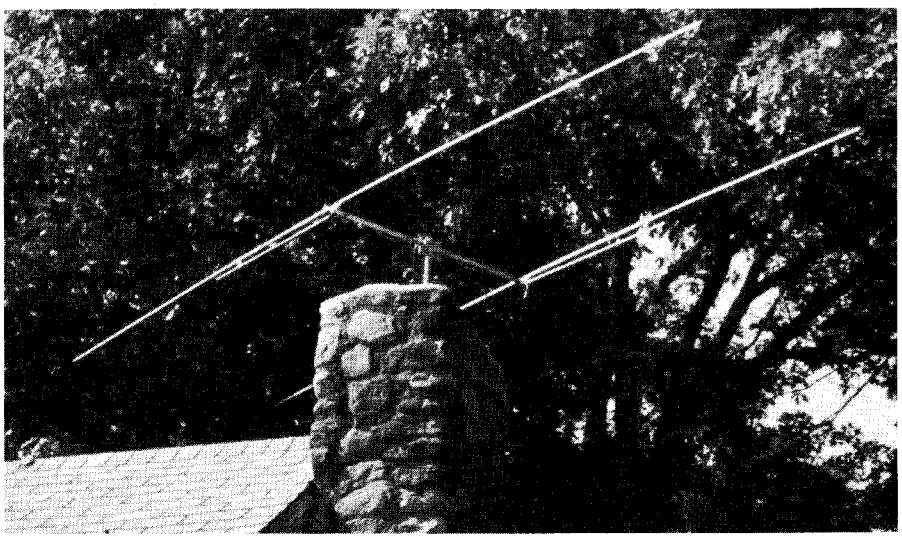
The 28HS2HB's boom and longer-element lengths give it a turning radius of just over 9 feet—a dimension that makes the antenna usable in a wide variety of operating environments. Weighing just 6 lbs, the 28HS2HB is quite manageable—even if antenna-raising day is a bit windy. Unassembled, the antenna is UPS shippable.

The 28HS2HB's boom-to-mast bracket accepts masts with diameters from 1¼ to 2½ inches. A standard SO-239 female UHF connector handles the antenna-to-feed line connection.

Much of the antenna consists of lightweight aluminum tubing. Slight bumps, stress applied to the elements during handling and raising, and even a stray tree branch (which, at one point, kept my small rotator from turning the antenna) did not harm 28HS2HB's mounting brackets and tubing.

Table 3
Maldol 28HS2HB 2-Element 10-Meter Beam

Manufacturer's Claimed Specifications	*ARRL Evaluation*
Antenna type: 2-element HB9CV.	As specified.
Frequency coverage: 28 to 29.7 MHz.	As specified.
Boom: 4 feet, 5 inches.	As specified.
Longer element: 17 feet, 8 inches.	As specified.
Turning radius: 9 feet, 2 inches.	As specified.
Power-handling capability: 500 W SSB, 250 W FM.	Tested at 100 W.
2:1 SWR bandwidth: not specified; 500 kHz for an SWR of 1.5 or less.	As specified.
Weight: 6 lbs.	As specified.



Instructions and Assembly

The 28HS2HB arrived with its box slightly torn on one end. Inspection revealed that, although none of the antenna's hardware had been damaged, its small-parts bag (including instructions) was missing. A quick call to EasyTech brought a faxed instruction manual so that I could confirm what was missing from the box. After a careful review, I determined that only the small-parts bag was missing. A follow-up call to EasyTech brought a replacement parts bag in just a few days. That's good service!

The 28HS2HB's instruction manual is concise and easy to follow. Its illustration of the antenna and its component locations assisted me with assembly while I followed the instruction text. The antenna parts list omitted one component—an aluminum matching-section tube—but the part itself was present, and the instruction text described it. I wish the manual included a paragraph describing the antenna and its design (it's an HB9CV type), but that's arguably more of a selling point than a user requirement.[2]

With the antenna instructions, parts and hardware in hand, I built the antenna quite easily—in my living room! (Few HF beam antennas can be assembled indoors.) One item not included on the antenna's "tools required" list, and which is significant for the smooth assembly of this antenna, is a metric ruler or metric measuring tape. (Seeing the labeling on the outside of the shipping box should have given me a clue to this: Maldol is based in Japan.) Remembering that 1 meter equals 39.37 inches helped, but I consider a metric ruler or tape to be essential in assembling the 28HS2HB.

Once I assembled the antenna's boom, elements and phasing line, measuring and setting the element lengths came next. To cover my 500-kHz subband of interest, I adjusted the antenna for minimum SWR at 28.400 MHz—the middle of the Novice/Technician phone band.

Tuning the antenna is simple. On each of the antenna's four adjustable element portions, a locking ring and set screw (which protrudes through a hole in the outer element section and presses against the inner section) holds the smaller-diameter element tube in place. The gamma section for feeding each of the two driven-element halves comes with factory recommended measurements and, once set, need not be adjusted further.

Initial SWR checkout can be accomplished by temporarily mounting the antenna on a tower, pole or push-up mast (the higher the better). Then, monitoring the match with a good SWR/power meter, apply a few watts to the antenna and note the SWR. If all looks well, then off to the tower (or, in my case, the roof) you go.

Installation and Operation

Once I'd set the 28HS2HB's center frequency, installing the antenna was easy.[3] Simply clamping the boom to the mast and connecting a good feed line completed the job. (I used Belden 9913 low-loss coax for my installation, but a good RG-8 foam coax is suitable). After another quick SWR check (my antenna agreed with the manufacturer's SWR curve), I was all set to operate.

On the Air with the 28HS2HB

Initially, like anyone with a new toy, I figured that the antenna would work terrifically or not at all. The antenna seemed to accept RF just fine, but I heard very few stations. It wasn't long before I found out

[2]The HB9CV mini-beam is described on pp 8.30 and 8.31 of the Radio Society of Great Britain's *VHF UHF Manual*, available from the ARRL Bookshelf as #R630.

[3]Although I chose to mount my antenna horizontally, the 28HS2HB can also be mounted vertically (one element above the other). Installed in this way, the 28HS2HB produces vertically polarized signals that make your station more generally compatible with FM repeaters, mobiles and base stations using vertical antennas. If you choose vertical polarization, mount the antenna high enough so that its longer element clears obstructions like tower-mounted antennas and roofs, and use a nonconductive mast if possible.

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.

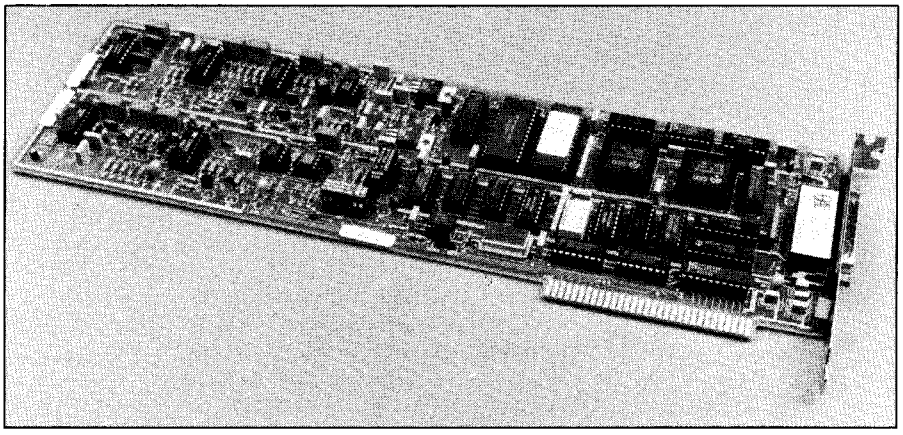
The 28HS2HB is rugged, and most of the its hardware resists oxidation and corrosion. I have, however, noticed rust on the nut and washer used in its RF connector assembly. Considering that my 28HS2HB has been in the air for just over three months, I recommend replacing these two parts with stainless-steel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

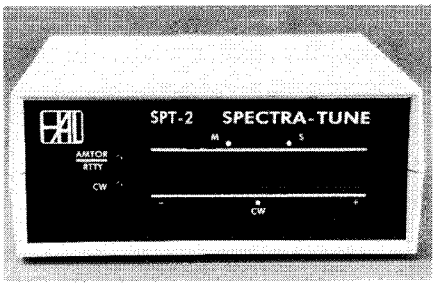
Other reasons include the SPT-2 and the FIL-1, two accessories that round out the PCI-3000 system. The SPT-2 SPECTRA-TUNE is an LED bar-graph RTTY/CW tuning indicator that connects (via a standard 25-pin serial cable) to the back panel of the PCI-3000 plug-in card and functions as a simple, but accurate, 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.

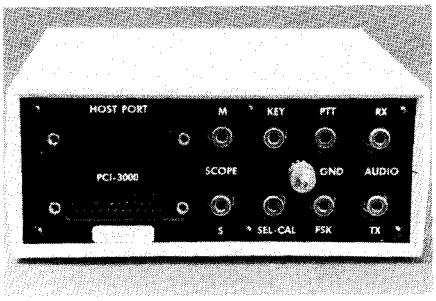
It's easy to tune RTTY signals with the SPT-2: Just line up the mark and space LEDs, and you're right on frequency. It's not quite as handy as a "crossed banana" oscilloscope display (the HAL ST-6000 has one built in), but it's a lot easier, faster and more precise than the tuning displays used on the 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.