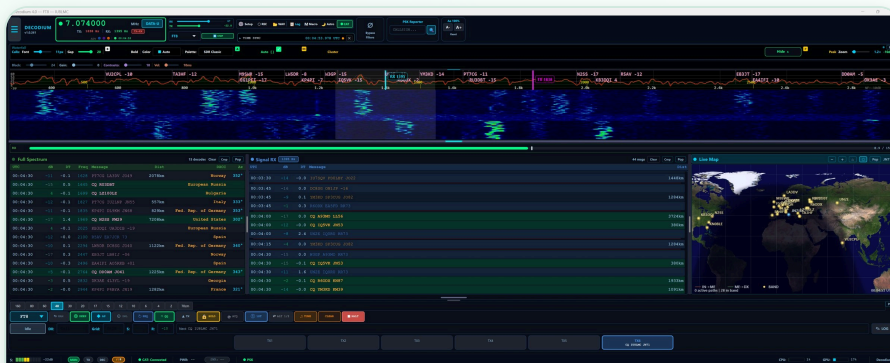


DECODIUM 4.0

“SHANNON” – DECODER · ADVANCED · UI ·
TROUBLESHOOTING



▸ Chapters 6-10 · Advanced features · Technical
reference

5

CHAPTERS
Ch. 6 → 10



CALL BUTTON
Direct call



TROUBLESHOOT
CAT · Audio · UI

A-E

APPENDICES
FT2 specs · ini

Continuation of User Manual Part 1. This part covers the decoder in depth, advanced features (including the v1.0.262 CALL button), UI customization, in-depth troubleshooting, and all technical appendices.

Chapter 6 – Decoder and Sensitivity

This chapter is for those who want to understand **how** DECODIUM 4.0 achieves superior decoding performance. It's not required to use the software, but it's essential for those who want to optimize setup or contribute to development.

6.1 Decoder architecture

The DECODIUM 4.0 decoder is structured as a **4-stage pipeline**:

1. Audio pre-processing (FFT, AGC, RMS norm)
↓
2. Sync acquisition (Costas correlation, MMSE channel estimation)
↓
3. LDPC decoding (Min-Sum normalized, 5-pass best-of)
↓
4. Post-processing (CRC validation, EMA averaging, message extraction)

Each stage is **isolated** in separate C++ modules. The principle: if a new algorithm proves superior in one stage, it can be replaced without touching the others.

6.1.1 Audio pre-processing

Incoming audio is transformed into three parallel representations:

REPRESENTATION	USE
Time-domain raw (48 kHz, float32)	Diagnostics and logging
FFT (2048-point Hann)	Sync acquisition and waterfall display
Symbol-rate filtered (41.667 Hz for FT2)	Decoder input

RMS normalization operates on three simulated audio channels to make the decoder robust to level variations: if the RX signal drops suddenly, the decoder doesn't lose sync.

Important: RMS norm **is not radio-side AGC**. It's an internal decoder normalization. On the radio you can (and should) leave AGC as you prefer for listening.

6.1.2 Sync acquisition

DECODIUM searches for the **16-tone Costas** pattern at the start of every slot. Three parallel strategies:

1. **Classical correlation** – WSJT-X standard method. Fast but fading-sensitive.
2. **MMSE adaptive estimation** – uses all 16 tones as pilots to estimate the channel and correct the signal. **+1.5 dB** on fading channels.
3. **EMA-weighted multi-period** – for stations repeating the call, accumulates information across consecutive slots.

The **Best-of-N** selector picks the sync with the best **correlation score**. This avoids locking onto interfering signals on a false-positive sync.

6.1.3 LDPC decoding

LDPC (Low-Density Parity-Check) is the error correction code used in FT8, FT4, FT2. DECODIUM uses original **K1JT** (Joe Taylor) mathematics but with two optimizations:

1. **Normalized Min-Sum** – replaces classical Sum-Product. Reduced complexity per iteration (~30% faster) with equivalent performance on AWGN channels.
2. **Multi-pass best-of** – 5 independent attempts with different syncs. The final CRC-14 confirms validity. Only decodes passing CRC reach the log.

Where the LDPC code lives: isolated in

`lib/ft2/decode174_91_ft2.f90` – the only Fortran file remaining in DECODIUM 4.0. The choice is deliberate: K1JT's math is perfect, rewriting it in C++ would add risk with no measurable benefit.

6.1.4 Post-processing

After decoding, every message passes through:

1. **CRC-14 validation** – if CRC fails, decode discarded (no log, no display)
2. **EMA averaging** – for stations seen in previous slots, applies weighted average to stabilize SNR/DT
3. **Callsign hash extraction** – the 77-bit payload is decompressed into callsign + grid + text message
4. **Best-of-N consolidation** – if multiple passes found the same message, the decode with the best SNR is kept

6.2 Sensitivity table

DECODIUM Lab internal measurements, AWGN channel, 12 kHz sample rate:

MODE	STANDARD FLOOR	DEEP (RAPTOR) FLOOR	GAIN
FT8	-21 dB	-23 dB	+2 dB
FT4	-17 dB	-19 dB	+2 dB
FT2	-16 dB	-23 dB	+7 dB
FT2 + EMA 4- period	n/a	-14.5 dB	(on dynamic SNR)

Fair comparison vs WSJT-X: WSJT-X reports -21 dB floor on FT8 and ~-17 dB on FT4. DECODIUM 4.0 without DEEP is equivalent. With DEEP enabled the gain is real but costs CPU (~25-30% more per slot). On modern PCs it's negligible.

6.3 Optional filters

In **Setup** → **Filters** are available post-decode filters that reduce false positives at the cost of sensitivity.

6.3.1 FDR (Frequency Domain Resilience)

Filter rejecting decodes with **inconsistent SNR across passes**. If pass 1 says **-18 dB** and pass 5 says **-8 dB**, it's probably a QRM artifact.

STATE	BEHAVIOR
FDR ON (default)	Filters inconsistencies, loses ~5% of borderline decodes
FDR OFF	Shows everything, accepts some false positives

When to disable FDR: if you're convinced some valid decodes are being lost. Typical case: QRP stations at marginal propagation where every decode matters.

6.3.2 Spectral Mask

Filter rejecting decodes **outside the expected spectral mask**. Useful in crowded bands where adjacent signals can induce false syncs.

6.3.3 Sliding Window AGC

Internal AGC applied to the audio buffer before FFT. Not to be confused with radio AGC. Improves dynamic range on signals with highly variable levels within the slot.

6.4 Bandwidth and selectivity


DECODIUM works by default on **3 kHz of audio bandwidth** (50 Hz - 3000 Hz). You can modify in **Setup** → **Audio** → **Bandwidth**:

BAND	USE
3 kHz (default)	Standard, covers all digital sub-bands
2.7 kHz	For radios with narrow SSB filter
2 kHz	Only the selected FT8/FT2 signal, reduces QRM

Caution: reducing bandwidth **also reduces the number of stations simultaneously decodable**. Use only if you have specific out-of-band QRM to exclude.

Chapter 7 – Advanced Features

7.1 CALL – Direct call (v1.0.262)

The  **CALL** button is the v1.0.262 novelty. It's located in the TX toolbar **next to ACQ**, and allows calling a specific callsign **without waiting for their CQ**.

7.1.1 When CALL is useful

CALL solves three concrete scenarios:

1. **Skeds with friends** – agree on a time, they don't CQ, you call them directly
2. **Fast replies to missed CQs** – DECODIUM decoded a CQ but you clicked 100ms too late
3. **Targeted DXpedition activations** – call repeatedly to a rare station without waiting for their CQ

7.1.2 CALL workflow step-by-step

1. **Click**  **CALL** – the `CallDialog` opens
2. **Enter the target callsign** – e.g. `F4CQS`, `JA1XYZ`, `VK7AB`
3. **Configure parameters:**

PARAMETER	MEANING	DEFAULT
Max retries	Maximum attempts before automatic stop	10
Timeout	Total seconds before abort	60s
Period	Call frequency (1 = every slot, 2 = every 2 slots, etc.)	1
Message format	TX1 message template	TARGET MYCALL MYGRID

4. Press ► Start

5. Decodium starts calling at the next available slot: F4CQS IU8LMC
JN71

6. The CALL button in the toolbar turns **green** with tooltip retry N/M

7. **Edge-detector on** transmittingChanged counts actual retries (not attempts failed by CAT errors)

8. Automatic stop if:

- Max retries reached
- Timeout expired
- The target replies (automatic handoff)

9. If the target replies, **natural handoff** to existing autoSeq flow: R-XX
→ RR73 → log

7.1.3 Operating conventions and etiquette

CALL is a powerful tool. Misusing it can create QRM. Guidelines:

⊘ Don't use CALL: - To **call stations clearly in QSO**. Wait for their 73. - To **call DXpedition in tight pile-up without coordination**. You just create QRM to the existing pile-up. - **Continuously in series** toward 10 different stations. Useless split is chaos.

✓ Use CALL: - When you have a **confirmed sked** and the time has come - For **fast replies to CQs** decoded but missed by a few ms - When you want to **complete an interrupted QSO** with a previous station (calls + grid already exchanged) - In **EmComm** where calling directly is standard practice

7.1.4 CALL ↔ AutoSeq ↔ Hold interaction

CURRENT STATE	CALL BEHAVIOR
AutoSeq OFF, Hold OFF	CALL handles everything, starts and stops on its own
AutoSeq ON, Hold OFF	If target replies, AutoSeq takes control. CALL ends.
AutoSeq OFF, Hold ON	CALL runs but doesn't advance messages. You control the flow.
AutoSeq ON, Hold ON	CALL stops immediately – Hold blocks autoSeq.

7.2 Call Roster

The Call Roster is a **dedicated window** that automatically tracks callsigns heard during the session.

7.2.1 Activate the Call Roster

Hamburger menu (☰) → **Tools** → **Call Roster**. Or shortcut **F7**.

The window shows three tabs:

- **Heard** – all stations decoded in the current session
- **Calling** – stations currently calling CQ
- **Roster** – your personal “watch” callsign list (see 7.2.3)

7.2.2 Roster columns

COLUMN	MEANING
Call	Decoded callsign
Grid	Locator extracted from payload
DXCC	Automatically decoded entity
Band	Band where heard
Mode	FT8, FT2, FT4
SNR	Best SNR in the session
First	UTC of first decode
Last	UTC of last decode (useful for “still active?”)
Count	How many times heard (frequency)
Status	★ if on your roster · ✓ if already worked (logbook check)

7.2.3 Personal roster

Right-click on a station → **Add to roster**. The personal roster is a list of “interesting stations” you want **not to miss**.

DECODIUM emits **audio/visual alert** when a station from your roster decodes. Configurable in **Setup** → **Roster** → **Alerts**.

Tip: Use the roster for Most Wanted DXCC, contest target list, recurring sked partners.

7.3 DX Cluster

7.3.1 Cluster connection

In **Setup** → **DX Cluster**:

FIELD	EXAMPLE
Server	<code>dxc.k0xm.net:7300</code>
Login	your callsign
Password	(usually empty, some clusters require registration)
Auto-connect on startup	✓ recommended

7.3.2 Cluster filters

DECODIUM applies filters to avoid being overwhelmed:

- **By band** – only active band or multi-band
- **By mode** – FT8, FT2, FT4, CW, SSB, etc.
- **By DXCC** – only entities of interest
- **By distance** – exclude local clusters (e.g. > 1000 km)
- **By age** – only recent spots (e.g. last 5 min)

7.3.3 Spotting

You can **spot stations** you decode: right-click on a decode → **Spot to cluster**. DECODIUM sends a spot to the connected cluster.

7.4 PSK Reporter

PSK Reporter is the worldwide “who hears whom” database. DECODIUM automatically uploads all valid decodes.

7.4.1 Enabling

In **Setup** → **PSK Reporter**:

- **Enable upload** – ✓ recommended
- **Upload interval** – 5 minutes (default)
- **Include FT2 decodes** – ✓ (requires updated PSK Reporter plugin)

7.4.2 Upload verification

In [Help → PSK Reporter status](#) you can see:

- Last upload performed
- Number of decodes uploaded in the session
- Any HTTP errors

Privacy: PSK Reporter publicly exposes your callsign + grid + station heard. If you don't want this, disable upload. It's entirely optional.

7.5 Astro Tools

Astro is the propagation tools suite integrated in DECODIUM.

7.5.1 Solar dashboard

In toolbar → **Astro**. The dashboard opens with:

- **Solar Flux Index (SFI)** – HF propagation indicator
- **K-index and A-index** – geomagnetic disturbance
- **Sunspot Number** – solar spots (SFI proxy)
- **MUF/LUF map** – Maximum/Lowest Usable Frequency in real time

7.5.2 Greyline tracker

DECODIUM displays the **terminator line (greyline)** on Live Map. Stations near the line are **propagatively favored** for DX on HF.

7.5.3 Auroral oval

When K-index > 4, DECODIUM highlights the auroral oval area on Live Map (high polar absorption). Useful for those seeking EME / VHF contacts.

7.6 In-depth Live Map

The Live Map isn't just decorative – it has operational features:

7.6.1 Map filters

Buttons above the map:

- **IN → ME** – only stations receiving you (requires PSK Reporter)
- **ME → DX** – only stations you decode
- **BAND** – only active band
- **All** – everything

7.6.2 Click on a dot

Single click on a station → filters Full Spectrum on that callsign. Double click → opens QRZ.com (configurable in Setup → Lookup) for details.

7.6.3 Counters

Bottom-right of the map:

- **Active paths** – number of active paths this slot
 - **In band** – stations decoded on current band
 - **UTC clock** – UTC time synced with system
-

Chapter 8 – UI Customization

DECODIUM 4.0 is highly customizable. This flexibility is designed to accommodate different operating styles: from the contester wanting everything at a glance, to the home operator preferring a relaxing interface.

8.1 Themes

In **Setup** → **Interface** → **Theme**:

THEME	STYLE	WHEN TO USE
Shannon Dark (default)	Background #050816 , green accents #00e588	Night operations, dimly lit environments
Shannon Light	White background, dark green accents	Day operations, high ambient brightness
Midnight	Pure black background, cobalt blue accents	Maximum contrast, OLED-friendly
Classic	WSJT-X theme reproduction	For those not wanting to be disoriented

The theme changes immediately without restart.

8.2 Waterfall palette

In top toolbar → **Palette**. Four options:

PALETTE	CHARACTERISTICS
SDR Classic (default)	Blue → green → yellow, identical to WSJT-X
Shannon Light	White → amber → red, high brightness
Shannon Dark	Black → green → white, maximum contrast on weak signals
Heat	Red → yellow → white heatmap, vintage taste

Tip: To search for weak signals, use Shannon Dark. To quickly identify strong stations in a pile-up, use Heat.

8.3 Font scaling

In top toolbar → **Aa 100%**. Three sliders:

- **A-** reduces global font size
- **100%** restores default
- **A+** increases global font size

Range: 80% → 150%. Useful for operators with visual issues or for public demonstrations.

8.4 Compact mode

For multi-monitor setups or small screens, **Setup** → **Interface** → **Compact mode** enables:

- Reduced internal padding
- Toolbar collapse (icons only)
- Hides redundant labels
- Maintains accessibility via tooltip

8.5 Pop-out windows

All main windows can be **detached from the main window**:

- **Live Map** → **Pop** button top-right
- **Full Spectrum** → **Pop** top-right
- **Signal RX** → **Pop** top-right
- **Call Roster** → Tools menu → Pop-out

Pop-out windows **maintain live decoder connection**. Useful for:

- Multi-monitor setup where you want the map on monitor 2
- Streaming/video where the map is a separate scene
- “Only watch Signal RX and hide everything else” operations

8.6 Multi-instance (MultiRig CLI)

DECODIUM 4.0 supports **parallel multiple instances** for stations with multiple radios. Launch via CLI:

```
# Instance 1 - main radio
decodium --instance 1 --rig-port COM3 --config=primary.ini

# Instance 2 - secondary radio
decodium --instance 2 --rig-port COM4 --
config secondary.ini
```


Each instance has:




- Separate configuration (distinct `.ini`)
- Separate ADIF log
- Independent windows
- Separate audio device

Important: The two instances **must not share** the same sound card. Use two separate USB CODEC interfaces.

8.7 Interface languages

In **Setup** → **Interface** → **Language**:

-  **English** (default)
-  **Italiano**

-  Español
-  Deutsch
-  Türkçe

Language change is **immediate** without restart. Translated: all menus, dialogs, tooltips. **Not translated** (because technical): parameter names (SNR, DT, Freq), protocol terms (CQ, RR73, 73), and standard ham mode abbreviations.

8.7.1 Contributing translations

Translations are Qt Linguist `.ts` files. To contribute: 1. Fork the GitHub repository 2. Modify `translations/decodium_xx.ts` with Qt Linguist 3. Pull request

Translators are **credited** in the program's About page.

Chapter 9 – Troubleshooting

This chapter collects real issues reported by the Telegram community during Public Beta. For each: symptom, probable cause, tested solution.

9.1 CAT problems

9.1.1 “Cannot open port”

Symptom: at startup or pressing Test CAT, error `Cannot open port COM3` (or Linux/macOS equivalent).

Possible causes: 1. Another program is using the same port (WSJT-X, JS8Call, FIDigi) 2. Missing permissions (Linux: not in `dialout` group) 3. USB-serial driver not installed or wrong 4. Defective or unplugged cable

Solutions:

```
Step 1: Close all other ham software and retry
Step 2: Verify the port exists
  - Windows: Device Manager → Ports (COM and LPT)
  - Linux: ls -l /dev/tty* | grep USB
  - macOS: ls /dev/cu.*
Step 3: On Linux, add user to dialout group:
  sudo usermod -aG dialout $USER
  (then logout/login)
Step 4: Unplug and replug the USB cable
Step 5: Update USB-serial driver (FTDI, Silicon Labs CP210x,
Prolific)
```

9.1.2 “Timeout reading from rig”

Symptom: CAT connects but then errors with `Timeout`.

Probable cause: wrong baud rate (radio says X, software says Y).

Solution: 1. Go to the radio menus and read the configured baud rate 2. In DECODIUM, Setup → Radio → Baud rate, set the **same value** 3. Press Test CAT

Common values: - Kenwood TS-590: 57600 (recommended) - Yaesu FT-991A: 38400 - Icom IC-7300: 19200

9.1.3 “Mode unexpectedly toggles to USB”

Symptom: you’re operating in DATA-U but on every TX the radio switches to USB.

Cause: known bug fixed in v1.0.261. If on previous version, upgrade.

Solution: download v1.0.262 (or at least v1.0.261). The fix ensures DATA-U/D1 preserved across TX/RX transitions.

9.1.4 HRD doesn’t reconnect after restart

Symptom: close DECODIUM and HRD, reopen DECODIUM, HRD not detected.

Cause: HRD must be started and connected BEFORE DECODIUM retries the bridge.

Solution (v1.0.261+): the new “last-successful CAT retry path” logic automatically attempts HRD at startup. If still failing: 1. Start HRD manually 2. In HRD, verify TCP server active (Tools → TCP Server → Status) 3. In DECODIUM, click Test HRD to force reconnection

9.2 Audio problems

9.2.1 No decodes visible

Symptom: everything seems OK, but no decodes appear for minutes.

Sequential diagnosis:

Check 1: Correct band?

Standard FT8 bands:

40m = 7.074 MHz

20m = 14.074 MHz

15m = 21.074 MHz

10m = 28.074 MHz

If radio is on 7.080 (FT2 band), no FT8 there.

Check 2: Audio IN VU meter moving?

Open `S:` indicator at bottom-left.

Bar still → audio IN problem

Bar in red zone → audio too high (clipping)

Bar in green zone → audio OK, problem elsewhere

Check 3: TIME SYNC white or red?

If red, sync NTP. Without sync, no FT8 decoding.

Check 4: Coherent mode?

Radio display says USB-DATA? Top-left DECODIUM says FT8?

If radio in CW or LSB, no digital audio decoding.

Check 5: Filters active?

Setup → Filters: aggressive FDR? Disable and retry.

9.2.2 Audio too loud (clipping)

Symptom: VU meter in red zone, sporadic decodes.

Solution: 1. **On the radio:** lower USB IN level (Kenwood Menu 64, Yaesu Menu 113, Icom USB AF Output Level) 2. **On the PC:** Audio control panel → USB CODEC microphone → reduce level 3. Target: VU in green zone, peaks not above -10 dB

9.2.3 PTT doesn't fire

Symptom: you press TX or TUNE but the radio doesn't go into transmit.

Diagnosis:

Check 1: Coherent PTT method?

Setup → PTT → method. If CAT, must match CAT port.

If RTS/DTR, you must have a PTT cable connected to the radio side.

Check 2: Test PTT works?

Setup → PTT → Test PTT

If yes → problem in TX message or SEQ

If no → wiring/PTT configuration problem

Check 3: Correct RTS/DTR semantics?

Empty = DECODIUM doesn't touch the line

ON = forces high (line always active)

OFF = forces low (line always inactive)

If you have a PTT cable wanting "high = TX", set ON.

9.3 Live Map problems

9.3.1 Empty map

Symptom: Live Map shows no stations.

Causes: 1. Internet not connected → DECODIUM downloads map tiles from OpenStreetMap 2. Firewall blocking DECODIUM 3. Decodes still 0 →

Live Map shows only after valid decodes

Solutions: 1. Check internet connection (ping `tile.openstreetmap.org`) 2. Add DECODIUM to firewall exceptions (Windows Defender, ufw on Linux) 3. Wait at least 30 seconds after the first decode

9.3.2 Slow or “jerky” map

Symptom: map lags, zoom is jerky.

Cause: GPU rendering not accelerated.

Solution (Windows): 1. NVIDIA / AMD Control Panel → 3D settings 2. Add `decodium.exe` with “High performance” profile 3. Restart DECODIUM

Solution (Linux):

```
export QSG_RENDER_LOOP=threaded
./Decodium-1.0.262-x86_64.AppImage
```

9.4 Application startup problems

9.4.1 “QML import failed”

Symptom: at startup, error with failed QML import.

Cause: Qt 6.11 version not available on system (Linux), or corrupted QML cache.

Solution: 1. Delete QML cache: `~/.cache/Decodium/qmlcache/` 2. Restart

On Linux, if persistent, verify the AppImage is not on `noexec` filesystem:

```
mount | grep noexec # if current folder is noexec, move
the AppImage
```

9.4.2 Crash on first launch (macOS)

Symptom: click DECODIUM, window appears and disappears.

Cause: Gatekeeper blocking execution.

Solution:

```
xattr -cr /Applications/DECODIUM.app  
open /Applications/DECODIUM.app
```

9.5 Log files and debug mode

9.5.1 Where are the logs

OS	PATH
Windows	%APPDATA%\Decodium\logs\
macOS	~/Library/Application Support/Decodium/logs/
Linux	~/.local/share/Decodium/logs/

Three main files:

- `decodium.log` – general application log
- `cat.log` – CAT communications (only with CAT debug active)
- `decoder.log` – decoder log (rarely useful)

9.5.2 Enable debug mode

In **Setup** → **Advanced** → **Debug logging**, enable:

- **CAT debug** – logs every CAT command sent/received
- **Audio debug** – logs audio levels per slot
- **Decoder debug** – logs multi-pass details

Important: debug mode generates huge files (hundreds of MB per hour). Enable only for active troubleshooting, then disable.

9.5.3 Bug report

To report reproducible bugs:

1. Reproduce the bug with debug mode ON
2. Open **Help** → **Report bug**
3. Logs are automatically attached
4. Description: what you were doing, what happened, what you expected

Bug reports with logs → high priority in community tracking.

Chapter 10 – Appendices

A. Keyboard shortcuts

KEY	ACTION
F1	Help / About
F5	Refresh decode list
F7	Open Call Roster
F8	Open Live Map (pop-out)
F9	Open Full Spectrum (pop-out)
Ctrl+T	Toggle TX (TX on/off)
Ctrl+H	Toggle HOLD
Ctrl+S	Toggle SEQ(auto-sequence)
Ctrl+L	Log current QSO
Ctrl+M	Open Macros editor
Ctrl+P	Open Setup (Preferences)
Ctrl+1..6	Trigger TX1..TX6 manually
Ctrl+Tab	Switch between Full Spectrum / Signal RX
Esc	Immediate TX stop

B. `decodium.ini` configuration file

The main configuration file resides in:

OS	PATH
Windows	<code>%APPDATA%\Decodium\decodium.ini</code>
macOS	<code>~/Library/Application Support/Decodium/decodium.ini</code>
Linux	<code>~/.config/Decodium/decodium.ini</code>

B.1 Main sections

```
[Station]
MyCall=IU8LMC
MyGrid=JN71DC
Operator=
DXCC=auto

[Radio]
RigType=KenwoodTS590
RigPort=COM3
RigBaud=57600
StopBits=1
HRDBridge=false

[Audio]
AudioIn=USB Audio CODEC
AudioOut=USB Audio CODEC
SampleRate=48000
BufferSize=1024

[PTT]
Method=CAT
PortShared=true

[FT2]
EnableASYMX=false
EnableQQ=true
EnableDEEP=true

[Filters]
FDR=true
SpectralMask=true
SlidingAGC=false

[UI]
Theme=ShannonDark
WaterfallPalette=SDRClassic
FontScale=100
Language=en
```

B.2 Manual edits

Edit `decodium.ini` with a text editor (DECODIUM must be **closed**).

Automatic backup: at every startup, DECODIUM creates `decodium.ini.bak`. If you modify and something goes wrong, restore from `.bak`.

C. FT2 technical specifications

For those wanting to understand or implement the protocol:

C.1 Modulation

- **Type:** 4-GFSK (4-tone Gaussian Frequency Shift Keying)
- **Nominal tone:** audio center (e.g. 1500 Hz)
- **Spacing between tones:** 41.667 Hz
- **Total RF bandwidth:** 167 Hz
- **Gauss BT filter:** 1.0 (inter-symbol smoothing)

C.2 Timing

- **Symbol duration:** 24 ms (1/41.667 baud)
- **Total frame:** 79 symbols = ~1.896 s
- **Costas sync:** 16 symbols at edges (7+9)
- **Payload:** 174 raw symbols (= 87 effective symbols with FEC, 77-bit payload)
- **T/R cycle:** 3.75-3.8 s (guard time included)

C.3 FEC

- **Code:** LDPC (174, 91) – rate ~0.52
- **Decode algorithm:** Normalized Min-Sum, 20 iterations max
- **CRC:** CRC-14 (polynomial 0x6757)

- **Correction capacity:** ~10 errored bits / 174

C.4 Payload

- **Useful length:** 77 bits
- **Supported formats:**
 - Standard QSO (callsign1, callsign2, grid/report)
 - Telemetry (numeric sequence)
 - Free text (max 13 characters)
 - ARRL field day, DXpedition mode

C.5 ASYMX

- **Specification:** 100% compatible extension with the FT2 standard physical layer
- **Implementation:** free TX without even/odd slot wait
- **Synchronization:** lives in the signal's Costas sequence, not in the station

D. Credits and license

D.1 Development

- **Martino Merola IU8LMC** – protocol designer, project lead
- **Salvatore Raccampo 9H1SR** – lead C++ developer, macOS/Linux builds
- **LU7DID** – Raspberry Pi port

D.2 Technical heritage

- **Joe Taylor K1JT** – FT8/FT4/JT65/WSPR protocols (WSJT-X), LDPC mathematics
- **The Qt Company** – UI framework (Qt 6.11)
- **OpenStreetMap** – Live Map tile data

- **Hamlib team** – CAT library

D.3 License


DECODIUM 4.0 is released under **GPL v3**. Complete source code:

- Main repository: <https://github.com/iu8lmc/Decodium-4.0-Core-Shannon>
- Salvatore mirror: <https://github.com/elisir80/Decodium-4.0-Core-Shannon>

D.4 Standards

- **ADIF 3.1.7** – unanimous 22:0 vote of March 22, 2026 for SUBMODE=FT2
- **Graham G3ZOD** – ADIF secretary, certification mediator

E. Changelog v1.0.0 → v1.0.262

VERSION	DATE	HIGHLIGHTS
v1.0.262-call	May 20, 2026	 CALL button (direct call)
v1.0.261	May 19, 2026	HRD/Icom data mode stability, QSO state hygiene
v1.0.260	May 18, 2026	UI state persistence, FT2 async stabilization
v1.0.259	May 17, 2026	QSO flow state machine, HRD data mode
v1.0.258	May 16, 2026	CAT and decode panel fixes
v1.0.257	May 15, 2026	macOS Apple Silicon build
v1.0.250	May 10, 2026	Public Beta entry point
v1.0.200	April 25, 2026	C++ rewrite complete, FT2 native
v1.0.100	March 22, 2026	ADIF 3.1.7 certification
v1.0.000	February 16, 2026	First FT2 QSO ever

End of the complete User Manual. For advanced technical documentation (full API reference, complete troubleshooting, decoder internals, complete FT2 protocol specs), see the *Reference Manual*.

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