Digital Voice the Easy Way

If you use FT8, then you already have all of the necessary hardware to use FreeDV for digital voice on the HF bands.

Ira Brodsky, KC9TC

Most communication and media technologies are going digital. Digitization enables performance enhancements and features that are not available in the analog world. However, digital transmission in the HF bands poses unique challenges, as operators frequently contend with noise (QRN), interference (QRM), and fading (QSB). Digital voice for the HF operator has been in development for more than 20 years, and an overview of that process is detailed at **www.arrl.org/qst-in-depth**. Tremendous progress has been made since the start of that development — HF digital voice no longer requires special hardware — but there's still room for improvement.

HF operators who enjoy portable operation or digital data modes should find FreeDV particularly intriguing. Digital signals are more immune to noise, and there are many tools available for improving the performance of digital systems, such as forward error correction. FreeDV may already have a modest edge over single sideband (SSB) under specific conditions, and there is reason to believe that the performance advantage will grow with time. FreeDV sounds the same at the receiver regardless of how strong the signal is, provided that there aren't too many bit errors. Some users believe FreeDV outperforms SSB when noise is present; others feel that SSB sounds more natural, while FreeDV can sound metallic or robotic.

HF Digital Voice Pros and Cons

HF digital voice can use less bandwidth than SSB and, therefore, can help reduce QRM on crowded phone bands. FreeDV signals consume between one-third and one-half of the bandwidth of SSB signals. This is partially accomplished by encoding voice at low bit rates. FreeDV's open-source vocoder, Codec 2, operates at speeds ranging from as low as 700 bits per second (bps) to as high as 3200 bps. The faster speeds result in better voice quality.

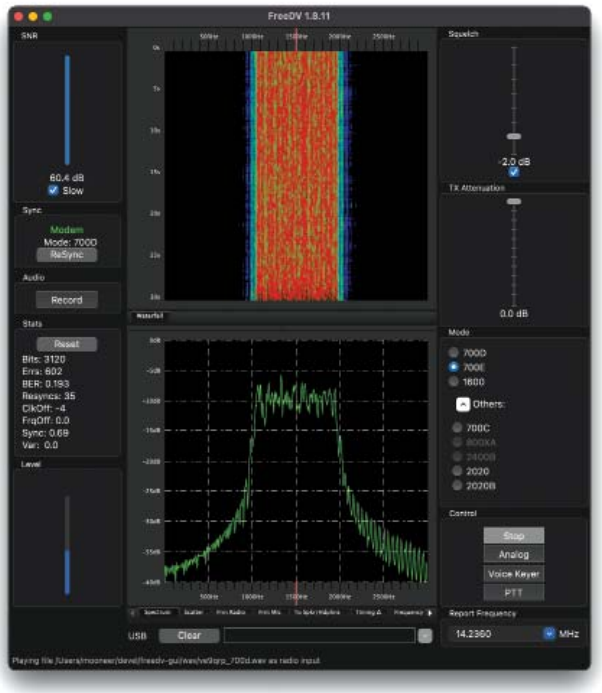

Figure 1 — FreeDV's main control console. At startup, the graphical user interface shows only the waterfall, but additional panes can be added.

FreeDV signals sound quiet, just as FM signals sound quiet compared to AM signals. When you listen to an SSB signal, you hear the other operator's voice along with the atmospheric noise present on the radio channel. When you listen to a FreeDV signal, you don't hear the atmospheric noise — you hear only the audio that was encoded by the transmitter. However, digital voice systems are subject to another type of noise known as *quantization*. This noise is created due to errors that occur when encoding continuous signals (analog) as discrete signals (digital). Quantization produces distortion in the audio rather than the background noise in analog signals.

One disadvantage of digital transmission is operators receiving either an exact copy of what was transmitted, or nothing at all. While SSB users often notice that signals are fading as propagation changes, HF digital voice users may find that a loud and clear signal will suddenly disappear.

Where on the HF spectrum can you use FreeDV? FreeDV is digital, but it is still considered to be a type of phone emission according to Part 97 FCC rules. Therefore, it must be used in the phone segments of the HF bands, but it isn't allowed on 60 meters. A FreeDV signal sounds like white noise to SSB users. Before transmitting with FreeDV, you should ask in SSB mode if the frequency is in use. The software makes this easy with an analog mode selection on the main screen (see Figure 1).

Setting Up FreeDV

FreeDV software is available for Windows, Linux, and macOS computers. More information about FreeDV, including links to download the latest software and user manual, can be found at **www.freedv.org**. A test sound file comes with FreeDV, and you can use it by selecting **PLAY FILE FROM RADIO** under the **TOOLS** tab; this allows you to hear what FreeDV sounds like. To receive FreeDV off the air, you can feed the audio from your radio into your computer's sound card. Check band usage with

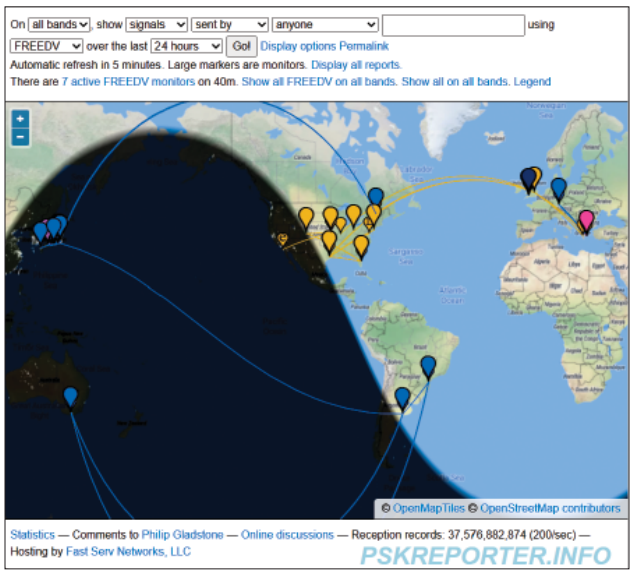

Figure 2 — With PSK Reporter and other similar tools, you can see your signal strength and where in the world it is being received. Similarly, users who enable FreeDV's reporting option can see who is decoding their digital voice signal, where they are located, and how strong their signal is. [**www.pskreporter.info/pskmap**]

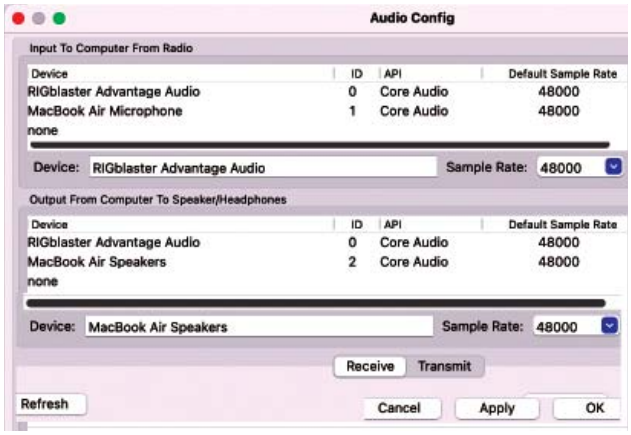

Figure 3 — Audio must be configured for both transmit and receive. In this case, receive audio is input to a laptop from a rig interface device and output from the laptop to its built-in speakers.

PSK Reporter (see Figure 2). You can also visit the FreeDV Reporter at **http://qso.freedv.org** and ask a FreeDV user to call you. To transmit and receive, you need to plug a rig interface (such as a SignaLink or RIGblaster) or an additional USB sound card into your radio or computer. Next, go to **AUDIO CONFIG** under the **TOOLS** tab (see Figure 3). You will need to separately configure transmit and receive via the buttons near the bottom of the window. For the receive configuration, in the top window, start by selecting the input device to the computer from the radio (for instance, a SignaLink or RIGblaster). Then, in the bottom window, select the output device from the computer (for instance, the computer's speakers). For the transmit configuration, select the input device to the computer (such as a laptop's built-in microphone), and the output device from the computer to the radio (again, a rig interface or the radio's built-in USB sound card).

If your transceiver can operate with voice-operated exchange (VOX), you are ready to transmit. Otherwise, you will also need to configure your push-to-talk (PTT) method. In the main FreeDV window (see Figure 1), there are four buttons under **CONTROL** in the lower right side of the screen. **START** turns on FreeDV reception, but you need to press the **PTT** button to transmit and release it to resume receiving. If you can't use VOX, go to **PTT CONFIG** under the **TOOLS** tab; this setup is outlined at **www.arrl.org/qst-in-depth**. You can also choose between several FreeDV operating modes. Mode 700D provides the best weak-signal performance, and it seems to be many users' default mode. Mode 2020 offers the best speech quality, but it requires stron-

ger signals. Set your radio to lower sideband on bands below 10 MHz, and set it to upper sideband on bands above 10 MHz. Turn off speech compression and noise reduction. Try to keep the frequency response of the receive path as flat as possible. If you are not already using a digital mode, additional FreeDV operating instructions are outlined at **www.arrl.org/qst-in-depth**.

The Future of Digital HF Voice

FreeDV is a work in progress that has contributions from radio amateurs around the world under a free software license. Many contributors are listed on **www.arrl.org/qst-in-depth**. FreeDV has been adapted to work on bandwidth-constrained geosynchronous satellites, such as the QO-100. FreeDV has also been used with internet-based software-defined radios to enable DX communication when propagation is poor or unavailable. FreeDV has many other helpful features, including a voice keyer that can be used to play a .wav file of your transmission. Digital transmission opens the door to capabilities that would be difficult or impossible with analog transmission. For instance, it facilitates automatic testing of HF channel conditions, as well as adjustment of transmission parameters like vocoder rate, modulation, frame sizes, and error correction. It can even embed a link in your phone transmissions that shows a live view of your station and an automatically generated, downloadable QSL card.

Most significant inventions aren't developed overnight. More often, they're the result of a series of incremental advances. HF digital voice technology has just reached the starting line, and it will be fascinating to see how it evolves over the next several years.

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See *QST* in Depth for More!

Visit www.arrl.org/qst-in-depth for the following supplementary materials and updates:

- ✓ The history of digital voice for HF
- ✓ How to configure your radio for PTT
- ✓ Easy ways to operate FreeDV if you are not already using a digital mode
- ✓ A list of FreeDV software contributors

Ira Brodsky, KC9TC, was first licensed in 1968, and he holds an Amateur Extra-class license. He has worked in the telecommunications field for more than 40 years as a sales engineer, a product line director, and an independent industry analyst specializing in wireless data. He has authored five books and more than 100 articles. Brodsky has earned the DX Century Club Award and the Worked All States Award, and he also enjoys satellite and portable operation. He can be reached at **ibrodsky64@gmail.com**.

For updates to this article, see the *QST* Feedback page at www.arrl.org/feedback.

Volunteer Monitor Program Report

The Volunteer Monitor (VM) Program is a joint initiative between ARRL and the FCC to enhance compliance in the Amateur Radio Service. This is the June 2023 activity report of the VM Program.

♦Advisory notices were issued to operators in North Carolina and West Virginia for excessively wide transmissions (over 8 kHz). The operators were reminded that FCC rule 97.307(a) requires that no amateur station use more bandwidth than necessary for the information rate and emission type being transmitted.

♦A licensee in Georgia received a second advisory notice regarding excessively wide transmissions and was informed that the matter would be referred to the FCC.

♦A commendation was issued to a licensee in Michigan for courtesy and special efforts made in resolving an interference issue on 14.230 MHz.

♦Licensees in New Jersey, Arizona, Vermont, and Illinois received advisory notices for FT8 operation on frequencies not allowed under their Technician-class licenses.

♦A licensee in Nevada received an advisory notice for an out-of-band signal due to operation too close to the band edge on 40 meters.

The totals for VM monitoring during May 2023 were 1,961 hours on HF frequencies, and 2,696 hours on VHF frequencies and above, for a total of 4,657 hours.

For the quarter ending June 30, 2023, there were 15 advisory notices and eight commendations issued, two FCC referrals, and two FCC meetings. *Thanks to Volunteer Monitor Program Administrator Riley Hollingsworth, K4ZDH*