

Lab599 Discovery TX-500

Digital Modes & FT8 Operation on macOS Tahoe

A Comprehensive Engineering Manual: Hardware Cabling, Audio Calibration, WSJT-X,
Native FT8/FT4 with Lab599 Utility, Firmware, and Thermal Management

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Lab599 Utility Version: v2.243 (Build 249)
Radio Firmware: TX-500 Firmware v1.30.00 (v1.30.0)

Abstract

This definitive engineering manual delivers an exhaustive, step-by-step operational blueprint for deploying the **Lab599 Discovery TX-500 QRP HF/6m SDR Transceiver** under **macOS Tahoe 26.7** using **WSJT-X v3.2.0 260818 improved PLUS** for FT8 and modern digital communications, with a native macOS operating path through **Lab599 Utility v2.243 (Build 249)**. Fully integrating the vendor's official *Lab599-TX500-DIG-mode-setup-EN* protocol, this guide incorporates the community-developed **Lab599 Utility for macOS** to overcome native platform limitations—providing reliable firmware flashing, automated FTDI D2XX driver and Gatekeeper quarantine resolution, sub-second real-time clock (RTC) synchronization, and battery power safety verification. Updating to **Firmware v1.30.00** is established as a mandatory prerequisite to eliminate legacy CAT and audio bugs. Key operational configurations include the author's field-verified cabling (**AD-508 USB-C Audio Cable** and **stock blue USB CAT adapter**), Kenwood TS-480 emulation, front-panel **MODE** cycling to DIG, precise audio level calibration (**100% output** to resolve the 0-Watt transmit bug, and $\leq 24\%$ **input** to prevent 85 dB ADC clipping), RF feedback mitigation, and passive/active thermal cooling strategies. The new edition introduces the utility's built-in FT8/FT4 digital studio, illustrated with receive, transmit, waterfall, contact-log, and PSK Reporter screenshots. The project continues to evolve at <https://github.com/fact0real/Lab599-Utility>.

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Revision History & Acknowledgments

Version	Date	Summary of Technical Updates
1.1	September 25, 2026	Documents macOS Tahoe 26.7 and Lab599 Utility v2.243 (Build 249). Introduces the native FT8/FT4 studio alongside the WSJT-X workflow, with waterfall, receive/transmit, contact logging, and optional PSK Reporter screenshots. Expands the app overview, links the project and invites community feedback. Adds the current dark-mode image and I Love FT8 closing mark; compacts the contents and vertically centers all table cells.
1.0	September 19, 2026	Comprehensive initial release. Fully integrates official Lab599 Digital Mode setup procedures (<i>Lab599-TX500-DIG-mode-setup-EN</i>) and introduces the native Lab599 Utility for macOS . Establishes the mandatory requirement of Firmware v1.30.00 to eliminate legacy CAT and audio bugs. Documents verified AD-508 USB-C audio and stock blue CAT adapter setup, Kenwood TS-480 WSJT-X configuration, repeated MODE button cycling to DIG, calibrated 100% output / $\leq$ 24% input gain rules, and thermal solutions. Incorporates expert peer-review refinements: full photographic cable matching, authentic macOS WSJT-X configuration panels, T1 font encoding and symbol fixes, decibel mathematical reconciliation, and restructuring of the unboxing narrative into a Foreword.

Acknowledgments & Community Contributions

Sincere appreciation is expressed to:

- **BladRunner** — author of the pioneer *TX500MacOS* guide shared in the **Lab599 Telegram Community (@lab599)**, whose early insights into Apple Silicon serial device nodes inspired ongoing macOS developments.
- **Lab599 Engineering Team** — for engineering one of the most rugged, high-performance portable SDR transceivers in amateur radio history and releasing the comprehensive *Lab599-TX500-DIG-mode-setup-EN* guide.
- **Uwe Risse (DG2YCB)**, **Joe Taylor (K1JT)**, and the WSJT development team for their relentless work on the WSJT-X improved PLUS suite.
- The groups.io/g/Lab599 and [WSJT-X Groups.io](https://groups.io/g/WSJT-X) communities for rigorous testing on CAT timing, Kenwood command emulation, and audio routing.

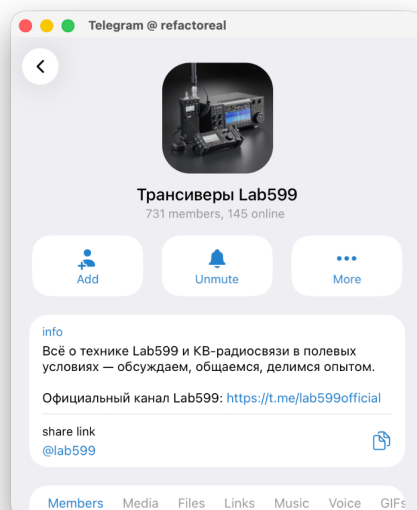


Figure 1: *The official Lab599 Telegram Community (@lab599), where BladRunner and other international operators share field notes, firmware updates, and digital mode configurations.*

Foreword: A Personal Journey

“After 7 long weeks of waiting, my TX-500 Discovery radio finally arrived today! Honestly, the delay took so long that I couldn’t even feel as excited as I expected to be when opening it. To top it off, the store canceled 4 items from my order after I placed it because they ran out of stock!

Maybe buying from Russia and shipping to Iran wasn’t the brightest idea after all! But in a world where the shadow of war looms everywhere, there really wasn’t much of a choice.”

— factoreal (EP2AES)

Logistics and geopolitical hurdles notwithstanding, once unboxed, the Discovery TX-500 stands out as an exceptional masterpiece in portable radio engineering. Its monolithic aluminum chassis, responsive filtering, and expedition-grade weather sealing represent an unparalleled standard for field-portable amateur radio operations.

However, bringing this sophisticated hardware into flawless harmony with Apple’s modern operating system (macOS Tahoe 26.7) reveals a distinct operational landscape: vendor software distribution is historically concentrated on Windows and Linux, FTDI driver architectures require explicit macOS security authorizations, and digital mode transfers demand exact soundcard gain staging.

This manual serves as the definitive engineering blueprint assembled to spare fellow Mac operators the frustration of undocumented firmware quirks, soundcard clipping, and OS-level communication traps. Every configuration parameter, cabling decision, and calibration step documented herein has been rigorously tested and field-verified.

1 Introduction: The Lab599 Discovery TX-500

1.1 Radio Overview & Architectural Reality

The **Lab599 Discovery TX-500** is an ultra-compact, all-mode QRP software-defined radio (SDR) transceiver engineered specifically for expeditionary, SOTA/POTA, and high-reliability field deployments.

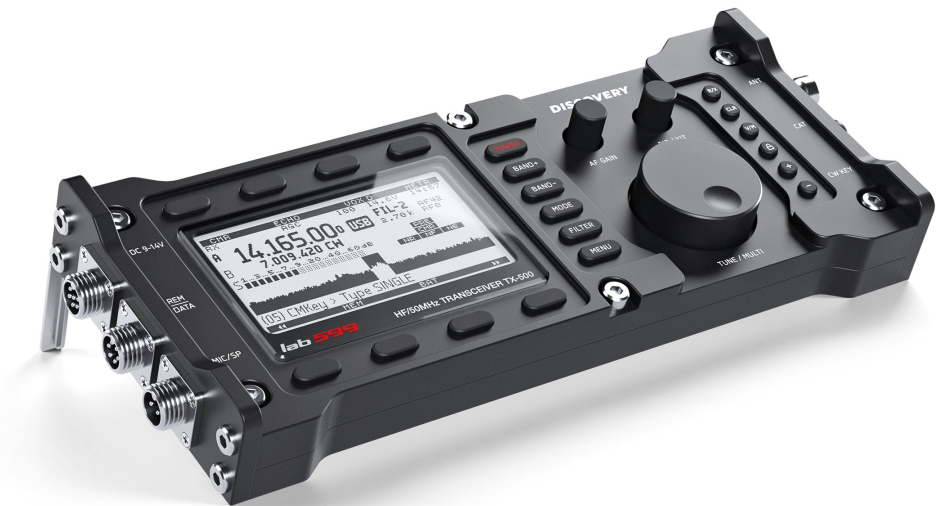


Figure 2: The Lab599 Discovery TX-500 QRP SDR Transceiver: solid CNC-machined aluminum monoblock body, integrated 48 kHz panadapter LCD, waterproof GX12 locking connectors, and fold-out kickstands.

The radio's enclosure is carved from a solid monoblock of aircraft-grade aluminum, providing rugged impact resistance, IP65-grade moisture protection, and serving as the primary passive heatsink for the transmitter. Featuring a 32-bit floating-point DSP architecture, a high-contrast 256 × 128 transfective monochrome LCD with a real-time 48 kHz spectrum/waterfall display, and waterproof GX12 aviation-style screw-lock connectors, the TX-500 eliminates the fragility of consumer-grade transceivers.

1.2 Technical Specifications

Parameter	Specification
Frequency Range (TX)	160 m through 6 m (all amateur allocations)
Frequency Range (RX)	0.500 MHz – 56.000 MHz (continuous general coverage)
RF Output Power	1.0 W to 10.0 W (continuously adjustable in 0.1 W steps)
Operating Modes	SSB (USB/LSB), CW, DIG, AM, NFM
Supply Voltage	9.0 V to 15.0 V DC external (13.8 V nominal)
Dimensions & Weight	228 × 90 × 30 mm, approximately 550 g
Panadapter / Display	48 kHz real-time spectrum/waterfall on 256 × 128 transfective LCD
DSP Architecture	32-bit floating-point DSP engine
Chassis Construction	Fully sealed CNC-machined anodized aluminum monoblock
Physical Connectors	GX12 aviation-type threaded locking connectors
CAT Control Emulation	Kenwood CAT (Menu 34: TS2000; WSJT-X: TS-480)

2 Firmware Requirement: Mandatory Update to v1.30.00

2.1 Why Updating to Firmware v1.30.00 Is Critical

Before attempting any digital mode operation on macOS, it is **mandatory** to ensure that the TX-500 is running the latest official firmware release: **TX-500 Firmware v1.30.00 (v1.30.0)** (`mtrx1.30.00.fw`).

Operating on earlier firmware revisions (v1.1x / v1.2x) introduces severe, well-documented bugs that cripple FT8 and WSJT-X operation:

1. Catastrophic Mode Reset Bug (DIG → USB):

In firmware versions prior to v1.30.00, receiving certain CAT status poll commands from WSJT-X causes the radio to involuntarily jump from digital mode (DIG) into voice SSB (USB) mode. When this occurs, transmit audio routing to the rear data connector is instantly cut, causing the transmitter to key with **0 Watts RF output power**.

2. Phantom Frequency Shifts:

Earlier firmware builds exhibited an internal VFO rounding defect when processing Hamlib high-rate frequency polling, leading to intermittent 100 Hz frequency offsets that break FT8 decoding.

3. Audio Mute Lockup During Rapid TX/RX Transitions:

During high-duty FT8 cycles (15-second intervals), older DSP code occasionally locked the internal audio codec in an attenuated state upon returning to RX, resulting in a sudden drop in decoded waterfall traces.

4. Digital Gain Scaling Calibration:

Firmware v1.30.00 completely re-engineered the digital line gain staging (**Menu 09: GAIN → DIG**), providing linear, predictable headroom that matches standard USB audio codecs without premature internal clipping.

MANDATORY FIRMWARE REQUIREMENT: v1.30.00

Do NOT attempt to operate FT8 or troubleshoot WSJT-X communication errors on older firmware versions (v1.1x / v1.2x). Firmware **v1.30.00** resolves core serial race conditions, enables stable Kenwood command processing, and ensures that the radio remains locked in DIG mode throughout automated digital sequencing.

2.2 Verifying Current Firmware on the Radio

To verify the installed firmware version directly on the physical radio:

1. Power on the TX-500.
2. Observe the bottom of the startup splash screen, which briefly displays the micro-controller firmware revision.
3. Alternatively, long-press the **MENU** button, scroll to **Menu 01 (ABOUT)**, and confirm that the MCU version reads `v1.30.00` (or `1.30.0`).

3 Lab599 Utility for macOS: Addressing Platform Compatibility

3.1 Addressing macOS Compatibility Limitations & Platform Gaps

Historically, the official firmware update software supplied by Lab599 (*Lab599-TRX-Update*) has been compiled **exclusively for Linux and Windows**. Mac operators were left without an official vendor executable to flash firmware, synchronize real-time clocks, or troubleshoot FTDI driver layers. Many operators were forced to maintain secondary Windows machines or set up cumbersome Linux virtual machines simply to perform occasional firmware updates.

3.2 The Solution: Native Lab599 Utility for macOS

To permanently eliminate this platform gap, the community engineered the **Lab599 Utility for macOS**, a universal native application built specifically for Apple macOS (supporting Apple Silicon M1–M4 and Intel Macs).

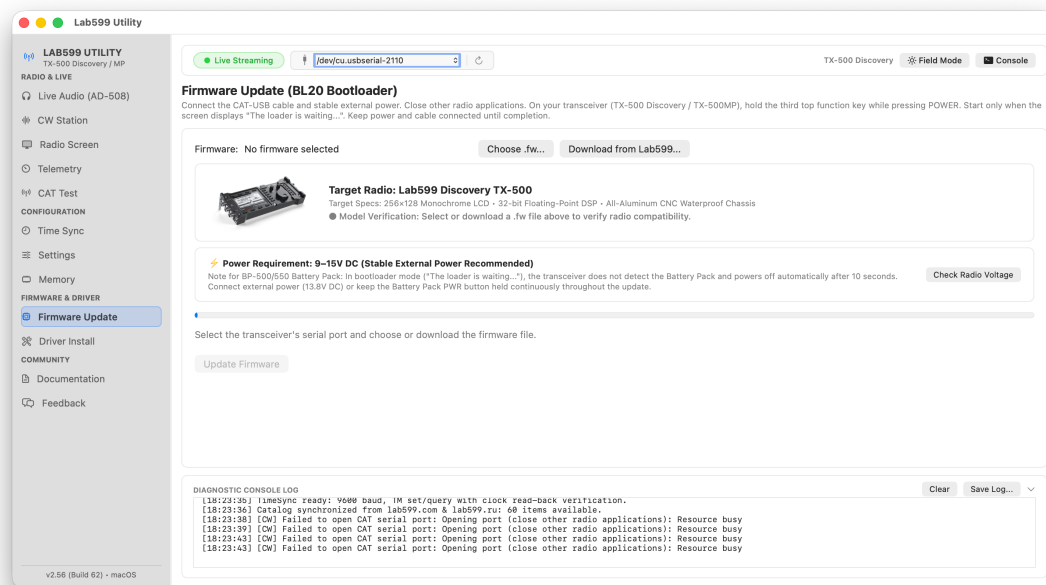


Figure 3: Lab599 Utility for macOS: Native firmware flasher, real-time telemetry, precision RTC time synchronization, FTDI driver manager, and battery power safety monitoring running on macOS Tahoe.

3.3 Core Features & Problems Solved by the Utility

1. Native macOS Firmware Flashing (Zero Windows/Linux Dependency):

The utility features an optimized serial flasher implementing the TX-500 bootloader protocol:

- Operates at **57600 baud, 8N1** over FTDI serial device nodes (`/dev/cu.usbserial-*`).
- Transmits the 16-byte BL20 initialization header, monitors the radio's initial OK acknowledgment, streams the binary firmware payload with local host queue drain pacing, and validates the final OK confirmation.
- Eliminates packet overrun errors and prevents radio bricking during serial transfers.

2. FTDI D2XX Driver Installation & Gatekeeper Authorization:

Apple's built-in CDC serial driver in macOS Sonoma, Sequoia, and Tahoe can occasionally delay port enumeration or lock serial device callouts. The **Driver Install** tab in Lab599 Utility

installs the official `libftd2xx.1.4.35.dylib`, provisions required symlinks in `/usr/local/lib`, and clears macOS Gatekeeper quarantine flags (`xattr -d com.apple.quarantine`).

3. Precision RTC Time Synchronization (TX500TimeSync):

FT8 decoding relies upon strict time synchronization ($\Delta t < 1.0$ s). During portable operations in remote areas devoid of internet connectivity, the Mac can synchronize the TX-500's internal hardware clock to sub-second precision via the utility's **Time Sync** module.

4. Live Telemetry & SWR Monitoring:

The **Telemetry** tab provides real-time interrogation and graphical display of DC supply voltage, transmit current draw, internal chassis temperature, forward RF power, and antenna SWR.

5. Battery Pack (BP-500 / BP-550) Power Safety Verification:

Critical Hardware Observation: When entering bootloader mode (*"The loader is waiting..."*), the TX-500 does not assert keep-alive handshake lines to attached BP-500/550 battery modules, causing the battery's internal circuitry to automatically power off after 10 seconds. The utility performs a voltage safety check and alerts the operator to connect stable external 12.0–13.8 V DC power before flashing.

6. Native FT8/FT4 Operation:

The integrated Digital Mode Studio provides a focused alternative to WSJT-X for receive decoding, waterfall monitoring, CAT-controlled transmission, contact logging, and optional PSK Reporter spots. Its operating path and screenshots are documented in Section 9.

3.4 Beyond Firmware: A Native Station Workspace

The illustrated **Lab599 Utility v2.243 (Build 249)** supports the TX-500 Discovery, TX-500MP, and TX-500PRO families and brings several everyday radio tasks into one macOS app. Firmware selection checks the target model against the update header before transfer. Its **Station** view keeps operator profiles, audio routes, saved frequencies, and connection checks together; the radio tools share a controlled CAT connection so that changing views does not leave an app-owned transmit session running.

- **See and diagnose the radio:** live telemetry displays supply voltage, current draw, RF power, SWR, PA temperature, frequency, and TX/RX state. Radio Screen mirrors the TX-500 LCD, while CAT Studio provides command-level diagnostics and verified frequency control.
- **Protect settings and memories:** save and restore the radio's settings block, manage 100 memory channels, use operating profiles, and import or export channel data as CSV.
- **Operate in more modes:** FT8/FT4 digital operation sits alongside the CW station, a voice keyer, live audio tools, DX Cluster, and the contact logbook. The digital studio is described in Section 9.
- **Work in the field:** Time Sync maintains an app-local UTC reference for digital slots and can set the radio clock; documentation and firmware downloads are available in the app.
- **Send feedback:** the Feedback view prepares a structured GitHub issue for corrections, bugs, and feature requests.

3.5 How to Update Firmware Using Lab599 Utility

Step 1. Connect stable external 12.0–13.8 V DC power to the TX-500 (do not rely on internal battery packs alone).

Step 2. Connect the CAT cable (stock blue USB adapter) from the TX-500 CAT port to your Mac.

Step 3. Enter Bootloader Mode: With the transceiver powered off, **press and hold the 3rd top function key** from the left while pressing the **POWER** button. Release both buttons when the LCD screen indicates:

The loader is waiting...

- Step 4.** Launch **Lab599 Utility.app** on macOS.
- Step 5.** Select the serial port (`/dev/cu.usbserial-XXXX`) from the port dropdown.
- Step 6.** Click **Choose .fw...** and select `mtrx1.30.00.fw` (or click *Download from Lab599...*).
- Step 7.** Click **Update Firmware** and confirm. The transfer executes reliably in approximately 45 seconds.
- Step 8.** Upon completion, the log confirms *"The radio acknowledged the complete firmware. Transfer successful."* Power-cycle the transceiver to boot into updated firmware v1.30.00.

4 Hardware Cabling & Physical Connections

4.1 Author's Field-Verified Real-World Setup (EP2AES)

For the author's primary operating station running macOS Tahoe on an Apple Silicon MacBook, the installation uses the following verified cabling configuration:

- **Digital Audio Link (REM/DATA Port, GX12 7-Pin):**
Official **AD-508 USB-C Audio-Data Cable** connected directly to the MacBook's native **USB-C** port. This incorporates an integrated hardware USB DAC/ADC audio codec inside the cable assembly, completely eliminating external soundcards, audio ground loops, and 3.5 mm analog patch leads.
- **Serial CAT Control Link (CAT Port, GX12 4-Pin):**
The **original stock blue-colored USB CAT adapter** included inside the TX-500 box (standard USB-A CAT serial cable with internal FTDI bridge and GX12 4-pin connector), connected to the Mac (directly or via an Apple USB-A to USB-C adapter).



(a) AD-508: USB-C digital audio codec cable

(b) Stock blue CAT adapter: GX12 4-pin to USB-A

Figure 4: Author's verified hardware cabling: High-resolution matched photographic overview of the AD-508 USB-C Audio Cable (left) and the stock blue USB CAT serial adapter (right).

4.2 Overview of Lab599 Cable Ecosystem

Cable Model	Radio Port	Computer Interface	Key Role / Operational Notes
AD-508	REM/DATA (7-pin)	USB-C (Digital)	Author's Top Recommendation. Direct USB-C audio codec; no external soundcard needed.
Stock Blue CAT	CAT (4-pin)	USB-A (Serial UART)	Supplied in radio box. FTDI chip; handles frequency tracking, VFO split, and CAT PTT.
AD-502	CAT (4-pin)	USB-A (Serial UART)	Black variant of the stock CAT cable; identical FTDI internal architecture.
AD-514	CAT (4-pin)	USB-C (Serial UART)	Direct USB-C CAT cable; eliminates the need for USB-A adapters.
AD-509	REM/DATA (7-pin)	USB-A (Digital)	Audio cable with inline C-Media USB soundcard module.
AD-506	REM/DATA (7-pin)	Dual 3.5 mm TRS (Analog)	Analog breakout for Speaker/Mic; requires an external USB soundcard on macOS.

5 Radio Menu Setup & Digital Configuration

5.1 Menu Setup Steps

Ensure the following configuration parameters are set in the TX-500 internal menu:

1. Press and hold the **MENU** button on the front panel to open the configuration menu.
2. Rotate the main tuning knob to navigate to each target menu item:
 - **Menu 34 (CAT PROTOCOL):** Set to TS2000.
(Kenwood TS-2000 command structure emulation; optimal for hamlib).
 - **Menu 35 (CAT SPEED):** Set to 9600.
(Standard 9600 baud rate; provides excellent polling reliability).
 - **Menu 22 (TX METR):** Set to MIC.
(Prepares the bar graph meter for transmit audio drive calibration).
 - **Menu 09 (GAIN → DIG):** Set to initial default 20.
(Digital input audio gain; calibrated during Section 8).
 - **Menu 11 (IF SHIFT):** Set to 0.
(Ensures center alignment of intermediate frequency filter).
 - **Menu 12 (RF GAIN):** Set to 100%.
(Ensures maximum receiver front-end sensitivity).
3. Press the **BACK** or **MENU** button to save settings and exit.

5.2 Switching to DIG Mode: Repeatedly Press the MODE Button

A common source of confusion among new TX-500 operators is locating the digital operating mode:

Step 1. The front panel features a dedicated push-button labeled **MODE**.

Step 2. Repeatedly press the **MODE** button to cycle through the operating modes in sequence:

LSB → USB → CW → DIG → AM → NFM

Step 3. Stop when the LCD top status bar clearly indicates DIG.

Step 4. In DIG mode, the TX-500 automatically mutes the front microphone jack, disables speech compression, and routes transmission modulation directly to the REM/DATA line input.

Verifying DIG Mode Indicator on LCD

Verify that the small font readout at the top left of the frequency display reads DIG. If it reads USB, the radio is in voice mode; the digital line-in will be completely disabled, resulting in 0 Watts RF output.

6 macOS Audio Calibration: The Two Golden Rules

6.1 Rule 1: Output Volume MUST Be 100% (1.0 / 0.0 dB)

CRITICAL WARNING: The 0-Watt Transmit Power Bug

The Symptom: WSJT-X triggers CAT PTT, the radio's red TX LED illuminates, the relays click, but the inline wattmeter shows **0.0 Watts RF power output**.

The Root Cause: Transceiver modulation in DIG mode requires a strong, unattenuated audio line-level signal (> 300 mV RMS). If macOS output volume is at its default setting (typically 50%), the drive voltage is insufficient to excite the balanced modulator, producing zero output power.

The Verified Rule: In macOS **Audio MIDI Setup**, select the output device corresponding to your cable (e.g., USB Audio 1) and set the **Output volume to exactly 100% (slider: 1.0 / 0.0 dB)**, as shown in Figure 5a.

6.2 Rule 2: Input Volume MUST Be Set to $\leq 24\%$ (Slider: 0.241 / Hardware Gain: 15.72 dB)

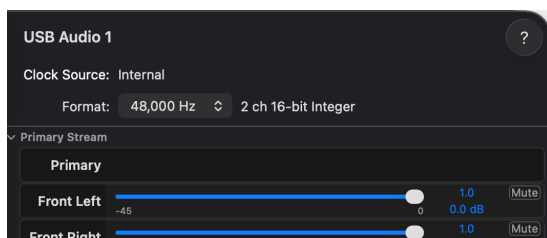
CRITICAL CALIBRATION: Eliminating Audio Clipping (85 dB Red Bar)

The Symptom: Upon connecting the audio cable, the vertical signal meter on the left edge of WSJT-X pegs at **85 dB** and turns **solid red**.

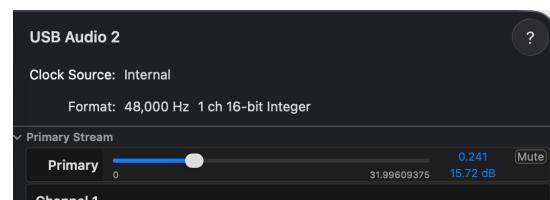
The Root Cause: An 85 dB red bar indicates severe soundcard ADC saturation (*Audio Clipping*). Overloaded input stages prevent the WSJT-X DSP decoder from distinguishing candidate tones, **completely inhibiting FT8 signal decoding**.

The Verified Rule: In macOS **Audio MIDI Setup**, select your input device and pull the **Input volume** slider down to $\leq 24\%$ (slider value 0.241, as shown in Figure 5b). This immediately drops the RX noise floor into the ideal **30–50 dB solid green decoding zone**.

Technical Decibel Reconciliation: In macOS Audio MIDI Setup, dragging the input slider to 24% sets the normalized position to 0.241. The macOS interface displays 15.72 dB because the AD-508/AD-509 USB audio codec reports an internal hardware preamplifier range of 0.0 dB to +32.0 dB ($0.241 \times 32 \text{ dB} \approx 15.72 \text{ dB}$ of hardware preamp gain relative to its floor). Mathematically, relative to full scale (1.0), 0.241 represents -12.36 dBFS of digital attenuation ($20 \log_{10}(0.241)$). Both values represent the exact same calibrated operating point: keeping the slider at $\leq 24\%$ (≤ 0.241) prevents hardware preamplifier overload and guarantees clean signal linearity.



(a) Output volume at 100% (1.0 / 0.0 dB): full RF drive

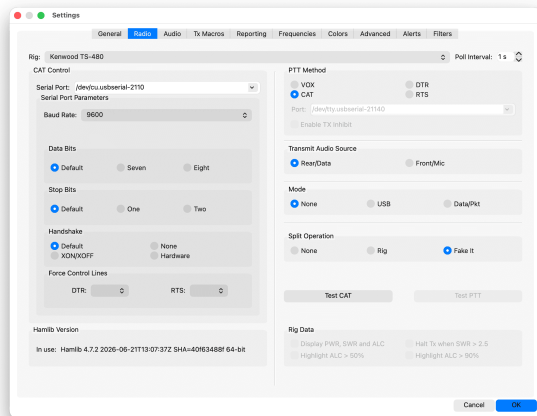


(b) Input volume at $\leq 24\%$ (0.241 / 15.72 dB): no clipping

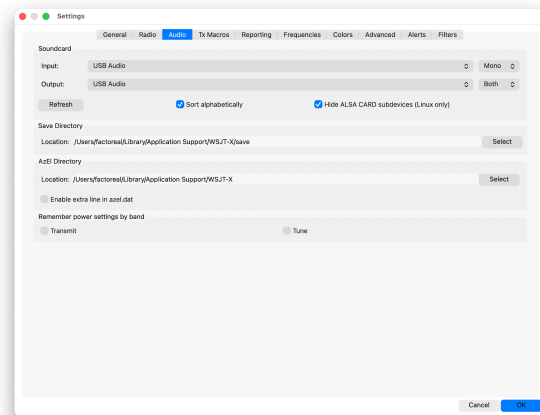
Figure 5: Audio MIDI Setup calibration on macOS Tahoe: Cropped, high-contrast overview showing 100% Output (left) to ensure full RF drive, and $\leq 24\%$ Input (right) to maintain unclipped 30–50 dB green decoding.

7 WSJT-X Software Configuration

Verified against **WSJT-X v3.2.0 260818 improved PLUS** running natively on macOS Tahoe 26.7.



(a) Settings → Radio tab: TS-480, 9600 baud, None mode



(b) Settings → Audio tab: USB Audio Device routing

Figure 6: Verified WSJT-X configuration panels on macOS Tahoe: Exact visual reference for Radio settings (left) and Audio routing (right) configured specifically for the Lab599 Discovery TX-500.

7.1 Settings → General

- **My Call:** Enter your callsign (e.g., EP2AES).
- **My Grid:** Enter your Maidenhead grid square (e.g., LM55).
- **Uncheck:** “Allow Tx frequency changes while transmitting”.

7.2 Settings → Radio (Most Critical Settings)

Field	Value and Technical Rationale
Rig	Kenwood TS-480 — MANDATORY selection in WSJT-X . While Menu 34 on the radio is set to TS2000, selecting Kenwood TS-480 in WSJT-X provides the most reliable polling stability, frequency tracking, and CAT PTT response without erratic communication errors.
Serial Port	/dev/cu.usbserial-XXXX (as identified via Terminal or Lab599 Utility).
Baud Rate	9600 (matches Menu 35).
Data Bits / Stop Bits	Default (8 Bits) / Default (try 2 Stop Bits if framing errors occur).
Handshake	Default (None).
Transmit Audio Source	Rear/Data (routes transmit modulation to the REM/DATA port).
Mode	None — MANDATORY: Prevents WSJT-X from overwriting DIG mode .
Split Operation	Fake It (shifts VFO on TX to ensure optimal audio passband).
PTT Method	CAT (clean, reliable serial PTT assertion).

Why Mode Must Be Set to 'None' in WSJT-X

If WSJT-X Mode is configured as Data/Pkt or USB, WSJT-X sends an automated Kenwood mode command at every transmit cycle. Transceiver firmware can interpret this command as an instruction to enter SSB voice mode, dropping transmit power to zero. By selecting **Mode: None**, WSJT-X omits mode commands, allowing the radio to stay permanently locked in DIG mode as set on the front panel.

7.3 Settings → Audio

- **Soundcard Input:** Select USB Audio Device (corresponding to the AD-508 / AD-509 cable).
- **Soundcard Output:** Select USB Audio Device (corresponding to the AD-508 / AD-509 cable).
- **Channel Configuration:** Select **Mono** for both Input and Output.

8 Transmit Calibration Protocol (Official Lab599 Method)

Once WSJT-X and the audio volumes are configured, execute the official transmit audio calibration procedure as documented in **Lab599-TX500-DIG-mode-setup-EN**:

Step 1. Connect a matched 50 Ω dummy load or resonant antenna to the BNC ANT connector.

Step 2. Verify that the radio's transmit meter is set to **MIC**:

- Navigate to **Menu 22 (TX METR)** and confirm it reads MIC.

Step 3. Set initial digital gain:

- In **Menu 09 (GAIN $\rightarrow$ DIG)**, set the initial value to 20.

Step 4. In WSJT-X, set the right-side **Pwr** slider to maximum (0 dB) or slightly backed off (-3 dB).

Step 5. Click the **Tune** button in the main WSJT-X window to transmit a continuous test tone.

Step 6. Observe the **MIC** bar graph scale on the TX-500 LCD screen:

- Rotate the radio's multi-function knob to **adjust the DIG value until all cells on the indicator scale are completely filled**.
- **Crucial Note from Official Lab599 Documentation:** "If, during the setup, the DIG level approaches the maximum (50), but the indicator scale is not filled, increase the audio output level on the PC." (This explicitly confirms why macOS output volume must be set to 100% in Audio MIDI Setup!)

Step 7. Click **Tune** again in WSJT-X to terminate transmission.

Step 8. Return the display meter to power indication if desired, and verify true RF power on your inline wattmeter.

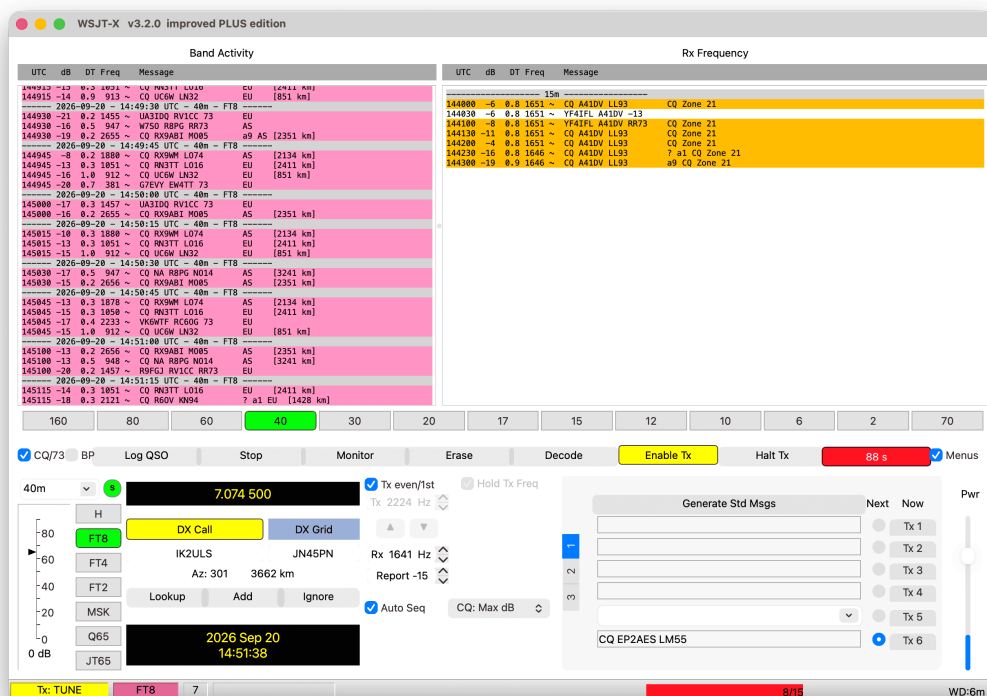


Figure 7: WSJT-X TUNE button engagement on macOS Tahoe: Transmitting a steady audio tone with the Tune button active (red) to calibrate the TX-500 DIG meter, displaying clean 40 dB unclipped receiver levels.

9 Native FT8/FT4 Operation with Lab599 Utility

Lab599 Utility for macOS v2.243 (Build 249), developed by **EP2AES (factoreal)**, includes an integrated **FT8 / FT4 Digital Mode Studio**. It offers a focused, native macOS path for operating the TX-500 without launching WSJT-X. The cabling, radio DIG mode, 9600-baud CAT connection, audio settings, and transmit precautions described earlier still apply. The utility is under active development.

9.1 What the Digital Studio Provides

- **Receive and decode:** FT8 and FT4 monitoring through the selected USB audio input, with a live audio waterfall, UTC slot status, and decoded-message tables showing signal strength, time offset, and audio frequency. Filters focus on CQ calls and messages addressed to the operator.
- **Transmit and QSO controls:** CAT-controlled TX/RX sequencing, selectable audio tones, band presets, a **Tune** control, RF power and DIG gain settings, and power, ALC, and SWR readings. Optional Auto-CQ and Auto-Hunter assistance requires operator supervision on air.
- **Contact records:** A session QSO counter, persistent contact log, and ADIF export.
- **Optional reception reporting:** The **PSKReporter** checkbox enables reports of real, decoded FT8/FT4 reception to PSK Reporter. Simulated decodes are excluded; network submission alone does not guarantee that a spot appears on the map.
- **Bench testing: Simulation Mode (No RF TX)** allows exploration of the interface without keying the radio. Disable it only after checking the radio, audio route, antenna or dummy load, and TX level.

9.2 A Short Operating Path

1. Connect the TX-500's CAT and AD-508 audio cables, select DIG on the radio, and confirm the 9600-baud CAT setting. Close other programs using the same serial port.
2. Open **Lab599 Utility.app**, select the CAT port, and open **FT8 / FT4 Digital**. Choose the USB audio device, mode, and band. Start monitoring and confirm that the waterfall and decode list respond.
3. Before transmitting, confirm a suitable antenna or 50 Ω load, a stable time reference, and clean audio drive. Use **Tune** briefly to check RF output, ALC, and SWR, then stop it. The app blocks real TX when estimated UTC uncertainty exceeds one second; reception remains available.
4. Arm transmission only when ready to operate. Review the selected RX/TX audio frequencies, slot choice, and decoded calls. Save completed contacts and export ADIF when needed.

Project and Feedback

The independently developed project is at github.com/fact0real/Lab599-Utility. I am developing it with great enthusiasm, and its features and screens continue to evolve. I would be very glad to hear your corrections and suggestions for improving the software and this guide through GitHub Issues or the app's **Feedback & Suggestion** view.

9.3 The Digital Studio in Use

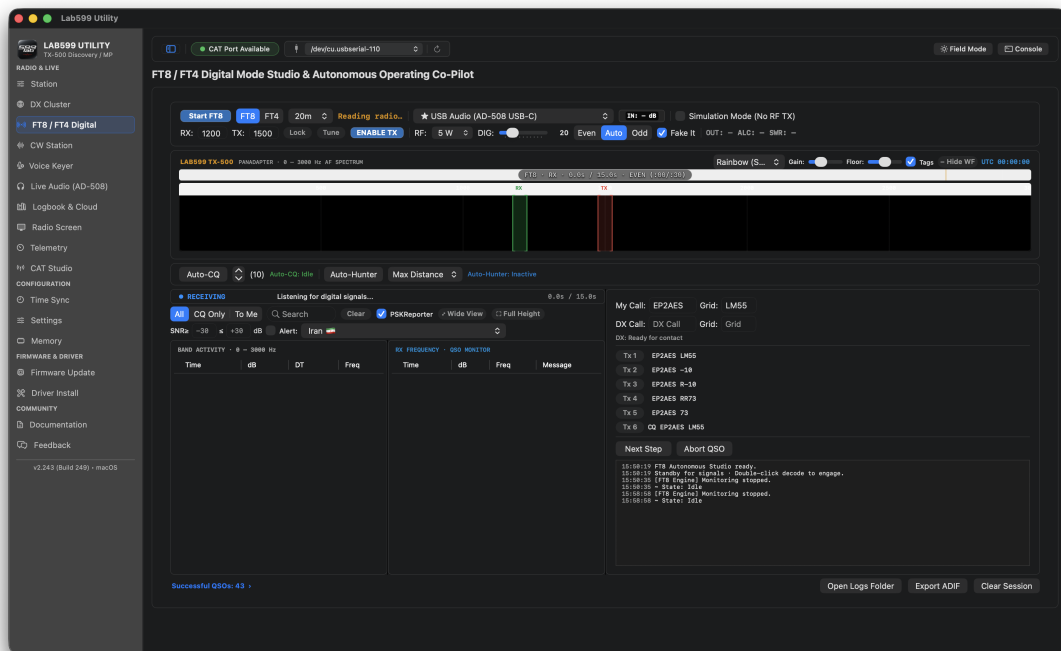


Figure 8: The dark-mode FT8/FT4 studio in Lab599 Utility v2.243 (Build 249): CAT and audio selection, waterfall, manual QSO controls, logbook entry point, and ADIF export. This screenshot shows the idle state.

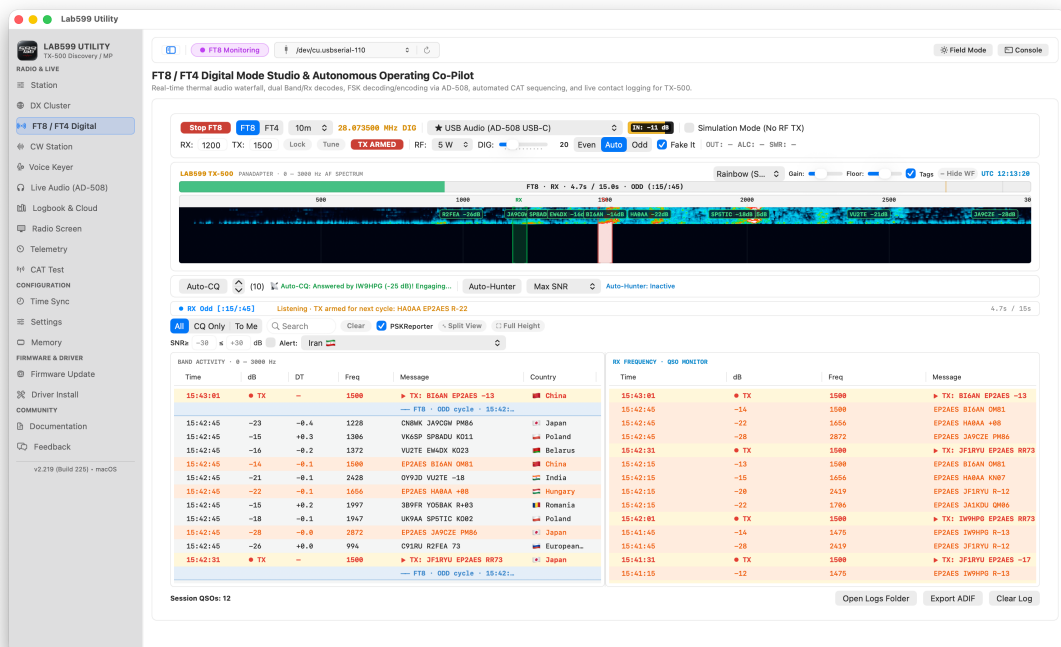


Figure 9: FT8 receive monitoring: the native studio shows the waterfall, decoded band activity, messages addressed to the operator, UTC cycle status, and contact controls.

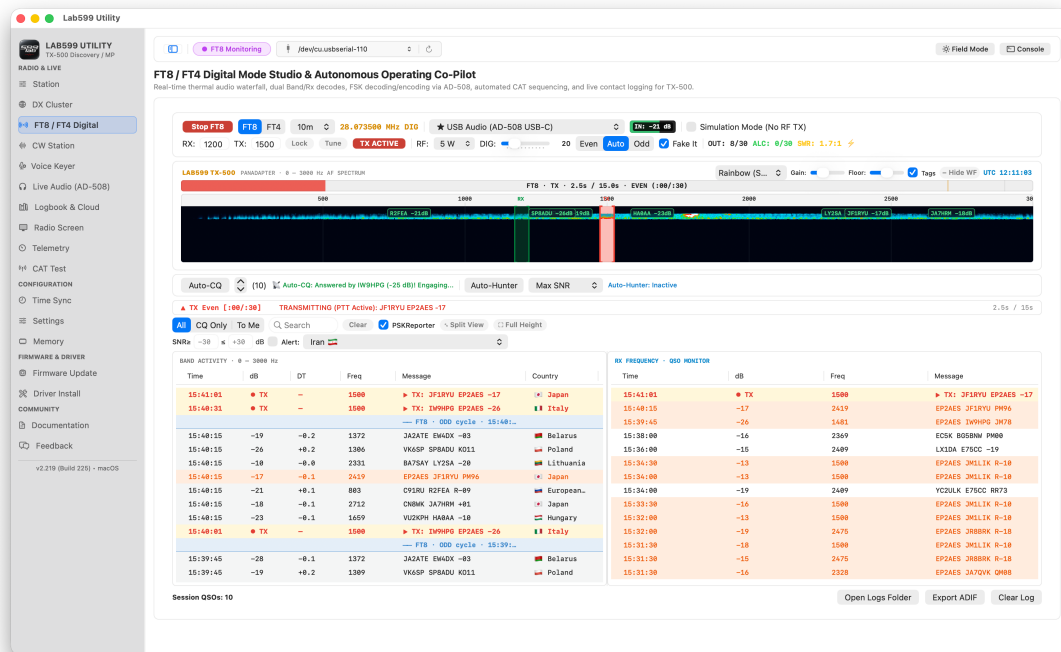


Figure 10: An FT8 transmit cycle: the red TX state and status line make the active transmission, power, ALC, and SWR visible in one view.

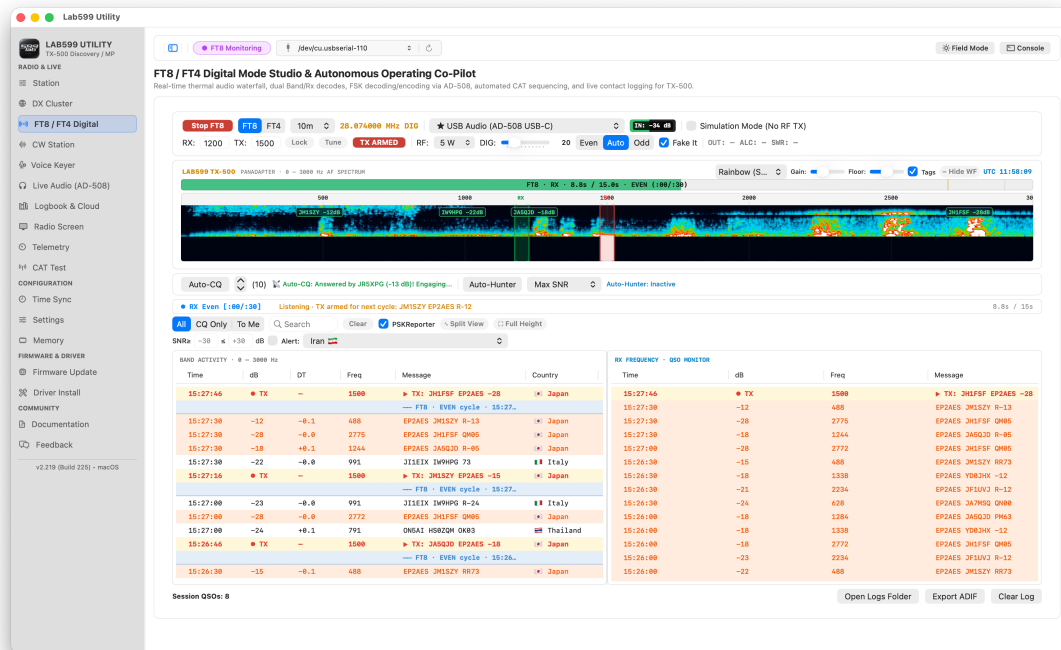


Figure 11: The audio waterfall and decoded-message tables during live FT8 reception. The highlighted rows distinguish messages involving the operator's callsign.

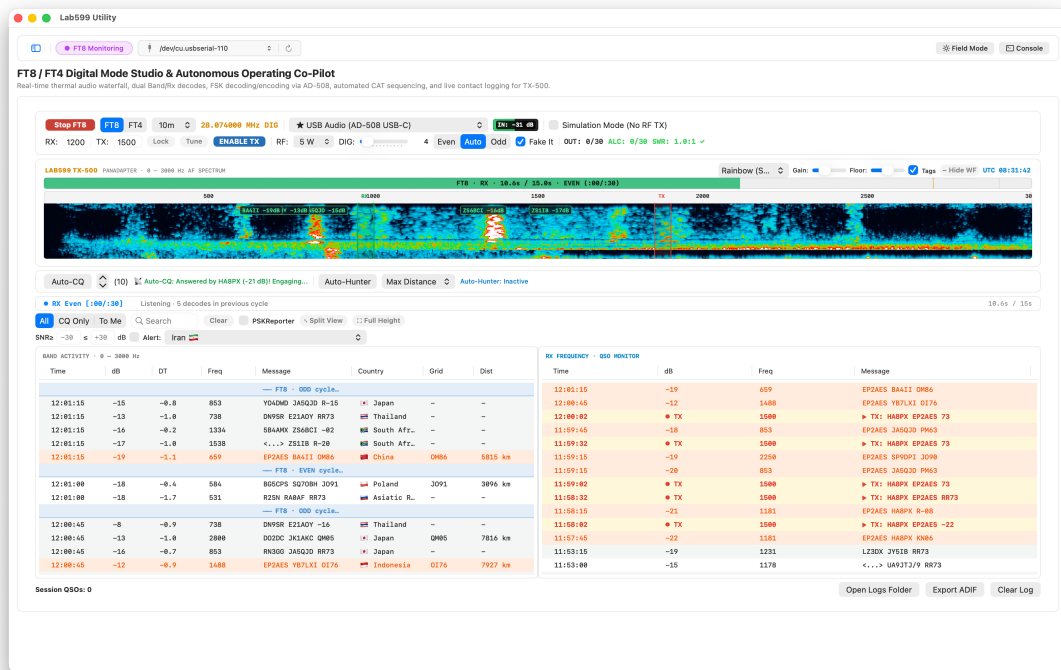


Figure 12: A wider digital-studio layout with band activity, grid and distance columns, the QSO monitor, and ADIF export controls.

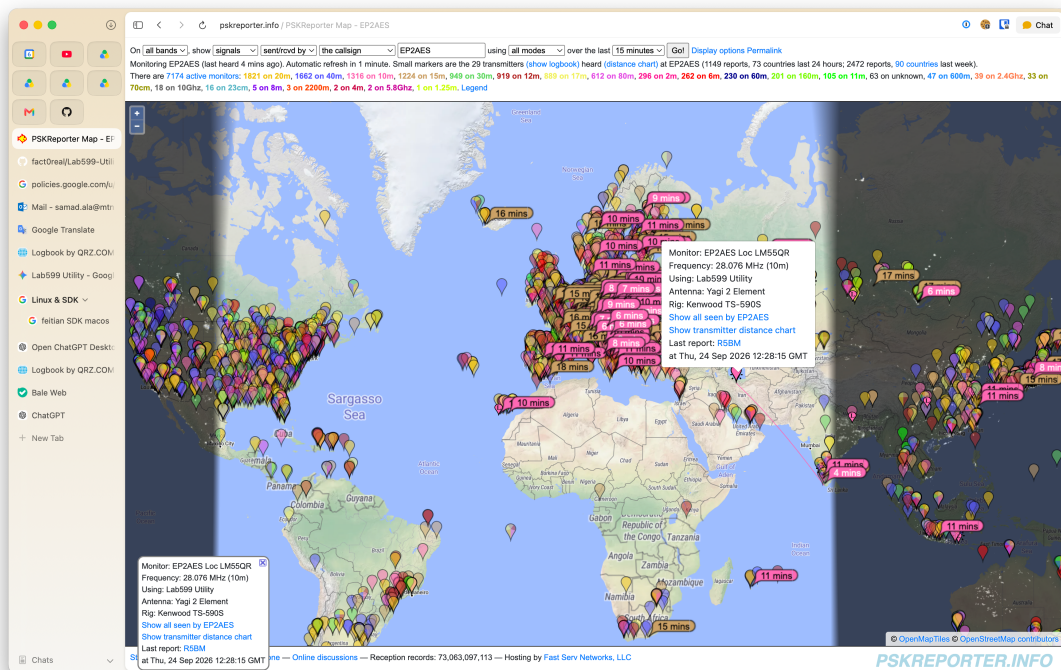


Figure 13: PSK Reporter map showing reception reports associated with EP2AES on 10 m. Reporting from Lab599 Utility is optional and enabled by the operator.

10 Comprehensive Bug Reference & Troubleshooting

Observed Issue	Underlying Root Cause	Verified Engineering Solution
WSJT-X shows 85 dB red bar (Audio Clipping)	Incoming RX audio excessively high; soundcard ADC saturated.	Follow Rule 2: Set macOS Input Volume to ≤24% (0.241) in Audio MIDI Setup. Adjust TX-500 Menu 09. Target 30–50 dB solid green bar.
Radio keys into TX but produces 0 Watts RF power	(a) macOS audio output too low, or (b) radio jumped from DIG to USB voice mode.	(1) Set macOS Output Volume to 100% (1.0) in Audio MIDI Setup; (2) Set WSJT-X Mode to None ; (3) Repeatedly press MODE to lock in DIG .
Radio unexpectedly jumps from DIG to USB mode	Legacy firmware bug in v1.1x/v1.2x reacting to CAT mode commands.	(1) Update firmware to v1.30.00 using Lab599 Utility; (2) In WSJT-X Settings → Radio, set Mode to None .
No vendor firmware update utility for macOS	Official Lab599 updater only supplied for Linux/Windows.	Use Lab599 Utility for macOS . Built-in native flasher runs at 57600 baud, 8N1 directly on macOS Tahoe.
Gatekeeper blocks FTDI driver / D2XX dylib	macOS quarantine attribute attached to downloaded library.	In Lab599 Utility, click Fix Gatekeeper & Authorize (or run: <code>sudo xattr -d com.apple.quarantine</code> on the dylib).
Radio powers off after 10s in Bootloader mode	BP-500/550 battery pack lacks keep-alive signal in loader mode.	Connect stable external 12.0–13.8 V DC power (or hold BP-550 power button continuously) during firmware flashing.
Decoding fails after Mac wakes from sleep	macOS resets USB audio sample rate from 48000 Hz to 44100 Hz.	Reset sample rate in Audio MIDI Setup to 48000 Hz. Disable Mac system sleep during active digital sessions.
Rapid TX/RX relay chattering	Common-mode RF circulating on USB cables corrupts UART packets.	Add 1:1 RF choke at antenna feedpoint; install Type-43 snap-on ferrites on USB and CAT cables; run Mac on battery power.

11 Thermal Management & Power Monitoring

11.1 Duty Cycle Considerations for FT8

FT8 is a continuous-carrier, constant-envelope digital mode with a **nearly 50% transmit duty cycle** (transmitting continuously for 12.6 seconds out of every 15-second period during an active transmit sequence). At 10 Watts output, the TX-500 draws approximately 1.8–2.2 A from a 13.8 V DC source, dissipating roughly 15 Watts of thermal energy inside its compact aluminum enclosure.

11.2 Thermal Physics of the TX-500

Because the TX-500 has no internal cooling fan, heat generated by the RF power amplifier transistors is conducted directly into the aluminum monoblock chassis. During extended operating sessions at full 10 W output:

- Chassis temperature can rise from ambient to over 55°C within 15–20 minutes of continuous CQ calling.
- If the internal temperature sensor reaches 65°C, the TX-500's thermal protection circuitry engages, automatically throttling RF output power to protect the final amplifier MOSFETs.

11.3 Method 1: External Cooling Fan (Shack Deployments)

For sustained home-station or fixed-camp operations:

1. Place a small 5 V USB or 12 V DC brushless cooling fan (60 mm or 80 mm) directed across the rear heat-dissipation fins.
2. Forced-air convection across the aluminum chassis reduces equilibrium operating temperatures by 15°C to 20°C, allowing unlimited continuous 10 W FT8 operation without thermal throttling.

11.4 Method 2: Sealed Ice-Pack Cooling (Field Deployments)

For ultralight portable field operations (POTA/SOTA) where carrying an electric fan is impractical:

1. Place a sealed, re-usable gel ice-pack wrapped in a thin microfiber cloth beneath the radio's flat aluminum base.
2. The TX-500's IP65-rated sealed chassis prevents moisture ingress, while the cloth absorbs condensation.
3. This method maintains chassis temperature below 35°C even during intense pileup operations.

12 RFI Mitigation Best Practices

When operating digital modes at 10 Watts in close proximity to an Apple laptop:

- **Common-Mode RF Current:** An unchoked antenna feedline can radiate RF currents back along the outside of the coax shield, inducing RF voltages onto the USB audio and CAT cables. This can cause USB disconnects or erratic WSJT-X CAT errors.
- **Ferrite Chokes:** Install **Type-43 or Type-31 snap-on ferrite chokes** at both ends of the CAT cable and the AD-508 audio cable.
- **1:1 Current Balun:** Always install a quality 1:1 current balun or common-mode choke at the antenna feedpoint.
- **Battery Operation:** Operating the MacBook Pro on its internal battery (unplugged from AC mains) isolates the digital station from ground loop hum.

13 Pre-Session Operational Checklist

Review this checklist before starting any digital operation:

- ☐ **Firmware Check:** Verify TX-500 is running **v1.30.00** (updated via Lab599 Utility).
- ☐ Connect **AD-508** (audio) to REM/DATA port and Mac USB-C.
- ☐ Connect **stock blue CAT adapter** to CAT port and Mac USB.
- ☐ Connect resonant antenna or matched 50 Ω dummy load to BNC ANT jack.
- ☐ Power on the TX-500 (12.0–13.8 V DC external power).
- ☐ Verify **Menu 34 = TS2000**, **Menu 35 = 9600**, and **Menu 22 = MIC**.
- ☐ Press front panel **MODE** button **repeatedly** until screen indicates DIG.
- ☐ Confirm Audio MIDI Setup: Output = **100% (1.0 / 0.0 dB)** and Input = **$\leq 24\%$ (0.241 / 15.72 dB) at 48000.0 Hz 16-bit**.
- ☐ Choose **one** digital operating app. For WSJT-X, set Rig = Kenwood TS-480, Baud = 9600, Mode = None, Split = Fake It, and PTT = CAT. For Lab599 Utility, open **FT8 / FT4 Digital**, select the CAT port and USB audio device, then start monitoring.
- ☐ Verify the CAT connection and confirm live audio reception in the chosen app. In WSJT-X, a green Test CAT indicator and a **30–50 dB** green RX level are useful checks; reduce input gain if its meter reads **85 dB red**.
- ☐ Use **Tune** in the chosen app; adjust **Menu 09 (GAIN $\rightarrow$ DIG)** while watching the MIC meter and an inline wattmeter. Stop Tune after the check.
- ☐ Position external fan or ice-pack if operating above 5 W continuous output.
- ☐ Enable **Auto Seq** and **Enable Tx** in WSJT-X, or deliberately arm transmission in Lab599 Utility after checking the UTC slot and disabling Simulation Mode. Begin operating!

14 Conclusion

Operating FT8 and digital modes with the **Lab599 Discovery TX-500** on **macOS Tahoe** delivers a truly uncompromising field and shack experience when configured correctly. By pairing the rugged hardware of the TX-500 with the native **Lab599 Utility for macOS**, ensuring the installation of **Firmware v1.30.00**, and maintaining calibrated audio levels, operators can use either the established WSJT-X workflow or the utility's integrated FT8/FT4 studio. The latter brings reception, CAT-controlled transmission, logging, and optional PSK Reporter reporting into one macOS app. The project is evolving, and community corrections and suggestions are welcome.

May this manual serve as a reliable guide for your digital expeditions. 73, and see you on the waterfall!

factoreal / EP2AES
Tehran, September 25, 2026



73 de EP2AES

github.com/fact0real/Lab599-Utility