Product Review Column from *QST* Magazine

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Ten-Tec Model 585 Paragon 160-10 Meter Transceiver

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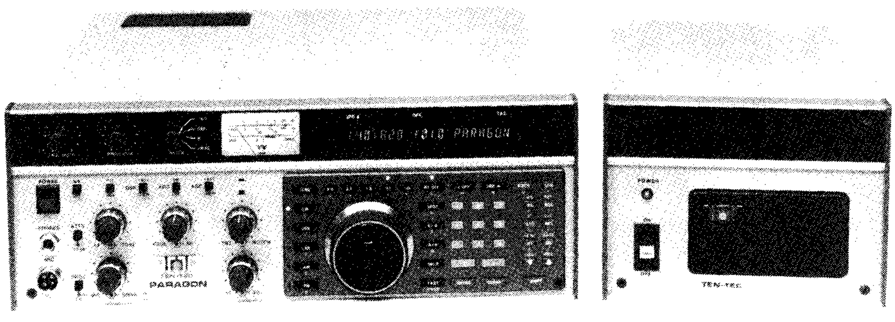
Reviewed by Mark Wilson, AA2Z

"When are you going to review the Paragon?" We often are asked about upcoming reviews, but no piece of equipment in recent history sparked as many inquiries as Ten-Tec's latest 160- to 10-meter transceiver. Although the previous top-of-the-line Ten-Tec (the Corsair II) is a fine performer, the Paragon makes the leap from VFO to frequency-synthesizer technology. It's the first Ten-Tec transceiver with memories, scanning features, keypad frequency entry and a general-coverage receiver. In addition, the Paragon offers AM, FM and FSK operation in addition to the usual SSB and CW, selectable IF filters, passband tuning, notch filter, audio filter, selectable AGC, QSK, clock/calendar and much more.

The Paragon's rear panel has all sorts of jacks for using the Paragon with external power amplifiers (with or without QSK capability), separate receiving antennas, VHF/UHF transverters and RTTY gear. There's even a 13.8-V, 2-A output for powering accessories such as a keyer or RTTY/packet box.



Frequency Control

The Paragon features a microprocessor-controlled, synthesizer-based VFO system. All the bells and whistles are here, including 62 memories that store information on frequency, mode, VFO selection and filter bandwidth. An interesting twist on the memory feature is the TAG function. You can label each memory with a 7-digit alphanumeric "tag" at the right-hand side of the main display. The tag can be any combination of letters and numbers, and this feature is handy for remembering what you've stored in memory. For example, I used the tag AUSTRLA for Radio Australia on 9580 kHz. Another novel feature is a front-panel switch to turn the last (10-Hz) digit on the frequency display on and off.

Storing and recalling memories is uncomplicated, just as it should be. The memory controls are grouped to the right of the main tuning knob. Because the microprocessor does all the work, these controls are momentary-contact pushbuttons. To keep the number of pushbuttons to a minimum (and the front panel to a reasonable size), most pushbuttons have two functions. The less-often-used functions are selected by first pressing the SHIFT switch. This is similar to using function keys on a scientific pocket calculator. A beep sounds each time you press one of the switches, and the beep loudness is adjustable by a rear-panel control.

In the memory mode, you can tune through the memories manually, or you can scan through them. Scanning rate is adjustable in 10 steps. The slowest rate dwells on each memory channel for about two seconds; the fastest leaves your head spinning! You also have the option of locking out any of the memory channels.

A useful memory feature is the "scratch pad," or temporary memory. To enter the current VFO frequency in the scratch pad, just press the STO button twice. To recall the scratch pad memory, press RCL twice. This feature is handy for DX or contest operators who want to store a pileup frequency and come back to it later.

The digital frequency display shows the *receiver* frequency. It does not take into account the offset between transmitter and receiver frequencies during CW operation. Actual transmitter frequency during CW operation is about 750 Hz higher than the frequency shown on the display.

The Paragon offers selection of A and B VFOs. It has the usual switches for making the VFO frequencies the same, selecting A or B or operating split. If you're operating split and want to monitor your transmit frequency, press SPOT. SPOT switches you to the transmit VFO so you can listen to what's happening on the transmit frequency and adjust your transmit VFO accordingly.

Receiver and transmitter offset tuning have a range of ±99.9 kHz. There is no separate offset-tuning knob; the main frequency-control knob becomes the offset-tuning control when the RX OFF. or TX OFF. buttons are pressed. This system, similar to the RIT on the Collins KWM-380, takes some mental retraining if you're accustomed to operating Japanese transceivers. I got used to the RIT system after a few hours of operation. One real drawback is that you can't use the receiver and transmitter offsets at the same time. Many contest operators like to use the receiver and transmitter offsets to monitor adjacent frequencies during runs. They might want to hunt and work nearby stations without moving the VFO, or they might want to ask the guy who just opened up 200 Hz away to please move.

To change frequency, you can use the main tuning knob or the keypad. The Paragon has no bandswitch, as such. There are several ways to change bands, but I found them all to be inconvenient—they require using more than one switch. (1) There are "arrow up" and "arrow down" pushbuttons to move up or down in frequency in 100-kHz or 1-MHz steps (step size depends on the setting of the FAST tuning switch). Pressing SHIFT and one of the arrow buttons moves you to the next ham band (including the WARC bands) up or down in frequency. (2) You can enter the new frequency on the keypad. If you want to go to the bottom edge of a band, this way isn't too bad. For example, to go to 40 meters, press 7 ENTER. If you want to go to the 20-meter phone band, though, you'll have to make at least five keystrokes (1 4 . 2 ENTER). (3) Enter your favorite frequencies for each band into the memories. In my opinion, the ideal combination is a set of switches for the ham bands (a separate switch for each band) *and* a keypad for forays into the many frequencies outside the ham bands that are available on the general-coverage receiver.

Tuning rate is adjustable. Tuning steps of 10 Hz (about 5 kHz per knob revolution) and 20 Hz (about 10 kHz per revolution) are available in the CW, SSB and RTTY modes. Step size is selected with the FAST button. The slower tuning rate is great for tuning around when using the narrow CW filter. The band seems a lot bigger than it would with a faster tuning rate. During AM and FM operation, tuning steps are 50 Hz and 100 Hz.

The tuning knob is weighted and has a

rubber grip around its circumference. The feel is a bit light, though. More weight and more flywheel action would be a nice addition.

Receiver

The Paragon's receiver is a multiple-conversion design with IFs at 75, 9 and 6.3 MHz. (For FM, the third IF is 455 kHz.) Signals enter the receiver through switched low-pass filters (also used on transmit) and high-pass filters. The front-end RF amplifier consists of four paralleled JFETs (J310s) in a broadband circuit. (The RF amplifier is not used below 1.6 MHz.) The first receive mixer is a singly balanced design using two more J310s. There is some crystal filtering at each IF. The 75-MHz IF has a 2-pole crystal filter; the 9-MHz IF features a pair of 8-pole crystal filters with bandwidths of 6.0 kHz for AM operation and 2.4 kHz for SSB and CW operation. Passband tuning and additional crystal filtering occur at the 6.3-MHz IF. The 6.3-MHz crystal filters have bandwidths of 2.4 kHz, 1.8 kHz, 500 Hz and 250 Hz and are selected by front-panel switches. Only the 2.4-kHz third-IF filter is standard; the others are available as options.

During ARRL lab testing, the Paragon's receiver turned in some impressive numbers. Blocking dynamic range, at about 136 dB, is fantastic. In this receiver, the limiting factor when listening to very weak signals adjacent to very strong signals is receiver phase noise, not dynamic range. Phase noise is very audible at the onset of receiver blocking. (Blocking signal levels were in the 0 to +5 dBm range—much higher than you would expect to find at your antenna terminals under normal circumstances.) Sensitivity is more than adequate, and the two-tone, third-order IMD dynamic range is excellent as well.

Mode selection is accomplished with a series of momentary-contact pushbuttons arranged vertically to the left of the main tuning knob. Choices are CW, USB, LSB, AM and FM. FSK is selected by pressing the SHIFT and CW keys.

Receiver bandwidth selection is handled by a horizontal row of pushbuttons above the main tuning knob. Choices are 6.0, 2.4, 1.8, 0.5 and 0.25 kHz. (The last three work only if the optional third-IF filters are installed.) Filter selection is independent of mode (except for FM). This is a great feature. For example, if you operate AFSK RTTY using the LSB mode, you can switch in any of the narrow filters to eliminate adjacent-channel interference. Also, there are times when a narrow CW filter is a hindrance, rather than a help. It's nice having a couple of wider filters available.

The Paragon has several QRM-fighting controls. The most useful of these is passband tuning, which allows you to shift the passband response to effectively reduce interference from nearby signals. Less effective are the BP/FADE audio filter controls. Perhaps *subtle* best describes the effects of these two controls. Notch filter depth is about 40 dB; this control is helpful at times, although the notch is sharp and adjustment is critical.

The Paragon's variable-pulse-width noise blanker works great on Soviet over-the-horizon radar ("woodpecker") interference, although its use noticeably degrades the receiver's strong-signal-handling performance—an effect common with noise blankers. The noise blanker didn't do much for my power-line noise, though.

Pressing the front-panel attenuator switch substitutes a 10-dB pad for the front-end RF amplifier. The net effect is that signal levels

Table 1

Ten-Tec Model 585 Paragon 160-10 Meter Transceiver, Serial no. 084

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: Receiver, 100 kHz to 29.9999 MHz; transmitter, 160-10 meter ham bands.	As specified, except transmitter coverage extends ≈10 kHz above each amateur band.
Modes of operation: USB, LSB, CW, AM, RTTY (FSK or AFSK), FM (optional).	As specified.
Frequency display: 7-digit blue fluorescent.	
Frequency resolution: 10 Hz.	As specified.
Power requirement: 13.8 V dc at approx 1.5 A on receive and 20 A on transmit.	13.8 V dc at 17 A at 110 W output.
Transmitter	*Transmitter Dynamic Testing*
Transmitter output power: 25 to 100 W adjustable. 100% duty cycle for 20 min; continuous with auxiliary air cooling.	Typically 110 W max, 16 W min; power output varied slightly from band to band.
Spurious signal and harmonic suppression: Greater than 45 dB below peak power output.	See Fig 1.
Third-order intermodulation distortion products: Not specified.	See Fig 2.
CW keying waveform: Not specified.	See Fig 3.
Transmit-receive turnaround time (PTT release to 90% audio output with an S9 signal): Not specified.	35 ms.
Receiver	*Receiver Dynamic Testing*
Receiver sensitivity SSB, CW and RTTY: (2.4 kHz bandwidth) 0.5 μV for 10 dB S/N from 0.1-1.6 MHz; 0.15 μV for 10 dB S/N from 1.6-29.999 MHz.	Minimum discernible signal (noise floor), with 500-Hz filter: 1.0 MHz: −117.0 dBm 3.5 MHz: −139.5 dBm 14 MHz: −137.0 dBm
AM: (6.0 kHz bandwidth) 3.5 μV for 10 dB S/N from 0.1-1.6 MHz; 1.0 μV for 10 dB S/N from 1.6-29.999 MHz.	1.0 MHz: 4.2 μV 3.5 MHz: 0.27 μV 14 MHz: 0.34 μV (Test signal 30% modulated with a 1-kHz tone.)
FM: (15 kHz bandwidth) 1.0 μV for 12 dB SINAD from 0.1-1.6 MHz; 0.3 μV for 12 dB SINAD from 1.6-29.999 MHz.	Not tested; FM option not installed.
Receiver dynamic range: 100 dB typical; third-order intercept point +18 dBm.	Blocking dynamic range (dB)†: 3.5 MHz, 136.5 14 MHz, 136 Two-tone, third-order intermodulation distortion dynamic range (dB)†: 3.5 MHz, 101.5 14 MHz, 101.0 Third-order input intercept (dBm): 3.5 MHz, 12.75 14 MHz, 14.5
S-meter sensitivity (μV for S9 reading): 50.	88 at 1.9 MHz; 44 at 14 MHz; 70 at 28 MHz.
Squelch sensitivity: AM, CW, SSB, FSK (1.6-29.999 MHz), less than 1 μV. FM (1.6-29.999 MHz), less than 0.4 μV.	SSB/CW, 0.6 μV min; FM not tested
Notch filter: 50 dB notch typical.	Max notch 40 dB.
Receiver audio output: 1.5 W at 8 ohms with less than 2% total harmonic distortion (THD).	2.3 W at 2% THD
Color: Gray.	
Size (height, width, depth): 5.75 × 14.75 × 17 in.	
Weight: 16 lb (not including power supply)	

† Tone spacing was the ARRL Lab standard of 20 kHz for blocking dynamic range test and two-tone, third-order IMD dynamic range test.

are reduced about 20 dB. (The net reduction is 10 dB below 1.6 MHz because the RF amplifier is not used there.)

The front-panel PHONES jack is designed for 4- to 16-ohm headphones with a standard (monaural) ¼-inch jack. If you use stereo headphones, you'll need to rewire the plug or use an adapter.

A welcome surprise is the Paragon's excellent AGC. Its action is smooth, and there are no noticeable pops. (Anyone who has owned a Ten-Tec OMNI, as I have, will notice the improvement immediately.) Best of all, the AGC slope allows loud signals to sound louder than weak signals, and this makes it easier to pull call signs out of a pileup. AGC release times are about 0.2 second with the switch in the FAST position and 2 seconds in the SLOW position. The manual details a modification to increase the SLOW release time by 1 second, but I didn't make this modification. The original SLOW release time is just about right for casual operation.

Transmitter

The front-panel DRIVE control varies power output from about 15 W to 110 W, with slight variations from band to band. Ten-Tec rates the transmitter at 100% duty cycle for up to 20 minutes with no additional cooling. The review unit passed a 20-minute key-down test with flying colors. As Fig 1 shows, the transmitter low-pass filters do their job well. The spectral output of this unit is exceptionally clean on all bands. The two-tone IMD products (Fig 2) are acceptable. The CW keying waveform (Fig 3) is well shaped, and the on-air signal sounds good. Rise and fall times are about 4 ms. If you want harder or softer keying, the manual shows how to set the rise and fall times in the range of 1-5 ms.

The Paragon's full-break-in CW (QSK) feature gets an A+. It works well, even at speeds of 40 WPM and higher. With some radios, the transmitted characters are noticeably truncated in the full-break-in mode; you have to adjust your keyer weighting to get an acceptable-sounding signal at higher speeds. Not so with the Paragon. I spent a lot of time monitoring the Paragon's transmitted signal with a second receiver in my shack; the full-break-in signal sounded great at all the keying speeds I tried from 10 to 50 WPM. I made no adjustments to the keyer weighting control.

The CW offset is factory aligned at 750 Hz. Some operators prefer lower offsets, on the order of 300-400 Hz. According to Ten-Tec, you can retune the BFO for a lower offset; I did not try this. Rear-panel controls are provided for adjustment of sidetone pitch and level.

On SSB, I got a number of good audio reports, even with the speech processor on. The rear-panel MONITOR LEVEL permits listening to the Paragon's transmitted audio in your headphones. The monitor is useful for setting up the speech processor. I adjusted the speech processor while listening with a second receiver. The processor adds punch, but its adjustment range is narrow.

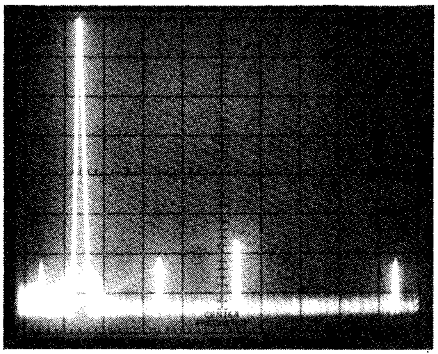


Fig 1—Worst-case spectral display of the Ten-Tec Paragon. Horizontal divisions are each 2 MHz; vertical divisions are each 10 dB. Output power is approximately 105 W at 3.5 MHz. All harmonics and spurious emissions are at least 56 dB below peak fundamental output. The Paragon complies with current FCC specifications for spectral purity.

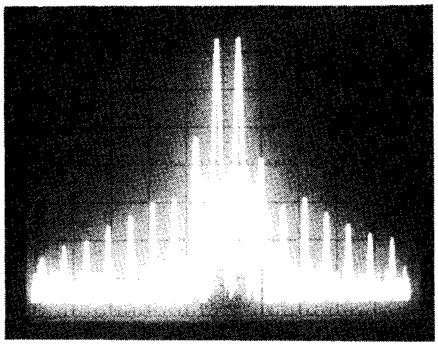


Fig 2—Spectral display of the Ten-Tec Paragon during two-tone intermodulation distortion (IMD) testing. Third-order products are approximately 33 dB below PEP output, and fifth-order products are approximately 49 dB down. Vertical divisions are each 10 dB; horizontal divisions are each 2 kHz. The transceiver was being operated at 100 W PEP output on 3.8 MHz.

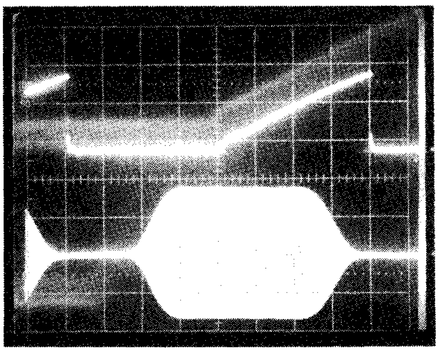


Fig 3—CW keying waveform for the Ten-Tec Paragon. The lower trace is the RF envelope; the upper trace is the actual key closure. Each horizontal division is 5 ms.

This is good; the signal is intelligible even with the processor and mic gain controls turned way up.

On SSB, you have the choice of PTT or VOX operation. The choice is just that—the microphone PTT switch has no effect when VOX is selected. I was disappointed that the VOX controls are on the Paragon's rear panel. I tend to adjust the VOX delay control quite often, and it's not convenient to get at.

Phase-Noise Measurements

With this review, we introduce transmitter phase-noise testing as part of the standard Product Review testing. March and April 1988 *QST* carry a two-part article describing phase noise, along with a complete discussion of ARRL laboratory phase-noise measurements.[1] The March/April article also shows results of ARRL lab testing of the phase-noise characteristics of other popular HF transceivers for comparison. Fig 4 shows two spectral photographs of the Paragon transmitter during phase-noise testing. This photograph was taken with the latest version (as of February 1988) of Ten-Tec's PLL board.

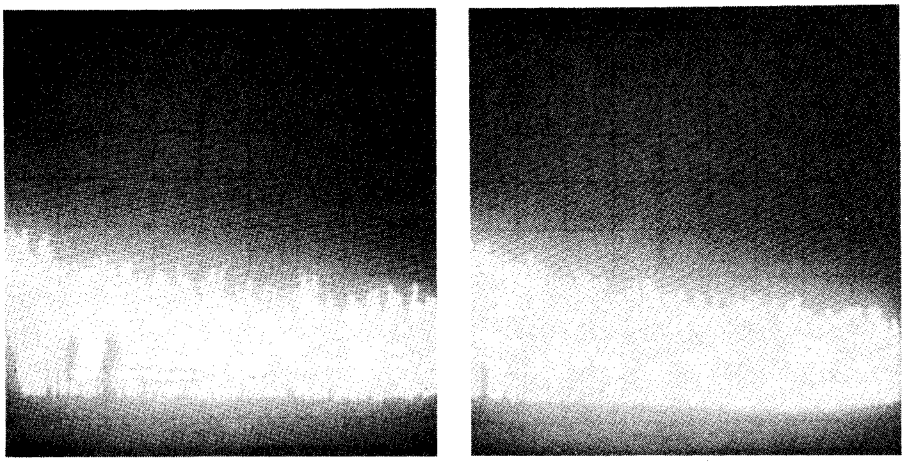
Initial tests made last fall indicated that the Paragon had very poor phase-noise characteristics. After ARRL lab engineers discussed the test results with Ten-Tec engineers, Ten-Tec provided a modified PLL board with improved filtering on the 723 voltage-regulator IC. Additional testing showed that the modified board greatly improved overall phase-noise performance, but close-in noise was much worse. Another modification resulted in much-improved phase-noise performance—both close in and far away from the carrier. These modifications are incorporated in current production boards. If you have an early Paragon, contact Ten-Tec about updating your PLL board.

Manual

The 22-page manual we originally received with the Product Review Paragon last fall contained all of the information needed to put the transceiver on the air, but it was skimpy. In February, Ten-Tec sent a copy of the final manual—what a difference! The new manual is more than 130 pages long. In addition to complete operating information, it features complete technical information usually found in service manuals that are available at extra charge. If you want to know how a modern transceiver works, you'll love the Paragon manual. More than 100 pages are devoted to circuit descriptions, schematics, PC-board layouts and parts-placement diagrams for *each PC-board subassembly in the radio.*

I especially liked the page of Condensed Operating Instructions, which shows initial control settings and tells you enough to get started. This page is sort of like the TV news version of how to operate the rig—short and to the point. It's a good idea because most hams don't like to read instructions anyway. After the initial thrill of using your new toy

[1]J. Grebenkemper, "Phase Noise and Its Effects on Amateur Communications," *QST*, Mar 1988, pp 14-20; and Apr 1988, pp 22-25. Feedback, May 1988 *QST*, p 44.



(A) (B)

Fig 4—Spectral display of the Ten-Tec Paragon transmitter output during phase-noise testing. Power output is 100 W at 3.5 MHz (A) and 14 MHz (B). Each vertical division is 10 dB; each horizontal division is 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 in the photos) represents −60 dBc/Hz and the baseline is −140 dBc/Hz. Phase-noise levels between −60 and −140 dBc/Hz may be read directly from the photographs. The carrier, which would be at the left edge of the photographs, is not shown. These photographs show phase noise at frequencies 2 to 20 kHz offset from the carrier.

has worn off, you can take time to go over the Detailed Operating Instructions section to find out the function and proper use of each front- and rear-panel control and jack.

Hookup

The Installation section of the manual gives a brief description of what you need to hook up the Paragon. It's pretty straightforward. For starters, you need a 13.8-V power supply capable of delivering about 20 A. Wiring information is given in case you don't use Ten-Tec's matching Model 960 power supply. The Installation section recommends a low-impedance dynamic or electret microphone (high-impedance mics—above 25 kΩ—won't work), although text accompanying the mic connector wiring diagram later in the manual says that the microphone circuit has been designed for high- or low-impedance mics with at least 5-mV output.

Before using the Paragon, you are encouraged to hook up a 9-V battery to back up the microprocessor and RAM when power is removed. The battery backup allows the Paragon to retain memory and frequency information, as well as clock/calendar time and date. Battery installation requires removing the top cover and plugging in a connector. Batteries not included...

According to the manual, the battery backup is not needed if you leave the Paragon connected to a 13.8-V dc source (even with the power switch turned off). This means leaving your power supply turned on all the time. The original manual indicates that an alkaline battery will provide about 150 hours (6.25 days) of backup if power is removed. (This 150-hour rating is very conservative. I unplug my radio equipment when I'm away from the shack, and my first 9-V alkaline cell lasted months.) The new manual includes information on a modification for using a 9-V NiCd battery for backup. According to the manual, you can keep the NiCd battery adequately charged if you use the Paragon at least 3-4 hours per week. This modification, which is factory installed in Paragons with serial numbers higher than 395, requires a soldering iron, a 2.2-kΩ, ¼-W resistor, and about 15 minutes of your time. It's well worth doing.

Operating Impressions

I enjoyed using the Paragon over a period of several months. In addition to casual CW and SSB operating and DXing, I used it in several SSB and CW contests—including the phone ARRL November Sweepstakes. I like the panel layout and the way most of the features work.

I initially had trouble getting on the "right frequency" during CW operation. The instructions on using the SPOT switch are confusing, and the peak S-meter reading does not correspond to zero beat. In fact, the manual suggests using the wide filter in conjunction with the SPOT switch; this is not acceptable on a crowded band. After some experimenting and after "working myself" on a second transceiver in the shack, I discovered how to get on frequency. Don't ask me to try to put it into words!

The receiver held up well except during peak phone-contest periods when there were many strong signals on the band. During those periods, I had difficulty finding open spaces on the band and had difficulty copying weaker signals. The problem seems to be receiver phase noise, rather than front-end overload. Use of the attenuator made a noticeable improvement in signal copy. The general-coverage receiver works fine. AM selectivity is good, thanks to the 6-kHz crystal filters.

All in all, Ten-Tec has a fine radio in the Paragon. It does some of the basics—like AGC and CW keying—very well. Most of the things I didn't like are subjective. The Paragon is certainly worth your consideration if you're in the market for a high-performance transceiver. It's also worth considering Ten-Tec's well-deserved reputation for excellent customer service.

Manufacturer: Ten-Tec, Highway 411 East, Sevierville, TN 37862, tel 615-453-7172. Price class: Paragon, $2245; Model 960 power supply, $230; Model 285 500-Hz CW filter, $70.

RX Noise Bridges

(continued from page 35)

(Z_o = 50 ohms), the velocity factor (given above), and the loss parameters, where

R = resistance/unit length $= 3 \times 10^{-4}$ ohms/cm; and

G = conductance/unit length $= 8 \times 10^{-8}$ S/cm.

These values are for a frequency of f = 3650 kHz. They were provided by Belden. Hence, using the program we can calculate Z'_{in} for a load impedance Z'_L:

$$Z'_L = 47.13 \angle -17.28 - 180° \quad \text{(Eq 5)}$$

$$Z'_L = 67.2 \angle 174.13° \quad \text{(Eq 6)}$$

and so

$$Z_a = 67.2 \angle 174.13 - 180° \quad \text{(Eq 7)}$$

$$= 67.2 \angle -5.9° = 66.8 - j7 \text{ ohms} \quad \text{(Eq 8)}$$

This impedance is close to that expected for a half-delta loop.

Notes

[1]C. J. Appel, "How to Measure Antenna Impedance," *QEX*, Jan 1987, p 3.
[2]J. Hall, ed., *The ARRL Antenna Book* (Newington: ARRL, 1983), 14th edition, p 15-10.
[3]M. Wilson, ed., *The 1988 ARRL Handbook*, (Newington: ARRL, 1987), p 16-2.

John S. (Jack) Belrose received his BASc and MASc (EE) degrees from the University of British Columbia in 1950 and 1951, respectively, and his PhD in Radio Physics from Cambridge University while in England on an Athlone Fellowship. From 1951 to 1953, he was employed by Canada's Defense Research Board, and worked in LF communications at the Radio Propagation Laboratory, in Ottawa. Since 1957, Jack has been with the Communications Research Centre, Dept of Communications, in Ottawa, where he is currently Director of the Radio Propagation Laboratory. Dr Belrose is Canadian Panel Coordinator for the AGARD Electromagnetic Propagation Panel and is Chairman of an Interim Working Party of the CCIR (Study Group 6). He is an ARRL Technical Advisor and has been a licensed amateur since 1948. His former call signs were VE7QH, VE3BLW and VE2SA. He has been licensed as VE2CV since Nov 1961.

Jack and his wife, Denise, have three children. Jack's hobbies are Amateur Radio (particularly antennas and radio communications technology), photography, canoeing, swimming, touring/camping by tent trailer and exercising his dog, Rufus.