RSR-DF ANALYZER

Reuter RSR200B / SDRplay SDR Software.

USER MANUAL & CONTROL REFERENCE

LIVE RECEIVER | RSRMW FILE ANALYSIS | COHERENT AUDIO | DIRECTION FINDING

Software baseline

BETA 2.4

13 September 2026

This software is for personal use only.

It may not be used for commercial applications.

Use of this program is entirely at your own risk. The developers cannot be held responsible or liable for any damage, data loss, malfunction or other negative effects resulting from its use.

SCOPE: This edition documents the BETA 2.4 feature set, updated through 13 September 2026. It is written as a user manual: first-time setup first, then normal operation, receiver-specific behaviour, DF/calibration, RSRMW, recording and the complete control reference.

About this software and acknowledgements

RSR-DF Analyzer is an independent Windows SDR and direction-finding application built around coherent multi-channel reception, weak-signal analysis, long-recording review and practical MW DX workflows. Its design has been strongly informed by Linrad and WavViewDX, while its station-identification and MW workflow depend heavily on the MWList database.

Linrad - created by Leif Asbrink, SM5BSZ - is an important technical reference for high-performance SDR, weak-signal work, high-resolution spectrum processing, carrier tracking and coherent signal processing. RSR-DF builds on these ideas as references and in some areas goes beyond Linrad's original capabilities.

WavViewDX - created by Reinhard Weiss - is an important practical reference for reviewing long IQ/RAW recordings, visual carrier analysis and efficient medium-wave DX workflow. Its clear presentation of carriers and recorded-band activity has influenced the usability goals of RSR-DF Analyzer. The dedicated RSRMW workspace was deliberately designed with a familiar WavViewDX-style workflow so users can switch easily between WavViewDX and RSR-DF, find interesting moments in recordings quickly and then use the DF functions as an additional identification clue.

MWList - maintained by Günter Lorenz together with many contributors - is an essential data source for the medium-wave station workflow. Its station database makes it possible to match received carrier frequencies with candidate stations, calculate station bearings and distances, populate MWList candidate views, and support the Azimuth Map and logging workflow. Without this carefully maintained database, these parts of the program would not be possible in their present form.

Thank you: the project gratefully acknowledges Leif Asbrink for Linrad, Reinhard Weiss for WavViewDX, and Günter Lorenz and the many MWList contributors for maintaining MWList and its station database. Thank you for making these tools, data and ideas available to the radio community. Their work provides valuable foundations and examples for weak-signal SDR, recorded-band analysis and practical medium-wave DX.

RSR-DF Analyzer is not presented as a fork or graphical copy of Linrad or WavViewDX. It has its own Windows/WPF architecture, receiver control, DF calibration model and workflow. MWList is used as an external station-data source. Where third-party components are included, their own licence and notice files remain authoritative.

Contents

READING PATH: New users should read Chapters 1-3 first. For normal listening, Chapters 5-11 are sufficient. For direction finding, continue with Chapters 12-15. Chapter 20 is the concise option-by-option reference.

1. First-time setup - do this before anything else

The application can open without a complete station profile, but several important functions deliberately refuse to guess missing information. In particular, the receiver/QTH coordinates are required for great-circle bearing, distance, Azimuth Map and station-candidate work.

MUST DO: Enter and save your own receiver location before relying on DF, the Azimuth Map or station bearings.

1.1 First five minutes

Step	First launch
1	Extract the complete ZIP to one folder and start RSR200B_DF_Analyzer.exe.
2	Open USER / STATION, create/select your profile and enter your receiver/QTH details.
3	For map/DF work, enter and SAVE signed decimal latitude and longitude for the receiving site.
4	If you use coherent DF, select the antenna system that is physically connected to CH1 and CH2.
5	Choose the Windows audio device; set AUDIO OUTPUT GAIN conservatively and use VOLUME for listening.
6	Connect the receiver, start LIVE IQ, tune a known signal and confirm spectrum, waterfall and audio.

The detailed steps below explain each item. If you only want normal listening, you can postpone antenna geometry and DF calibration; QTH coordinates become essential when you use map, bearing, distance or station-candidate functions.

1.2 Unpack and start

1. Extract the complete ZIP to a writable folder. Do not run inside the ZIP.
2. Keep all supplied folders beside RSR200B_DF_Analyzer.exe, including Bridge, WebViewRuntime, GlobeEngine, GlobePacks and Manual.
3. The required .NET and offline 3D browser runtimes are included. Install only the manufacturer hardware driver/API separately for your receiver.
4. Start RSR200B_DF_Analyzer.exe. Your settings are created on first use.

1.3 Create or select a USER / STATION profile

Open USER / STATION. A clean installation starts with a generic USER profile. Enter your receiver-site details and press SAVE USER / STATION before relying on QTH-dependent functions. The supplied default contains no personal name, callsign, e-mail, QTH, logbook or DF references. These values belong to the receiving site, not to the transmitter you are browsing.

Field	Priority	What to enter
Station name	Recommended	A name for this receiving installation or operator profile.
Callsign	Optional	Amateur-radio callsign or another short identifier.

Field	Priority	What to enter
Location name	Recommended	Town, site or receiving-location name.
QTH latitude	REQUIRED for map/DF	Signed decimal degrees, -90 to +90. North is positive; south is negative. Example format: 52.12345.
QTH longitude	REQUIRED for map/DF	Signed decimal degrees, -180 to +180. East is positive; west is negative. Example format: 5.67890.
Maidenhead locator	Optional	Useful station locator. It does not replace accurate latitude/longitude for the map.
MWList e-mail	Only for MWList publishing	Exact e-mail address registered at MWList. Needed only when you publish logs online.
MWList OMID / user ID	Only for MWList publishing	Numeric MWList / myAM OMID registered for that account. Needed only for online publishing.

COORDINATES: Enter the receiver location in signed decimal degrees: latitude N = + / S = -, longitude E = + / W = -. Use the receiving-site coordinates, not transmitter coordinates, and press SAVE USER / STATION after editing. The software validates the legal ranges and never invents a location.

> **FIRST RUN: Verify your own USER / STATION details before using map, bearing, logging or DF functions. The public beta is intended to start without another operator's personal data.**

How to enter your receiver location correctly

- **Use the receiving site, not the transmitter.** The coordinates define the centre of your station/antenna system.
- **Use signed decimal degrees.** Example format: latitude 53.12345 and longitude 6.12345.
- **Enter latitude first and longitude second.** North and east are positive; south and west are negative.
- **Copy decimal coordinates from a GPS or map service.** Do not type degree/minute/second symbols into the decimal latitude/longitude fields.
- **Save the profile after editing.** Press SAVE USER / STATION and verify that the same QTH returns when the profile is selected again.

1.4 Select the active antenna system

The public beta starts with one generic antenna system. If you use coherent two-channel DF or want an antenna lobe on the Azimuth Map, open Antenna Systems and enter/select the system that is physically connected. Each coherent antenna system has its own geometry and DF-reference/calibration context. A single-channel receiver such as RSPdx can still use the saved antenna heading/lobe on the map, but it cannot produce a measured two-channel DF bearing.

- Give the antenna system a clear name.
- Enter the actual A1/A2 geometry in metres using one common local coordinate reference; the relative positions define the CH1/CH2 baseline.
- Enter the antenna-lobe heading when a directional antenna is shown on the Azimuth Map.
- Enter the full -3 dB beamwidth when it is known; this controls the lobe sector shown on the map.
- Save the antenna state and make sure the intended system is ACTIVE.

DF USERS: Do not copy calibration from a physically different antenna pair, cable path or receiver path. Calibration belongs to the active hardware/antenna context.

1.5 Check audio output

Choose the intended Windows audio output device. Set AUDIO OUTPUT GAIN conservatively first, then use VOLUME for normal listening level. Output gain and audio volume are separate controls.

For the first audio check, leave optional Signal Options and automatic combining off. First confirm a clean basic signal on CH1 or CH2; add enhancement functions only after normal reception works.

1.6 Prepare MWList (optional)

A station database is needed for automatic candidate lists. The package does not include an MWList database. Import a compatible MWList/FMSCAN CSV or text database once; after a successful import the local copy is stored and loaded automatically at later starts. A failed import does not overwrite the last valid local database.

- Credentials are not required merely to view candidate stations.
- Valid MWList account data are required when publishing logs to the online service.
- The local logbook can be used independently of online publishing. It is persistent per USER: imported entries and new SAVE LOG entries are loaded again with that USER and can be exported later.

You can postpone DF calibration, MWList credentials and detailed antenna geometry if you only want to listen. Do complete them before relying on bearings, mapped candidates or online MWList logging.

1.7 First-start checklist

Check	Needed?	Pass condition
Application starts	Yes	Main window opens without missing-DLL errors.
USER / STATION saved	Yes	Your QTH is stored in the active profile.
Active antenna system	DF users	Correct physical antenna pair/system is selected.
Audio device	Recommended	Sound comes from the intended Windows device.
MWList database	MW DX users	Candidates appear around a tuned MW channel.
Receiver connection	LIVE users	RSR200B, RSPduo or RSPdx connects and IQ starts; DF is available only on a valid coherent two-channel source.
DF reference calibration	Before trusting bearings	At least one valid known-station reference has been captured; more references improve frequency-dependent calibration.

2. Receiver hardware, coherent DF and antenna planning

Direction finding in this application is based primarily on the phase difference between simultaneous CH1 and CH2 IQ. Receiver coherence, known antenna geometry and frequency-dependent calibration are therefore more important than a visually strong signal alone.

1.8 Guided USER / STATION setup

The first-run USER / STATION workflow is the authoritative place for the receiving-site identity used by the rest of the application. The guided setup is intended to make the required receiver/QTH fields explicit instead of allowing map, MWList or DF functions to guess a location.

- **USER is the owner of the persistent station context.** QTH, MWList access, local logbook data, station-specific preferences and related saved state belong to the selected USER.
- **Station/QTH coordinates are still the receiving site.** Enter signed decimal latitude/longitude and save the profile before relying on great-circle bearing, distance, maps or MWList candidate geometry.
- The wizard does not create a DF calibration automatically. The active antenna system, physical CH1/CH2 geometry and known-station references remain separate calibration data.
- Switching USER must load that USER's own persistent context without silently borrowing another USER's logbook or station-specific saved settings.

FIRST-RUN RULE: Finish and save USER / STATION before treating map bearings, station distances, logged-state colouring or DF-reference geometry as authoritative.

1.9 Receiver selection and normal listening

Receiver selection remains separate from USER / STATION. Choose the physical receiver/source that is actually connected, then confirm normal audio and spectrum operation before enabling coherent or experimental processing. A missing HR/DF lock is not itself a reason to mute normal demodulated audio; lock state controls measurement validity, not whether a correctly tuned demodulator is allowed to produce sound.

KEY IDEA: A phase reading is useful only when both channels describe the same instant, the same carrier and a known physical antenna pair.

2.1 Why the Reuter RSR200B is well suited to DF

The RSR200B is a direct-sampling two-channel receiver. Its two independent 16-bit ADC channels, common adjustable clock, GPS-disciplined clock option and simultaneous dual-channel data path form a strong basis for stable coherent measurements. The receiver also exposes independent input/gain/attenuator routing and precise channel-combination controls.

- Both antenna signals are digitized inside one receiver and can be streamed together, reducing unknown timing between separate devices.
- Direct sampling avoids a separate tuner chip in each DF path over the applicable HF input range.
- A common clock and optional GPS discipline improve repeatability of frequency and phase measurements over time.
- The application receives actual CH1+CH2 IQ and keeps DF separate from audio-only combining/null controls.

BEST MATCH FOR THIS SOFTWARE: The application architecture and calibration identity were designed around the RSR200B coherent two-channel path. This does not remove the need for antenna/cable calibration, but it provides a particularly suitable hardware foundation.

2.2 RSPduo: capable, but more demanding for precision DF

The SDRplay RSPduo is a useful 14-bit dual-tuner SDR. Its manufacturer explicitly supports simultaneous reception from two antennas for direction finding, diversity and noise reduction, and dual-tuner mode provides two simultaneous spectrum slices. It is therefore a genuine two-channel option - not a single-channel receiver pretending to do DF.

For precision phase DF in this application the RSPduo is usually more demanding to validate than the RSR200B. Its two signals pass through separate tuner/front-end paths and the dual-tuner transport/driver path adds more variables that must remain consistent. This does not make the RSPduo unsuitable for DF, but it generally requires more careful mode control, calibration and repeatability checks before a bearing is treated with the same confidence as a purpose-built coherent receiver path.

- Use DUAL TUNER mode and verify that both tuners are streaming current paired IQ.
- Calibrate the actual tuner/input/cable/antenna path used for the measurement.
- Do not assume that a calibration made in a different tuner mode, sample-rate path or computer session is transferable.
- The RSPduo can work well for experiments and practical bearings, but expect more calibration and validation effort.

Receiver	Main DF advantage	Practical caution
RSR200B	Two direct-sampling 16-bit ADC channels in one receiver, common disciplined clock architecture and simultaneous coherent IQ.	Still requires correct antenna geometry and path calibration.
RSPduo	Affordable dual-tuner 14-bit receiver; simultaneous two-antenna processing is supported.	Separate tuner/front-end paths and dual-tuner transport make phase-path validation and calibration more critical.

Receiver	Main DF advantage	Practical caution
RSPdx	Single-channel SDRplay receiver with ANT1 / ANT2 / ANT3 selection; full normal reception, HR, recording and map workflow.	No simultaneous coherent two-channel IQ, so no measured phase DF; the Azimuth Map still works without a DF overlay.

2.3 RSPdx: single-channel reception with three antenna inputs

The SDRplay RSPdx is supported as a single-channel receiver. It has three switchable physical antenna inputs, shown in the application as ANT1, ANT2 and ANT3. Only one RF input is active at a time; these are not simultaneous coherent channels and therefore do not provide two-channel phase DF.

- ANT1 / ANT2 / ANT3 changes only the physical RF input. Frequency, mode, bandwidth, audio state, HR history and an active recording remain unchanged unless the hardware itself requires a safe update.
- Spectrum, waterfall, audio, HR Carrier View, gain/AGC, recording, reconnect and the signal meter remain available on RSPdx.
- When RSPdx is active, the right-side DF result panel is hidden. The Azimuth Map remains available and still shows MWList stations, QTH-based bearings/distances, logged-state colours and the configured antenna heading/lobe; only measured PRIMARY/MIRROR DF overlays are absent.
- The official SDRplay Hardware API/driver must be installed on the Windows PC. If it is missing, the application reports this explicitly instead of failing with a generic receiver-not-found message.

2.4 How two-antenna phase DF works

For a plane wave, the phase difference between two antennas depends on frequency, antenna spacing and arrival angle. With angle measured from broadside, a useful simplified relation is:

PHASE RELATION: phase difference = 360 degrees x (spacing / wavelength) x sin(angle from broadside). Wavelength = speed of light / frequency.

A single straight two-antenna baseline normally produces a PRIMARY and a geometrically mirrored AMBIGUITY direction. The application shows both candidates. Directional antenna patterns, known station geography, additional baselines or other evidence are needed to choose the physically correct one.

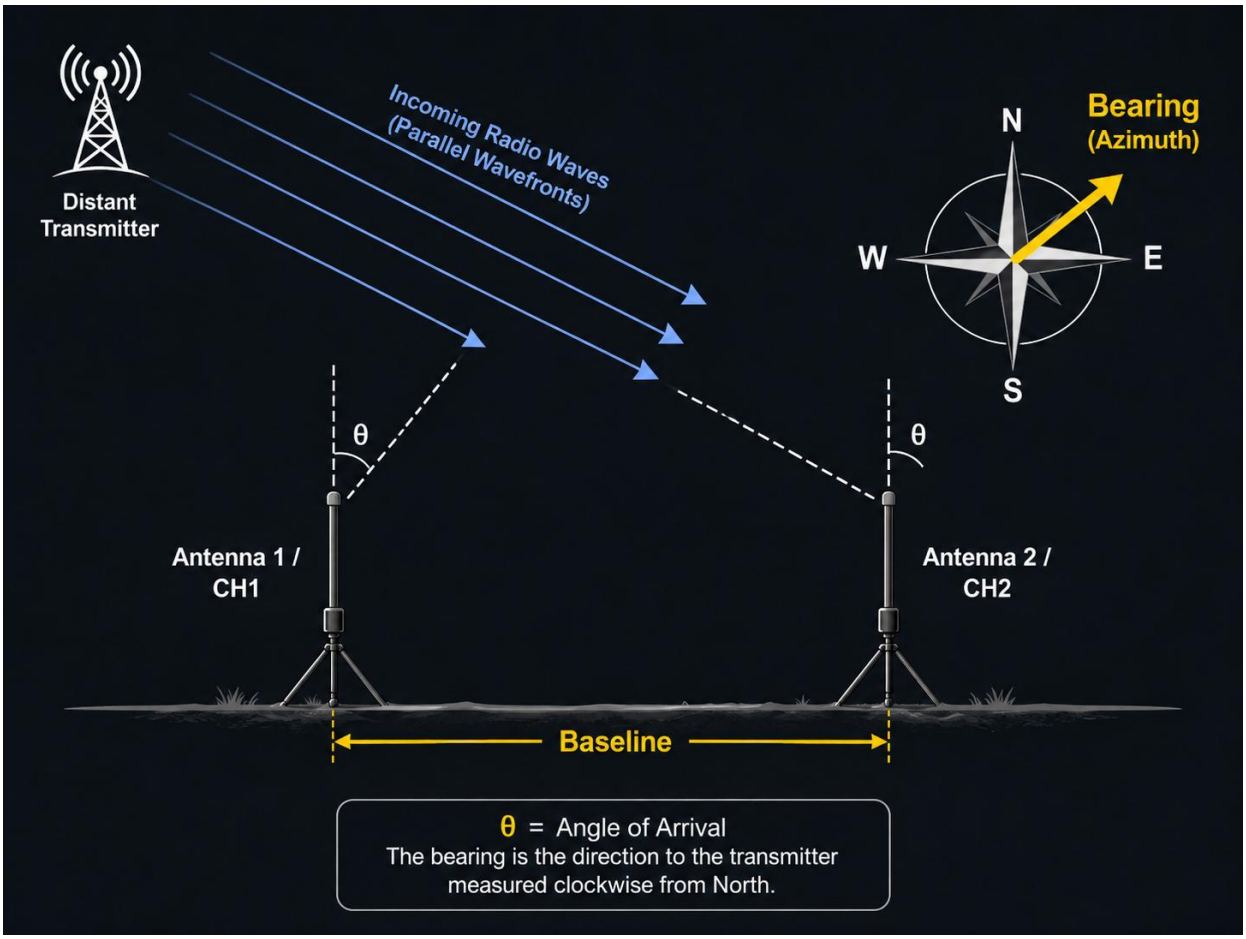


Figure 1. Two-antenna phase-DF principle: CH1 and CH2 receive the same wavefront at slightly different phase, and the known baseline converts that phase difference into a bearing.

2.5 Antenna spacing: sensitivity versus ambiguity

Express spacing as a fraction of wavelength (d/lambda), not only in metres. A longer baseline creates more phase change per degree and therefore better theoretical angular sensitivity. Above about 0.5 wavelength, however, extra 360-degree phase wraps can produce additional ambiguous solutions unless another baseline or prior direction information resolves them.

Spacing	Behaviour	Use
0.02-0.05 wavelength	Small phase change; weak angular sensitivity, but compact and easy to keep unambiguous.	Useful where site size is limited; requires very stable phase measurement.
0.05-0.10 wavelength	Moderate sensitivity.	Practical compact baseline, especially at lower MW frequencies.
0.10-0.25 wavelength	Good general compromise between sensitivity and simple ambiguity behaviour.	Recommended starting range when enough physical space is available.
0.25-0.50 wavelength	High phase sensitivity; geometry and calibration become increasingly important.	Useful for stronger angular discrimination; remain aware of endfire sensitivity loss.
More than 0.50 wavelength	Potentially very high sensitivity, but multiple phase-wrap solutions occur.	Use only with ambiguity-resolution methods, multiple baselines or strong prior direction constraints.

Frequency	Wavelength	0.05 lambda	0.10 lambda	0.25 lambda	0.50 lambda
531 kHz	564.6 m	28.2 m	56.5 m	141.1 m	282.3 m
810 kHz	370.1 m	18.5 m	37.0 m	92.5 m	185.1 m
1000 kHz	299.8 m	15.0 m	30.0 m	74.9 m	149.9 m
1500 kHz	199.9 m	10.0 m	20.0 m	50.0 m	99.9 m
10 MHz	30.0 m	1.50 m	3.00 m	7.49 m	14.99 m
100 MHz	3.00 m	0.15 m	0.30 m	0.75 m	1.50 m

EXAMPLE: A 60 m baseline is about 0.106 wavelength at 531 kHz, 0.162 wavelength at 810 kHz, 0.200 wavelength at 1 MHz and 0.300 wavelength at 1.5 MHz.

2.6 What angular accuracy can be expected?

The table below is only the phase-noise limit at broadside. It assumes a differential phase uncertainty of exactly 1 degree and contains no cable error, antenna mismatch, multipath, skywave, ground effect or geometry error. Real field accuracy is usually worse and can be much worse at night on medium wave.

d / wavelength	Theoretical angle error for 1 degree phase error at broadside
0.025	about 6.37 degrees
0.05	about 3.18 degrees
0.10	about 1.59 degrees
0.20	about 0.80 degree
0.25	about 0.64 degree
0.50	about 0.32 degree

- Accuracy is best near broadside to the baseline and degrades toward endfire, where a given phase error represents a much larger angle error.
- For a strong local/ground-wave signal with careful calibration, a few degrees can be a realistic goal; this is not a guaranteed specification.
- For night-time MW skywave, multipath and ionospheric motion can dominate. Use the displayed uncertainty/confidence, compare repeated measurements and do not force a precise station identity from an unstable bearing.

A receiver may expose several switchable antenna sockets without providing several coherent channels. For example, RSPdx ANT1/ANT2/ANT3 are three selectable inputs to one receive channel; they do not constitute a three-channel DF array.

2.7 How many antennas?

Antennas / coherent channels	What it provides	DF interpretation
1 antenna	Normal reception; a directional antenna pattern can give a rough bearing by rotation or lobe/null comparison.	No simultaneous phase-difference DF.
2 antennas / 2 coherent channels	Minimum for the application's phase DF; one baseline and current PRIMARY/MIRROR display.	A straight baseline has mirror ambiguity and no redundancy.
3 non-collinear antennas / 3 coherent channels	Two independent baselines can help resolve the mirror and test consistency.	Requires truly coherent 3-channel hardware and software support.
4 antennas / 4 coherent channels	Several baselines, redundancy, averaging and stronger ambiguity/outlier checks.	Requires coherent 4-channel acquisition and full geometry support; CH3/CH4 coherent DF is not active in the current build.

MORE IS NOT AUTOMATICALLY BETTER: Extra antennas improve DF only when every channel is coherent, calibrated and correctly described by the software. Two excellent matched/calibrated channels are more useful than four unrelated receivers.

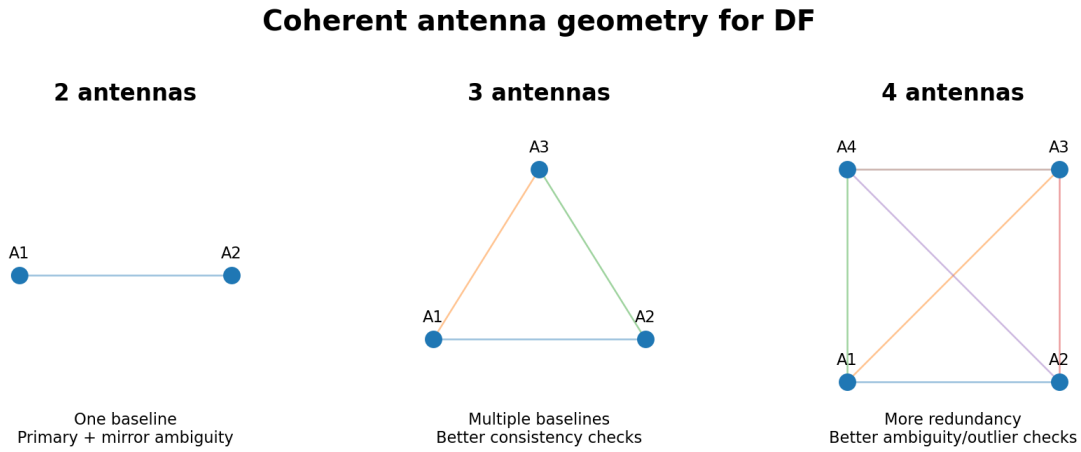


Figure 2. Two antennas provide one baseline; three or four coherent antennas can add independent baselines and consistency checks when the hardware and software support them.

2.8 Practical antenna installation

- Use antennas with the same polarization and, preferably, closely matched patterns and electronics.
- Use known antenna coordinates and enter A1/A2 X/Y in metres from one common local reference.
- Keep cable type, connectors, filters and preamplifiers stable. Electrical delay is often more important than small position error on MW.
- Avoid nearby metal, buildings and unequal coupling where practical; they can alter phase and pattern differently on each channel.
- Use several known reference stations across frequency. A single reference anchors one frequency but cannot fully prove frequency-dependent path delay.
- For different antenna types, select the appropriate pair type and add realistic extra phase uncertainty instead of pretending they are identical.

3. Quick start: receive your first signal

3.1 LIVE receiver

1. Select the LIVE / RSR200B workspace.
2. **Select the intended receiver backend. RSR200B uses its Reuter/ExtIO receiver path. SDRplay RSPduo and RSPdx use the SDRplay Hardware API when the official driver/API and device are available.**
3. Connect the receiver and start LIVE IQ.
4. **Click the main frequency to enter a value numerically in kHz (for example 1530.000) and press ENTER, or tune with the mouse wheel over the frequency digits. Manual frequency changes are authoritative and must not spring back to a previous tracker frequency.**
5. Choose MODE and BANDWIDTH.
6. **On coherent two-channel receivers select CH1, CH2 or COMBINED as required. On RSPdx select ANT1, ANT2 or ANT3. Source/antenna selection changes the signal source only; it must not silently change mode, frequency, bandwidth or other independent receiver settings.**
7. Use the main spectrum/waterfall for broad tuning and Fine Carrier / HR for narrow carrier work.
8. Before using advanced processing, tune a known local/strong station and confirm that frequency, spectrum, waterfall and audio all refer to the same signal source.
9. **For DF on a coherent two-channel receiver, wait for a current valid lock before interpreting azimuth. RSPdx has no measured DF result, but MWList and the Azimuth Map remain usable.**

3.2 RSRMW / recorded files

1. Open the RSRMW / FILES workspace.
2. Load one or more compatible RAW/IQ recording segments.
3. Review the import/analysis preset and start import when no valid cache/index is already available.
4. Click a time/frequency position in the recording display.
5. Use RSRMW navigation, HR, audio and DF on the selected recording position.

WORKSPACE ISOLATION: LIVE and FILES have separate source/playback engines. Loading or seeking a file must not retune the physical LIVE receiver unless you explicitly use a LIVE tune action.

4. Workspaces: LIVE RSR200B and RSRMW

Workspace	Source	Main purpose
LIVE / RSR200B	Physical receiver	Real-time tuning, spectrum, audio, recording, coherent CH1/CH2, live DF.
RSRMW / FILES	RAW/IQ recordings	Recorded-file playback, time/channel analysis, HR carrier work, offline DF, MW analysis.

The user interface shares many controls, but source identity, file position and receiver lifetime are intentionally kept separate. Context-specific controls should only appear where they make sense.

5. Tuning, frequency and source selection

5.1 Main frequency control

- Mouse wheel over a frequency digit changes that digit directly and immediately makes the new receiver frequency authoritative; a tracker/UI refresh must not restore the previous frequency.
- Click the main frequency for direct numeric entry in kHz; for example, enter 1530.000 and press ENTER to tune to 1530.000 kHz.
- Fine in-band tuning is designed to stay continuous without restarting the audio/HR/DF state for small logical frequency changes.
- Hardware-center/LO movement is distinct from the selected carrier. Horizontal spectrum dragging pans the viewport without replacing the selected carrier. When not recording, panning beyond current IQ coverage can move the receiver LO in controlled updates. During active recording the LO remains fixed so the RAW file keeps one valid centre frequency; uncovered RF is shown as black/no data while the recording continues.

5.2 Auto Carrier and manual carrier selection

AUTO CARRIER searches automatically whenever valid carrier data arrive after a real frequency or RSRMW block change. An empty first spectrum does not stop later acquisition. Manual selection remains authoritative: clicking a carrier selects that target, but a click is not required to start or restart carrier search.

5.3 CH1 / CH2 / COMBINED and RSPdx ANT1 / ANT2 / ANT3

On a coherent two-channel receiver, the source selector chooses CH1, CH2 or COMBINED for listening/display. On RSPdx it selects the physical RF input ANT1, ANT2 or ANT3. In either case, switching source/antenna must preserve frequency, mode, bandwidth, passband, volume, HR history, recorder state and other independent user settings.

6. Modes, bandwidth and passband

Mode	Typical use
DSB	Normal double-sideband AM envelope reception.
DSB-DQ	Direct-quadrature DSB path; useful for comparing weak-signal AM behaviour.
SAM	Synchronous AM using the reconstructed carrier reference.
COH AM	Coherent AM variant for difficult AM signals.
COH2 / COH3	Alternative coherent AM implementations; compare them on fading or distorted signals.
CSB	Coherent/selectable-sideband AM path using the reconstructed carrier.
C-QUAM	AM stereo decoder with automatic mono fallback when stereo quality is insufficient.
AMQ-AUTO	Analyzes USB/LSB quality and automatically uses the cleaner AM sideband.
USB / LSB	Conventional single-sideband reception and selective-sideband AM listening.
USB-DQ / LSB-DQ	Direct-quadrature weak-signal SSB variants.
CW	Narrow carrier/Morse reception where exposed by the active mode path.

Mode	Typical use
FM	Narrow FM where exposed and supported by the active source rate.
WFM	Wide FM with stereo/RDS processing when sufficient IQ bandwidth is available.

BANDWIDTH controls the demodulation passband. PASSBAND SHIFT moves the useful filter region without unnecessarily changing the selected RF/carrier. In AM-family modes, sideband selection and adjacent-channel controls are especially useful when interference is stronger on one side.

6.1 FM/WFM audio settings

- WFM de-emphasis can use OFF, 50 us or 75 us where exposed by the current settings path.
- Audio low-pass can be used to limit high-frequency audio content independently of RF tuning.

7. Signal Options - audio/DSP tools

independent checkboxes and can be combined where technically sensible.

Option	Purpose
DX AGC	Slow/fast post-demodulator AGC for large level changes; does not replace carrier lock or DF.
Impulse NB	Selective residual impulse blanker after wanted-channel isolation. NB effect controls sensitivity/replacement strength.
Carrier track MAX	Slow coherent CH1+CH2 combination that tracks maximum wanted-carrier level. Audio only; DF remains independent.
Carrier track NULL	Slow two-channel least-squares cancellation for co-channel interference. Audio only.
Speech enhance	Mild presence enhancement and soft limiting. Speech effect controls strength.
Adaptive sideband	For AM/SAM, chooses the cleaner sideband using Fine Carrier spectrum evidence.
AM ADJACENT SUPPRESSION	Independent lower/upper adjacent-channel rejection referenced to the current MASTER carrier; see Chapter 8.

INTERACTION: The build explicitly warns that Carrier track MAX and Carrier track NULL can oppose each other; Carrier track NULL has priority when both are enabled.

8. Notches and adjacent-channel control

8.1 Four per-carrier notches

Up to four independent notches can be used to suppress tones or narrow interfering carriers. Each notch has an enable state plus frequency offset and width. In the HR view, a notch can be moved while its exact offset/width remain editable in the notch controls.

6.2 MODE selector order

The visible MODE selector is presented in the following order. This is the operator-facing order only; it does not redefine the DSP implementation of the individual demodulators.

AM → SAM → CSB → AMQ AUTO → COH AM → COH2 → COH3 → C-QUAM → DSB → DSB-DQ → USB → LSB → USB-DQ → LSB-DQ → CW → FM → WFM

7.1 SPIKE FILTER (experimental)

SPIKE FILTER is an experimental impulse-noise tool for short broadband disturbance bursts such as atmospheric sferics. The intended target is a brief pulse or pulse cluster that would otherwise become a crack, short ringing burst or "ping" after narrow receive filtering. It is not designed only as a one-sample outlier remover.

- Detection is applied early enough in the receive chain that a short broadband impulse can be reduced before a narrow filter turns it into a longer ringing event.
- SPIKE SENSITIVITY controls how readily an event is classified as an impulse. Very aggressive settings can also react to wanted transients, so compare OFF and ON on the same signal.
- The filter is experimental. Use it as a listening aid; it does not alter DF calibration, station identity or logged frequency.

8.3 Direct notch placement and persistence

- **ADD NOTCH** in HR Carrier View places an available audio notch at the selected narrow carrier. **REMOVE NOTCH** removes the selected HR notch. The notch centre/offset and width remain editable under AUDIO NOTCH FILTERS.
- Notches are persistent per USER and are kept separately for CH1, CH2 and COMBINED. In RSRMW they are also stored per block so a notch created for one analysis block does not overwrite the notch set of another block.
- Changing source or block restores the matching saved notch set. The four notch positions remain independent.

8.2 AM Adjacent Suppression

AM Adjacent Suppression is intended for a strong station immediately below or above the wanted AM signal. Lower and upper sides are controlled independently.

Setting	Meaning
Lower enabled / Upper enabled	Turns suppression on for the selected adjacent side.
Offset	Positions the adjacent-interference region relative to the wanted carrier.
Width	Sets the width of the affected adjacent region.
Depth	Sets suppression depth from 0 to 60 dB.
Carrier notch	Adds the dedicated carrier-notch behavior for that adjacent side when required.

USE PROGRESSIVELY: Start with the side that actually contains the interfering station. Increase strength only as far as needed; very aggressive suppression can affect wanted audio near the passband edge.

9. Combined Channel Control - nulling and interference reduction

Several controls can make interference weaker, but they do so in very different ways. Some work inside a single IQ stream, some require two coherent antenna channels, and some are not nulls at all - they deliberately add signals constructively.

The key question is therefore not simply “which null is strongest?” but “what kind of interference do I have, and which information does the receiver have available to separate it?”

9.1 What each tool actually does

Use this table as the quick reference. “1 stream” means that coherent CH1+CH2 reception is not required merely to use that function. “2 coherent” means that phase coherence between both channels is essential.

Control	Input	Main objective	Best starting point
HP Filter - experimental	1 stream	Model / reduce an unwanted AM interferer from sideband symmetry	Adjacent AM QRM where the selected interfering station has usable information on at least one side.
Spatial - experimental	2 coherent	Directional phase/amplitude cancellation	Interferer arriving with a different CH1/CH2 vector than the wanted station.
MAX SIGNAL	2 coherent	Constructive combination for maximum carrier level	Wanted carrier is weak and both channels contain useful signal.
MAX SNR	2 coherent	Optimize wanted carrier relative to noise	Weak-signal listening where raw level is not the only goal.
AUTO NULL / NULL TRACKING	2 coherent	Destructive combination	Suppress a selected coherent signal/direction.
Carrier Track MAX / NULL	2 coherent	Slow audio-only tracking variants	Continuous listening after the desired objective is chosen.
Notch 1-4	1 stream	Reject a narrow tone/carrier	Whistle, heterodyne or narrow interfering carrier.
AM Adjacent Suppression	1 stream	Reject selected adjacent RF overlap	Strong station immediately above or below wanted AM.
Adaptive sideband / AMQ AUTO	1 stream	Choose the cleaner AM sideband	One sideband is cleaner; no directional null is required.

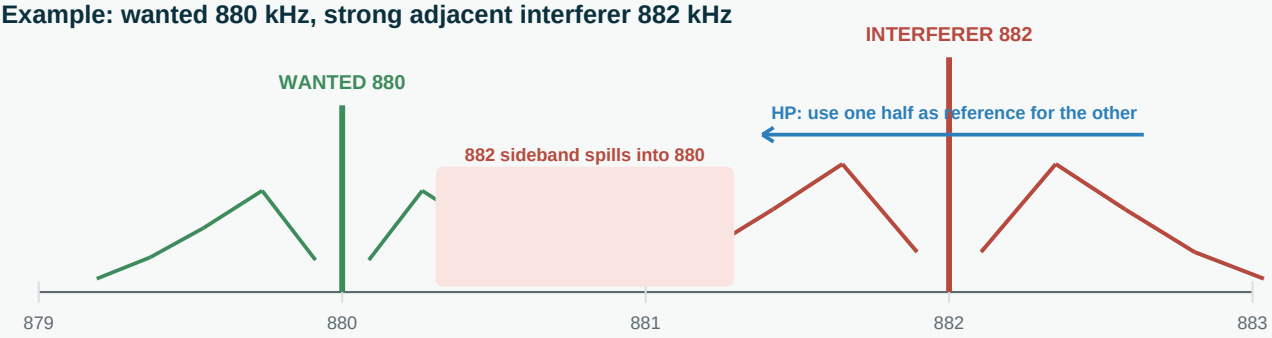
IMPORTANT DISTINCTION: MAX SIGNAL and MAX SNR are not null functions: they improve the wanted combination. AUTO NULL and Spatial search for cancellation. HP Filter works in the AM sideband/spectral domain and can work from one IQ stream.

9.2 HP Filter - new experimental filter type

HP Filter is a new experimental single-stream AM interference tool. A coherent CH1+CH2 pair is not required merely to use HP. In the current build its main purpose is to make a selected unwanted AM station less dominant by exploiting the relationship between that station's two sidebands.

Example: you want to listen to **880 kHz**, but a strong station on **882 kHz** produces sideband energy that overlaps the wanted 880 kHz passband. HP can target the 882 kHz station, use the cleaner half of its AM structure as a reference for the opposite half, and use that model to reduce part of the 882 kHz contribution. The result is not perfect separation, but 880 kHz can become audibly more open or freer.

Example: wanted 880 kHz, strong adjacent interferer 882 kHz



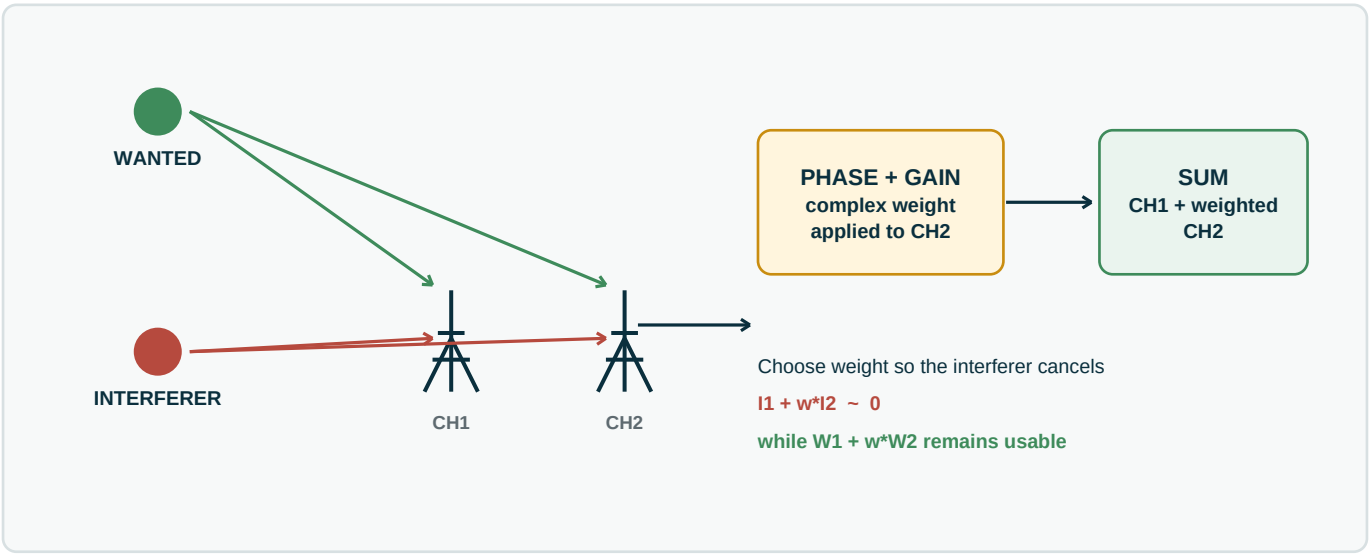
What HP is doing in the current build

- It works in the **AM spectral / sideband domain**, not by steering a two-antenna spatial null.
- The HP target can be the **unwanted adjacent AM carrier**, for example 882 kHz while listening to 880 kHz.
- One usable half of the selected interferer can help estimate or mirror the corresponding information on its other half, making the interfering contribution more predictable for reduction.
- The goal is practical QRM relief: reduce part of the selected interferer so the wanted station is easier to hear. It is not a promise of perfect source separation.
- The blue HP target line is a processing target. Moving it is not the same as retuning the receiver.

IN DEVELOPMENT - HP REPAIR / ENHANCE: A separate positive HP variant is being researched for the wanted station itself: use the cleaner wanted sideband, block by block, to repair or blend the damaged wanted sideband during adjacent QRM or selective fading. This is a future/experimental development and is **not presented as a current build function**.

9.3 Spatial nulling - use the two coherent channels as an antenna system

Spatial is different from HP. It requires a valid coherent CH1+CH2 pair. The same transmitter reaches both antennas with a characteristic relative phase and amplitude. A different transmitter, arriving from another direction, normally produces a different two-channel vector.



Why a spatial null can remove one station but not another

The cancellation coefficient is matched to the interferer's CH1/CH2 relationship. If the wanted station has a sufficiently different relationship, it does not cancel at the same coefficient. That is the spatial information: the antennas provide another dimension that a single IQ stream cannot provide.

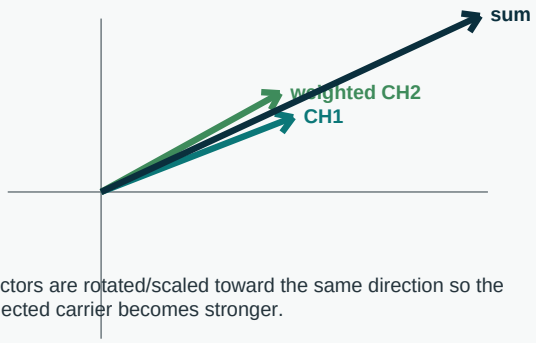
Control	What it searches for
Spatial - experimental	A phase/amplitude solution that reduces the targeted spatial interferer while preserving as much wanted audio as possible.
AUTO NULL / NULL TRACKING	A destructive coherent combination around the selected signal/target.
Carrier Track NULL	A slower audio-only coherent cancellation tracker; DF remains independent.

COHERENCE REQUIRED: If CH1 and CH2 are not a valid coherent pair from the same current receiver/path generation, Spatial or coherent nulling has no reliable physical meaning.

9.4 MAX SIGNAL and MAX SNR - constructive combining, not nulling

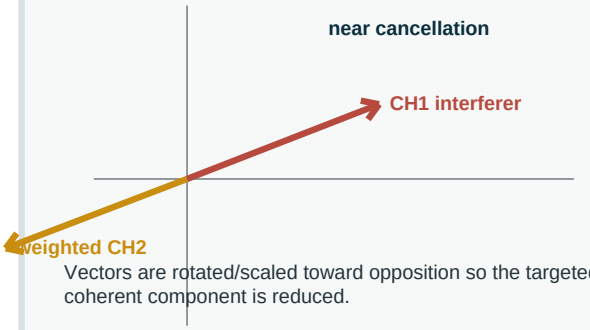
MAX SIGNAL and MAX SNR use the same coherent two-channel freedom - relative phase and balance - but their objective is the opposite of a null. They search for a useful addition of CH1 and CH2.

MAX SIGNAL / constructive



Vectors are rotated/scaled toward the same direction so the selected carrier becomes stronger.

AUTO NULL / destructive



Vectors are rotated/scaled toward opposition so the targeted coherent component is reduced.

Control	Objective	Practical interpretation
MAX SIGNAL	Highest absolute selected-carrier level	Useful when both channels carry the wanted signal well. It can also increase noise or QRM if those combine constructively.
MAX SNR	Best selected-carrier SNR	Often the more useful weak-signal objective when the strongest result is not the cleanest result.
Carrier Track MAX	Slow audio-only maximum tracker	Continuously follows a strong coherent combination for listening; it does not redefine DF.
Carrier Track NULL	Slow audio-only cancellation tracker	Opposes MAX when both are enabled; NULL has priority in the documented signal-option interaction.

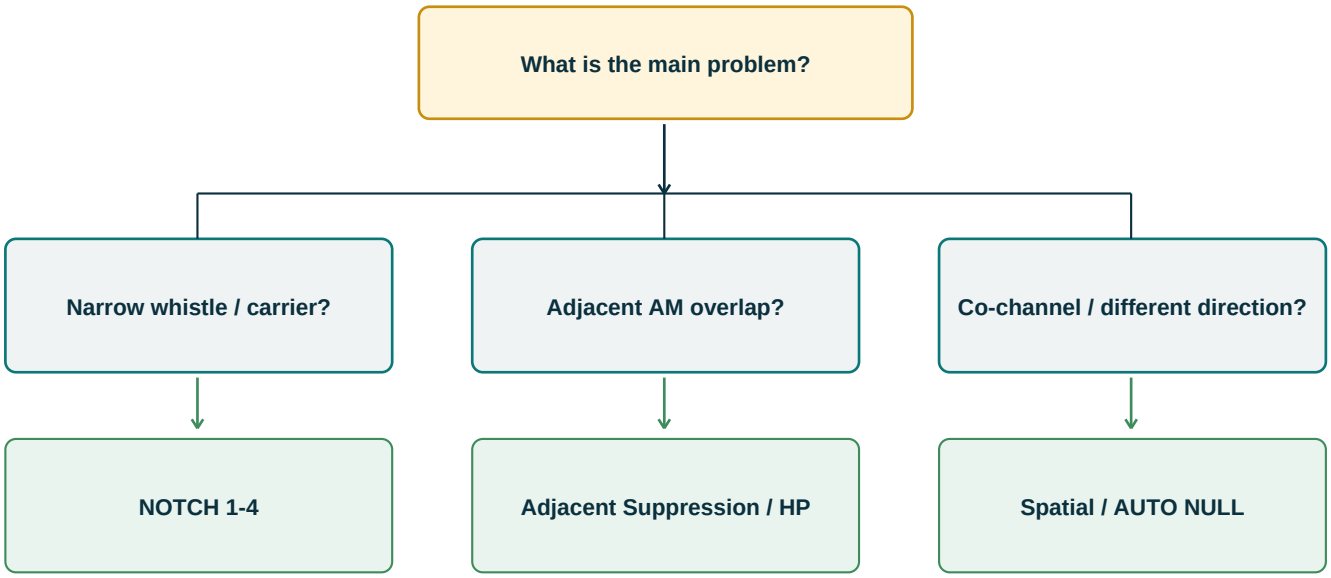
PRACTICAL RULE: For a weak wanted station, try MAX SNR first when noise/QRM dominates. Use MAX SIGNAL when raw carrier strength is the main problem. For an unwanted station from another direction, use a nulling objective instead.

9.5 Frequency-selective tools and a practical choice guide

Some problems are better solved without any spatial processing. A narrow heterodyne, an adjacent-channel overlap or a dirty AM sideband may be easier to remove directly in frequency/sideband space.

Tool	Use it when...
Notch 1-4	A narrow tone or carrier is the problem. Place the narrow rejection exactly on that component.
AM Adjacent Suppression	The dominant problem is a station immediately above or below the wanted AM passband.
Adaptive sideband / AMQ AUTO	One AM sideband is cleaner and simply selecting that side is enough.
HP Filter - experimental	An adjacent AM station is the problem and you want to model/reduce that selected interferer from its sideband structure.
Spatial - experimental	The problem is directionally separable and a valid coherent CH1+CH2 pair is available.

Which control should I try first?



9.6 Practical operating sequence

1. Start with the relevant processing OFF and listen to the unmodified signal.
2. Select the exact wanted carrier and make sure the active bandwidth/passband really contains the audio you want.
3. Decide whether you have one usable IQ stream or a valid coherent CH1+CH2 pair.
4. Choose one tool that matches the interference mechanism. Add a second tool only after the first has a clearly audible benefit.
5. Keep A/B comparing against OFF. A deeper-looking null is not useful if it removes intelligibility from the wanted station.
6. HP and Spatial may be combined experimentally, but there is no universal best setting or order; judge the result on the actual signal.

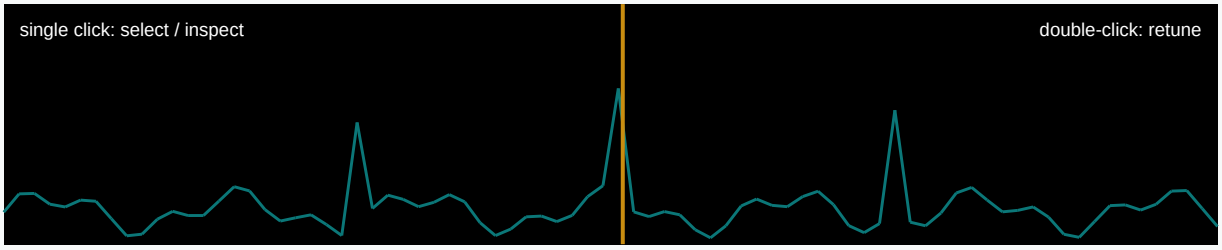
10. Spectrum, waterfall and signal meters

10.1 Main spectrum and waterfall

- **Double-click** in SPECTRUM, WATERFALL or BARS to retune intentionally. A normal single click is not the general retune action.
- Drag pans the frequency viewport. This is a view/LO navigation action, not a new carrier selection; the selected carrier and HR history remain authoritative.
- Mouse wheel zooms the RF view around the cursor.
- LEVEL/FLOOR and RANGE/CONTRAST are display controls; they do not alter raw IQ, DF phase or recorded data.

The selected antenna/source should drive both the main spectrum and waterfall consistently; a source change should not leave one display on a different channel.

Spectrum interaction at a glance



Drag = pan view | Mouse wheel = zoom | RF retune only on deliberate double-click

At first start, when no saved profile/display setting intentionally overrides it, the normal display defaults are RANGE/GAIN 100 dB and DISPLAY LEVEL -41 dBm. These are presentation defaults only; they do not change the incoming IQ or receiver gain.

Spectrum/waterfall zoom uses progressively finer real FFT products as the visible span narrows. The finest valid product remains authoritative: once fine data are available, a coarse preview must not overwrite them. Temporary missing data are shown as a hold/gap rather than a coarse fallback. At strong zoom the application can reach sub-Hz bin spacing when the source rate/data support it, and spectrum and waterfall use the same frequency mapping. Frequencies outside the actually received IQ coverage are black/no data, not synthetic or stale signals.

10.2 S-meter and units

Signal levels can be shown in dBFS. dBm is meaningful only when an appropriate calibration/offset is configured. Coherent receivers can show CH1/CH2/BOTH or combined-related readings as applicable. On RSPdx the upper meter shows only the antenna/input rows and the lower meter shows one active-antenna signal trace with its current value.

11. Fine Carrier / HR Carrier View

Fine Carrier / HR is the precision carrier-analysis view. It is designed for narrow-frequency work, weak carrier separation, precise manual target selection and the synchronized HR/AFC/DF target chain.

- The visible HR Carrier View is a narrow high-resolution window with a maximum span of 2 kHz (about +/-1 kHz around its chosen view centre); zoom can go narrower.
- The HR view centre can be moved independently within available LIVE/RSRMW coverage. If the new zone is outside the already available narrow IQ, the analyzer uses the correct RAW/spectrum data for that RF area.
- Selecting a carrier does not recenter the HR view. The selected carrier, audio reference and HR view centre are independent, and A -> B -> A carrier selection keeps the view/history in place.
- Carrier detection starts automatically in a newly visible valid RF zone; clicking a carrier is only for selecting a specific target.
- LOCK/HOLD/NO LOCK qualify the carrier solution. Pan/zoom and display floor/range do not retune audio, clear valid history or change Adaptive Sideband's RF reference.

RSRMW: When analyzing a recording, RSRMW navigation and HR selection must remain synchronized with the actual playback/sample position.

The HR view should begin drawing useful spectral information immediately after a target frequency is selected. Carrier LOCK refines the estimate; it is not a visibility gate. Existing history is persistent: normal UI/DSP state changes do not erase it. When valid data are unavailable, a black gap/interrupt is inserted and new valid measurements continue after the gap; stale data are never replayed as new measurements. Old history disappears only through an explicit history-clear action or normal oldest-data overwrite when a bounded history buffer is full. The live frequency and LOCK/HOLD/NO LOCK information overlay remains clipped inside the HR Carrier View.

12. Direction Finding: practical workflow

The DF system uses coherent CH1/CH2 phase together with antenna geometry and receiver/path calibration. A numeric bearing should only be trusted when the measurement is current and valid. On a single-channel RSPdx the DF result panel is hidden; use MWList, QTH bearings and the Azimuth Map without a measured PRIMARY/MIRROR overlay.

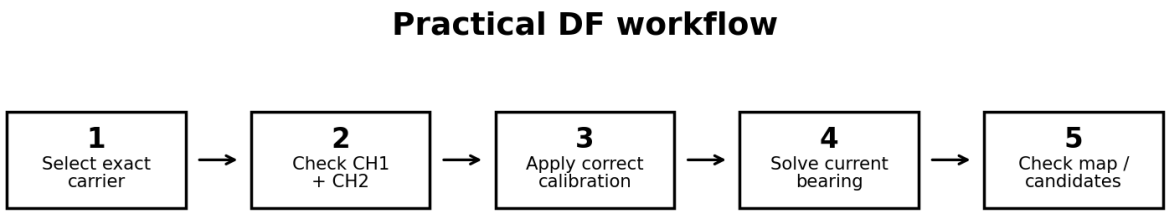


Figure 3. Practical DF workflow: select the exact carrier, verify both coherent channels, apply the correct calibration and only then interpret the bearing and station candidates.

1. Tune/select the exact carrier you want to measure.
2. Confirm both CH1 and CH2 contain usable current signal and that the coherent source is valid.
3. Wait for Fine Carrier/DF to show a current valid lock/measurement.
4. Confirm the correct antenna system and receiver path are active.
5. Confirm that a valid calibration model/reference set applies at this RF.
6. Read PRIMARY azimuth together with uncertainty/confidence. Remember that a two-antenna phase baseline normally also has a mirror ambiguity.
7. Use the Azimuth Map and MWList candidates as supporting evidence, not as automatic station proof.

MIRROR AMBIGUITY: A two-antenna baseline can produce two geometric azimuth candidates. The map can display PRIMARY and MIRROR; antenna directivity, known geometry and station evidence help resolve the ambiguity.

12.1 Elevation measurement and accuracy

Azimuth is the horizontal compass direction to a transmitter. Elevation is the vertical arrival angle above the local horizon. The ELEVATION DF display should therefore be read as a separate propagation/geometry estimate, not as another azimuth value.

Elevation is normally harder to determine reliably than azimuth. A horizontal two-antenna baseline is primarily sensitive to horizontal direction; a strong elevation solution needs suitable antenna geometry, a validated model and stable phase information. On MW, skywave, ground reflections and multipath can change the apparent arrival angle quickly.

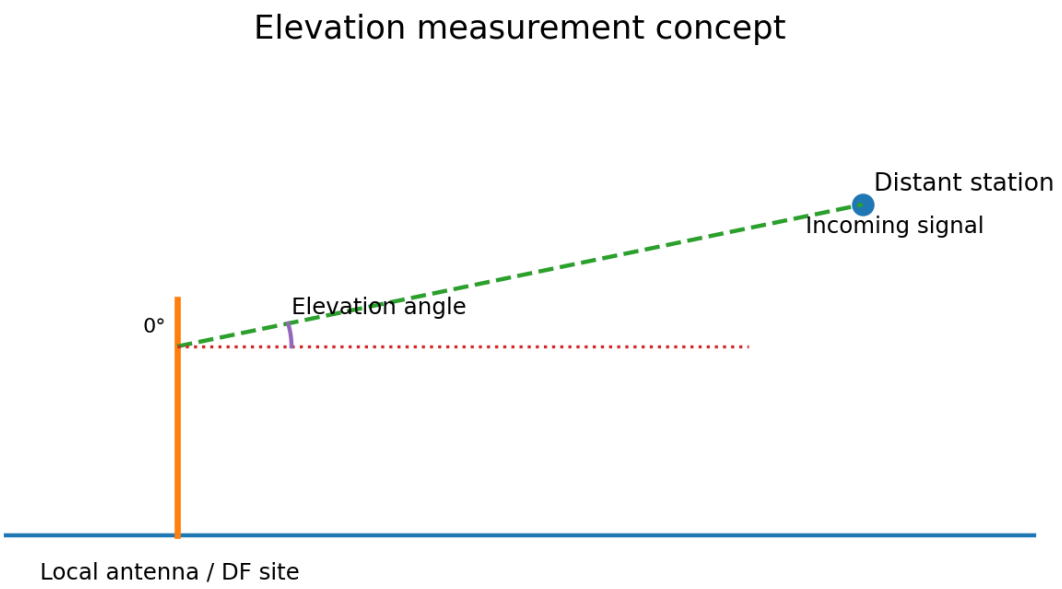


Figure 4. Elevation is the angle above the horizon. It is most useful as supporting propagation information unless the vertical geometry and calibration are well proven.

Practical accuracy: under controlled geometry with a strong stable path, repeatable single-digit-degree behaviour can be meaningful, but it is not a guaranteed specification. Night-time MW skywave and multipath can produce much larger apparent errors or real short-term changes.

- Trust repeatability and stability more than a single impressive-looking number.
- Large rapid elevation changes usually deserve a multipath/fading check before interpretation.
- Use elevation together with azimuth, confidence/uncertainty, signal stability and known-station checks.
- If the active antenna geometry does not provide a useful vertical aperture, treat elevation as an estimate rather than an independently precise measurement.

13. DF calibration and known-station references

13.1 Why calibration is frequency dependent

Receiver, cable and path phase are not assumed to be one fixed angle across the entire band. The current calibration architecture stores reference evidence and evaluates a frequency-dependent correction for the active receiver/path/antenna system.

13.2 Add a known-station reference

1. Receive a station whose transmitter identity and location are known.
2. Acquire the exact selected/locked carrier with current coherent CH1+CH2 IQ.
3. **In the right-side MWLIST DATABASE panel, open the DIRECTION FINDING section and choose ADD DF REFERENCE. This control is no longer duplicated in the main RSR200B hardware menu.**
4. Enter or confirm the station/transmitter name and exact transmitter latitude/longitude. A selected MWList row may prefill these fields, but it is not accepted as proof automatically.
5. Use CALCULATE BEARING + DISTANCE FROM QTH and check that the calculated station direction is plausible.
6. Explicitly confirm that this is the received station/transmitter, then add the reference.
7. Repeat at other useful frequencies/known stations. Compatible references refine the model; additional frequency spread normally improves the calibration model.

10.3 Processed-spectrum feedback

When a processing function changes the signal in a way that is meaningful in the spectrum, the main and mini spectrum are intended to show the processed result rather than continuing to display only the unprocessed input. This applies to the active NULL/HP/SPATIAL processing paths where a processed spectral preview is available.

- While the blue HP/SPATIAL target line is dragged, the mini-spectrum trace and peaks remain visible and continue updating so the target can be placed on a real carrier.
- Releasing the target returns the mini spectrum to its normal processed view; dragging is a placement operation and does not clear the spectrum history.
- The small spectrum follows the selected RSRMW block centre when the active block changes.

11.1 HR Carrier View interaction

- HR zoom remains centred on the carrier that was clicked/selected. Zooming must not drift the view away from that carrier.
- The HR spectrum emphasizes narrow vertical carriers; horizontal display streaks/lines are not part of the intended carrier presentation.
- ADD NOTCH / REMOVE NOTCH can be used directly from the HR carrier context. The current notch band and centre are shown while positioning/editing the notch.

11.2 Demodulated audio and carrier lock

Carrier lock and audio validity are deliberately separated. HR/DF may show HOLD, NO LOCK or STALE when there is not enough current carrier evidence for a fresh measurement, but ordinary demodulated audio is not gated off merely because that measurement lock is absent. If audio disappears while tuned correctly, check source, mode, bandwidth/passband, volume and audio output rather than treating an HR lock as a prerequisite for sound.

12.2 Instantaneous and averaged DF presentation

- The main DF arrow is the **instantaneous** current azimuth when a valid measurement is available.
- The separate azimuth/DF popup can show a **running average while that popup remains open**. The averaging period belongs only to one continuously selected carrier.
- Selecting another carrier resets that running average. Measurements from a previously selected carrier are not mixed into the new carrier.
- MATCH % follows the current carrier and the active matching method; it must not be a stale historical average from another carrier.

IMPORTANT: The reference capture uses fresh coherent raw CH1/CH2 evidence; it must not depend circularly on already having a valid calibrated bearing.

13.3 Common reference states

State	Meaning
VALID / USED	Reference is compatible with the active context and contributes to the model.
STALE	Receiver/path/source/RF generation changed while the measurement was being captured.
NO LOCK	Target is selected but no sufficiently reliable current carrier phase measurement exists.
CALIBRATION REQUIRED	No suitable enabled reference/model anchors the current receiver/path/antenna system.
CONFLICT / INVALID	Reference evidence or model is statistically/physically inconsistent for the active solution.

13.4 Calibration Graph

CALIBRATION GRAPH visualizes the DF references that belong to the currently loaded USER. The X-axis is reference frequency and the Y-axis is azimuth in degrees. It is intended to show at a glance how the measured DF result compares with the geographically expected direction across frequency.

ACTUAL: the azimuth recalculated from the loaded USER QTH and the transmitter coordinates stored with the reference.

MEASURED: the real bearing produced by the software during a valid DF-reference capture and stored as MeasuredAzimuthDeg. New or repeated valid captures update this stored measurement and the graph refreshes immediately.

The graph uses small round points and smooth visual connecting curves for both series. The points remain the authoritative measurements; the smooth line is only a visual aid. A line is broken at the 359/0-degree wrap so a north-crossing sequence is not drawn incorrectly across the whole chart. Zoom, pan and reset-view are available for detailed inspection.

Older USER/reference files may contain raw phase and calibration evidence but no stored MEASURED azimuth. In that case the graph correctly shows ACTUAL only. The software does not invent a historical bearing from theoretical azimuth or raw phase; re-measure the reference if a MEASURED point is required.

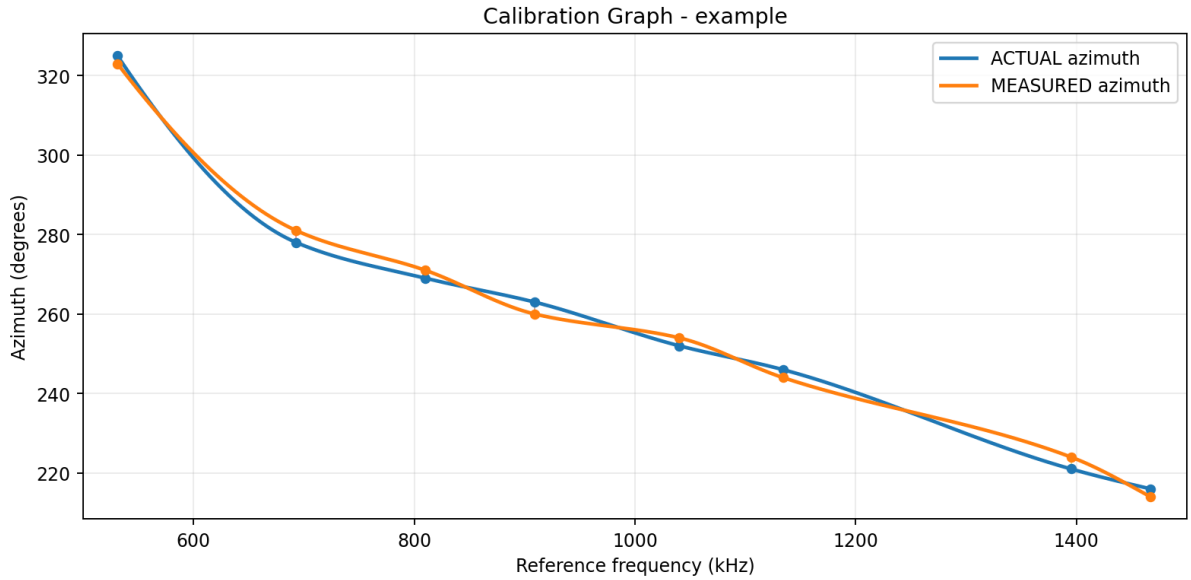


Figure 5. Calibration Graph example. ACTUAL and MEASURED are separate USER-specific data series; small vertical differences show the bearing error at each reference frequency.

14. Azimuth Map

The Azimuth Map is receiver-centred and uses a great-circle azimuthal-equidistant projection: direction from the centre corresponds to the initial great-circle bearing, while radius represents distance.

- PRIMARY DF and MIRROR DF can be shown/used independently when a coherent DF source is active. With RSPdx these measured overlays are unavailable, but the map itself remains fully usable.
- Antenna heading and -3 dB beamwidth can be displayed as an antenna-lobe sector.
- Great-circle range rings and world graticule provide geographic context.
- MWList transmitter candidates are plotted when the QTH and station database are available. Standard map markers are dots: logged stations are green and not-yet-logged stations are blue station text/details appear on hover.
- Candidate matching uses the same running-average match state as the MWList list; highest average match is ranked first. The visible MATCH % follows the matching method selected in DF/calibration settings and the current carrier context; changing the selected carrier starts a new averaging period.
- A selected candidate is an identity choice only; automatic ranking does not prove that the station has been heard.
- Logged state comes from the active USER logbook. Imported logs and newly saved logs are treated identically, so a station becomes/remains green on the Azimuth Map after import, logging, USER switching and restart.
- Hover information can include station/site data and available day/night transmitter power.

QTH REQUIRED: If receiver latitude/longitude are missing, the map cannot calculate valid receiver-centred bearings and will request USER / STATION coordinates.

15. MWList and local logbook

15.1 Candidate ranking

Around the current MW channel, the MWList panel shows possible transmitters. The application accumulates a running average match for each candidate while the same listening context remains active. Where coherent

14.1 Last-valid bearing on map views

Map views preserve orientation when a fresh DF measurement temporarily disappears, but they distinguish that retained direction from a current measurement.

- Opening the 3D map uses the most recent valid DF/azimuth snapshot for the currently selected carrier when one exists.
- If lock is subsequently lost, that direction may remain visible as **LAST VALID / STALE**. It is an orientation aid only and must not be interpreted as a new measurement.
- The map refresh action requests the latest state for the current carrier. A newly valid bearing replaces the stale snapshot.
- The Great-Circle DF popup follows the same principle: the last direction may remain visible as stale rather than disappearing immediately when current lock is lost.

14.2 Station markers

The standard station-marker convention is the same in the normal Azimuth Map, FLAT MAP and 3D map: **green = logged** and **blue = not logged**. Logged state is derived from the active USER logbook and the relevant UTC date/context where the view is date-sensitive.

STALE MEANS NOT CURRENT: A retained map arrow is useful for orientation, especially during fading or playback navigation, but only a fresh valid DF state should be used as the current measured bearing.

SELECTION IS EXPLICIT: The best-ranked row is not automatically selected as station identity. Click a row when you actually want to identify it.

A successfully imported MWList database is stored locally and automatically loaded at the next application start. A new import replaces the local active database only after the new copy has been saved successfully; a corrupt/missing local database is reported without crashing and can be re-imported.

15.2 Tune to station

Selecting a MWList row does not automatically retune the receiver. TUNE TO STATION is a deliberate LIVE action. This prevents candidate browsing from unexpectedly changing the current radio/DF target.

15.3 Local logging

The local logbook stores station/frequency and listening details. A new log can include UTC date/time, exact frequency, SNR, calibrated dBm, SINPO, public details and private details.
• SNR is captured from the selected carrier/source context when LOG is opened. SAVE keeps that snapshot; if no valid SNR exists, the field stays empty.
• Station latitude/longitude stored with the log are shown compactly in LOGBOOK and remain available to the Azimuth Map; old entries may fall back to MWList when coordinates are absent.
• SAVE LOG adds the entry to the active USER's persistent logbook. PUBLISH TO MWLIST uses the selected station and configured account.
• LOGBOOK import/export/synchronize supports CSV and ODS with add-only duplicate protection (station identity + UTC calendar day). Direct MWList log CSV import is supported for historical logs.

16. RSRMW: recordings, import and navigation

16.1 Import / analysis presets

Preset	Use
MW 10 kHz	10 kHz broadcast-channel analysis.
MW 9 kHz	9 kHz broadcast-channel analysis.
MW 9 + 10 kHz	Combined channel-grid analysis.
Continuous / Other	General non-channelized or non-MW analysis.

The import dialog can also select dual-channel mode, analysis quality, seconds-per-line/time resolution, FFT density, contrast and channel inclusion/exclusion. Higher resolution costs more import time and cache space.

16.2 Cache / direct reopen

Validated RSRMW cache/index data can be stored beside the RAW recording. When a compatible cache exists, the recording can be reopened without repeating the full import. If the cache is unavailable or invalid, import the recording again.

16.3 Timeline and navigation

- Clicking a time position in the RSRMW bars/timeline seeks to that point.
- If the same click also hits a carrier, the carrier may be selected while the seek still occurs.

15.4 MWLIST DATABASE / DIRECTION FINDING controls

The compact right-side MWLIST block is arranged for candidate search and explicit station selection rather than for every possible log/publish action.

Control / item	Operation
SHOW MWLIST MAP	Opens the MWList/Azimuth Map view for the active candidate context.
SEARCH FREQUENCY	Enter a positive frequency in kHz to show candidates around that frequency.
SEARCH STATION	Enter a station name or part of a name to filter/find station entries.
ADD DF REFERENCE	Uses the explicitly selected known station as the identity for a DF-reference capture.
ADD LOG FOR SELECTED STATION	Opens a new local log for the explicitly selected station.
Frequency tolerance	Sets the candidate frequency search tolerance.
REFRESH CANDIDATES	Rebuilds the candidate list from the current search/QTH/region/match context.
World-region filters	ALL / NA / SA / EUR / AFR / ASIA / OCE include or exclude regions from the candidate list.

Publishing details, exact-frequency publishing and the full local-logbook workflow are not required to occupy the compact right-side candidate block; use the applicable logbook/publish workflow when those functions are needed.

15.5 LOGBOOK STATISTICS / ANALYSIS

- Statistics can use ALL log entries or a selected UTC date range. Summaries include countries, continents, USA states and unique stations where the stored data support them.
- Time views can be grouped by day, month or year and displayed PER PERIOD or CUMULATIVE.
- **UNIQUE STATIONS uses stable station identity.** An existing station/MWList identifier is used where available; older entries without such an identifier use one consistent canonical station key derived from their stored station data. Display/sort rows themselves are not treated as separate stations.
- Duplicate log rows for the same station therefore do not inflate the overall UNIQUE STATIONS total. In per-period statistics the same station counts once for that period; it can count again in another period when that is what the selected time aggregation represents.

- Playback time, audio, HR and DF should all refer to the same authoritative sample position.
- Multiple compatible segments are treated as one logical recording sequence.

During active RSRMW file playback, the recording date/time at the current sample position is shown next to the computer clock in the same display format. It follows PLAY, PAUSE and seek operations so the operator can compare recording time and current PC time without opening another panel.

16.4 BARS, SPECTRUM and display scaling

BARS and SPECTRUM are two views of the current RSRMW file/session; opening a different file replaces the old file-specific display. SPECTRUM keeps its own vertical dBm scale where calibration permits. The intensity mapping changes presentation only, not measured data, DF or playback. Green logged-frequency labels follow the UTC date represented by the loaded recording/playback context, not merely the computer's current calendar day.

17. Recording and scheduler

The integrated recorder captures IQ from the active LIVE receiver. Once recording is active it continues until the user explicitly stops/finalizes it (including an explicit confirmed application exit). Loading or navigating RSRMW files, playback/seek, panel changes and other normal software actions must not stop the recorder. The application reports recording state, finalizing state, gaps, disk/write errors and available disk capacity; RECORDING ACTIVE is also visible in the RSRMW main window while LIVE recording continues.

17.1 Before recording

- Connect the LIVE receiver and start IQ.
- Verify the authoritative sample-rate readback and recorder centre/span.
- Choose the destination folder and confirm enough free disk space.
- While recording, the hardware centre/LO remains fixed so the RAW metadata stays valid. The display may be panned outside recorded IQ coverage, but uncovered RF is shown as black/no data; recording continues without an implicit stop. Other protected physical changes are allowed only where the UI/driver can preserve recording continuity and metadata correctness.

After STOP, the recorder may briefly show FINALIZING while the writer closes/renames metadata safely. A new recording is not started until the previous worker has fully finished, preventing two sessions from sharing counters or manifests.

17.2 Scheduler

- One-shot scheduling uses a future UTC date/time.
- Daily scheduling uses UTC start/stop times in HH:mm format.
- For scheduled recording, keep receiver availability and disk capacity in mind.

Automatic recording filenames use the compact form rsr200df_YYYYMMDD-HHMM-HHMM plus the normal file extension. Example: rsr200df_20260814-0244-0254. Seconds and separators inside the date/time fields are intentionally omitted for shorter filenames.

If the application is closed while the recorder is active, a confirmation asks: "Are you sure? Recorder is active." YES finalizes/stops the recording and then exits; NO cancels the application close and leaves the recording active.

18. Settings, profiles and persistence

18.1 USER profiles

At least one USER profile always remains. Profiles can be created, selected, deleted, saved and transferred as portable RSR200B USER profile text files. QTH, MWList access and active antenna identity are persistent profile data, and each USER has its own persistent local logbook. Corrupt or temporarily unreadable profile/logbook

16.5 IMPORT, LOAD and recording indexes

IMPORT and LOAD have deliberately different meanings. IMPORT performs analysis and builds/repairs the recording index. LOAD opens already completed indexed analysis and must not silently start a full re-import.

- A completed shared session index such as ***.raw.session.rsridx** / ***.session.rsridx** can be selected with LOAD for a fast reopen of the analyzed recording.
- If an index is incomplete, invalid, belongs to changed RAW data or does not have its required RAW segments, LOAD reports the problem. Use IMPORT explicitly to rebuild it; LOAD does not begin analysis on its own.
- As soon as a real import starts, the UI shows an immediate **IMPORTING...**/busy indication so there is visible feedback before the first analyzed rows appear.

16.6 RSRMW BARS / SPECTRUM behaviour

- After import completes, the initial BARS/SPECTRUM view is fully refreshed and scaled immediately. A first zoom action is not required merely to make the normal blocks visible.
- Switching the display unit between SNR and dBm rescales/relabels the same underlying data. It must not delete or hide the existing BARS history.
- Zoom-out can return to the full recorded spectrum rather than stopping at an artificially narrow 300-400 kHz view.
- The green logged-frequency indication follows the **UTC date represented by the loaded recording/playback position**, not merely the computer's current date.

16.7 LIVE BARS

- LIVE BARS builds the BARS-style history directly from current LIVE spectrum/FFT data. It does not need to re-read a RAW file that may simultaneously be recorded.
- LIVE BARS can run while LIVE reception is active even when recording is OFF.
- When BARS is selected in LIVE, the MW raster can be chosen as 9 kHz or 10 kHz where the active LIVE source supports the view.

storage is treated as a recoverable read-only condition rather than being silently replaced by empty fallback data.

- Use a separate profile when another receiving site or antenna/calibration context should not share the same station settings.
- Do not assume a copied profile creates valid DF calibration for different physical hardware.

18.2 What is normally persisted

- Mode/bandwidth and relevant audio/DSP settings.
- Volume/output/display preferences.
- Panel visibility and workspace state where appropriate.
- Waterfall/spectrum presentation and theme colours.
- User/QTH/MWList access, active antenna-system identity, locally imported MWList database and USER-specific logbook state.

HARDWARE STATE: Physical receiver state that may be unsafe or stale should be obtained from the current hardware/driver rather than blindly assumed from an old session.

- A successful MWList import is stored locally and loaded automatically on the next start. A USER logbook also reloads automatically and continues to accumulate new SAVE LOG entries. Theme colours are persistent per profile; the public beta default theme is derived only from the designated default-beta colour profile, not from any personal USER/QTH/logbook data.

19. Panels, CONTROLS menu and layout

The right side is organized into functional panels such as MODE, SIGNAL OPTIONS, COMBINED CHANNEL CONTROL, notches, MWLIST DATABASE / DIRECTION FINDING, LOGBOOK and receiver-specific analysis panels.
• Closing/hiding a panel is a layout action and does not delete its DSP/settings state.
• Supported panels can be detached and dragged back to dock; RESTORE DEFAULT returns the canonical docked layout.
• The MWLIST station-table block detaches as one complete unit. In the normal docked state it has no permanent extra drag header or splitter.
• Panel visibility, ordering/layout where supported, display choices and theme colours remain persistent through the existing profile/workspace settings.
Use CONTROLS to restore a hidden panel. HELP > MANUAL opens this user manual.

This manual follows the current BETA 2.4 labels and behaviour. Receiver-specific controls are hidden when they do not apply.

17.3 Hardware controls while recording

A running recording owns physical receiver state that would invalidate the recorded metadata if it changed unexpectedly. For that reason RF GAIN / HARDWARE is blocked while recording is active.

> **"RF GAIN / HARDWARE is not available during recording."**
> Stop/finalize the recording before changing protected physical gain, AGC or input routing.

18.3 Source-, USER- and block-specific persistence

- Right-menu per-channel listening/DSP settings are saved for the active USER and the applicable source: CH1, CH2 or COMBINED.
- The four notch settings are likewise independent by USER and source. In RSRMW they are additionally independent per analysis block.
- A change made in one block or source therefore does not overwrite the corresponding settings of another block/source; returning to it restores its own saved state.

19.1 Layout persistence and panel treatment

- Movable/dockable panels use a visible border in the same visual family as the VOLUME block so their movable extent is clear.
- The full strip above the main spectrum - including SPAN, VIEW CENTER, RF LO, DISPLAY LEVEL, DISPLAY GAIN / RANGE and DISPLAY - is treated as one movable/dockable strip.
- The saved panel arrangement is stored per Windows account in the application user-data area under AppData and is restored on normal restart.
- **RESTORE DEFAULT** resets the layout only. It does not intentionally reset frequency, mode, bandwidth, DSP, DF calibration, logbook or recorder settings.

19.2 RSRMW right-side playback area

- The redundant upper RSRMW import/load/status block is not part of the compact right-side column. Import and load remain available through the top-menu/recordings path.
- The complete **RECORDING TIME / PLAYBACK POSITION (UTC)** section is placed at the top of the RSRMW right-side playback controls so the current recorded position remains directly visible.

20. Complete control reference

This chapter lists the user-visible controls in the current BETA 2.4 feature set. A control may be hidden or disabled when it does not apply to the active workspace, receiver, source or mode. Short workflow explanations remain in the preceding chapters.

STATE RULE: Changing CH1, CH2 or COMBINED is a source-selection action. It must not silently alter MODE, frequency, bandwidth, passband, volume or other independent receiver settings.

20.1 Top menus and quick controls

Control	Function
RSR200B / RSRMW	Selects the LIVE receiver workspace or the recorded-file analysis workspace.
CONTROLS	Opens panel visibility/layout commands and access to right-side control panels. Closing a panel does not delete its DSP or receiver state.
X-PANELS	Shows/hides individual right-side panels.
RESTORE DEFAULT LAYOUT	Restores the standard panel/right-column layout without intentionally resetting receiver/DSP settings.
FREQ STEP	Selects tuning step: 10 Hz, 1 kHz, 2.5 kHz, 5 kHz, 10 kHz, 100 kHz, 1 MHz or 10 MHz.
DF METHODS / CALIBRATION	Opens DF/calibration methods and calibration tools through CONTROLS; measured DF controls are unavailable on single-channel RSPdx.
RSRMW MW GRID	Selects 9 kHz or 10 kHz MW grid for RSRMW analysis.
LIVE IQ RECORDER / SCHEDULER	Opens the integrated LIVE IQ recorder and scheduling controls.
HELP / MANUAL	Opens MANUAL from the HELP menu; the menu uses the same submenu/chevron convention as CONTROLS and SETTINGS.

20.2 Main frequency, display and meter

Control	Function
Frequency display	Click for direct kHz entry (for example 1530.000 + ENTER); mouse wheel over a digit tunes authoritatively and does not revert on tracker refresh.
MODE	Selects the demodulator; see Chapter 6 for every mode.
BANDWIDTH	Sets the wanted RF/demodulation passband.
PASSBAND SHIFT	Moves the passband relative to the selected carrier without changing station identity.
VOLUME	Normal listening level.

Control	Function
AUDIO OUTPUT GAIN	Fixed output headroom/gain choices 0, +6, +12 or +18 dB; separate from VOLUME.
SPAN	Controls visible main-spectrum bandwidth.
VIEW CENTER	Moves/pans the display centre without changing the selected carrier. Outside current IQ coverage, the LO may follow when not recording; during recording the LO stays fixed and uncovered RF is black.
RF LO	Shows/sets the hardware centre where the active receiver path permits it.
DISPLAY LEVEL	Moves the displayed baseline/floor.
DISPLAY GAIN / RANGE	Changes visual contrast/range; it does not change RF hardware gain.
BARS / WATERFALL / SPECTRUM	Selects the active display presentation.
S-METER source / antenna	Shows source-dependent signal values. Coherent receivers use CH1/CH2/BOTH as applicable; RSPdx uses ANT1/ANT2/ANT3 and one active-antenna lower trace.

20.3 MODE and audio-filter controls

Control	Function
AM, SAM, CSB, AMQ AUTO, COH AM, COH2, COH3, C-QUAM, DSB, DSB-DQ, USB, LSB, USB-DQ, LSB-DQ, CW, FM, WFM	
CH1 / CH2 / COMBINED or ANT1 / ANT2 / ANT3	Selects the audio/display signal source. RSPdx uses the three physical antenna inputs and has no BOTH/coherent combine source.
LOW EDGE / HIGH EDGE	Sets explicit lower and upper filter edges where the selected mode uses them.
SHARPNESS: NORMAL / SHARP / VERY SHARP	Controls filter transition steepness. Steeper is not always more natural-sounding.
FM-W de-emphasis: OFF / 50 us / 75 us	Selects wide-FM de-emphasis standard.
AUDIO LOWPASS (kHz)	Limits high-frequency audio; 0 means off where shown.
SAM / COH* / CSB carrier reference AUTO	Lets the carrier engine choose reconstructed-carrier ENBW with hysteresis.
Manual carrier ENBW	Sets two-sided carrier-reference ENBW when AUTO is off.
Passband shift (Hz)	Numerical version of PASSBAND SHIFT.
Audio high-pass (Hz)	
RSRMW AUTO MASTER search width	Total search width used by the recorded-file master-carrier logic.

20.4 SIGNAL OPTIONS, adjacent suppression and notches

Control	Function
DX AGC	Post-demodulator level control for weak/fading audio; carrier lock and DF remain independent.
Impulse NB	Suppresses short impulses after wanted-channel isolation.
NB effect 0-100	Controls blanker sensitivity/replacement strength; 0 is most conservative.
Carrier track MAX	Tracks coherent phase/balance for maximum selected-carrier level.
Carrier track NULL	Tracks a coherent cancellation solution for co-channel interference; takes priority over MAX if both are selected.
Speech enhance	Adds mild speech presence/soft limiting.
Speech effect 0-100	Controls speech enhancement strength.
Adaptive sideband	Selects the cleaner AM sideband from current Fine Carrier evidence.
AM ADJACENT SUPPRESSION	Master enable for the lower/upper adjacent rejection settings.
LOWER / UPPER enable	Activates suppression on only the side containing the interfering station.
OFFSET / WIDTH / DEPTH	Positions the adjacent region, sets affected RF width and suppression depth (0-60 dB).
CARRIER NOTCH	Adds the optional carrier notch for that adjacent side.
Notch 1-4 enable	Enables each independent per-carrier notch.
Notch offset / width	Sets distance from selected carrier and rejected width; enabled markers can be dragged in Fine Carrier.

20.5 COMBINED CHANNEL CONTROL and playback audio

Control	Function
Phase (-180 to +180 degrees)	Manual relative CH2 phase applied to audio combining.
Balance (-60 to +60 dB)	Manual relative CH2 level applied to audio combining.
MAX SIGNAL	Tracks the highest absolute selected-carrier level.
MAX SNR	Tracks selected-carrier SNR using a fixed off-passband noise reference.
AUTO NULL	Tracks a cancellation solution.
STOP / HOLD	Freezes the current coefficient and stops tracking without resetting phase/balance.
RESET 0 / 0	Stops tracking and returns phase/balance to zero.

Control	Function
START PLAYBACK / STOP PLAYBACK	Starts or stops RSRMW audio.
Auto-retune while tuning	Keeps playback demodulation following tuning changes.

20.6 Fine Carrier / HR and DF

Control	Function
Carrier kHz / exact carrier GO	Enters the exact carrier/master target.
AUTO CARRIER	Automatically searches/reacquires when valid carrier data arrive; a manual click is not required to restart search.
Search width (Hz)	Sets the carrier-search window around the selected target.
FIND STRONGEST PEAK	Selects the strongest plausible peak in the visible Fine Carrier window.
HR span	Maximum visible HR span is 2 kHz (about +/-1 kHz around the chosen HR view centre); zoom can go narrower for fine carrier work.
Waterfall analysis seconds	Sets the history interval used to build the high-resolution view.
REFRESH HIGH RES	Refreshes/rebuilds the current high-resolution analysis without automatically deleting accumulated HR history.
AUTO PASSBAND	Builds a useful passband from the current HR evidence; requires a suitable HR span.
SHOW ANALYSIS DIAGNOSTICS	Opens advanced HR/FFT/lock diagnostic information.
LOCK / HOLD / NO LOCK	Shows current carrier state inside the HR view together with the current carrier frequency; state changes do not clear existing HR history.
DF compass	Shows PRIMARY and AMBIGUITY directions, phase/balance and current validity. Hidden when RSPdx is active.
DF ANALYSIS / RESULT	Shows detailed carrier, phase, calibration, antenna and uncertainty evidence. Hidden when RSPdx is active.
AZIMUTH HOLD	In RSRMW, preserves the current bearing while playback navigation changes.
Phase over time / window length	Measures phase stability over a selected time window from the current position.

20.7 Azimuth Map, MWList and Logbook

Control	Function
MAP	Opens the receiver-centred Azimuth Map.
PRIMARY / MIRROR	Shows either or both measured two-channel DF candidates when coherent DF is available; absent on RSPdx while the map remains usable.

Control	Function
Antenna lobe	Shows the saved antenna heading and -3 dB beamwidth.
Range rings / world graticule	Adds distance/orientation references to the map.
MWList frequency tolerance	Sets how close database entries must be to the current MW frequency.
REFRESH CANDIDATES	Rebuilds candidates using current frequency, QTH, region filters and match evidence.
ADD LOG FOR SELECTED STATION	Opens a new local log for the explicitly selected candidate.
ADD DF REFERENCE	In MWLIST DATABASE > DIRECTION FINDING, uses the selected known station identity to create a coherent DF calibration reference.
TUNE TO STATION	Explicitly retunes LIVE; ordinary row selection never tunes.
OPEN MWLIST MAPS	Opens the MWList/Azimuth Map workflow; stations from the active USER logbook are shown as logged (green).
DETAILS	Optional public MWList comment, maximum 135 characters.
PUBLISH EXACT FREQUENCY	Publishes the current authoritative manual HR MASTER when available.
LOG TO MWLIST	Posts the selected candidate using configured account and active RX-QTH identity.
ALL / NA / SA / EUR / AFR / ASIA / OCE	Includes/excludes world regions from candidates.
CURRENT FREQUENCY / ALL LOGS	Selects local-logbook scope.
Log fields	UTC, exact frequency, SNR snapshot, calibrated dBm, SINPO, stored station coordinates, public details and private details.
Import / export / synchronize CSV / ODS	Exchanges compatible USER logbook data. Direct MWList log CSV import is supported; synchronized imports are add-only and update logged-state map colouring.

20.8 RSRMW import, timeline and playback

Control	Function
IMPORT / LOAD	Opens compatible RAW/IQ recordings; supported import paths include RAW/WAV/IQ/JSON/CSV according to source metadata.
MW 10k / MW 9k / MW 9+10k / Continuous-Other	Selects the analysis preset.
Dual-channel mode: CH1+2 / CH1 / CH2	Selects which recorded channels are imported/analyzed.
FAST / HIGH QUALITY / CUSTOM	Selects import-analysis quality.
Seconds per line	Sets time resolution of the RSRMW display.
FFT samples / minute	Sets analysis density.

Control	Function
dB min / highlight / max	Sets RSRMW intensity mapping. Values below the visibility/noise gate remain black; the display mapping does not change measured data.
Hidden channels / included off-channel stations	Controls which channel rows are displayed/analyzed.
START IMPORT / CANCEL	Starts or cancels the import/index process.
PLAY / PAUSE / STOP	Controls recorded-file playback.
-60 / -30 / -10 / -1 / +1 / +10 / +30 / +60 s	Relative timeline jumps where shown.
GO TO UTC / TIME	Seeks to an exact recording time.
Timeline/BARS click	Always seeks to the clicked time; a carrier hit may additionally select that carrier.
Cache / direct reopen	Uses a validated recording index/cache to avoid unnecessary full re-import; opening another file replaces the current file-specific RSRMW display.
Recording timestamp beside PC clock	During active RSRMW playback, shows the date/time of the current recording sample next to the computer clock and follows play/pause/seek.
BARS / SPECTRUM	Switches RSRMW presentation while preserving playback, selected time/carrier, HR and DF state. SPECTRUM has its own vertical dBm scale where calibration permits.

20.9 LIVE IQ Recorder / Scheduler

Control	Function
Active Source	Shows the receiver/session being recorded.
Center MHz / Record Span MHz	Sets recorder centre and requested captured bandwidth within authoritative source coverage.
Hardware Gain / AGC / readback	Shows or sets physical receiver state where safe; recorder-owned settings may be locked while active.
Choose folder	Selects recording destination and exposes available disk capacity.
Split: 5/10/15/30/60/120 min or no split	Controls segment duration.
Duration minutes	Optional fixed recording duration.
One-time UTC + ARM	Arms a single future UTC start.
Daily UTC start/stop + ARM DAILY	Arms recurring daily UTC recording.
START / STOP RECORDING	Starts recording or requests safe finalization. Normal RSRMW/UI actions do not stop an active recording; after STOP, FINALIZING may be shown until the writer is fully closed.

Control	Function
Timing/status/disk indicators	Show source timing, ACTIVE/FINALIZING state, gaps/errors and free space. RECORDING ACTIVE is also shown in the RSRMW main window while LIVE recording continues.

20.10 USER / STATION, antenna and general SETTINGS

Control group	Options and function
USER profiles	ADD USER, DELETE, select active profile, SAVE USER/STATION, SAVE USER FILE and LOAD USER FILE.
Station identity	Station/profile name, callsign, location name, signed decimal latitude/longitude and Maidenhead locator.
MWList access	Database import, registered e-mail, numeric myAM/OMID and SAVE MWLIST CREDENTIALS. A successful imported database is stored locally and auto-loaded at startup.
Antenna systems	ADD, DELETE, select active system; coherent references/calibration remain tied to that system. The public beta starts with one generic antenna system.
A1 / A2 geometry	X and Y east/north coordinates in metres from one local reference.
Manual phase calibration	Optional CH1-CH2 phase correction for the active physical path.
Antenna pair type	Identical/closely matched or different antennas with the same polarization.
Extra phase uncertainty	Adds honest uncertainty for non-identical antennas or uncertain path behaviour.
Heading / -3 dB beamwidth	Defines the directional-antenna lobe shown on the map.
UTC time	AUTO or MANUAL PC-time adjustment in hours/minutes; APPLY or RESTORE AUTO.
COLOURS palettes	Reuter Perceptual, HSV Spectrum, Material Design or High Contrast 256-colour palettes.
COLOURS targets	Top blocks/source, instruments, spectrum/waterfall/HR/meter, RSRMW colours and shared subpanel roles including background, border/header, title text, control/label text, informative/help text and button text.
RSRMW visual controls	Trace width/visibility and dB floor-highlight-max plus main/HR waterfall floor/range and reset controls.
SIGNAL METER	Minimum/maximum dBFS, dBm/S-point units and APPLY.
MONITOR / DIAGNOSTICS	Receiver identity, temperature, IQ, phase/balance, DF source and audio status.
Flight recorder / debug report	Turns development diagnostics on/off and saves a debug report.
TEST AUDIO TONE	Checks the Windows audio output path.

Control group	Options and function
SHOW PLAYBACK DIAGNOSTICS	Opens advanced FILES playback timing/buffer information.
RF dBm offset	Applies the calibrated meter offset needed before dBm values are meaningful.
Reference station fields	Known frequency and true azimuth used by ADD DF REFERENCE.
Calibration references	Enable, edit, delete or clear stored points for the current receiver/path/antenna system.
Calibration model	AUTO, LINEAR, CURVED or LEGACY diagnostic selection where available; AUTO is the normal choice.
ACTIVATE / SHOW FREQUENCY CALIBRATION	Enables or displays the active frequency-dependent model.
CALIBRATION GRAPH	Plots USER-specific ACTUAL and stored MEASURED azimuth versus reference frequency; supports zoom/pan/reset and handles the 0/360-degree wrap safely.

20.11 Receiver hardware, source and advanced diagnostics

Control	Function
Receiver: Reuter RSR200B / SDRplay RSPduo / RSPdx	Selects the LIVE hardware backend. RSR200B and RSPduo can provide coherent two-channel DF in the appropriate mode; RSPdx is single-channel and keeps MAP/MWList without measured DF.
RSPduo mode: Dual Tuner / Single A / Single B	Selects tuner architecture; DF requires valid paired dual-tuner IQ.
SELECT / CONNECT SDR	Finds/selects the backend/device and establishes control. Missing SDRplay Hardware API is reported explicitly.
CONNECT / DISCONNECT / RECONNECT	Controls receiver connection. In the RSR200B menu RECONNECT is placed directly below DISCONNECT.
HARDWARE CONTROL / OPEN EXTIO CONTROLS	Opens receiver-specific physical controls; the block is grouped with SELECT / CONNECT SDR in the RSR200B menu.
SHOW HARDWARE DIAGNOSTICS	Shows bridge, ExtIO, driver, USB/API and source-path status.
LIVE AM DISTORTION DIAGNOSTIC	Advanced 10/20/30-second diagnostic capture; use only when investigating AM distortion.
RECEIVER / IQ SOURCE: HARDWARE / IQ FILE PLAYBACK	Chooses physical LIVE IQ or an IQ-file source path.
OPEN IQ / PAUSE	Loads or pauses the IQ-file source.
START LIVE IQ / STOP IQ	Starts or stops acquisition.
USB LO / center kHz APPLY	Applies hardware centre frequency through the USB path.
LAN manual IP CONNECT	Connects to an RSR200B over the configured LAN path where supported.

Control	Function
RSR200B link CH1+CH2 attenuation	Applies matched physical attenuation to both channels.
RSR200B ADC/input routing	Selects HF1/HF2/VHF and parallel/individual ADC routing supported by the receiver.
RSR200B VHF preamp	Controls the receiver VHF preamplifier.
RSR200B resync coherent LO1+LO2	Requests coherent receiver resynchronization after a path change.
RSPduo link tuner A+B	Applies paired gain/control changes where appropriate.
RSPduo tuner A/CH1 and B/CH2 gain/AGC	Controls physical tuner gain and hardware AGC separately from DX AGC.
RSPdx ANT1 / ANT2 / ANT3	Selects one of the three physical RSPdx RF inputs. There is no BOTH/coherent combine path and no measured DF panel.

21. Troubleshooting

Symptom	Check / action
Check that the complete ZIP was extracted and all supplied runtime folders remain beside the application.	
RSR200B will not connect	Confirm the RSR200B ExtIO/driver files are present, receiver is powered/connected, and reconnect/reselect the receiver path.
RSPduo / RSPdx not found	Connect the SDRplay device and verify that the official SDRplay Hardware API/service is installed and running. The application reports "SDRplay Hardware API not installed" when that dependency is missing.
No audio	Confirm IQ/source is active, selected audio device, output gain, volume, mode and bandwidth. Check CH1/CH2/COMBINED on coherent receivers or ANT1/ANT2/ANT3 on RSPdx.
Spectrum source does not match selection	Re-select the intended source/antenna and verify both spectrum and waterfall follow the same authoritative source. At high zoom, fine FFT data should not repeatedly fall back to a coarse trace.
HR says NO LOCK	The target remains selected but no reliable current carrier solution exists; allow more data or choose a stronger/cleaner carrier.
DF has no numeric result	Confirm both channels, current coherent IQ, carrier lock, antenna system and applicable calibration.
DF says STALE	A source/path/RF generation changed during the measurement. Wait for fresh current coherent IQ.
AZ Map has no receiver location	Enter latitude and longitude in USER / STATION and save the profile.
No MWList candidates	Import/check the MWList/FMSCAN station database and verify current frequency/QTH.

20.12 Additional current control reference

Control / item	Operation
SPIKE FILTER (experimental)	Experimental broadband impulse/sferic suppression; SPIKE SENSITIVITY sets detection strength.
ADD NOTCH / REMOVE NOTCH	Places or removes a notch from the HR carrier context; notch offset/width remain editable under AUDIO NOTCH FILTERS.
HR NOTCH BAND / CENTER	Shows the current HR notch placement while the notch is positioned or adjusted.
LIVE BARS	Starts/uses live BARS history from current LIVE FFT data; independent of recording.
9 kHz / 10 kHz LIVE BARS raster	Chooses the MW channel raster when entering the LIVE BARS view.
SEARCH FREQUENCY	Searches MWList candidates around an entered positive frequency in kHz.
SEARCH STATION	Searches/filters MWList by station name or partial name.
LOGBOOK STATISTICS / ANALYSIS	Opens date-range and station/country/region statistics, including stable UNIQUE STATIONS counting.
LOAD *.rsridx	Loads a completed recording index without starting analysis. Use IMPORT when analysis must be built/rebuilt.
LAST VALID / STALE	Shows a retained previous DF bearing for orientation; it is explicitly not a fresh measurement.
RF GAIN / HARDWARE during recording	Unavailable while the recorder owns the physical receiver state.

MODE

Current visible order: **AM, SAM, CSB, AMQ AUTO, COH AM, COH2, COH3, C-QUAM, DSB, DSB-DQ, USB, LSB, USB-DQ, LSB-DQ, CW, FM, WFM.**

Symptom	Check / action
MWList publish fails	Check exact registered e-mail/OMID and external MWList service response.
RSRMW cache unavailable	Re-import the RAW recording to rebuild a validated index/cache.
Recording refuses hardware change	The recorder owns latched settings; stop recording before changing protected physical receiver controls.
Calibration Graph shows ACTUAL but no MEASURED	The reference may predate stored MeasuredAzimuthDeg. A new valid DF-reference capture stores the measured bearing; historical values are not guessed from raw phase or theoretical azimuth.
HR history disappears	Normal tuning, source, mode, seek and lock-state changes should preserve HR history. Missing data should appear as a black gap; use diagnostics if history is cleared unexpectedly.
Recorder stays FINALIZING	Allow the previous writer to finish. A new recording is intentionally blocked until finalization completes; disk/rename errors are reported rather than silently treated as a successful stop.

22. Glossary, acknowledgements and technical references

Term	Meaning
AFC	Automatic Frequency Control; follows small carrier drift.
AGC	Automatic Gain Control.
Carrier	Narrow RF spectral component used for tuning, demodulation or DF.
CH1 / CH2	The two coherent receiver channels.
COMBINED	Phase/balance combination of CH1 and CH2.
DF	Direction Finding.
dBFS	Digital signal level relative to full scale.
dBm	Power referenced to 1 mW; only meaningful with a valid calibration/offset.
HR	High Resolution / Fine Carrier analysis.
IQ	Complex in-phase and quadrature sample data.
MW	Medium Wave.
MWList	External station database/logging service and its imported candidate data.
QTH	Receiver/station location.
RSRMW	Recorded-file / MW analysis workspace.
SAM	Synchronous AM.
SNR	Signal-to-noise ratio.

21. Troubleshooting - current cases

Control / item	Operation
LOAD says the index is incomplete/invalid	Do not wait for LOAD to analyze the RAW data. Choose IMPORT explicitly to rebuild the index.
LOADed DF shows LAST VALID / STALE	The displayed direction is retained for orientation only. Wait for a fresh valid measurement or use the map refresh action.
RF GAIN / HARDWARE cannot be changed	Check whether recording is active. Stop/finalize the recording before changing protected physical hardware state.
HR/DF says NO LOCK but the station is tuned	Audio should not depend on HR/DF lock alone. Check MODE, source, bandwidth/passband, volume and Windows audio output if sound is missing.
BARS changed from SNR to dBm	The history should remain visible and only be rescaled. dBm still requires valid calibration; without it use the available relative/SNR presentation.
A logbook UNIQUE STATIONS count looks too high	Statistics deduplicate by stable station identity. If old imported rows have poor/incomplete station identity, correct/refresh the station data rather than treating duplicate display rows as different stations.
Map bearing remains visible after fading	Check the state label. LAST VALID / STALE is a retained bearing, not a fresh DF result.
Import seems slow before data appears	A real import first shows IMPORTING/busy state, then analyzed rows. Reopening a completed *.rsridx with LOAD is the fast path.

DIAGNOSTIC RULE: Do not use a stale DF state, an invalid index or an uncalibrated dBm label as if it were current authoritative measurement data.

Term	Meaning
ANT1 / ANT2 / ANT3	The three switchable physical RF inputs of RSPdx. Only one is received at a time; they are not three coherent DF channels.

The project acknowledges Linrad and WavViewDX as important technical and workflow references, and MWList as the essential station-data source behind the integrated medium-wave candidate, bearing, map and logging workflow. See the front-matter acknowledgement for context; the references below identify sources used for hardware and DF background statements.

22.2 Technical references used for hardware and DF background

Reference	Used for
K&M Burkhard Reuter, RSR200 product page and RSR200 Operator Manual V2.11/V2.25	Direct-sampling architecture, two independent 16-bit ADCs, clock/GPS, inputs, simultaneous channel streaming and diversity controls.
SDRplay, RSPduo Dual Tuner 14-bit SDR datasheet V0.6	Dual-tuner/14-bit architecture, two-antenna DF/diversity use, dual-tuner bandwidth and external clocking.
V. S. Doan et al., Phase-difference measurement-based angle of arrival estimation, IET Radar, Sonar & Navigation (2023)	General phase-difference DF and ambiguity-resolution background.
Standard two-element phase-interferometer geometry	Wavelength/spacing relationship and first-order angular-error examples in Chapter 2.
Linrad - Leif Asbrink, SM5BSZ	High-performance SDR, weak-signal, high-resolution spectrum/carrier and coherent-processing reference.
WavViewDX - Reinhard Weiss	Practical MW-DX recording review, carrier visualization and recorded-band workflow reference.
MWList - Günter Lorenz and contributors	Medium-wave transmitter database used for station candidates, bearing/distance context, Azimuth Map integration and logging workflow.
SDRplay Hardware API / RSPdx documentation	RSPdx single-channel device handling and ANTENNA_A / ANTENNA_B / ANTENNA_C input selection used for ANT1 / ANT2 / ANT3.

ACCURACY NOTE: The numerical spacing/error examples are analytical illustrations, not a guaranteed specification of the receiver, antennas, propagation path or application.

Appendix A - Recommended difficult-MW workflow

1. Tune the wanted MW channel and identify the carrier neighborhood in the main spectrum.
2. Open Fine Carrier / HR and select the exact wanted carrier manually.
3. Choose AM/SAM/COH AM/SSB as appropriate and set bandwidth/passband.
4. Enable Adaptive sideband or AM Adjacent Suppression if interference is concentrated on one side.
5. Use per-carrier notches for individual tones/carriers.
6. **On coherent hardware compare CH1, CH2 and COMBINED; use phase/balance or automatic combine/null only when coherent CH1+CH2 is valid. On RSPdx compare ANT1, ANT2 and ANT3 as independent physical antenna inputs.**
7. **For DF on coherent two-channel hardware, confirm current lock and calibrated bearing with uncertainty. On RSPdx skip measured DF and use MWList/map/program evidence instead.**
8. Compare the primary/mirror direction with Azimuth Map and MWList candidates.
9. Explicitly select the station identity and save a local log when identified.