Mark J. Wilson, K1RO, k1ro@arrl.org

Product Review

Explore the *QST* Product Review Archive
www.arrl.org/qst-product-review-and-short-takes-columns
Search reviews by year or issue of publication, or by manufacturer's name.

Yaesu FTDX101D HF and 6-Meter Transceiver

Reviewed by Joel R. Hallas, W1ZR
QST *Contributing Editor*
w1zr@arrl.org

The Yaesu FTDX101D is a 100 W 160 – 6 meter SSB, CW, AM, FM, and digital-mode transceiver. A 200 W version, the FTDX101MP, is also available, but this review just covers the FTDX101D version. The product name is interesting, as it commemorates the classic FT-101 series, a very successful and popular Yaesu 100 W transceiver family available from 1971 to 1985. Of course, the new model offers the features and performance that amateurs expect in today's high-end radios.

How It Works

The FTDX101D provides two independent, high-performing receivers, each (as I write this) at the very top of the receiver dynamic range performance sweepstakes with 2 kHz spaced, third-order intermodulation distortion measuring a remarkable 110 dB. This rejection is important when there are multiple strong signals in a packed band, such as during contests and DX pileups. Just as important, reciprocal-mixing dynamic range and blocking dynamic range are also excellent. See the "Lab Notes" sidebar and test results elsewhere in this review for more information.

Yaesu has achieved this outstanding performance using a dual-conversion downconverting architecture. The first conversion is to approximately 9 MHz, where the roofing filters are located. Roofing filter bandwidths of 600 Hz, 3 kHz, and 12 kHz are provided. Optional roofing filters of 300 and 1,200 Hz are available but were not included in the review radio. (These filters must be factory installed.)

The second conversion is to 24 kHz, to what Yaesu calls the "narrowband SDR receiver" where digital signal processing (DSP) provides the operational bandwidth (narrower than the roofing filter) and many other signal processing functions. In addition to the bandwidth filtering, the transceiver provides an adjustable, sharp, capacitor-tuned RF preselector for the main receiver, **VC TUNE**, that can be moved across the bandpass to provide an additional aid in eliminating interfering signals. (A second **VC TUNE** unit for the sub receiver is available as an option.)

A third independent receiver is included for use by the spectrum scope. This receiver uses direct-sampling SDR architecture to provide wideband coverage, up to 1 MHz slices of spectrum. Some may wonder why direct sampling hasn't been selected for the main receiver channels — the simple answer is performance.

Bottom Line

The Yaesu FTDX101D is a very effective, full-featured, high-performance transceiver that would work well in most stations, especially those involved in serious contesting or DX chasing, where strong close-in signals abound. Its very low transmitted phase noise, narrow keying sidebands, and good IMD characteristics will be appreciated by other operators using nearby frequencies.

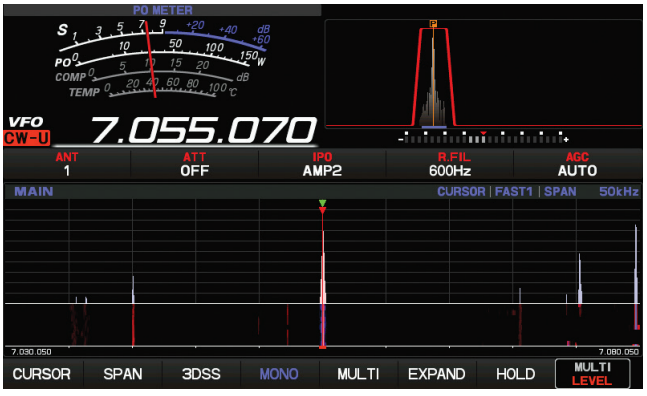


Figure 1 — The Yaesu FTDX101D display showing a single panadapter, with waterfall below, for 50 kHz of the 40-meter band centered on the frequency tuned by VFO A. The "filter function display" at the upper right shows the received passband with the received signal within. The spectrum span can be adjusted from a width of 1 kHz to 1 MHz in 10 steps.

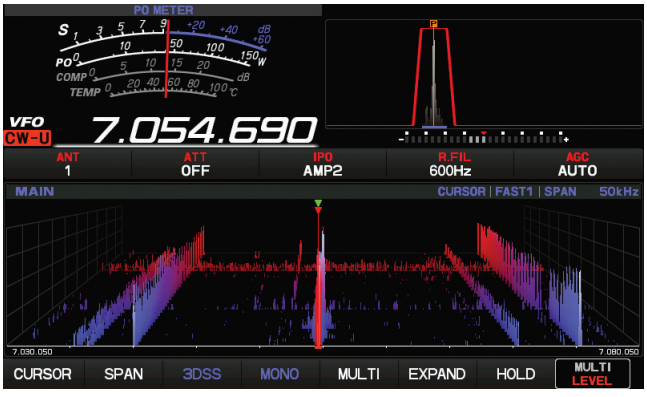


Figure 2 — Same as Figure 1, except we have tapped the **3DSS** on-screen button and now have a three-dimensional view with time marching out the back of the screen, instead of the waterfall. This way, you can see what happened before, as well as what's happening now.

Current Amateur Radio technology does indeed support direct-sampling SDR in high-end radios, as evidenced by recent transceivers from multiple manufacturers. However, their close-in dynamic range, as measured in the ARRL Lab, has been around 100 dB — somewhat lower than the FTDX101D. While 100 dB close-in dynamic range is better than top-notch receivers of just a few years back and more than sufficient for most real-world operation, for now, if you want the transceiver with the best-performing close-in dynamic range, a downconverting design with roofing filters near the antenna is required. The dynamic range of the direct sampling receiver is more than enough for the panadapter.

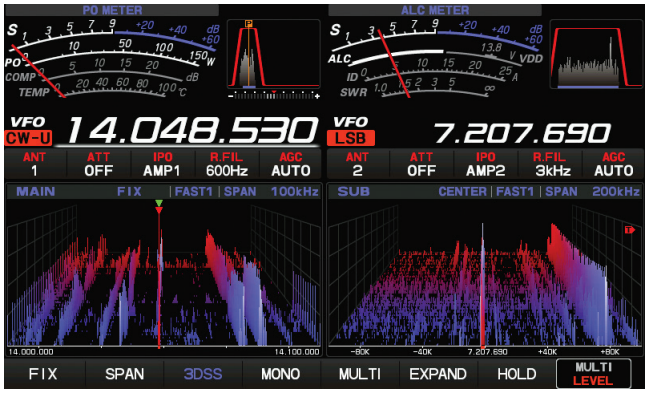


Figure 3 — Same as Figure 2, except a second spectrum view of the sub receiver display has been added to the right of the first spectrum display for the main receiver. Note that the second receiver is on a different band and using a different mode, bandwidth, and antenna. Either receiver can be tuned anywhere within the FTDX101D's tuning range, independent of the other receiver's settings. The two displays can also be one above the other, if you prefer — lots of flexibility available.

The FTDX101D Display

After first looking over the ARRL Lab measurements, the most noticeable feature of the '101D may be its 7-inch color TFT display, and all that it can do. While many similarly-priced HF transceivers offer similar-sized displays, this one is incredibly versatile, in terms of both what it can show and how it shows it.

Its most basic spectrum display is shown in Figure 1, providing a look at the spectrum around the desired receive frequency in usual panadapter (amplitude versus frequency) and waterfall (time and relative intensity versus frequency) views. The graphic at the upper right, next to the frequency display, shows the detailed spectrum of the received passband. By selecting the on-screen **3DSS** button, the traditional waterfall is eliminated, and the display becomes three-dimensional, as shown in Figure 2. With 3DSS enabled, the display combines information from the direct sampling receiver and the main and sub receivers. I find this very useful, because it's more intuitive to see what's been happening on the band while you were looking elsewhere.

A big plus is looking into what's happening on both the main and sub receivers at once. This is largely a reflection of the flexibility of the dual receiver architecture, which is more independent than most. A careful look at the two 3D spectrum plots in Figure 3 highlights this. Note that the two receivers are not just on different bands, but also on different antennas and modes. This allows for easy monitoring of quiet bands, each on their own (or the same) antennas, as well as diversity reception — the A and B VFOs can be locked together.

The display can also provide other functionality. Figure 4 shows a view of the RF spectrum combined with an oscilloscope (time versus amplitude) display of the received audio, as well as the associated audio spectrum. Figure 5 shows the top-level menu selections. Pressing the **FUNC** button

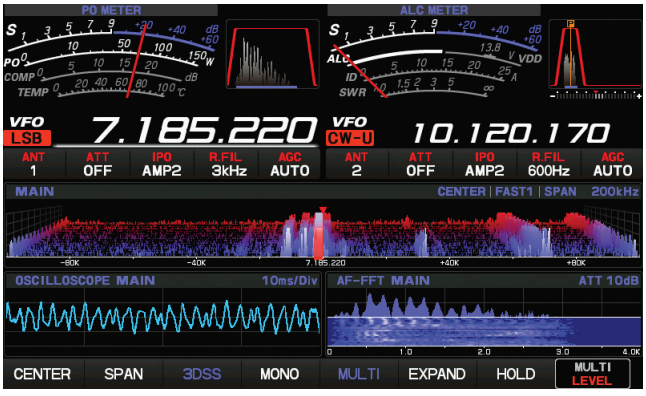


Figure 4 — In this view, the 40-meter RF spectrum is shown and below that, the received audio is shown with both oscilloscope and spectrum analyzer views.

Figure 5 — Pressing the **FUNC** button (below the screen) opens up the top menu display. The **MULTI** button is used to select the desired function, and then pressing the **MULTI** button brings up the adjustable parameter, or an additional layer of menu items.

below the screen opens up the top menu display. The **MULTI** button is used to select the desired function, and then pressing the **MULTI** button brings up the adjustable parameter or an additional layer of menu items. The menus are all straightforward and in plain English — resorting to the manual is not generally required to understand menu choices.

Default meter scales are transmit power and receive signal strength. Other meter choices, such as compression or ALC, can be selected by touching the meter area to bring up a menu. Touch the **EXPAND** button on the bottom right of the screen, and all scales are shown simultaneously with a corresponding reduction in panadapter size.

If you need an even larger display, the **EXT DISPLAY** video connector on the rear can be used to drive a DVI-equipped monitor, so you can watch band activity from across the room.

Computer Connectivity

The FTDX101D includes USB and RS-232-C serial ports. The RS-232-C cable requires a female connector on each end, but is wired straight through. If you've connected other Yaesu radios to your PC, you already have the cable. If not, a standard female-to-male, nine-pin, straight-wired serial cable can be used with a nine-pin, female-to-female gender adapter. The RS-232-C connection worked well for computer control, as well as for PTT functionality while using sound card modes.

To use the USB interface, before connecting the cable between radio and computer, you need to install the Silicon Labs CP210x virtual COM port driver, available from Yaesu's website. Once this is installed, connect the FTDX101D to your PC with a standard USB-A to USB-B cable and apply power to the radio. In your PC's **DEVICE MANAGER** screen, look under **PORTS (COM & LPT)** for **SILICON LABS CP210x USB TO UART BRIDGE (COMxx)**. There will be two new virtual COM ports, one "standard" and the other "enhanced." The enhanced port can be used for CAT functionality, while the standard port is used for PTT connectivity. This information was based on communication from Yaesu and was recently added to the *CAT Operation Reference Manual* available from Yaesu's website. I found that the enhanced port worked well for CAT and also for PTT with CAT selected as the PTT method in *WSJT-X* digital mode software.

Other computer-related interconnections include front-panel USB jacks for a keyboard and mouse and a front-panel slot for an SD memory card. The mouse can be used to select options on the screen, while the memory card can be used to save settings and memory contents or for upgrading the radio's firmware. I used the memory card to save the screen images used in this article.

The FTDX101D does not provide a direct ethernet connection for LAN or internet access, although an external optional LAN unit was announced but not yet available when this review was written.

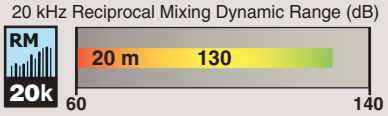
Firmware updates can be handled by downloading the new file and copying it to an SD card, and then plugging the SD card into the slot on the radio's front panel. Similarly, remote operation requires the use of software on a connected PC.

On the Air with the Yaesu FTDX101D

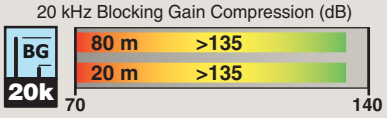
I enjoyed using the FTDX101D as my main station transceiver over a few months and had an opportunity to test it in most modes. While getting started was simple, as with most full-featured radios, expect to spend some time with the manual to be able to fully appreciate and learn to operate all the advanced features. You can almost assume that any feature or function you've encountered on any transceiver is also supported on this radio.

Yaesu FTDX101D Key Measurements Summary

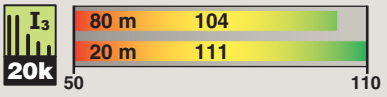
20 kHz Reciprocal Mixing Dynamic Range (dB)



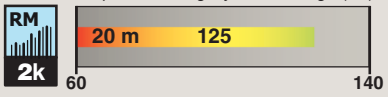
20 kHz Blocking Gain Compression (dB)



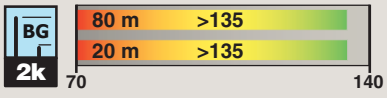
20 kHz Third-Order IMD Dynamic Range (dB)



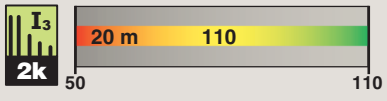
2 kHz Reciprocal Mixing Dynamic Range (dB)



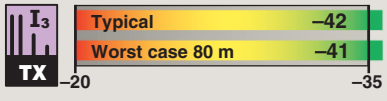
2 kHz Blocking Gain Compression (dB)



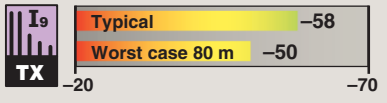
2 kHz Third-Order IMD Dynamic Range (dB)



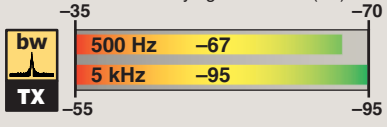
Transmit Third-Order IMD (dB)



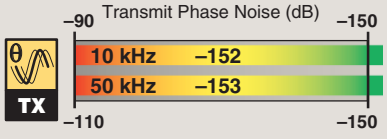
Transmit Ninth-Order IMD (dB)



Transmit Keying Sidebands (dB)



Transmit Phase Noise (dB)



KEY: QS1911-PR140

Measurements for Main receiver with preamps off. Bars off the graph indicate values over scale.

Table 1
Yaesu FTDX101D, serial number 9F020045

Manufacturer's Specifications	Measured in the ARRL Lab
Frequency coverage: Receive, 0.03 – 75 MHz; transmit, 160 – 6 meter amateur bands only.	Receive and transmit, as specified, including 60 meters on 5.332, 5.348, 5.3585, 5.373, and 5.405 MHz.
Power requirement: Transmit, 23 A, Receive (with signal), 4 A at 13.8 V dc (±10%).	At 13.8 V dc: Transmit, 19 A (typical), 12 A (AM) at maximum RF power output; 7.7 A at minimum RF output. Receive, 3.24 A (maximum brightness), 2.99 A (minimum brightness). Power off, <1 mA.
Modes of operation: SSB, CW, AM, FM, FSK, PSK, SSB data modes.	As specified.

Receiver	Receiver Dynamic Testing*
SSB/CW sensitivity (preamp 2 on): 0.16 µV (1.8 – 30 MHz) 0.125 µV (50 – 54 MHz) 0.2 µV (1.705 MHz – 24.5 MHz) 0.16 µV (70 – 70.5 MHz).	Noise floor (MDS), 500 Hz bandwidth, 600 Hz roofing filter:
	Preamp *Off* *P1* *P2* 0.137 MHz –121 –131 –124 dBm 0.475 MHz –123 –132 –135 dBm 1.0 MH –125 –134 –137 dBm 3.5 MHz –125 –133 –137 dBm 14 MHz –125 –134 –138 dBm 50 MHz –127 –135 –138 dBm 70 MHz –128 –137 –138 dBm
ADC overload level: Not specified.	–2 dBm for Main and Sub receiver.
Noise figure: Not specified.	Preamp off/1/2, 14 MHz: 22/13/9 dB; 50 MHz, 20/12/9 dB.
AM sensitivity: 6 kHz BW, 10 dB (S+N/N) 6.3 µV (0.5 – 1.8 MHz) 2.0 µV (1.8 – 30 MHz) 1.0 µV (50 – 54 MHz) 2.0 µV (70 – 70.5 MHz).	10 dB (S+N)/N, 1 kHz tone, 30% modulation, 9 kHz BW:
	Preamp *Off* *P1* *P2* 1.0 MHz 3.16 1.00 0.78 µV 3.88 MHz 3.75 1.23 0.90 µV 29.0 MHz 2.57 0.90 0.86 µV 50.4 MHz 2.37 0.90 0.78 µV
FM sensitivity: 12 kHz BW, 12 dB SINAD 0.25 µV (28 – 30 MHz) 0.20 µV (50 – 54 MHz) 0.25 µV (70 – 70.5 MHz).	For 12 dB SINAD, 3 kHz deviation, 16 kHz BW:
	Preamp *Off* *P1* *P2* 29 MHz 1.03 0.38 0.33 µV 52 MHz 0.90 0.34 0.29 µV 70 MHz 0.94 0.34 0.30 µV 9 kHz BW: 29 MHz 0.98 0.34 0.32 µV 52 MHz 0.85 0.32 0.28 µV 70 MHz 0.89 0.31 0.29 µV
Spectral sensitivity: Not specified.	Panadapter and waterfall, preamp Off/1/2++ 14 MHz, –128/–137/–144 dBm 50 MHz, –133/–143/–146 dBm 3DSS, preamp Off/1/2++ 14 MHz, –120/–128/–137 dBm 50 MHz, –128/–137/–145 dBm
Blocking gain compression dynamic range: Not specified.	Blocking gain compression dynamic range, 500 Hz BW, 600 Hz roofing filter:**
	20 kHz offset *5/2 kHz offset* *Preamp* *Off/P1/P2* *Preamp off* 3.5 MHz >135/>143/145 >135/>135 dB 14 MHz >135/>144/146 >135/>135 dB 50 MHz >137/139/133 >137/>137 dB
Reciprocal mixing dynamic range: Not specified.	14 MHz, 20/5/2 kHz offset: 130/128/125 dB

ARRL Lab Two-Tone IMD Testing (500 Hz bandwidth), 500 Hz Roofing Filter

Band/Preamp	*Spacing*	*Measured IMD Level*	*Measured Input Level*	*IMD DR*
3.5 MHz/Off	20 kHz	–125 dBm –97 dBm	–21 dBm –10 dBm	104 dB
14 MHz/Off	20 kHz	–125 dBm –97 dBm	–14 dBm –5 dBm	111 dB
14 MHz/P1	20 kHz	–134 dBm –97 dBm	–23 dBm –11 dBm	111 dB
14 MHz/P2	20 kHz	–138 dBm –97 dBm	–31 dBm –17 dBm	107 dB
14 MHz/Off	5 kHz	–125 dBm –97 dBm	–15 dBm –5 dBm	110 dB
14 MHz/Off	2 kHz	–125 dBm –97 dBm	–15 dBm –6 dBm	110 dB

Manufacturer's Specifications		Measured in the ARRL Lab		
Band/Preamp	*Spacing*	*Measured IMD Level*	*Measured Input Level*	*IMD DR*
50 MHz/Off	20 kHz	–127 dBm –97 dBm	–25 dBm –15 dBm	102 dB
50 MHz/P2	20 kHz	–138 dBm –97 dBm	–38 dBm –27 dBm	100 dB

Second-order intercept point: Not specified.	Preamp Off/P1/P2 dB 14 MHz, +73/+71/+71 dBm 21 MHz, +77/+81/+81 dBm 50 MHz, +85/+85/+85 dBm
IF and image rejection: IF, ≥70 dB (1.8 – 28 MHz, VC on), ≥60 dB (50 MHz); image, ≥70 dB (1.8 – 28 MHz), ≥60 dB (50 MHz).	IF rejection: VC off/on, 7 MHz, 91/109 dB, 10.1 MHz, 66/97 dB, 14 MHz, 52/88 dB, 50 MHz, 114/114 dB; Sub receiver: 7 MHz, 64 dB, 10 MHz, 62 dB, 14 MHz, 97 dB, 50 MHz, 128 dB. Image rejection: 14 MHz, 69 dB, 50 MHz, 70 dB. Sub receiver: 14 MHz, 69 dB, 50 MHz, 73 dB.
Noise reduction: Not specified.	For S-5 level, 10 dB; S-9 level, up to 18 dB.
FM adjacent channel rejection: Not specified.	P2 on, 29 MHz: 86 dB; 52 MHz, 87 dB (FM and FM narrow).
FM two-tone third-order IMD dynamic range: Not specified.	20 kHz offset, P2 on, 29 MHz: 86 dB,† 52 MHz, 85 dB. 10 MHz offset, P2 on: 29 MHz, 120 dB; 52 MHz, 92 dB.
Squelch sensitivity: FM, 28 – 30 MHz, 0.25 µV, 50 – 54 MHz, 0.2 µV, 70 – 70.5 MHz, 0.2 µV; HF (SSB) 0.16 µV.	FM: P2 on, 29 MHz, 0.27 – 0.52 µV, 52 MHz, 0.21 – 0.66 µV, 70 MHz, 0.26 – 0.71 µV. HF squelch: 0.47 – 20.4 µV.
S-meter sensitivity: Not specified.	S-9 signal, preamp Off/P1/P2: 14 MHz, 115/40.7/14.8 µV 50 MHz, 107/40.2/16.2 µV Scaling: 3 dB per S-unit.
Notch filter depth: Not specified.	Tunable notch filter, >70 dB; auto notch >70 dB, attack time 2 ms for one or two tones.
IF/audio response: Not specified.	Range at –6 dB points:‡ CW (500 Hz BW): 453 – 945 Hz; Equivalent Rectangular BW: 489 Hz; USB (2.4 kHz BW): 289 – 2,406 Hz; LSB (2.4 kHz BW): 289 – 2,406 Hz; AM (9 kHz BW): 98 – 1,668 Hz.
Audio output: 2.5 W at 10% THD at 4 Ω.	As specified. 0.3% at 1 V_{RMS}.
Receive processing delay time: Not specified.	26 ms.

Transmitter	Transmitter Dynamic Testing
Power output: 5 – 100 W (SSB, CW, FM), 5 – 25 W (AM).	SSB, CW, FM (typical): 4.8 – 96 W; AM: 4.8 – 24 W.
RF power output at minimum specified operating voltage: Not specified.	At 12.4 V dc: 14 MHz, 94 W; 50 MHz, 90 W.
Spurious-signal and harmonic suppression: ≥ 50 dB (HF); ≥ 63 dB (50 MHz).	HF: 71 dB typical; 62 dB worst case (160 m); 50 MHz, 77 dB. Complies with FCC emission standards.
Third-order intermodulation distortion (IMD) products: Not specified.	3rd/5th/7th/9th order, 100 W PEP: –42/–41/–48/–58 dB (HF typical) –41/–44/–46/–50 dB (worst case, 80 m) –36/–37/–51/–66 dB (50 MHz) At 50 W RF output: –32/–44/–57/–64 dB (14 MHz) –35/–42/–51/–66 dB (50 MHz)
CW keyer speed range: Not specified.	4.8 to 60 WPM, mode A, B, Y, ACS.
CW keying characteristics: Not specified.	See Figures 6 and 7.
Transmit-receive turn-around time (PTT) Release to 50% audio output: Not specified.	S-9 signal, AGC fast, SSB, 62 ms; AGC fast, CW, full break-in, 26 ms.
Receive-transmit turn-around time (TX delay): Not specified.	SSB, 12 ms; FM, 16 ms (29 & 52 MHz).
Transmitted phase noise: Not specified.	See Figure 8.
Amplifier key line closure to RF output: 15 to 30 ms (adjustable).	As specified.

Size (height, width, depth, including protrusions): 5.9 × 16.5 × 15 inches; weight, 26.5 pounds.

Second-order intercept points were determined using S-5 reference.

++Measurements with scope sensitivity set to **NORMAL**, scope level +30.0 dB and span 5 kHz. Scope sensitivity varies with settings.

*Main receiver values shown. Sub receiver performance is identical unless indicated.

**Blocking dynamic range exceeds these values. No blocking was observed with up to +10 dBm signal at the antenna jack, the maximum level used in ARRL Lab testing. See Lab Notes.

†Measurement is noise limited at the value indicated.

‡Default values; bandwidth is adjustable.

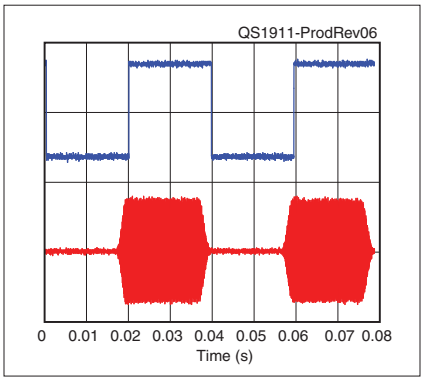


Figure 6 — CW keying waveform for the Yaesu FTDX101D showing the first two dits in full-break-in (QSK) mode using external keying and the default rise time setting. Equivalent keying speed is 60 WPM. The upper trace is the actual key closure; the lower trace is the RF envelope. (Note that the first key closure starts at the left edge of the figure.) Horizontal divisions are 10 ms. The transceiver was being operated at 100 W output on the 14 MHz band.

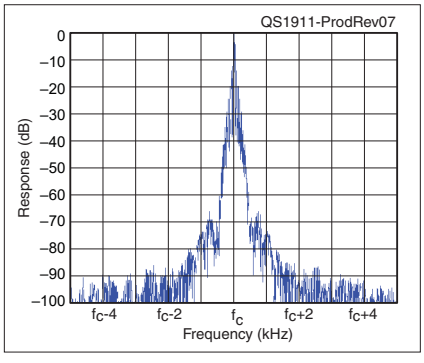


Figure 7 — Spectral display of the Yaesu FTDX101D transmitter during keying sideband testing. Equivalent keying speed is 60 WPM using external keying and the default rise time setting. Spectrum analyzer resolution bandwidth is 10 Hz, and the sweep time is 30 seconds. The transmitter was being operated at 100 W PEP output on the 14 MHz band, and this plot shows the transmitter output ±5 kHz from the carrier. The reference level is 0 dBc, and the vertical scale is in decibels.

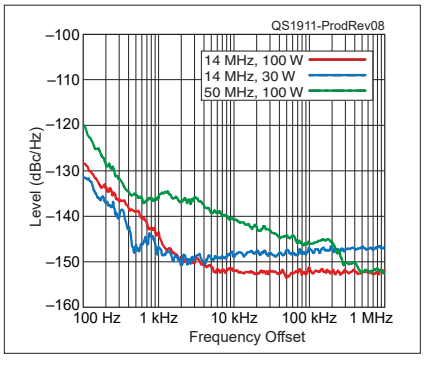


Figure 8 — Spectral display of the Yaesu FTDX101D transmitter output during phase-noise testing. Power output is 100 W on the 14 MHz band (red trace), 30 W on the 14 MHz band (blue trace), and 100 W on the 50 MHz band (green trace). The carrier, off the left edge of the plot, is not shown. This plot shows phase noise 100 Hz to 1 MHz from the carrier. The reference level is –100 dBc/Hz, and the vertical scale is 10 dB per division.

I operated the FTDX101D with my Elecraft 500 W linear amplifier and auto tuner, just using the Yaesu's amplifier keying connection. My amplifier requires drive in the 20 to 30 W range. While an automatic level (ALC) input is provided, the radio's power-level memory kept everything in line.

The transceiver also provides band data on a 15-pin rear connector. This can be used to automatically band switch a linear amplifier to follow the transceiver. Elecraft offers a cable that will connect to this radio to provide the required interface. Using this cable would have made it unnecessary to manually change the amplifier's band, or wait until it detected the RF and switched itself.

Running with Dual Receivers

The main and sub receivers both work very well. They can be locked together with the **SYNC** button for diversity reception, with one channel in each ear and receivers on different antennas, or they can be completely independent on the same or different bands. A push of the **MAIN/SUB** button interchanges the two frequencies.

There are three antenna connectors on the rear panel. The antenna connections for the main and sub receiver are selected by the **ANT** button on the main screen. The third antenna can be set by a menu item to be a third transmit/receive antenna, or it can be set to be a receive-only antenna while transmitting on antenna 1 or 2.

The main receiver VFO is controlled by the large center knob, while the sub receiver is tuned with a concentric ring to the rear of the main tuning. The outer ring can be set to be used for other things as well, which makes sense because the second receiver is not always in use. My main use of the second receiver is to be able to chase DX stations operating on split frequencies — listening on a frequency different from the transmit frequency. The DX station is first tuned in on the main receiver and then the sub receiver is used to listen to, and help select, my transmit frequency. Push the **SPLIT** button to transmit on the sub receiver frequency. Fortunately, there is a **LOCK** button that fixes the main receiver frequency, so if you accidently brush it while tuning the sub receiver, you won't lose the DX station.

The frequency memories also store the mode, selectivity choice, and other parameters, such as the repeater offset and tones needed for FM. The memories are added, loaded, or deleted from the main menu, with each selected from the list by touching a button on the screen. A cluster of three dedicated buttons handles memory operations — the fairly standard **V/M** (VFO or memory mode), **M>V** (copy contents of selected memory to VFO), and **V>M** (copy VFO frequency and other parameters to memory). The maximum number of regular memories is 99, which can be divided into five groups of up to 20 channels each. In addition, there are nine special memory pairs intended for setting upper and lower bounds for scanning particular regions, such as band segments. Also provided are 10 special memories for the 60-meter channels, five for SSB and five for CW.

The Spectrum Scope

The spectrum scope is quite useful and flexible. It can observe a portion of the spectrum near the tuned frequency, as shown in Figure 1. If set to cover a particular portion of a band that includes both the A and B receiver channels, they both are shown on the same scan. Alternately, the B channel could be on a different portion of the band, or even a different band and mode, and can be shown on a separate span (press the **MULTI** key on the display) below the first — each with its own width and tuning rate, as shown in Figure 2. The width can be adjusted from 1 kHz to 1 MHz, by pushing the **SPAN** button on the bottom row of the scope display.

The rear panel also provides main and sub receiver output jacks with the full RF spectrum for use with an additional receiver, in case two receivers are not enough. There is also a jack that provides the 9 MHz first IF signal in wideband form (ahead of the roofing filters) for use with an alternate panadapter or other signal processing hardware.

Antenna Tuner

The internal antenna tuner quickly tunes an antenna system with up to a specified 3:1 SWR to near 1:1, and it remembers the tuner settings for that frequency. I found that it could tune some antennas with a higher SWR, but the internal SWR meter only shows up to a 3:1 value, so it can be hard to tell. Attempting to use an antenna with more than the specified mismatch can be a risky business. While the radio cuts back to 10 W out (adjustable) during tuning, it will try to push whatever power setting you select during operation, and damage to tuner components is possible in any tuner if ratings are exceeded.

Voice Operation

Voice modes all worked well with good audio reports received on SSB and AM. I was unable to make any FM contacts on 10 or 6 meters — not unusual here. The transceiver is supplied with a handheld Yaesu SSM-75G electret microphone that plugs into the eight-pin front-panel jack. The jack supplies electret bias voltage on a dedicated line, so a dynamic microphone can be directly connected to the **MIC** pins. To use an electret mic not designed to operate with Yaesu radios, you will need to fabricate a simple adapter to bring the bias voltage to the mic. One was described in a *QST* "Doctor is In" column.[1] Both the supplied electret

[1]J. Hallas, W1ZR, "The Doctor is In," *QST*, Sep. 2015, pp. 56 – 57.

mic and a professional-quality dynamic mic worked well with the FTDX101D, and I received good reports.

While SSB and CW modes can be selected directly from front-panel buttons, a long push of the **MODE** button brings up a screen offering other modes, including AM, FM, and data (SSB data modes or FSK). For 10- or 6-meter FM operation, the FTDX101D provides easy split-frequency offsets, as well as CTCSS tone encoding for repeater access. The settings are available from the main menu's **RADIO SETTING** screen, which offers selections for each mode. Choices include AGC levels, frequency response, gain settings, and audio source (front-panel **MIC** jack or rear-panel **RTTY/DATA** or USB jacks).

A variable three-band equalizer can be selected from the **TX AUDIO** menu. There are separate groups of settings for operation with the speech processor/compressor on and off. This allows a setting for casual conversation, and a different set of parameters for DX or contest operation using the speech compressor if punchier audio is appropriate.

The three equalizer bands can be set to be centered between 100 to 700 Hz, 700 to 1,500 Hz, and 1,500 to 3,200 Hz, with each having a selectable bandwidth (**Q**) and gain. The equalizer can also be set to **OFF** in either mode, if you prefer the way you sound with just the microphone's audio characteristics. I found that I could use the equalizer to improve the sound from my flat-response studio-type mic. The equalizer is effective in SSB, AM, and FM, although AM and FM only use the equalizer settings with the speech processor off.

On receive, SSB bandwidth is adjustable from 300 Hz to 4 kHz, with the SSB bandwidths also available for SSB data modes. AM mode uses 6 and 9 kHz bandwidths, and FM uses 9 and 16 kHz. Each mode has a receive audio filter, separate from the DSP bandwidth selection. This allows the setting of the low- and high-frequency cutoff points in 50 Hz steps, as well as the roll-off slope of each to either 6 or 18 dB per octave. This can all be turned off if desired, leaving the response to that of the DSP IF filters. The audio filter could reduce any out-of-band noise entering the receiver beyond the IF.

Lab Notes: Yaesu FTDX101D

Bob Allison, WB1GCM, ARRL Test Engineer

Receiver tests showed that the Yaesu FTDX101D has an excellent receiver. Two-tone, third-order IMD dynamic range measured 110 dB at 2 kHz spacing, the highest of any HF transceiver tested at the ARRL Laboratory. Reciprocal mixing dynamic range (RMDR) is impressive at 125 dB, and blocking gain compression dynamic range is also impressive at >135 dB. Note that the blocking dynamic range is higher than indicated by the test results. The ARRL Lab tests with signals up to +10 dBm (10 mW), but Yaesu indicates that the receiver can handle signals up to +27 dBm. The blocking dynamic range test results would be higher if we tested with stronger signals. With such measurement figures, the user should not experience false signals, increased background noise, or reduced speaker audio from one or more strong, adjacent signals.

Speaker audio distortion is very low at normal listening levels, keeping fatigue at bay during long operating events. AM enthusiasts will appreciate the FTDX101D's good AM sensitivity, especially on the higher bands where background noise levels are low.

With digital processing being the norm for current transceivers, signal latency can be an issue, taking hundreds of milliseconds from the time a signal arrives at the antenna jack to when it comes out of the speaker. This is not an issue with the FTDX101D, with only 26 milliseconds of signal processing time. This is especially important for high-speed CW operation, where hundreds of milliseconds is an eternity.

Transmit quality is equally impressive, making the FTDX101D a good neighbor for others using nearby frequencies. For example, the FTDX101D greatly exceeds FCC requirements for harmonic and spurious suppression. It also has excellent transmit phase noise, keeping broadband noise low for other receivers tuned to the same amateur band. The CW rise time is adjustable, and the keying waveform and sidebands shown in Figures 6 and 7 are with the default 4-millisecond setting. As the rise time decreases, the keying waveform corners sharpen and the keying sidebands increase, potentially interfering with stations operating on nearby frequencies. The 6-millisecond setting is even better. Avoid the 1- and 2-millisecond settings. On SSB, the transmit intermodulation distortion (IMD) is relatively low, especially the higher-order products that can interfere with stations on nearby frequencies.

During transmitter testing, I observed some power overshoot on the first transmitted syllable or CW character, which might cause a problem with an external linear amplifier. Yaesu quickly found that there was a delay in the automatic level control attack time, and they corrected the problem in production. They published a list of serial numbers of the early production radios affected and offered to update any affected radio free of charge, and even pay shipping both ways. After the update, the review radio and another later production radio we tested had no signs of overshoot.

Voice-operated transmit control (**VOX**) worked flawlessly, as did the anti-VOX function, which eliminated triggering from loud received stations, even with the mic pointed at the speakers. Enabling VOX just requires pushing a dedicated physical **VOX** button below the display screen, while setting (and remembering) VOX parameters is accomplished via buttons on the **MAIN** menu screen.

A monitor function is provided, and a recording function can be used to record and play back audio signals. It can be used to record either transmitted or received signals, and recordings can be reviewed off line or transmitted. The voice memory can store and replay often repeated contest messages. It includes five memories, each capable of storing up to a maximum of 20 seconds of voice audio. The optional FH-2 remote-control keypad may also be used to control the messages.

CW Operation

The designers of the Yaesu FTDX101D did a good job of including many useful features for CW operators. Full-break-in and semi-break-in operation are supported. The transmit-receive switchovers use relays, which are just barely audible, and not at all objectionable. There are both front- and rear-panel ¼-inch stereo **KEY** jacks, and each can be set up separately, so paddles can go in the front, with a straight key, computer keying, or external keyer connected in the rear — very handy.

The built-in iambic (mode A, B, or Y) or bug-emulating electronic keyer can be adjusted from a Lab-measured 4.8 to 60 words per minute. The keyer mode, weight, and contest serial number are settable independently for the front and rear key jacks. Automatic character spacing may be turned on to ensure precise spacing between Morse characters.

"The designers of the Yaesu FTDX101D did a good job of including many useful features for CW operators. Full-break-in and semi-break-in operation are supported."

The **CW SETTING** menu button provides for five CW keyer memories, each able to store 50 characters. They are entered by selecting the **REC/PLAY** button on the **MAIN** menu, which is also used to send them. The message contents can be entered by sending with a paddle or via a virtual keyboard that appears on the display if **TEXT** is selected in the **KEYER SETTING** menu. The memories can also be controlled using an optional FH-2 remote-control keypad. This may be a worthwhile investment if you plan to use the keyer memories frequently, because this should avoid tying up the display during memory operation.

A CW decoder is available as well, with decoded text displayed on the screen. For best results, adjust the **MIC/SPEED** control to match the speed of the received CW signal.

The two receivers can be set independently to the default CW bandwidths of 50, 100, 250, 400, 500, 800, 1,000, or 3,000 Hz. The filter width and center frequency for any of these default settings can be adjusted using the front-panel concentric knobs. I detected just the slightest trace of ringing at the 50 Hz setting. A very sharp audio-peaking filter is available, which can help bring a CW signal out of the noise or interference.

The radio includes an on-screen CW tuning indicator graphic to help you manually tune in a received station for the selected CW offset. If you prefer to let the radio handle that, a tap of the **ZIN/SPOT** button beneath the display screen automatically sets the receiver tuning to match your selected BFO offset (pitch). A longer push provides a steady tone of that frequency to use as a reference.

Data Modes

The FTDX101D offers several options for digital-mode operation. The radio has an internal decoder for RTTY and BPSK or QPSK modes, and you can program built-in memories to transmit on those modes. Connections are also available to use the radio with digital-mode software running on an external PC.

Text from the internal decoder displays on the screen in place of the spectrum scope, providing up to 11 lines of text. Five transmit memories, each up to 50 characters in length, can be programmed using either a text-entry virtual keyboard that appears if the **REC/PLAY** button is pressed, or via a USB PC keyboard plugged into one of the front-panel USB jacks (the other can be connected to a mouse, or equivalent). The memories can then be accessed via the main display or the optional FH-2 keypad.

Through the transceiver's USB port (with the CP210x drivers installed as described previously), you can also set up a connection to the radio's internal sound card for any of the "sound card" digital modes, such as FT8, PSK, or AFSK RTTY. When the radio is connected via the USB port to a Windows PC, Windows installs drivers and a **USB AUDIO CODEC** shows up as a sound device on the computer. For radio control and PTT with digital-mode software such as *WSJT-X*, supporting modes like FT8 and FT4, either a virtual or real COM port can be used, as described ear-