Ten-Tec Jupiter HF Transceiver

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The evolutionary path that has led up to Ten-Tec's latest HF transceiver—the Jupiter—has followed an interesting course.

Ten-Tec laid the groundwork for the Jupiter in 1998. Drawing on experience garnered from developing DSP-based receivers for their commercial and government markets, they set out to create a low priced radio for their short-wave customers. This became the RX-320: a compact "black box" receiver that connects to a computer and is entirely operated through software (see "Product Review," *QST*, Mar 1999).

Their Pegasus—debuted at Dayton Hamvention '99—was a logical extension: add a transmitter to the RX-320 and market it as an amateur HF transceiver. Paul Danzer, N1II, shared his impressions of this computer-controlled transceiver in our February 2000 column.

The flexibility that's made possible by using software to control these radios is perhaps one of their most notable attributes. Since their releases, Ten-Tec has turned out several updated versions of their respective GUI (*graphical user interface*) software packages. These updates can be downloaded from Ten-Tec's Web site free of charge.

Computer-connectivity also allows Pegasus owners to download and install updates to the "firmware"—the algorithms used within the radio's internal processor—opening the door to even more significant post-purchase enhancements.

The cost savings that were realized by eliminating expensive display and control components allowed Ten-Tec to set the price of the Pegasus in what most consider the affordable range. Apparently, however, a significant number of Ten-Tec's customers and prospective customers have expressed a strong desire to fork over a few additional bucks for a standalone front-paneled version of the Pegasus.

Hail Jupiter!

Borrowing heavily from the earlier design work—and the parts bin in several instances—of its older stable mate, Ten-Tec engineers got down to business. They built up logic and keypad boards that would take over the assignments that the connected computer handles in the Pegasus system. They wrapped up the pieces in an all new enclosure and topped it off with a fairly stylish injection-molded front panel. The result? The Model 538, aka Jupiter.

The Jupiter is a "conventional" 100 W transceiver with general coverage receive from 0.1 to 30 MHz and transceive capabilities on the 160 through 10-meter amateur bands. The SSB, CW, RTTY (AFSK), AM and FM modes are included and there are 128 memories, dual VFOs, RIT *and* XIT, adjustable AGC, a built-in CW keyer, true QSK and a spectrum scope feature. The heart of the system—an Analog Devices AD2181 Digital Signal Processor—also delivers 34 DSP receive filter bandwidths, 18 transmit filter bandwidths, passband tuning, automatic notch and noise reduction, an adjustable noise blanker and a speech processor. A built-in automatic antenna tuner is not available, but Ten-Tec has recently added the LDG Electronics line of external automatic tuners to their product offering.

The dimensions of the Jupiter seem to have been intentionally tailored with convenient desktop operation as a primary objective. While it certainly isn't too large to take along on Field Day, it's unlikely that we'll be seeing it in many mobile installations. A peek under the covers reveals a cavernous interior populated by just a handful of PC boards. It appears as if this radio could have easily been compressed down to a fraction of its size.

Bottom Line

Ten-Tec skillfully grafts a front panel onto their Pegasus computer-controlled transceiver. The result—the Jupiter—is a standalone radio that still manages to retain much of the flexibility of its PC dependent sibling.

The front panel controls include 26 buttons and a rocker-type **POWER** switch. Only seven of these buttons perform more than one operation. The design team did a commendable job of providing direct front panel access to those functions that are used most often, and clearly labeling and carefully positioning all of the controls. The result is a transceiver that's easy and intuitive to operate. Settings that are varied less often, referred to as "set and forget" parameters in the *Operating Manual*, are adjusted via a single menu.

There are five rotary controls: the large main tuning knob, the filter **BANDWIDTH** knob, the **PBT** (passband tuning) knob, the **RIT/XIT** knob and the **MULTI** knob. The **MULTI** knob—true to its label—is used to vary several different settings. The control's active assignment is indicated in reverse video (light color text on a small dark background field) in the lower left corner of the display window. The relative level of the particular setting is represented on a linear scale along the bottom of the screen. The equivalent numeric value—displayed as a percentage—is shown to the far right. The **MULTI** knob is used to control the volume, the RF gain, the mike gain, the all-mode squelch, the RF power output level, the

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Table 1
Ten-Tec Jupiter (Model 538), serial number 12C10820

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, 28-29.7 MHz.	Receive and transmit, as specified.[1]
Power requirement: Receive, 1.5 A; transmit, 20 A; 12-14 V dc.	Receive, 1.2 A; transmit, 17 A. Tested at 13.8 V.
Modes of operation: SSB, CW, FM, AFSK, AM	As specified.
Receiver	***Receiver Dynamic Testing***
SSB/CW sensitivity, 3 kHz bandwidth, 10 dB S/N: 0.35 μV.	Noise floor (MDS), 525 Hz bandwidth: 1.0 MHz –121 dBm 3.5 MHz –127 dBm 14 MHz –135 dBm
AM sensitivity: Not specified.	10 dB (S+N)/N, 1-kHz tone, 30% modulation: 1.0 MHz 7.1 μV 3.8 MHz 2.2 μV
FM sensitivity: Not specified.	For 12 dB SINAD: 29 MHz 0.73 μV
Blocking dynamic range: Not specified.	Blocking dynamic range, 525 Hz filter: 3.5 MHz 113 dB 14 MHz 123 dB*
Two-tone, third-order IMD dynamic range: Not specified.	Two-tone, third-order IMD dynamic range, 525 Hz filter: 3.5 MHz 87 dB 14 MHz 85 dB*
Third-order intercept: +10 dBm.	3.5 MHz +11 dBm 14 MHz +7.3 dBm
Second-order intercept: Not specified.	+53.6 dBm.
FM adjacent channel rejection: Not specified.	20 kHz channel spacing: 29 MHz, 72 dB.
FM two-tone, third-order IMD dynamic range: Not specified.	20 kHz channel spacing: 29 MHz, 72 dB.
S-meter sensitivity: 50 μV at S9.	S9 signal at 14.2 MHz: 26 μV.
Squelch sensitivity: Not specified.	At threshold: SSB, 14 MHz, 0.14 μV; FM, 29 MHz, 0.36 μV.
Receiver audio output: 1.0 W into 4 Ω, THD not specified.	0.7 W at 4% THD into 4 Ω.[2]
IF/audio response: Not specified.	Range at –6 dB points, (bandwidth): CW-N (525 Hz bandwidth): 363-1000 Hz (636 Hz); CW-W: 286-2857 Hz (2571 Hz); USB-W: 200-2667 Hz (2467 Hz); LSB-W: 250-2667 Hz (2417 Hz); AM: 49-2985 Hz (2936 Hz).
Spurious and image rejection: 60 dB.	First IF rejection, 84 dB; image rejection, 82 dB.
Transmitter	***Transmitter Dynamic Testing***
Power output: SSB, CW, FM, 5-100 W; AM, 25 W (AM low power level not specified).	SSB, CW, FM, 1.3-105 W: AM 0-25 W.
Spurious-signal and harmonic suppression: ≥40 dB	46 dB. Meets FCC requirements for spectral purity.
SSB carrier suppression: ≥50 dB.	As specified. 60 dB.
Undesired sideband suppression: ≥60 dB, 1.5 kHz tone.	As specified. 65 dB.
Third-order intermodulation distortion (IMD) products: 25 dB below two tone.	See Figure 1.
CW keyer speed range: Not specified.	1 to 59 WPM.
CW keying characteristics: Not specified.	See Figure 3.
Transmit-receive turn-around time (PTT release to 50% audio output): <20 ms.	S9 signal, 20 ms.
Receive-transmit turn-around time (tx delay): Not specified.	SSB, 20 ms; FM, 9 ms. Unit is suitable for use on AMTOR.
Composite transmitted noise: Not specified.	See Figure 2.

Size (HWD): 5.12×12.75×14.35 inches; weight, 9 pounds.

Note: Unless otherwise noted, all dynamic range measurements are taken at the ARRL Lab standard spacing of 20 kHz.
*Measurement was noise-limited at the value indicated.
Third-order intercept points were determined using S5 reference.
[1]Transmit range extends a few kHz beyond the edges of each band (example 1797-2009 kHz for 160 meters). Receive sensitivity reduced below 1 MHz.
[2]Maximum volume.

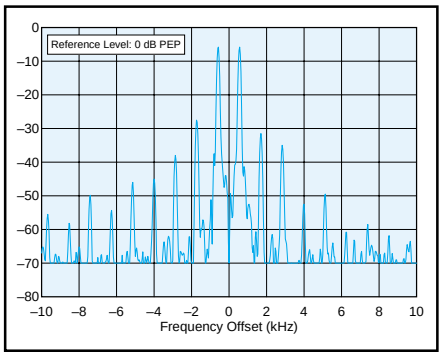

Figure 1—Worst-case spectral display of the Jupiter transmitter during two-tone intermodulation distortion testing. The worst-case third-order product is approximately 29 dB below PEP output, and the worst-case fifth-order product is down approximately 36 dB. The transceiver was being operated at 100 W PEP at 24.950 MHz.

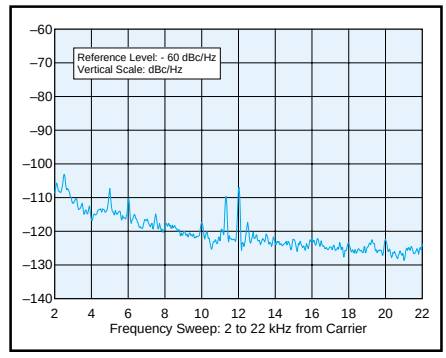

Figure 2—Worst-case spectral display of the Jupiter transmitter output during composite-noise testing. Power output is 100 W at 14.020 MHz. The carrier, off the left edge of the plot, is not shown. This plot shows composite transmitted noise 2 to 22 kHz from the carrier.

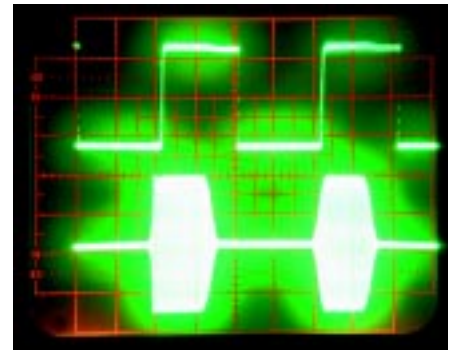

Figure 3—CW keying waveform for the Jupiter showing the first two dits in full-break-in (QSK) mode using external keying. Equivalent keying speed is 60 WPM. The upper trace is the actual key closure; the lower trace is the RF envelope. Horizontal divisions are 10 ms. The transceiver was being operated at 100 W output at 14.020 MHz.

CW keying speed, the transmit audio monitor volume and the CW sidetone volume. Just press the corresponding button first—**AF**, **RF**, **MIC**, for example—and then use the **MULTI** knob to adjust the setting to the desired value. When in the menu mode, this same knob is used to change the setting of the selected item.

The Jupiter's display is a 240×128-pixel dot-matrix LCD that measures about $4^{1}/_{2}\times2^{3}/_{4}$ inches. It's best viewed from head on, as extreme viewing angles and bright room lighting can make it difficult to read. The illumination level is fixed, but the contrast is adjustable.

A row of icons that show the state of the automatic notch filter, the DSP noise reduction, the squelch, the transmit audio monitor, the 20-dB attenuator, the VOX and the tune features are located along the upper edge of the screen. Enabled features appear in reverse video. The frequency of the main VFO is displayed just below. The digits are $^{5}/_{8}$-inch tall and in a stylized font. Just to the left—along the edge of the screen—is a column of icons that indicates the AGC setting (slow, medium or fast), transceive or split operation (**RXTX** when transceiving on the main VFO or **RX** alone when working split) the mode and the digital receive filter bandwidth (adjustable in steps from 300 to 8000 Hz). The selected tuning step size is shown near the right edge of the window.

Below the main VFO information is a smaller set of characters that show the frequency and mode of the sub VFO. When the radio is set up for split operation a **TX** icon appears to the left. An S meter is located to the right. On receive, the meter shows the relative signal strength graphically, and also displays the value numerically (ie **S9 + 20**). The same meter depicts the relative RF output power (or the SWR if desired) when transmitting, and this is also accompanied by a numeric value (**P 100** for power out or **1.6:1** for SWR for example).

A spectrum scope takes up a large portion of the lower half of the screen. Activate the *Sweep* feature and the receiver will rapidly scan through any of eight preset ranges from 240 Hz to 2.4 MHz and generate a plot of the signal strength vs frequency. Once the process is complete, a dotted-line cursor representing the current operating frequency appears at the center of the screen. You can then tune up and down through the spectrum snapshot and locate active or available frequencies. An *Autosweep* feature can be enabled that will automatically sweep a new range of frequencies should you tune off the edge of either end of the displayed plot.

The headphone, key and mike jacks are mounted along the left side of the front panel. The headphone and key jacks are $^{1}/_{4}$-inch. The key jack will accept a straight key, bug or paddles, and menu selections allow adjustment of the CW weighting, the QSK delay, the sidetone pitch and the sidetone volume. CW message memories are not included. The mike jack is a standard 4-pin style and provides a 9 V dc pin for powering electrets or amplified mike elements. The Jupiter does not come with a microphone, hand-held and desk models are sold separately. VOX operation is not possible when using the Ten-Tec hand mike, as the mike element is switched out of circuit when its PTT button is released.

'Round Back

The transceiver comes complete with a 6-foot dc power cord, an extra 2-pin Molex dc power connector, a male phono connector, a spare 25 A automotive-style fuse, a $^{1}/_{4}$-inch stereo plug and a 4-pin mike plug.

Ten-Tec also supplies a 6-foot ribbon cable with a 5-pin DIN connector on one end and four color-coded female phono jacks on the other. The DIN connector mates with the transceiver's rear-panel **ACC 1** socket. The phono jacks then serve as connection points for fixed-level audio out, line-level audio in and PTT (the fourth connector is a spare). This prefabricated cable simplifies wiring the Jupiter to a multimode TNC or computer sound card for digital modes such as PSK31, RTTY or SSTV.

A rear-panel 8-pin DIN **REMOTE** jack allows connection of Ten-Tec's optional 302J Remote Encoder/Keypad. This small desktop accessory—originally designed for use with the computer-controlled Pegasus—includes a main tuning knob, a keypad for directly punching in frequencies and three additional menu-definable function buttons.

There are six phono jacks mounted on the rear panel, including a pair of 13.5 V dc output jacks, an **EXT T/R** jack for controlling non-QSK amplifiers (+24 V dc/200 mA maximum), **TX EN**able and **TX OUT** jacks for sequencing QSK-equipped amplifiers and a **SPARE** jack. There's also a $^{1}/_{4}$-inch **EXT**ernal **SPEAKER** jack and a female DB-9 **SERIAL INTERFACE** connector.

Shared Talents

The Jupiter is capable of operating in a *Pegasus Emulation Mode*. Simply connect an appropriate cable between the **SERIAL INTERFACE** jack and a computer's COM port and fire up and configure Pegasus control software, and the PC will take over command. While in this mode, the radio's front panel controls are disabled and a message in the LCD display reads "**PEGASUS EMULATION MODE**." For

a detailed description of what it's like to operate the Jupiter in this configuration, have a look at the aforementioned Pegasus review. Memories and other settings that are programmed in through the front panel of the Jupiter cannot be copied or transferred to the Pegasus control software, or vice versa.

The Jupiter, just like the Pegasus, will accept firmware (internal software) updates. During the course of this review period, Ten-Tec made several revisions available on their Web site. Updates have included fixes for bugs that cropped up in earlier releases, but have also improved the accuracy of the S meter, extended the low frequency response of the mike audio and added a noise blanker, a speech processor and AM transmit capabilities. The current version is 1.09—there's no telling what new talents the Jupiter might develop through future revisions!

Updating the firmware is easy. All of the necessary files are contained in a small *EXE* file (version 1.09 is only 372 kB). It took under two minutes to download (using a 56k modem). The *EXE* file installed the firmware installation program and three text files onto my PC. The text files contained step by step instructions for performing the update and setting up and using the new features. The actual update process took about 25 seconds; a radio microprocessor reset is the final step. It sure was neat to see a few new features appear on the menu!

More Than Just an Operator's Manual

Ten-Tec did a particularly nice job with the Jupiter's *Operator's Manual*. It contains around 100 pages of mostly $8^{1}/_{2} \times$ 11-inch sheets, but it also includes several larger foldout pages with complete (and legible) schematics of the various PC boards. The actual operating instructions for the radio only fill about 20 pages, but the extensive additional information that's provided elevates this manual close to the level of a full-blown factory service manual. All of the material is well organized and thoroughly indexed and the programming instructions are clear and easy to follow.

On the Air

The Jupiter is a joy to operate. All of the rotary controls have a smooth action, and key presses are confirmed with a pleasant mechanical "click."

Overall, CW operation was pretty impressive. The built-in keyer works great and it's easy to adjust the speed on the fly. For those of you who haven't experienced Ten-Tec QSK, let's just say that it would be impossible to overstate the smoothness of its action. There's virtually no perceptible delay (at the shortest delay setting) and no clacking relays sounding along with the T/R switchover. I logged universally favorable reports on the CW transmit signal, but I did see a few messages on an e-mail reflector concerning a "raspy" sound to the note. I set up a second receiver and listened to the signal myself, and compared it to those of a couple of other rigs I own. The signal does indeed have a slightly different sound—not unlike that of CW signals *received* through DSP filters. I don't consider it particularly objectionable, but it *is* different. It's along the same lines as the difference between the sound of a digital and an analog telephone call. It sounds somewhat, well, digital.

SSB operation with the Jupiter is a unique experience. When the bands weren't very crowded, I found myself opening the receive filter bandwidths far wider than the 2.8 kHz or so that I'm limited to on my other equipment. This typically significantly improved the audio fidelity of the stations that I was listening to. When conditions were crowded, I'd crank the filter into more conventional 2.85 kHz and narrower setting to fight QRM.

The DSP (which works at the third IF) did a respectable filtering job with SSB and CW signals in most cases, but strong nearby signals can make it tough to copy weak ones. The passband tuning helps considerably if the interference is only on one side, though, and the automatic notch filter does an excellent job on carriers. The data in Table 1 points to receiver performance that's about on par with other mid-priced transceivers, and my on-the-air experience confirms this.

The SSB transmit signal consistently received nice audio reports. I experimented a little with local stations using the extreme transmit filter bandwidth settings, but got reports that more neighbor-friendly settings of 2.85 kHz sounded about the same. A fuller-range microphone element (and wider receive filters on their end) would probably help. The audio heard through the transmit audio monitor does not change when the bandwidth is varied.

Some Humble Opinions

There are a couple of controls on the Jupiter that I found myself constantly fiddling with, and I can't help but think that it may be worth it for Ten-Tec to consider revising them in future firmware updates. Let me preface this by saying that we all operate our radios differently, and what I might find to be an annoyance may not be perceived as such by others.

The first is the tuning action. The tuning steps can be set to seven different sizes from 1 Hz to 100 kHz for each step of the main tuning knob's rotary encoder. One revolution of the knob contains 120 "steps." Therefore, when the 1 Hz size is selected, it takes 25 turns of the knob to tune a measly 3 kHz. That's an awful lot of cranking—even when hunting signals in a busy CW sub-band! When you switch to the larger step sizes (as with all radios that use variable step arrangements) received signals—as you tune through them—take on the sound of a musical scale. When you encounter an interesting signal, you'll probably need to switch back to the 1 Hz setting for fine tuning. If you're the type of operator (like I am) that does quite a lot of tuning around and listening, you'll find yourself constantly playing around with the step setting. It would be more convenient if the *speed* of tuning was variable—not just the step size—especially if it could be made to be mode-specific (slow for CW and moderately fast for phone).

The second is the receive filter bandwidth setting. As is the case with all Ten-Tec radios, the available filter bandwidths are independent of mode—and this is a *good* thing. As you move from one mode to another, however (CW to SSB for example), you'll need to manually crank the filter bandwidth up to the wider setting. Switch back—SSB to CW—and you'll probably want to crank it back down. It would be nice if the radio would automatically recall the last filter setting used in a particular mode and revert to that setting. The filter bandwidth and the operating mode *are* retained in the memories, though, and the memories are tunable. This provides a suitable work-around: program several "starting" frequencies on the SSB, CW and the digital portions of each band—with the appropriate mode and bandwidth—in the memories, and then use the memory channels, in lieu of the **BAND** button or tuning knob, for hopping around. (Unfortunately, the tuning step size is not retained in the memories.)

Remember: The firmware used in this radio is updatable. If you've got suggestions of your own, be sure to share them with the friendly folks at Ten-Tec. You may just see your refinements turn up in a future revision!

A Work in Progress

The Jupiter is one harbinger of a change that we're seeing both in ham radio and consumer electronics. The ability for the end user to easily update firmware opens the door to the possibility of near endless evolution throughout a product's serviceable life.

Manufacturer: Ten-Tec, 1185 Dolly Parton Pkwy, Sevierville, TN 37862; 865-453-7172; fax 865-428-4483; **sales@tentec.com**; **www.tentec.com**. Price: Jupiter (Model 538), $1189; hand-held microphone (Model 701), $28; desk microphone (Model 705), $89.95; Remote Encoder/Keypad, (Model 302J), $139.