MOONEER SALEM K6AQ

FREEDV DIGITAL VOICE

ABOUT ME

- Been licensed since the early 2000s
  - KG6AOV was my original callsign
- Currently a software developer at a medical device company
  - Primarily C/C++ with some C# and Python thrown in
- Do open source development in my spare time
  - FreeDV being the biggest so far

WHAT IS DIGITAL VOICE?

- Like livestreaming, but for radio
  - Microcontroller or PC converts your analog voice into 1s and 0s
  - Data is then modulated into a signal that our radios can transmit
- Reverse process happens on RX
  - Device demodulates back to 1s and 0s
  - Sound card produces analog signal to speakers/headset

WHY USE DIGITAL VOICE?

- Less bandwidth than a similar analog signal
  - Many digital voice modes cut this in half or potentially more
  - Smaller bandwidth => higher power density => lower minimum SNR
- Digitization of received signal inherently adds some noise immunity
  - Forward error correction can potentially fix significant issues (with various tradeoffs)

DISADVANTAGES OF DIGITAL VOICE

- Your signal is either Q5 or Q0 (“digital cliff effect”)
  - Example: Analog TV vs. ATSC digital TV during DTV transition
- More difficult to implement compared to traditional modes
  - Transceiver circuits readily available for traditional modes
  - Potentially no need to include a microcontroller or other computer control

HOW POPULAR IS IT, ANYWAY?

- In use on VHF/UHF since the early 2000s
  - D-Star first started appearing in Icom radios in 2004
- Significant demand from hams continues through today
  - Example: >200,000 unique DMR IDs
  - M17 up and coming

WHY NOT AS MUCH USED ON HF?

- The existing modes use far more bandwidth than is standard
  - Typical SSB voice signal is ~3KHz for comparison
  - Approximately as wide as AM at best (e.g. 6.25 KHz for D-STAR)
  - Limits the locations on the bands where it can be used
- VHF/UHF+ propagation is significantly different than HF
  - Examples: selective fading, sunspot cycle

WHY NOT AS MUCH USED ON HF?

- The existing modes have patent issues
  - AMBE codec as used in DMR and Fusion expires in 2028 (!)
  - D-Star is now okay, however
- Developing a legal product results in increased costs
  - Such costs may be prohibitive for many

WHAT IS AVAILABLE ON HF?

- D-Star is capable of being used on HF
  - The only legacy VHF/UHF+ DV mode that can be
  - Requires an HF-capable Icom radio—a significant expense!
  - 6KHz bandwidth means limits on where it can be used

WHAT IS AVAILABLE ON HF?

- AOR digital voice modems
  - Limited hardware availability (“made to order”)
  - Significantly expensive even when new

WHAT DOES FREEDV PROVIDE?

- Digital voice modes optimized for HF band conditions
  - 1 to 1.5KHz bandwidth
  - Modes are optimized for HF (i.e. good handling of fading)
- A way to use digital voice with your existing radios
  - If you’re already using FT8, you can use FreeDV

WHAT DOES FREEDV PROVIDE?

- Increased comfort during long radio sessions (e.g. contests)
  - Lack of background noise when signal decodes
- Easier voice contacts if you’re using a compromised station
  - No longer limited to FT8 or other data modes :)
  - QRP is definitely possible!

COMPROMISED STATION EXAMPLE

- Condo with HOA restrictions
  - MFJ mag loop (15-40m)
  - Self-imposed ~50W max power limit to avoid interfering with neighbors
- Decoded signal from recent QSO with K0PFX (St. Louis, MO)
  - ~1600 miles away from QTH

DX EXAMPLE

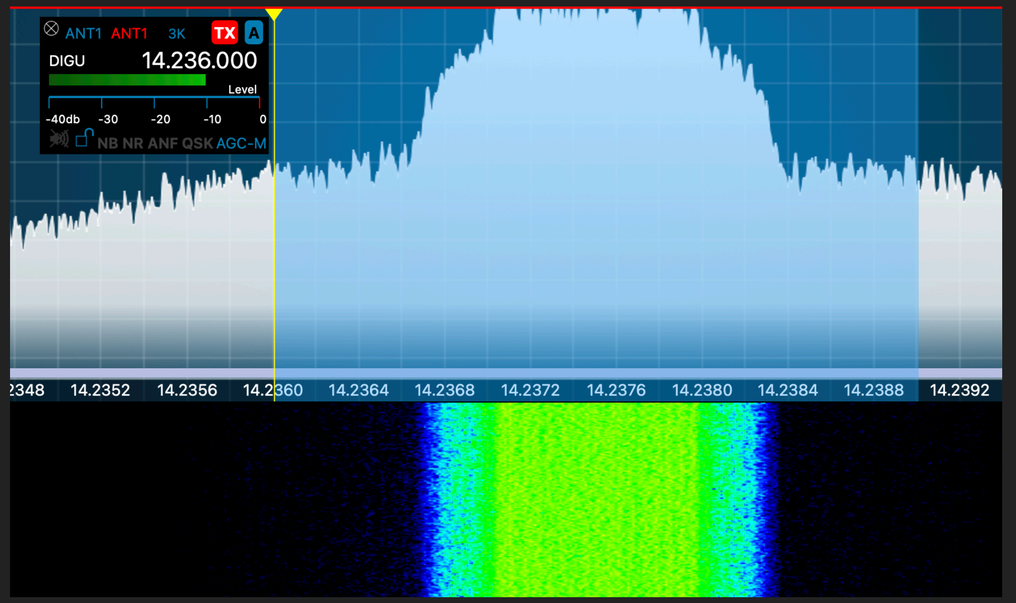
- QSO between K0PFX and LU5DKI (Jose from Argentina)
  - SSB contact was immediately adjacent
  - Fading was present in the signal received by the radio
  - ~5000 mile path (!)

HIGH QUALITY EXAMPLE

- QSO between K0PFX and WA5QPZ (Austin, TX)
  - Uses “2020” mode for higher voice quality
  - ~700 mile path

WHAT DOES IT LOOK LIKE ON THE AIR

- “Buzzing” type sound if you’re not running FreeDV hardware or software
  - Similar to other wide bandwidth data mode
- Multiple carriers on waterfall if using a pan adapter



IS IT LEGAL?

- Disclaimer: I am not a lawyer! Please seek expert legal advice.
  - This will also vary for operation outside of the US
- The ARRL considers digital voice as having designator J2E
  - J = SSB, 2 = single channel with digital information , E = telephony
- See “Practical HF Digital Voice”, May/June 2000 QEX

IS IT LEGAL?

- J2E is considered a “phone” emission per §97.3(5)(c)
  - §97.305(c) thus governs where DV can be used on HF
  - 60 meters is not allowed (§97.307(f)(14)(i) limits phone to J3E)
- Is FreeDV actually J2E?
  - Theoretically don’t need a SSB radio to transmit it
  - Even if not, §97.3(5)(c) gives a lot of leeway on what’s “phone”

NOT RELATED TO LEGALITY (BUT STILL A GOOD IDEA)

- The standard “considerate operator” practices still apply
  - ID every 10 minutes, only as much power as needed, etc.
  - Some/many of these are actually FCC rules too
- Reminder: Listen before transmitting!
  - Spectrum is shared and people unfamiliar with FreeDV may end up transmitting on the calling frequencies

WHERE CAN IT BE USED

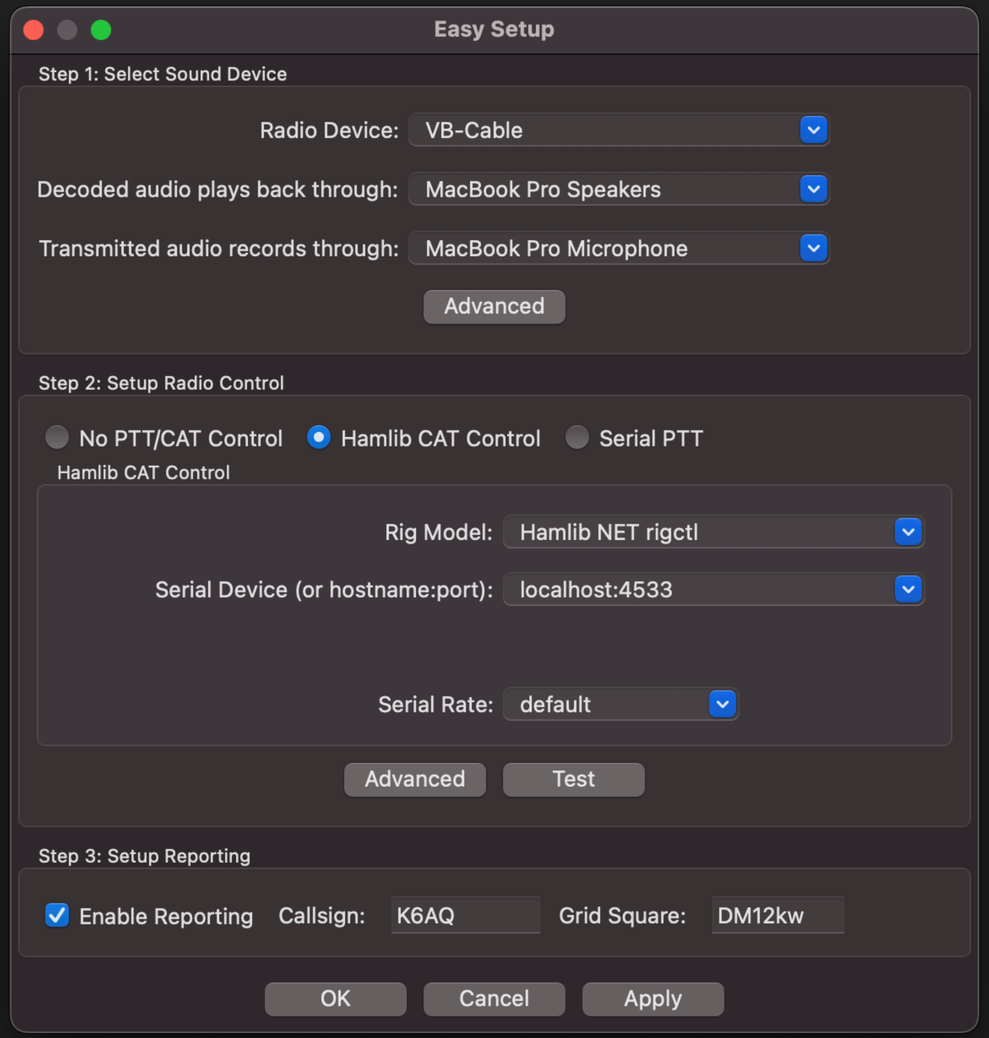
- Standard conventions match analog voice
  - USB > 10MHz, LSB < 10MHz
- Most activity is on 14.236 MHz +/- QRM
  - 7.177 MHz, 28.330 MHz also common

GETTING ON THE AIR

- FreeDV client application
  - Available at https://freedv.org/
  - Binaries for Windows (32/64 bit) as well as Mac (Intel/ARM)
  - Source code on GitHub
- Requires two sound cards to transmit
  - One of them is likely the same one you use for other digital modes

EASY SETUP

- A new startup screen to streamline FreeDV setup
  - Single radio audio device (e.g. one plugged in via USB)
  - Supports CAT control and serial PTT configuration
  - “Test” button keys radio and emits a constant carrier



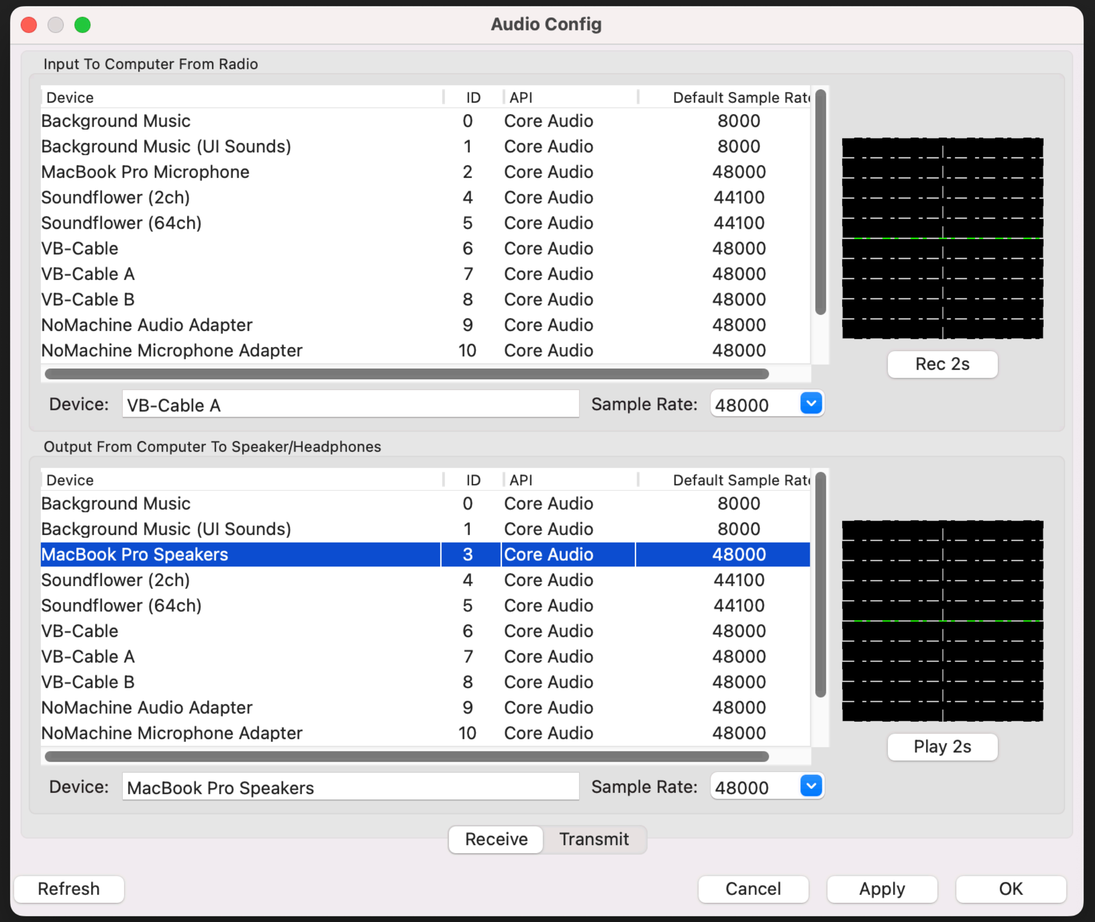
ADVANCED SETUP

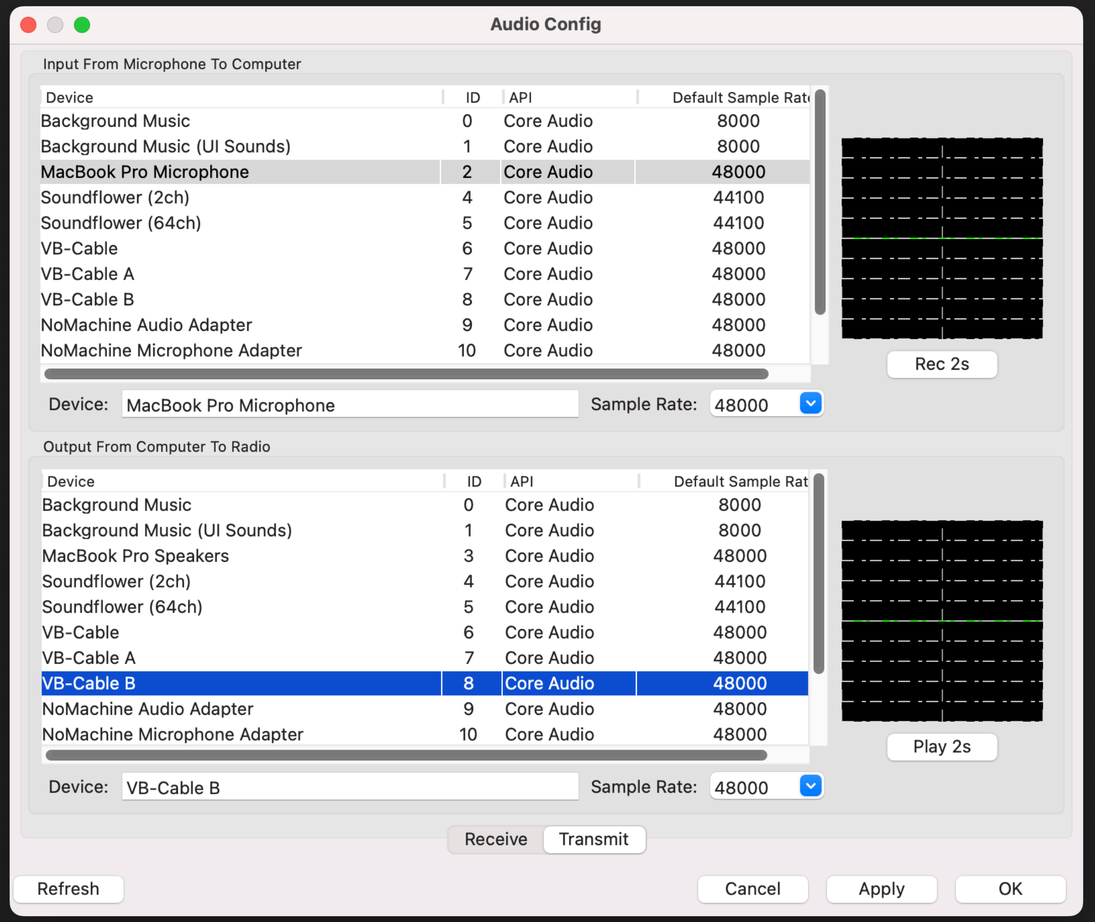
- Still possible (and required depending on setup)
  - Example: SDR radios using multiple virtual audio cables
- Minimum setup: sound card configuration
- Additional optional setup:
  - CAT control/serial PTT (if not using a VOX based digital interface)
  - PSK/FreeDV Reporter reporting

SOUND CARD CONFIGURATION

- Tools->Audio Options
  - Two tabs: Receive and Transmit
  - Typically audio devices are reversed on the Transmit tab

EXAMPLE AUDIO CONFIGURATION

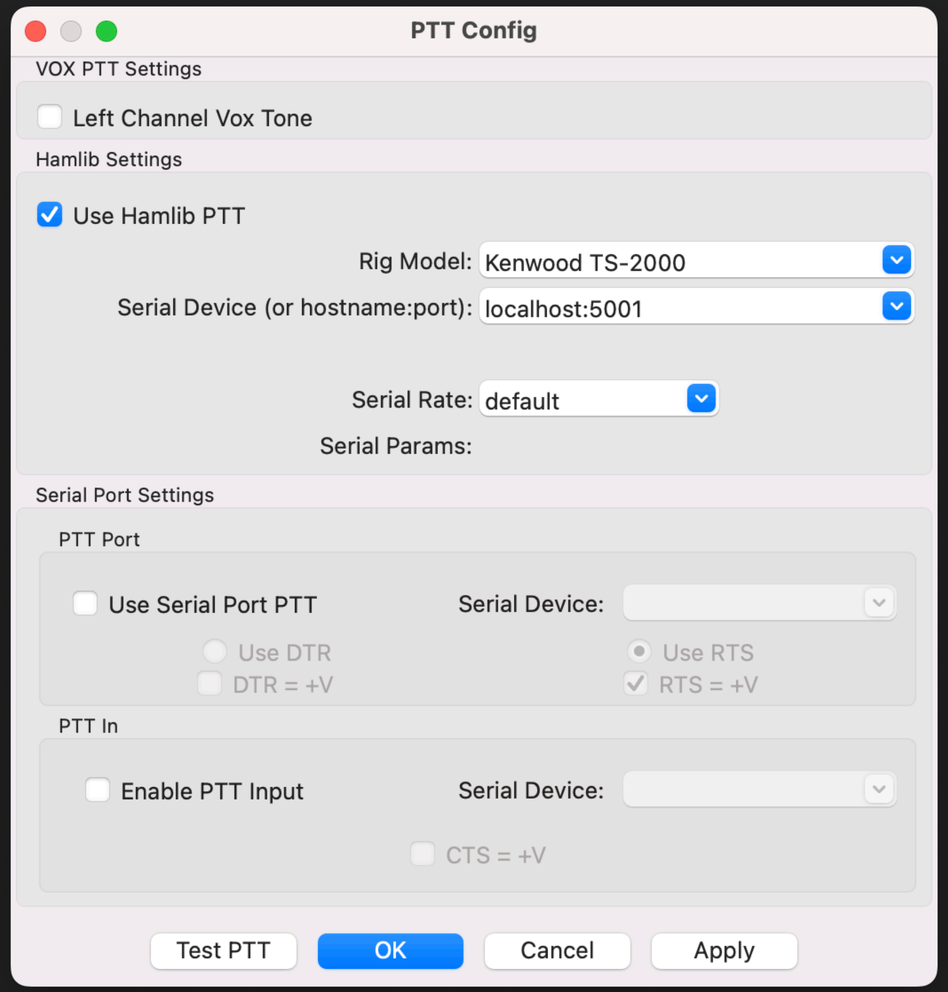




CAT/PTT CONTROL

- Tools->PTT Config
  - Supports all radios that Hamlib does
  - Can also use serial PTT if preferred

EXAMPLE PTT CONFIGURATION



HARDWARE OPTIONS

- SM1000 handheld microphone
  - US$195 as of October 2023
  - Supports 700D/E as well as 1600
- Only need RJ45<->Radio + power
  - Good for portable use
- Now back in stock at https://www.tindie.com/products/edwin/sm1000-freedv-adpapter/

EZDV

- Handheld device based on the ESP32S3 microcontroller
  - Supports the same modes as the SM1000
  - Can use Icom IC-705 and Flex radios over Wi-Fi (CAT and audio)
- Full day of operation using a 20000 mAh battery
  - Charging via USB-C

EZDV

- 3.5mm TRRS jacks on bottom
  - Wired headset as well as PTT/audio for radios without Wi-Fi support
- Source code and HW schematics available, TAPR to sell in 2024
  - https://github.com/tmiw/ezDV

HOW TO FIND CONTACTS

- FreeDV Reporter: https://qso.freedv.org/
  - Live TX/RX status of stations using the FreeDV application
  - Chatroom style interface to allow of live coordination with other users

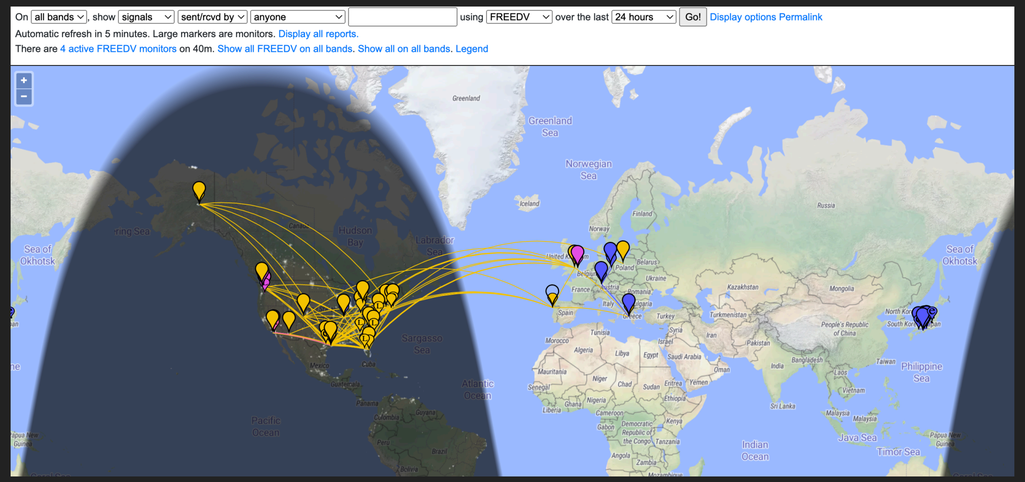
FreeDV Reporter

Active Stations | Chat (6) | Calling Frequencies

Callsign	Locator	Version	Frequency	Status	Transmit Mode	Last TX	Last RX Callsign	Last RX Mode	SNR	Last Update
VK2ZIW	QF56HG	FreeDV 1.9.1	14.2360 MHz	Receiving	700D	--	--	--	--	10/7/2023 11:34:18 PM
N4YKU	EM79	FreeDV 1.9.2	14.2360 MHz	Receiving	700D	--	--	--	--	10/10/2023 6:29:24 PM
JA3JHG	PM85AC	FreeDV 1.9.1	10.1470 MHz	Receiving	700E	10/10/2023 11:26:58 PM	--	--	--	10/11/2023 12:07:22 AM

HOW TO FIND CONTACTS

- PSK Reporter
  - Map based view of who can decode your signal
  - Good for determining propagation



HOW TO FIND CONTACTS

- FreeDV Activity Day
  - Third weekend of every month (both Saturday and Sunday)
  - 12AM Pacific (0800Z) - 11:59PM Pacific (0759Z)
  - Not a contest! Just a time for people to get together on the air

DISCORD

- A chat service that enables troubleshooting and QSO coordination
- Go to https://discord.gg/QrZDwy5n7K to join (or scan QR code)

DISCORD

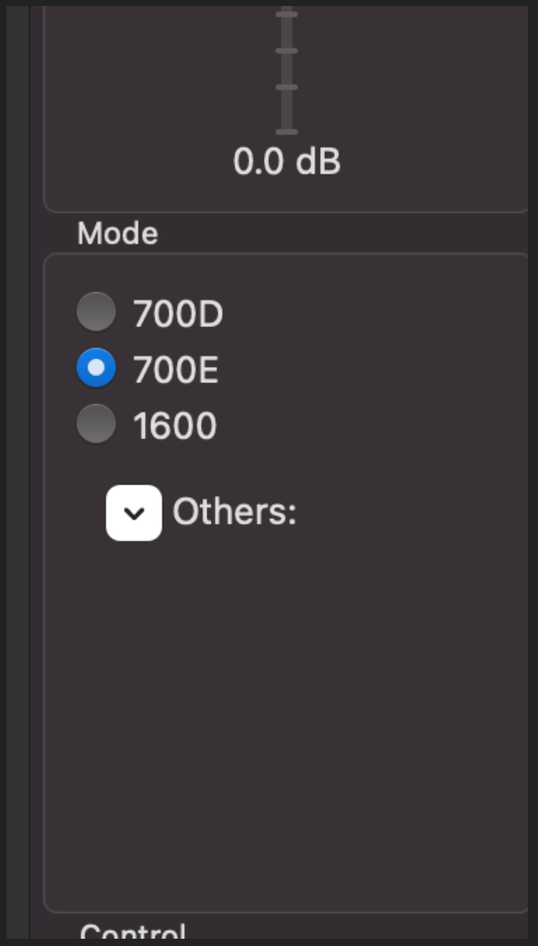

FreeDV HF Digital Voice
qso-finder
Find people on the air to chat with here! 14.236 MHz is also...
Events
announcements
rules
TEXT CHANNELS
general
qso-finder
moderator-only
VOICE CHANNELS
General
OTHER NETWORKS
freedv-irc
PSK Reporter BOT Yesterday at 7:10 PM
JA4ECX (PM64VU11TQ) received JA3JHG (PM85AC) on 7200.000 KHz on 2023-01-17 03:06:07
PSK Reporter BOT Yesterday at 11:30 PM
JA4ECX (PM64VU11TQ) received JA3JHG (PM85AC) on 7200.000 KHz on 2023-01-17 07:25:37
PSK Reporter BOT Yesterday at 11:50 PM
JA4ECX (PM64VU11TQ) received JA3JHG (PM85AC) on 7200.000 KHz on 2023-01-17 07:46:15
January 17, 2023
PSK Reporter BOT Today at 3:10 PM
K0PFX (EM48US) received K5WH (EL29fx) on 14236.000 KHz on 2023-01-17 23:07:08
WA6NUT (DM68wt39) received K5WH (EL29fx) on 14236.000 KHz on 2023-01-17 23:05:04
K0SHD (EN14kv08) received K5WH (EL29fx) on 14236.000 KHz on 2023-01-17 23:05:00

WHAT MODE TO USE?

- Different modes available depending on current conditions
  - Most commonly used: 700D/E, 1600, 2020
- 700D: smallest bandwidth, lowest minimum SNR (-2 dB)
- 700E: fast fading (e.g. NVIS), a bit more SNR required vs. 700D
- 1600: mainly used for satellite contacts
- 2020: highest quality mode available, not as resilient as other modes

WHAT MODE TO USE?

- FreeDV will automatically detect and receive the correct mode
  - Detected mode is displayed in the left hand side of the main window
- Select the TX mode on the right hand side of the main window
  - Can change TX modes even while transmitting



WORK IN PROGRESS

- “Universal” FreeDV mode
  - One mode that can work for all HF band conditions
  - Simpler usage – no need to select modes to receive or transmit
  - Integrates lessons from experiences using the existing modes
- Have DSP and codec experience? Come work for us! (Thanks again ARDC!)

WORK IN PROGRESS

- Integration with additional radios
  - External devices currently allow integration with Flex and Icom radios over Wi-Fi
  - Full integration improves ease of use—no need to configure anything or keep track of additional hardware
- Radio manufacturer or have connections to one? Reach out after the talk :)

THANK YOU!

- Contact me anytime with questions
  - Email: mooneer@gmail.com
  - Discord: themindiswatching
  - Personal GitHub: https://github.com/tmiw
- Or visit the FreeDV/M17/HamOpen booth (#64 and #65)

Q&A