

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



Free Shipping!

AOR USA ARD9800

Digital Voice and Image Interface with Hand Mic and Cables

Special Order Item!*

HRO Discount Price: \$789.95*

[Buy It](#)

*After Coupons & Promotions.

[Tweet](#) [Share](#) [Save](#) [Add To Wish List](#)

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

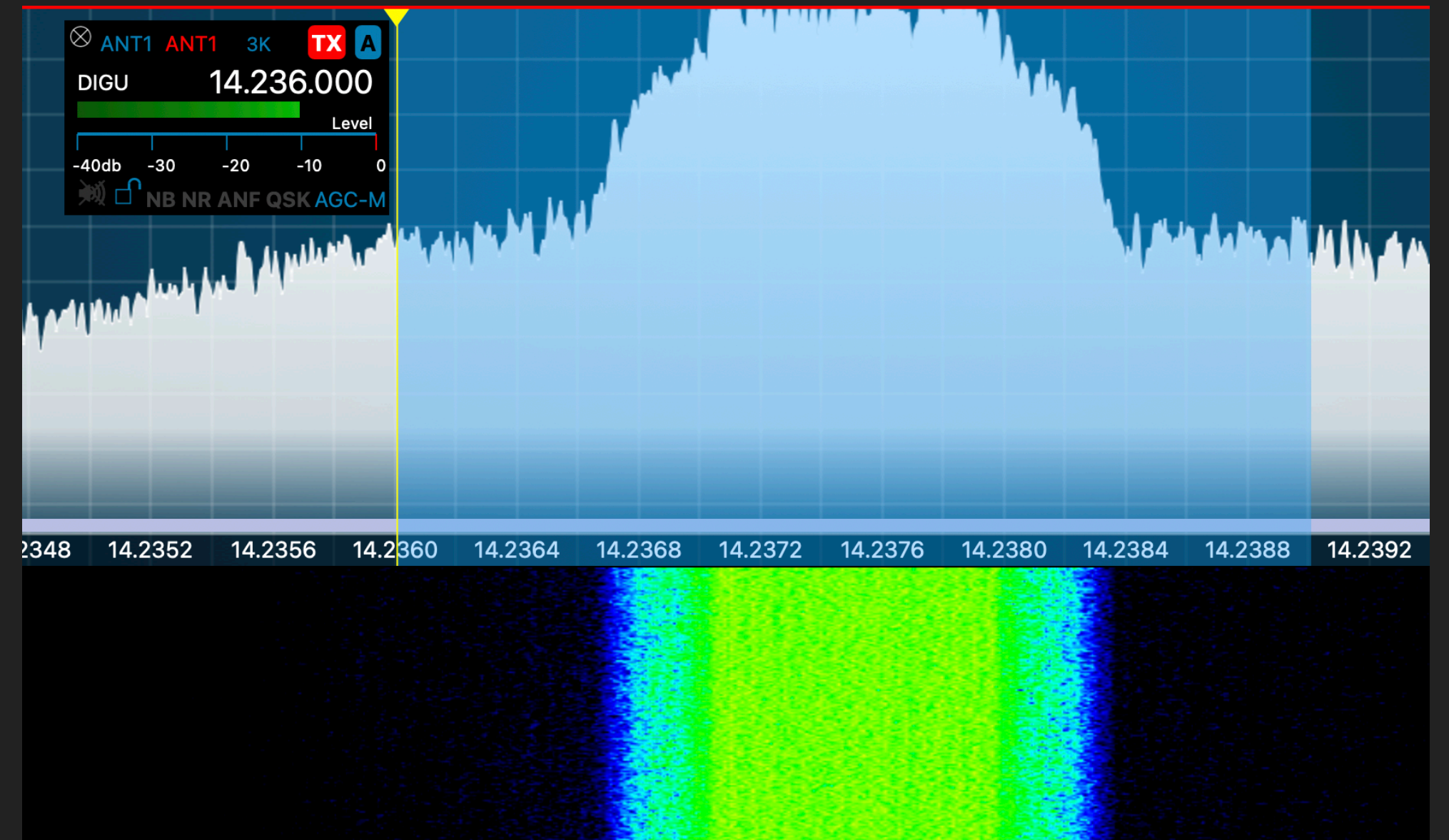
- ▶ QSO between K0PFX and LU5DKI (Jose from Argentina)
 - ▶ SSB contact was immediately adjacent
 - ▶ Fading was present in the signal received by the radio
 - ▶ ~5000 mile path (!)

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?
 - ▶ A SSB radio could be seen as a transverter from audio frequencies to RF
 - ▶ 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 that you use for e.g. FT8, the other for e.g. Zoom meetings/watching videos

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

Easy Setup

Step 1: Select Sound Device

Radio Device: VB-Cable

Decoded audio plays back through: MacBook Pro Speakers

Transmitted audio records through: MacBook Pro Microphone

Advanced

Step 2: Setup Radio Control

No PTT/CAT Control Hamlib CAT Control Serial PTT

Hamlib CAT Control

Rig Model: Hamlib NET rigctl

Serial Device (or hostname:port): localhost:4533

Serial Rate: default

Advanced Test

Step 3: Setup Reporting

Enable Reporting Callsign: K6AQ Grid Square: DM12kw

OK Cancel Apply

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

Audio Config

Input To Computer From Radio

Device	ID	API	Default Sample Rate
Background Music	0	Core Audio	8000
Background Music (UI Sounds)	1	Core Audio	8000
MacBook Pro Microphone	2	Core Audio	48000
Soundflower (2ch)	4	Core Audio	44100
Soundflower (64ch)	5	Core Audio	44100
VB-Cable	6	Core Audio	48000
VB-Cable A	7	Core Audio	48000
VB-Cable B	8	Core Audio	48000
NoMachine Audio Adapter	9	Core Audio	48000
NoMachine Microphone Adapter	10	Core Audio	48000

Device: Sample Rate:

Output From Computer To Speaker/Headphones

Device	ID	API	Default Sample Rate
Background Music	0	Core Audio	8000
Background Music (UI Sounds)	1	Core Audio	8000
MacBook Pro Speakers	3	Core Audio	48000
Soundflower (2ch)	4	Core Audio	44100
Soundflower (64ch)	5	Core Audio	44100
VB-Cable	6	Core Audio	48000
VB-Cable A	7	Core Audio	48000
VB-Cable B	8	Core Audio	48000
NoMachine Audio Adapter	9	Core Audio	48000
NoMachine Microphone Adapter	10	Core Audio	48000

Device: Sample Rate:

Audio Config

Input From Microphone To Computer

Device	ID	API	Default Sample Rate
Background Music	0	Core Audio	8000
Background Music (UI Sounds)	1	Core Audio	8000
MacBook Pro Microphone	2	Core Audio	48000
Soundflower (2ch)	4	Core Audio	44100
Soundflower (64ch)	5	Core Audio	44100
VB-Cable	6	Core Audio	48000
VB-Cable A	7	Core Audio	48000
VB-Cable B	8	Core Audio	48000
NoMachine Audio Adapter	9	Core Audio	48000
NoMachine Microphone Adapter	10	Core Audio	48000

Device: Sample Rate:

Output From Computer To Radio

Device	ID	API	Default Sample Rate
Background Music	0	Core Audio	8000
Background Music (UI Sounds)	1	Core Audio	8000
MacBook Pro Speakers	3	Core Audio	48000
Soundflower (2ch)	4	Core Audio	44100
Soundflower (64ch)	5	Core Audio	44100
VB-Cable	6	Core Audio	48000
VB-Cable A	7	Core Audio	48000
VB-Cable B	8	Core Audio	48000
NoMachine Audio Adapter	9	Core Audio	48000
NoMachine Microphone Adapter	10	Core Audio	48000

Device: Sample Rate:

CAT/PTT CONTROL

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

EXAMPLE PTT CONFIGURATION

PTT Config

VOX PTT Settings

Left Channel Vox Tone

Hamlib Settings

Use Hamlib PTT

Rig Model:

Serial Device (or hostname:port):

Serial Rate:

Serial Params:

Serial Port Settings

PTT Port

Use Serial Port PTT Serial Device:

Use DTR Use RTS

DTR = +V RTS = +V

PTT In

Enable PTT Input Serial Device:

CTS = +V

Test PTT **OK** Cancel Apply

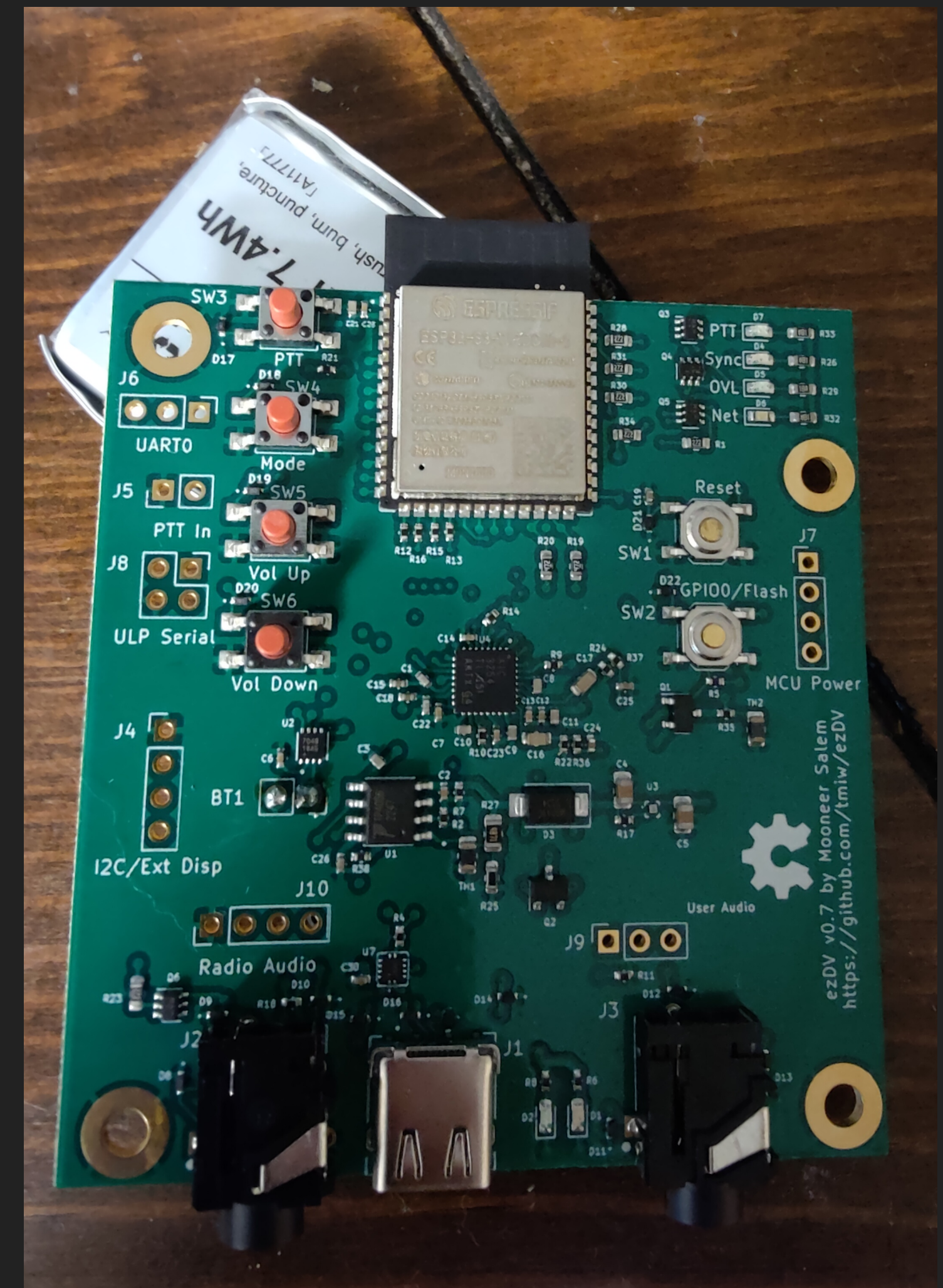
HARDWARE OPTIONS

- ▶ 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/>



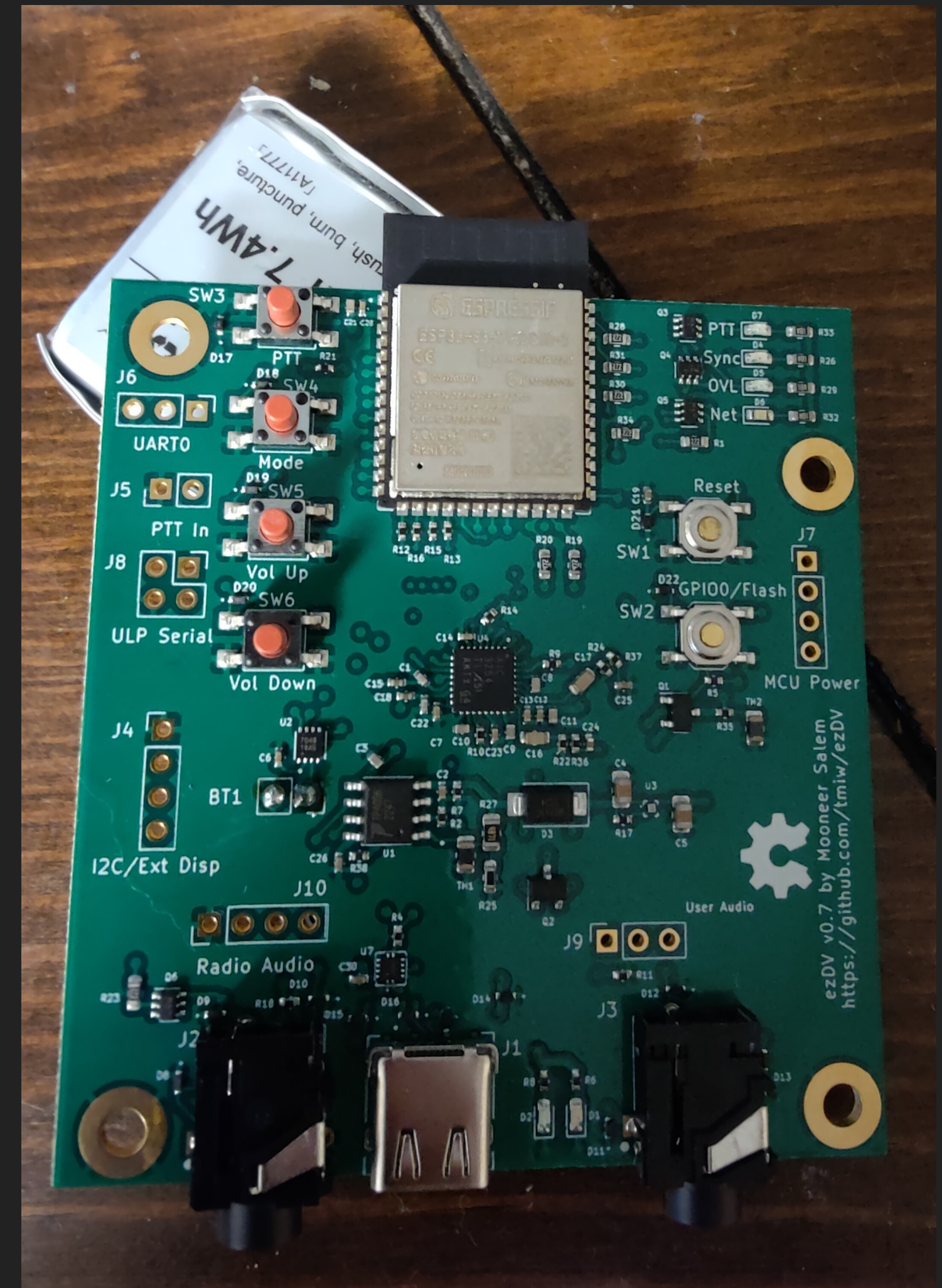
EZDV

- ▶ 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

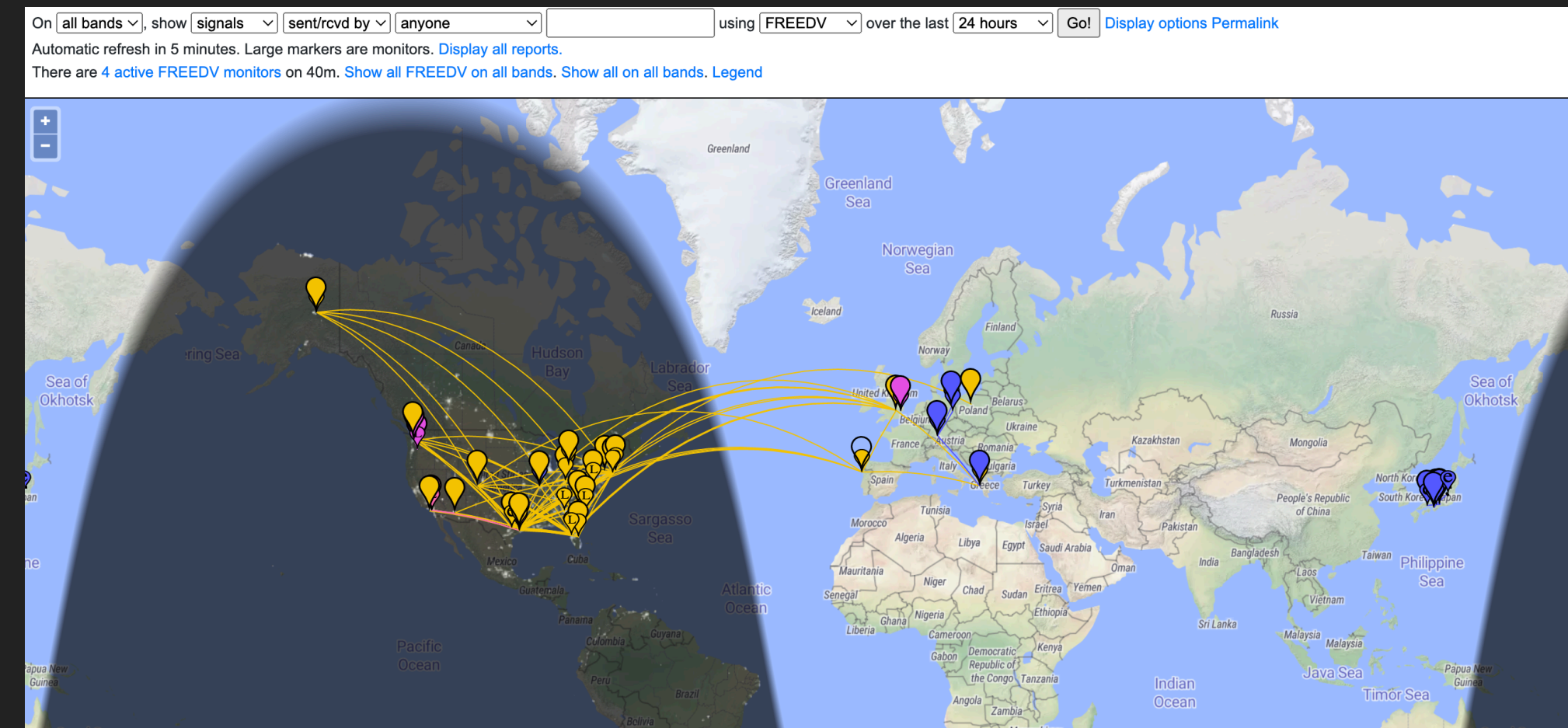
- ▶ FreeDV Reporter: <https://qso.freedv.org/>
 - ▶ Live TX/RX status of stations using the FreeDV application
 - ▶ Chatroom style interface to allow of live coordination with other users

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 (0700Z) on 3/16 - 11:59PM Pacific (0659Z) on 3/17
 - ▶ 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... # 🔇 📌 👤 Se

📅 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

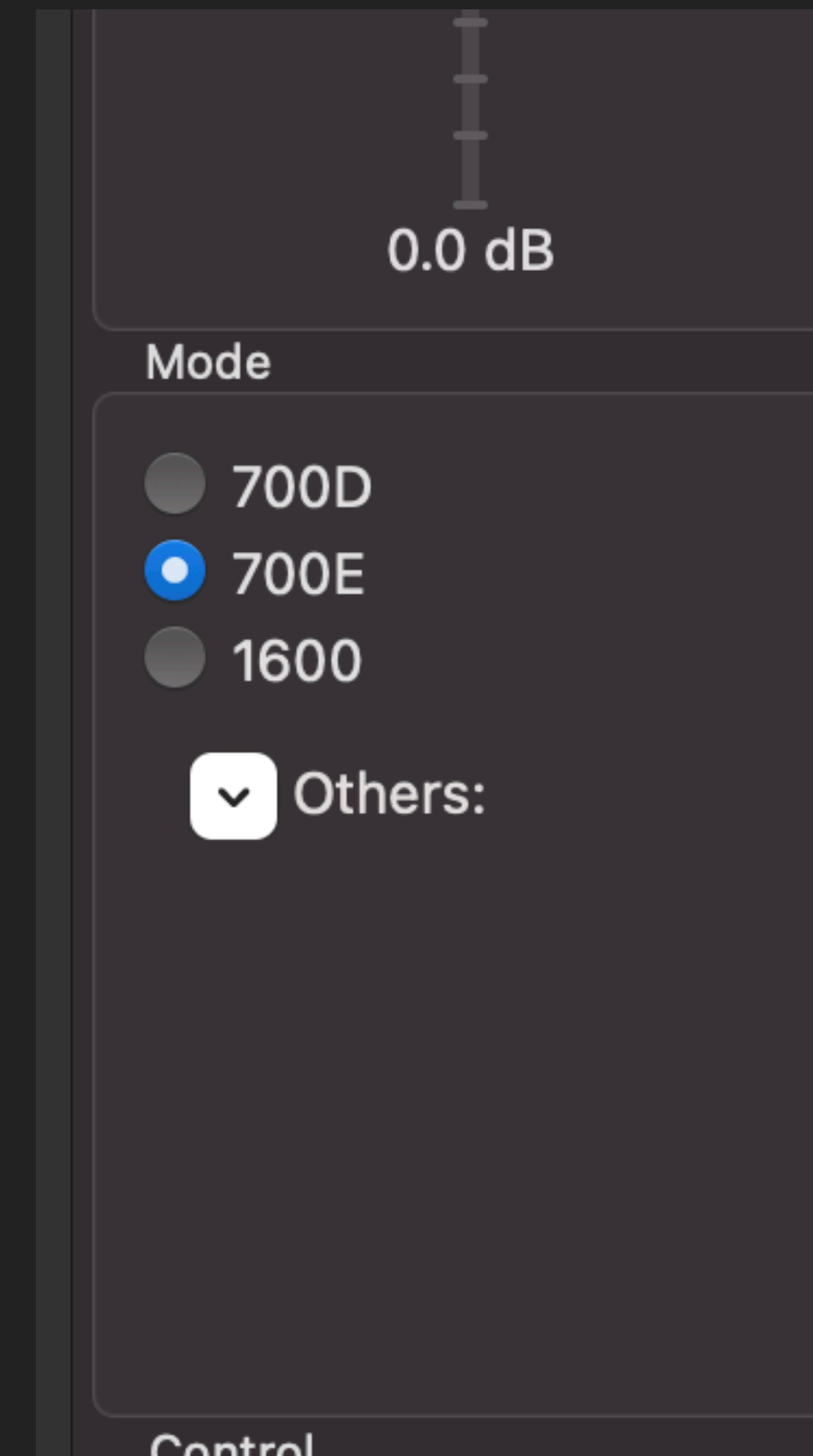
PSK Reporter BOT Today at 3:10 PM
KOPFX (EM48US) received K5WH (EL29fx) on 14236.000 KHz on 2023-01-17 23:07:08
WA6NUT (DM68wt39) received K5WH (EL29fx) on 14236.000 KHz on 2023-01-17 23:05:04
KOSHD (EN14kv08) received K5WH (EL29fx) on 14236.000 KHz on 2023-01-17 23:05:00

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>

Q&A