Touchstone Monitor & Reference: Operation Manual

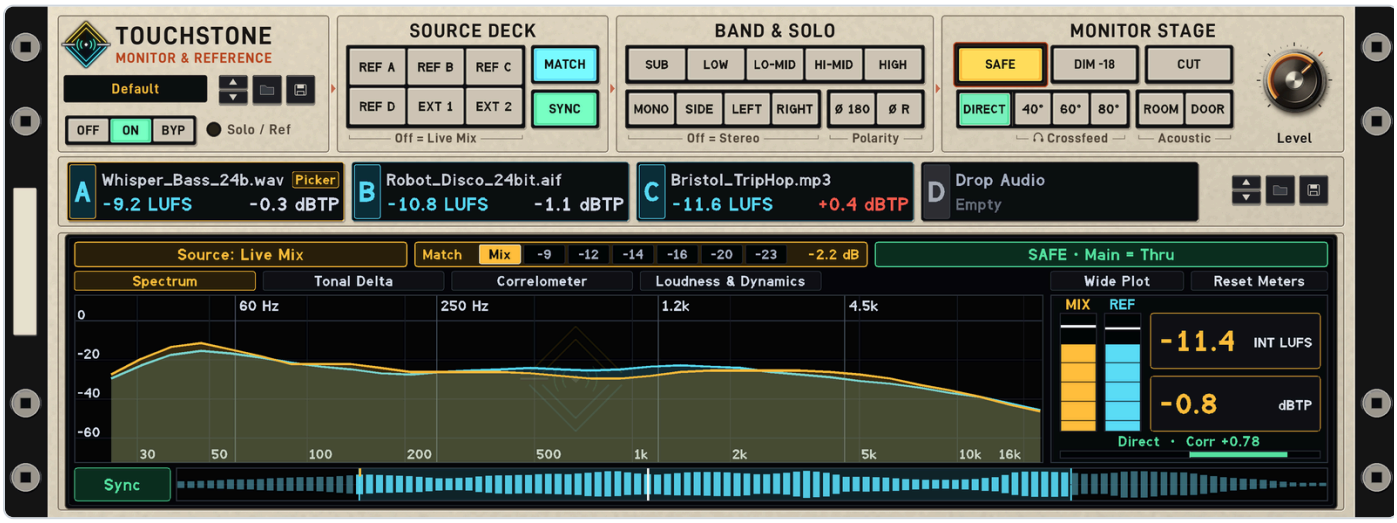
Product Identifier: `ca.boraas.Touchstone`
Version: 1.0.1
Device Classification: Studio Effect (`Audio Meter` , `Stereo` , `Misc`)
Rack Format: 4U Full-Width Console (collapses to active 1U folded strip)
Supported Platforms: Reason 10.1 or later (macOS Universal Apple Silicon/Intel & Windows 64-bit, Standalone DAW & Reason Rack Plugin)
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1. Overview & Signal Flow

Touchstone is a 4U studio control room, 4-slot loudness-matched reference deck, 5-band phase-aligned audition matrix, binaural headphone virtualization console, and 4-view mastering meter built natively for Reason.

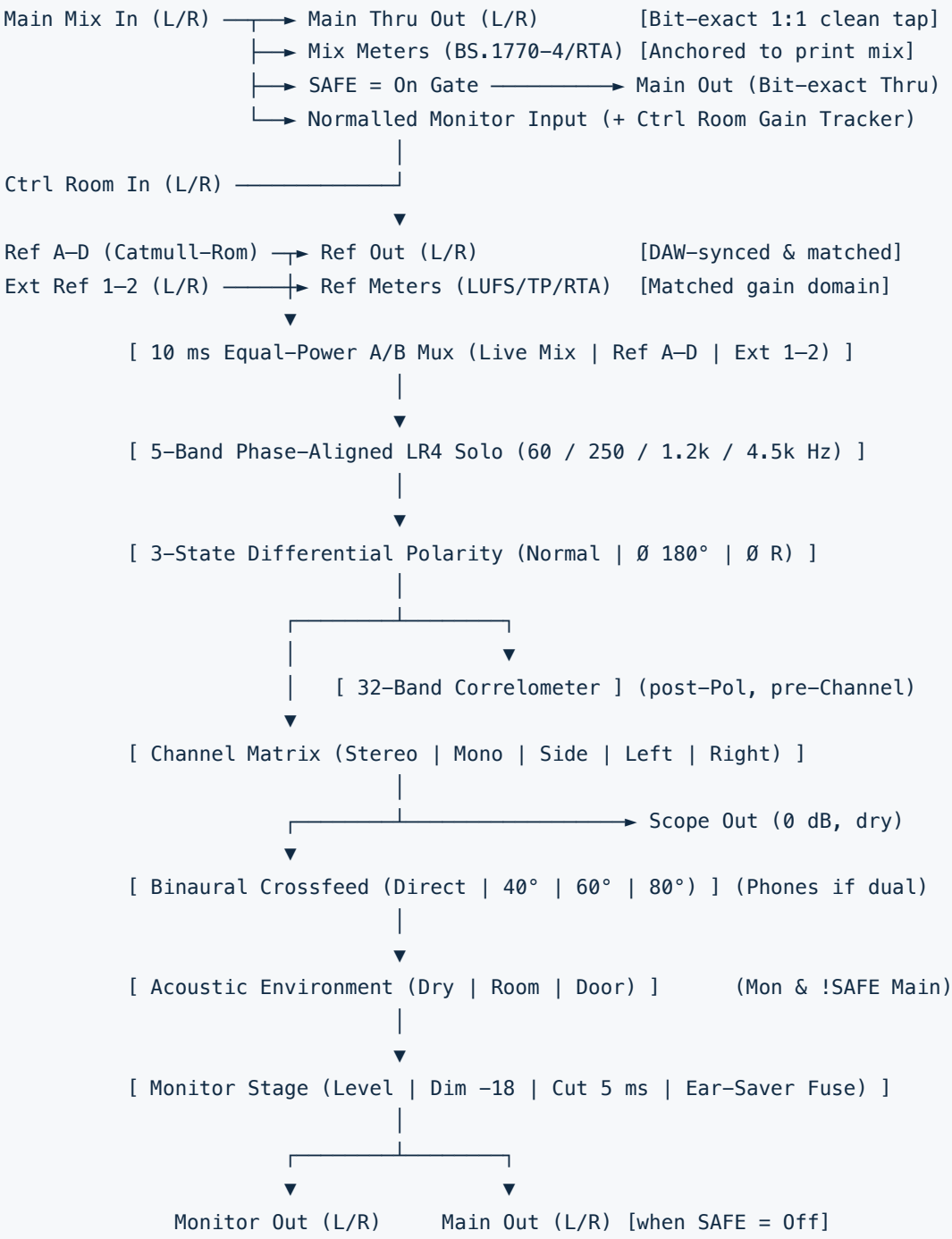
Because Reason's Master Section doesn't include a separate non-bouncing monitor bus, leaving a reference player, mono check, or headphone crossfeed active on `Master Out 1/2` prints straight into your exported audio file. Touchstone fixes this with five acyclic stereo output buses, hardware-normalled dual-bus `Main Mix In` / `Ctrl Room In` routing, background ITU-R BS.1770-4 loudness scanning, and continuous side-by-side metering even while you stay on `Live Mix` .



Touchstone 4U Front Panel — Spectrum RTA, Reference Cartridges & Meter Bridge

1.1 Exact Signal Flow & Pre/Post Tap Points

Every rear output and internal meter taps the DSP graph at a deterministic point so downstream analyzers, hardware headphones, and song bounces never interfere with each other:



1.2 Exact Output Bus & Meter Immunity Summary

Tap / Bus	Source A/B + Match	5-Band Solo	Polarity (Ø 180 / Ø R)	Channel (Mono/Side/L/R)	Crossfeed (40°–80°)	Acoustic (Room/Door)	Dim / Cut / Level / Fuse
`Main Out` (`SAFE` On)	No (Bit-Exact Thru)	No	No	No	No	No	No

Tap / Bus	Source A/B + Match	5-Band Solo	Polarity (Ø 180 / Ø R)	Channel (Mono/Side/L/R)	Crossfeed (40°–80°)	Acoustic (Room/Door)	Dim / Cut / Level / Fuse
Main Out (SAFE Off, Single Out)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Main Out (SAFE Off, Dual Out)	Yes	Yes	Yes	Yes	**No** (Phones only)	Yes	Yes
Main Thru Out	No (Always Bit-Exact)	No	No	No	No	No	No
Monitor Out	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Scope Out	Yes	Yes	Yes	Yes	No	No	No (0.0 dB unity)
Ref Out	Latched Ref + Match	No	No	No	No	No	No
Mix & Ref Meters / RTA / Delta	Mix = raw, Ref = matched	Visual shade	No	No	No	No	No
32-Band Correlometer	Yes	Yes	Yes	No (pre-Mono/Side)	Yes (when single out)	No	No

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2. Front-Panel Reference (4U Console & 1U Folded Strip)

Touchstone's 4U Warm Studio Cream console is arranged into three horizontal tiers: **Tier 1** (Upper Tactile Console), **Tier 2** (Unified 4-Slot Reference Deck), and **Tier 3** (Full-Rack-Span Mastering CRT). Every hardware radio bank uses **click-to-toggle-off** logic: clicking an unlit chiclet selects it immediately, and clicking the sole lit chiclet returns straight to its flat default state.

2.1 Bay 1: Identity, Patch Browser & Power

- **Patch Display & Browser**: Loads and saves `.repatch` presets across all 8 factory control room configurations.
- **OFF | ON | BYP Power Switch**:
  - **OFF** (Coral): Mutes all monitor/main outputs cleanly and displays a Coral **Power Off** banner on the CRT.
  - **ON** (Jade): Normal active control room operation.
  - **BYP** (Tungsten): Passes `Main Mix In` straight through `Main Out`, `Main Thru`, and `Scope Out` and displays **Bypassed** on the CRT.
- **Solo / Ref Warning LED**: Illuminates warm amber whenever non-flat monitoring (`Ref A–D`, `Ext 1–2`, `Band Solo`, `Mono/Side/L/R`, `Polarity`, `Crossfeed`, `Room/Door`, `Dim`, `Cut`, non-unity `Level`, or dual-bus `Ctrl Room In`) is audible on **Main Out** with **SAFE** turned off. Dimmed automatically whenever `SAFE` protects `Main Out` or the device is `Off` / `Bypassed`.

2.2 Bay 2: Source Deck (`REF A–D` , `EXT 1–2` , `MATCH` , `SYNC`)

- `REF A` – `REF D` **(Ice Cyan)**: Selects any loaded resident reference track with a click-free 10 ms equal-power crossfade. Clicking the active pill returns to `Live Mix` .
- `EXT 1` / `EXT 2` **(Tungsten)**: Switches to the rear stereo External Reference inputs (`Ext Ref 1 L/R` , `Ext Ref 2 L/R`), metered continuously in real time with BS.1770-4 loudness and 2x-oversampled peak ceilings.
- `MATCH` **(Ice Cyan)**: Enables ITU-R BS.1770-4 loudness matching across `Ref A–D` and `Ext 1–2` . Target selection lives in the CRT Row A `Match` capsule:
  - `[Mix]` (`Follow Live Mix` , **default)**: Automatically scales references (`−24.0` to `+18.0 dB`) to match your live mix's loudness, guarded by a `−0.3 dBTP` true-peak ceiling so quiet acoustic mixes never clip hot masters.
  - **Fixed & K-System Targets (`[−9]` , `[−12]` , `[−14]` , `[−16]` , `[−20]` , `[−23]`)**: Locks references immediately to `−9 LUFS` (Loud/Club), `−12 LUFS` (K-12), `−14 LUFS` (K-14 / Streaming), `−16 LUFS` (Apple / AES), `−20 LUFS` (K-20), or `−23 LUFS` (EBU R128) even when your live mix is silent or stopped, while keeping `Live Mix` untouched at `0.0 dB` unity. Clicking any target chip while `MATCH` is off arms and enables `MATCH` in one click; clicking an active fixed chip toggles back to `Mix` .
- `SYNC` **(Jade)**: Switches between `DAW Sync` (lit) and `Cue Loop` (unlit):
  - `DAW Sync` : Locks reference playback to Reason's timeline (`15,360 PPQ` + tempo). Jumping to Bar 49 in the sequencer jumps to the exact matching timestamp in the reference track, shifted by your `Cue Position` waveform offset so intros and drops line up.
  - `Cue Loop` : Transport-independent continuous loop playback respecting Reason Sample Editor **Play Range** and **Loop Range** markers. Scrub and loop choruses even when Reason's main transport is stopped.

2.3 Bay 3: Band & Solo Matrix

- **5-Band LR4 Multi-Solo (`SUB | LOW | LO–MID | HI–MID | HIGH`)**: Phase-aligned 24 dB/oct Linkwitz-Riley crossovers at **60 Hz**, **250 Hz**, **1.2 kHz**, and **4.5 kHz** (`Sub < 60 Hz` , `Low 60–250 Hz` , `Lo–Mid 250 Hz – 1.2 kHz` , `Hi–Mid 1.2–4.5 kHz` , `High > 4.5 kHz`). Matched 2nd-order Butterworth allpass networks guarantee `0.00 dB` flat magnitude summation across any single band or multi-band subset (`band_solo` 5-bit mask `0..31`).
  - Click one band to solo it; click the sole active band again to return to **Full Range**.
  - `Shift + Click` adds or removes any band independently (selecting all 5 returns to Full Range).
  - **Click-and-drag** horizontally across pills to select any contiguous band span.
  - Filter states stay continuously warm behind an 8 ms raised-cosine step-bridge declicker for pop-free switching on sustained sub-bass.
- **Channel Solo (`MONO | SIDE | LEFT | RIGHT`)**:
  - `MONO` : `−6 dB` constant-voltage mono sum `0.5 * (L + R)` sent to both outputs.
  - `SIDE` : Stereo difference `0.5 * (L − R)` on Left and `−0.5 * (L − R)` on Right.
  - `LEFT` / `RIGHT` : Routes the isolated channel to both ears for asymmetric pan checks.
- **Differential Polarity (`Ø 180 | Ø R`)**: Applied immediately *before* the Channel Matrix and Correlometer. `Ø 180` inverts both Left and Right (`−L, −R`); `Ø R` inverts Right only (`L, −R`), making it easy to catch inverted stereo stems that cancel in mono.

2.4 Bay 4: Monitor Stage

- `SAFE` **(Armored Amber)**: Locks `Main Out L/R` to bit-exact `Main Mix In` passthrough (`0.00 dB` , 0 samples latency).
- `DIM −18` **(Ice Cyan)**: Smoothly pads monitor output by `−18.0 dB` .

- **`CUT` (Coral)**: Click-free 5 ms mute on `Monitor Out` (and `Main Out` when `SAFE` is off). `Main Thru`, `Scope Out`, `Ref Out`, `SAFE` `Main Out`, and all meters keep running uninterrupted.
- **Headphone Crossfeed (`DIRECT || 40° | 60° | 80°`)**: Woodworth spherical-head fractional ITD (`0.176 ms`, `0.261 ms`, `0.342 ms` via 4-point Catmull-Rom delay lines) combined with a 700 Hz contralateral head-shadow low-pass and `1 / (1 + crossGain)` direct-path normalization so mono sub-bass remains `0.0 dB` calibrated across `40°` (Nearfield), `60°` (Equilateral), and `80°` (Wide Mains). When both `Main Out` and `Monitor Out` are patched, Crossfeed isolates strictly to `Monitor Out` (`Phones` footer tag).
- **Acoustic Environment (`ROOM | DOOR`)**:
  - `ROOM` (Jade): Treated ITU-R BS.1116 control room model voiced for closed-back headphones (`DRR ≈ +8.2 dB`): `12 dB/oct` `150 Hz` bass-trap high-pass on the reflection feed (`< 0.12 dB` impact below 60 Hz), 4 lateral cross-ear early reflection pairs (`5.9–25.1 ms`, `2.6 kHz` desk-shadow LP, 2-stage Schroeder allpass rear diffuser), and a tight `~155 ms` `2×2` Householder FDN studio decay with `±0.20 LU` loudness neutrality across `44.1–192 kHz`.
  - `DOOR` (Amber): Closed solid-core studio door / hallway translation check (`85% Mid / 15% Side` acoustic pre-summing, `48 Hz` structural HP, `340 Hz` door leaf mass-law LP, `1.1 kHz` perimeter seal LP, and 3-tap asymmetric corridor slap).
  - Both `ROOM` and `DOOR` apply to `Monitor Out` and un-safe `Main Out` (remaining 100% dry on `SAFE` `Main Out`, `Main Thru`, `Scope Out`, `Ref Out`, and all meters), crossfading click-free over 10 ms and dropping to 0% CPU when `Dry`.
- **`Level` (`-24.0` to `+12.0 dB`, default `0.0 dB`)**: Smooth rotary monitor trim (`Cmd/Ctrl + Click` resets to `0.0 dB`).
- **Control Room Ear-Saver Fuse**: Guards the monitor path against non-finite samples, runaway spikes above `+6.02 dBFS` (`|x| > 2.0`), or DC offsets `>= 0.35`, clamping cleanly to `±2.0` and latching `FUSE! Reset` on the CRT until clicked. Normal audio below `+6.02 dBFS` passes bit-identically untouched.

2.5 Tier 2: Reference Deck Cartridges & Sample Management

- **4 Broadcast Cartridges (`A` – `D`)**: Each wide cartridge displays its index tab (Solid Cyan = Active audition, Dark Cyan = Loaded & ready, Tungsten outline = Active Sample Picker target, Charcoal = Empty), natural-cased filename, `Active` / `Picker` badge, and offline intrinsic **Integrated LUFS** + **dBTP** true peak (always showing the raw file analysis even when `LUFS Match` is trimming playback in the CRT).
- **Song-Length Streaming & Reason Sample Editor**: Touchstone reads resident MP3, WAV, or AIFF references via contiguous per-batch `JBox_GetSampleData` pulls through a 4-point Catmull-Rom cubic resampler (`22.05–192 kHz`) without duplicating full songs on the real-time heap. Use Reason's **Sample Editor** (`Edit Sample` in the Sample Browser) to trim **Play Range** (`play_range_start` / `end`), define **Loop Range** (`loop_range_start` / `end`) for `Cue Loop` chorus auditioning, or adjust `preview_volume_level`.
- **Keeping Self-Contained `.reason` Song Files Small**: When Reason saves a self-contained song, all audio files resident in `user_samples` slots are bundled inside the `.reason` document. A single 4-minute 24-bit/48 kHz stereo WAV adds ~65 MB, and four full songs can add ~250 MB+. Clear unused Reference Deck slots (click the slot to select it in `Picker`, then click **Delete Sample** in Reason's Sample Browser) before final song archival or collaboration transfers to keep project files fast and compact.

2.6 Compact 1U Folded Strip

Folding Touchstone in the rack exposes `OFF / ON / BYP`, the Patch Browser, `A / B / C / D / E1 / E2` source chiclets, `SUB / LOW / LM / HM / HI` band solo chiclets, `XFEED` toggle, armored `SAFE`, mini `Level` knob, and a `385 × 65 px` horizontal scribble tape.



Touchstone 1U Compact Folded Rack Strip

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3. Dual-Bus `Ctrl Room In` Gain Tracking & Loop Protection

When you wire Touchstone as a standalone post-master hub with **both** **`Main Mix In`** (from Master Section `Master Out`) **and** **`Ctrl Room In`** (from Master Section `Ctrl Room Out`):

1. **Uninterrupted Metering Anchor**: `Main Mix In` permanently anchors `SAFE` passthrough, `Main Thru`, `Live Mix` LUFS/True Peak, and the Mix RTA spectrum.
2. **Automatic SSL `Ctrl Room` Knob Following**: Touchstone runs a closed-form least-squares gain estimator (`g = sum(x*y) / sum(x^2)`) gated on normalized stereo cross-correlation (`rho >= 0.99`). Turning Reason's SSL `Ctrl Room` level knob down automatically scales `Ref A–D` and `Ext 1–2` by the exact same gain so switching to a reference never blasts your ears, and holds that gain cleanly across transport stops.
3. **PFL/AFL Solo & FX Cue Freeze (`Source: CR Cue / Solo`)**: Whenever you press Solo/PFL on a mixer channel or audition an FX return, `Ctrl Room In` diverges from `Main Mix In` (`rho < 0.98`). Touchstone switches the Row A badge to Jade **`Source: CR Cue / Solo`** and freezes the tracked reference gain so soloing a quiet percussion stem never drags down your reference volume.
4. **Cyclic Feedback-Loop Protection**: If `Ctrl Room In` is accidentally wired into a dead cyclic loop while using Touchstone inside a Master Insert, Touchstone ignores the zero-signal loop so your monitoring never mutes, and lights the dark-cockpit Coral fault LED in the top-right corner of the rear **`CTRL ROOM IN`** pocket.

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4. Mastering CRT Workstation (All 4 Views + Wide Plot)

Tier 3 hosts a full-rack-width pure-vector mastering CRT structured in four stationary rows:

- **Row A (Status Header)**: `Source` pill (click to cycle), `Match [Mix] [−9] [−12] [−14] [−16] [−20] [−23] ±x.x dB` target & gain pill, and `SAFE • Main = Thru` / `LIVE • Monitor on Main` guard pill.
- **Row B (Stationary Mode & Action Bar)**: Four mode tabs (**`Spectrum`**, **`Tonal Delta`**, **`Correlometer`**, **`Loudness & Dynamics`**), center active status pill (`CUT • Monitor Muted`, `Control Room • Reflections`, `Studio Door • Hallway`, or `Solo: ...` — click to clear), **`Wide Plot`** toggle (lit Cyan when engaged across all four views), and **`Reset Meters`** (`FUSE! Reset` in Coral when tripped).
- **Row C (Main Canvas + Right Meter Bridge)**: Shares one calibrated `25 Hz – 18 kHz` logarithmic axis, `92 px` left axis gutter, and `60 Hz / 250 Hz / 1.2k / 4.5k` crossover lines across all analyzer views. When `Wide Plot` is off on `Spectrum`, `Tonal Delta`, or `Correlometer`, the right **Meter Bridge** displays tall `MIX` and `REF` peak+RMS bars (`12 dB` graticule), large hero **`INT LUFS`** and **`dBTP`** (`FUSE!`) cards (Tungsten for Live Mix, Cyan for Active Ref; click to reset), active Crossfeed/Channel/Polarity/Acoustic status, and a broadband bipolar **`Corr`** bar.
- **Row D (Cue Scrubber)**: Clickable **`Sync`** / **`Cue`** pill beside a 116-bar interpolated waveform scrubber displaying Sample Editor loop shading, live Target Reference playhead (active even while listening to `Live Mix`), and Tungsten `Cue Position` marker.

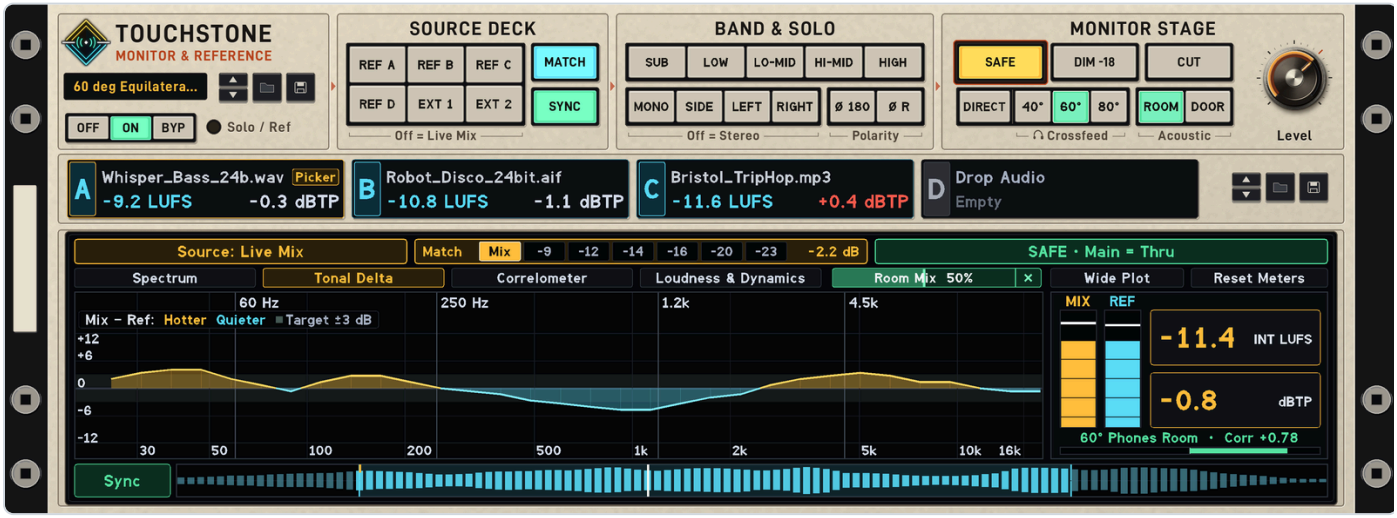
4.1 View 1: `Spectrum` (32-Band Dual RTA)

Overlays your **Live Mix** (Warm Tungsten) and **Target Reference** (Ice Cyan) across 32 1/3-octave TPT state-variable filter bands (`25 Hz – 18 kHz` , `0` to `–60 dB` grid) with translucent 5-band solo shading whenever `Band & Solo` is active. Toggle `Wide Plot` to stretch the analyzer edge-to-edge across the entire CRT.

4.2 View 2: `Tonal Delta` (Mix – Ref Match Curve)

Graphs the exact spectral difference `Mix – Ref` across `±12 dB` on the shared `25 Hz – 18 kHz` log axis:

- **Warm Tungsten fill above** `0 dB` : Your mix is hotter than the reference in that frequency range.
- **Ice Cyan fill below** `0 dB` : Your mix is quieter than the reference in that frequency range.
- `±3 dB` **Sweet-Spot Corridor**: Shaded target band around `0 dB` so you can spot tonal imbalances in seconds without swapping away from `Live Mix` .

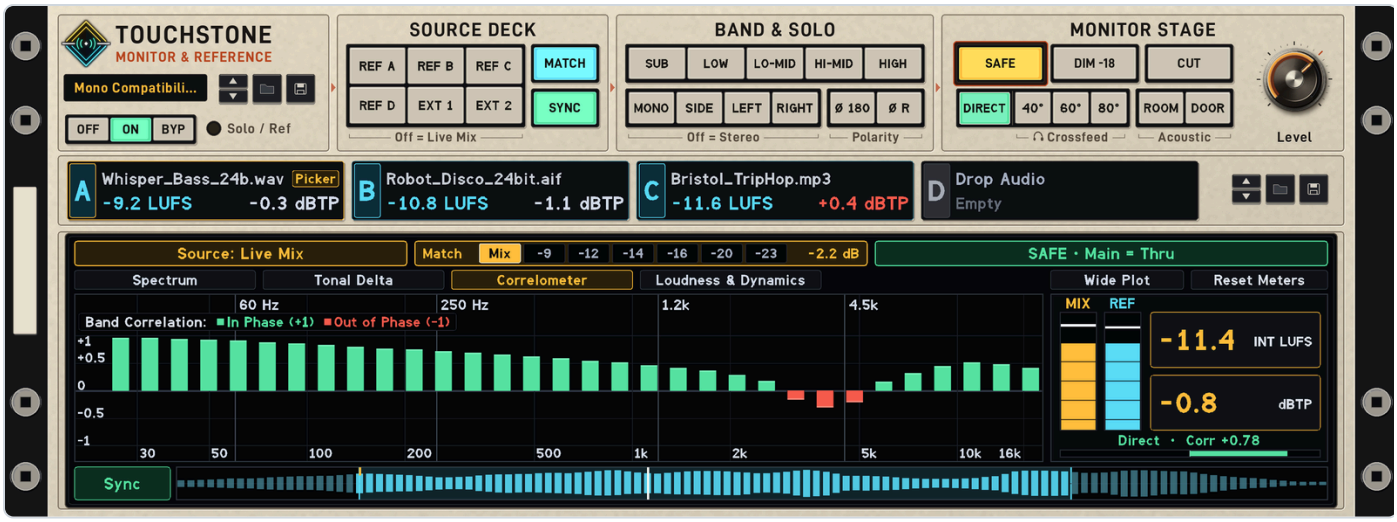


Tonal Delta View with 60° Headphone Crossfeed & Room Active

4.3 View 3: `Correlometer` (32-Band Spectral Phase)

Measures per-band Pearson left/right stereo phase correlation (`r = lr / sqrt(ll * rr)` , 220 ms leaky accumulators) across all 32 bands, tapped **post-Polarity (** `Ø 180` **/** `Ø R` **) and pre-Channel Matrix (** `Mono` **/** `Side` **)** so you can inspect true underlying stereo phase even while auditioning Mono:

- **Broadcast Jade bars rising toward** `+1` : In-phase, mono-compatible energy.
- **Coral Red bars dropping toward** `–1` : Out-of-phase energy that will thin out or cancel in mono.

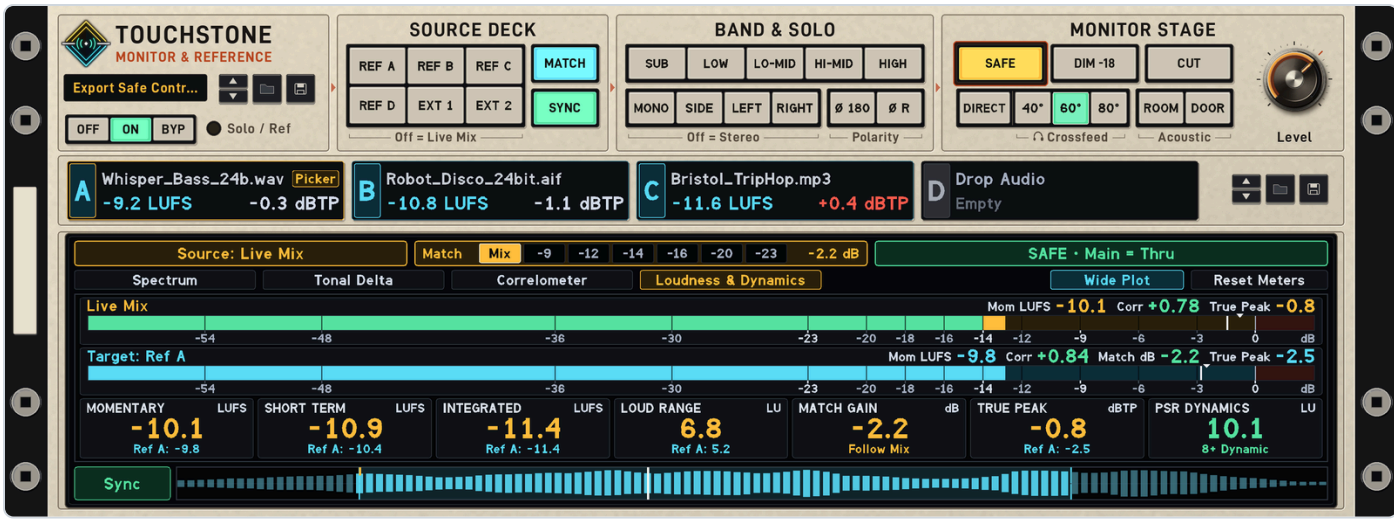


Correlometer View — 32-Band Spectral Stereo Phase Bars

4.4 View 4: `Loudness & Dynamics` (Split Matrix & `Wide Plot` 7-Card LPM Mode)

Provides two full-width loudness and dynamics layouts tailored for mastering and streaming targets:

1. **Compact Split Layout (`Wide Plot` Off)**:
   - **Left Zone**: Two Reason Big-Meter-style horizontal `−60` to `+3 dB` lanes — **`Live Mix`** (Jade `< −14`, Tungsten `−14..0`, Coral `> 0`) and **`Target / Active Reference`** (Cyan) — with live peak ticks, latched max true-peak triangles, bright `−14 / −9 / 0 dB` target ticks, and live `Mom LUFS`, `Corr`, `Match dB`, and `True Peak` readouts.
   - **Right Zone**: A 5-column **`MIX`** **vs.** **`REF`** matrix comparing **`INT`** (BS.1770-4 gated Integrated LUFS), **`SHORT`** (3-second Short-Term LUFS), **`LRA`** (EBU Tech 3342 Loudness Range in LU), **`TP`** (4x Catmull-Rom latched max True Peak in dBTP, Coral `> −0.1`), and **`PSR`** (`TP − Short`, colored Jade `≥ 8.0 LU` Dynamic, Tungsten `5.5–8.0 LU` Tight, Coral `< 5.5 LU` Squashed). Tap anywhere in the matrix to flush all meters.
2. **Full-Width LPM Layout (`Wide Plot` On)**:
   - **Upper Tier**: Twin full-rack-width horizontal meter lanes spanning `−54` to `+3 dB` with extended broadcast ticks (`−23`, `−20`, `−18`, `−16`, `−14`, `−12`, `−9`, `−6`, `−3`, `0 dB`).
   - **Lower Tier (7 Equal-Width LPM Cards)**: **`MOMENTARY`** (`LUFS`), **`SHORT TERM`** (`LUFS`), **`INTEGRATED`** (`LUFS`), **`LOUD RANGE`** (`LU`), **`MATCH GAIN`** (`dB` — shows active target or `Δ ±x.x` preview when bypassed), **`TRUE PEAK`** (`dBTP` / `FUSE!`), and **`PSR DYNAMICS`** (`LU` + `8+ Dynamic` / `5.5–8 Tight` / `<5.5 Squashed`). Primary numerals follow your listened source (Tungsten on Mix, Cyan on Ref) while bottom sub-lines keep the counterpart source in view. Tap any card to flush meters.



Loudness & Dynamics Wide Plot — Twin Mix/Ref Lanes & 7 LPM Readout Cards

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5. Factory Patch Reference (8 `.repatch` Presets)

All 8 presets live in `Resources/Public/` and are tagged for the Reason 13+ Browser (`Touchstone.rsmeta`):

#	Preset File (`Resources/Public/`)	Key Configuration	Recommended Use
1	`Default.repatch`	`Live Mix`, `Match` On (`Follow Mix`), `DAW Sync`, Full Range, Stereo, Direct, Dry, `SAFE` Off, `Level 0.0 dB`, `Spectrum`	Clean Master Section insert starting point
2	`Export Safe Control Room (Phones Out 3–4).repatch`	`SAFE` **On**, `60°` Crossfeed **On**, `Match` On	Permanent dual-output rig (`Main Out` → `1/2`, `Monitor Out` → `3/4`)
3	`60 deg Equilateral Headphone Studio.repatch`	`60°` Crossfeed **On**, `Match` On, `SAFE` Off	Everyday studio headphone mixing on a 2-output rig
4	`40 deg Nearfield Desk Check.repatch`	`40°` Crossfeed **On**, `Match` On, `SAFE` Off	Tight nearfield / desktop speaker imaging check
5	`80 deg Wide Mains Check.repatch`	`80°` Crossfeed **On**, `Match` On, `SAFE` Off	Wide mains / club stereo spread and reverb tail check
6	`Sub and Low-End Translation (Sub 60 Hz).repatch`	`Band Solo` = **`SUB`** (`< 60 Hz`, mask `1`), `Match` On	Comparing kick/808 sub weight cleanly against a reference
7	`Midrange Vocal and Snare Focus (250 Hz – 4 kHz).repatch`	`Band Solo` = **`LO-MID + HI-MID`** (`250 Hz – 4.5 kHz`, mask `12`), `Match` On	Checking vocal intelligibility, snare body, and midrange balance
8	`Mono Compatibility and Phase Check.repatch`	`Channel Mode` = **`MONO`**, `Match` On	Instant mono-collapse check for bass, leads, and stereo FX

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6. Rear Audio & Control Room CV Reference

Flip the rack (`Tab`) to access Touchstone's 2-row 4U rear patchbay (**18 Audio Jacks** arranged as 4 stereo inputs over 5 acyclic stereo outputs, plus **3 Control Room CV Jacks** and an on-panel routing cheat sheet).



Touchstone 4U Rear Patchbay — Audio Matrix & Control Room CV

6.1 Stereo Audio Inputs (Top Row — 8 Jacks)

- **`MAIN MIX IN (L/R)`** (**`Auto-Routed`**): Primary mix input feeding `SAFE` passthrough, `Main Thru` , Mix metering, and (when `Ctrl Room In` isn't patched) the `Live Mix` monitor path.
- **`CTRL ROOM IN (L/R)`** (**`Console CR`**): Optional input from Reason Master Section `Ctrl Room Out` for standalone post-master rigs. Includes the top-right Coral cyclic-loop fault LED.
- **`EXT REF 1 (L/R)`** & **`EXT REF 2 (L/R)`** (**`Stereo In`**): Live external stereo reference inputs (parallel stems, rough mixes, alternate mastering chains, or hardware loopback) metered in real time for BS.1770-4 loudness matching.

6.2 Acyclic Stereo Audio Outputs (Bottom Row — 10 Jacks)

- **`MAIN OUT (L/R)`** (**`Safe On = Thru`**): Auto-routed primary output. Executes a bit-exact copy of `Main Mix In` whenever `SAFE` is on (or in settled flat Mix state).
- **`MAIN THRU (L/R)`** (**`Always Clean`**): Permanent bit-exact `1:1` copy of `Main Mix In` , immune to every monitor control.
- **`MONITOR OUT (L/R)`** (**`Phones / Xfeed`**): Dedicated un-bounced headphone/monitor bus for `HW Out 3/4` . Carries full control room monitoring even while `SAFE` locks `Main Out` , and receives isolated Crossfeed whenever both outputs are patched.
- **`SCOPE OUT (L/R)`** (**`Pre-Level • Dry`**): Unity `0.0 dB` post-Source, post-Band-Solo, post-Polarity, and post-Channel-Matrix output strictly pre-Crossfeed, pre-Room/Door, pre-Dim/Cut/Level, and pre-Fuse for feeding external analyzers.
- **`REF OUT (L/R)`** (**`Sync • Matched`**): Continuous DAW-synced, LUFS-matched output of your latched Target Reference (`Ref A–D` or `Ext 1–2`) for feeding external EQs or profilers (such as Solstice `Ref In`) without leaving `Live Mix` . Skips background rendering at 0% CPU when unplugged and listening to `Live Mix` .

6.3 Control Room CV Matrix (3 Jacks)

- **`SOURCE` (`0–1V Select` CV In)**: Stepped unipolar CV selecting `Live Mix` (`0`), `Ref A–D` (`1–4`), and `Ext 1–2` (`5–6`) for blind A/B testing or hardware controller switching.
- **`BINAURAL` (`Gate In` CV In)**: Gate `>= 0.5` engages Headphone Crossfeed without altering your saved patch state.
- **`REF ACT` (`Gate Out` CV Out)**: Outputs `1.0` (`100%`) whenever monitoring `Ref A–D` or `Ext 1–2`, and `0.0` on `Live Mix` (ideal for driving rack status indicators or muting auxiliary meters during reference checks).

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7. MIDI CC & Reason Remote / Combinator 2 Reference

7.1 MIDI Implementation Chart (`midi_cc_chart`)

MIDI CC	Parameter	Range / Behavior
CC 7	`Monitor Level` (`monitor_trim`)	`-24.0` to `+12.0 dB` (`0.0 dB` at ~67%)
CC 12	`Monitor Source` (`monitor_source`)	7 steps: `Live Mix`, `Ref A–D`, `Ext 1–2`
CC 13	`LUFS Loudness Match` (`lufs_match`)	Off / On
CC 14	`Frequency Band Solo` (`band_solo`)	32 steps (`0..31` 5-bit band mask)
CC 15	`Channel Solo Mode` (`channel_mode`)	5 steps: `Stereo`, `Mono`, `Sides`, `Left`, `Right`
CC 16	`Headphone Crossfeed` (`binaural_enable`)	Off / On
CC 17	`Crossfeed Speaker Angle` (`speaker_angle`)	3 steps: `40°`, `60°`, `80°`
CC 18	`Monitor Dim (-18 dB)` (`dim_enable`)	Off / On
CC 19	`Export Safe` (`export_safe`)	Off / On
CC 20	`Reference Cue Position / Offset` (`ref_offset`)	`0.0%` to `100.0%` waveform offset

7.2 Reason Remote & Combinator 2 Mapping Table (`v1.0.1`)

Property Path	Remote Internal Name	Short / Tiny	Type / Range
`/custom_properties/monitor_source`	`Monitor Source`	`Source` / `Src`	7 steps (`Live Mix`, `Ref A–D`, `Ext 1–2`)
`/custom_properties/lufs_match`	`LUFS Match`	`Match` / `Mtch`	Boolean (`Off` / `On`)
`/custom_properties/lufs_match_target`	`LUFS Match Target`	`Target` / `Tgt`	7 steps (`Follow Mix`, `-9`, `-12`, `-14`, `-16`, `-20`, `-23`)
`/custom_properties/sync_mode`	`Sync Mode`	`Sync` / `Sync`	2 steps (`DAW Sync` / `Cue Loop`)
`/custom_properties/band_solo`	`Band Solo`	`BandSolo` / `Band`	32 steps (`0..31` additive 5-band bitmask)

Property Path	Remote Internal Name	Short / Tiny	Type / Range
`/custom_properties/channel_mode`	`Channel Mode`	`Channel` / `Chan`	5 steps (`Stereo` , `Mono` , `Sides` , `Left` , `Right`)
`/custom_properties/polarity_invert`	`Polarity Invert`	`PolInv` / `Pol`	Boolean (`Ø 180°` L+R invert)
`/custom_properties/polarity_right`	`Polarity Right`	`PolRight` / `PolR`	Boolean (`Ø R` Right-only invert)
`/custom_properties/binaural_enable`	`Binaural Room`	`Xfeed` / `Xfd`	Boolean (`Off` / `On`)
`/custom_properties/speaker_angle`	`Speaker Angle`	`Angle` / `Angl`	3 steps (`40°` , `60°` , `80°`)
`/custom_properties/acoustic_mode`	`Acoustic Environment`	`Acoust` / `Env`	3 steps (`Dry` , `Control Room` , `Studio Door`)
`/custom_properties/monitor_trim`	`Monitor Trim`	`Level` / `Lvl`	Continuous `−24.0` to `+12.0 dB` (`0.0 dB` default)
`/custom_properties/dim_enable`	`Monitor Dim`	`Dim` / `Dim`	Boolean (`−18.0 dB` pad)
`/custom_properties/monitor_cut`	`Monitor Cut`	`Cut` / `Cut`	Boolean (5 ms monitor mute)
`/custom_properties/export_safe`	`Export Safe`	`Safe` / `Safe`	Boolean (`Main Out` bit-exact Thru)
`/custom_properties/ref_offset`	`Cue Position`	`CuePos` / `Cue`	Continuous `0.0%` to `100.0%`
`/custom_properties/crt_view`	`CRT View`	`CRTView` / `View`	4 steps (`Spectrum` , `Tonal Delta` , `Correlometer` , `Loudness & Dynamics`)
`/custom_properties/crt_wide`	`CRT Wide`	`WideCRT` / `Wide`	Boolean (Full-Width Plot / LPM 7-Card Mode)

8. Technical Specifications

- **Product**: Touchstone Monitor & Reference (`ca.boraas.Touchstone` , v1.0.1)
- **Device Type & Format**: `studio_fx` , 4U Full-Width Rack Extension + active 1U Folded Rack Strip
- **Audio Engine & Sample Rates**: Pure C++17 64-bit internal filter/metering precision, 32-bit float audio bus, `22.05 kHz` to `192 kHz`
- **Latency**: `0` samples on `Main Out` (`SAFE` On / flat Mix) and `Main Thru` (zero host PDC required)
- **Reference Deck**: 4 resident `user_samples` slots (MP3/WAV/AIFF, 4-point Catmull-Rom cubic resampling, background offline BS.1770-4 + 4x True Peak + 256-bin waveform scan) + 2 rear stereo `Ext Ref` inputs
- **Loudness & True-Peak Standards**: ITU-R BS.1770-4 K-weighted Integrated (`−70 LUFS` absolute / `−10 LU` relative gates, `0.05 LU` histogram), Short-Term (3 s), Momentary (400 ms), EBU Tech 3342 `LRA` (`0.10 LU` histogram), 100 ms (10 Hz) EBU R128 hop rate, 4x Catmull-Rom inter-sample True Peak, and `PSR` (`TP − Short`)

- **Loudness Match**: `Follow Live Mix` or 6 fixed/K-System targets (`−9` , `−12 K−12` , `−14 K−14` , `−16` , `−20 K−20` , `−23 EBU`), `−24.0` to `+18.0 dB` range with `−0.3 dBTP` headroom ceiling and `10 ms` equal-power crossfades
- **Band Audition Crossover**: 5-band phase-aligned 4th-order Linkwitz-Riley (`24 dB/oct`) at `60 Hz` , `250 Hz` , `1.2 kHz` , and `4.5 kHz` with 2nd-order allpass phase alignment (`0.00 dB` flat sum), `0..31` additive multi-solo mask, and `8 ms` raised-cosine step-bridge declicker
- **Headphone Crossfeed**: Woodworth spherical-head fractional ITD (`0.176 / 0.261 / 0.342 ms` at `40° / 60° / 80°`) + `700 Hz` head-shadow LP + `0.0 dB` mono sub-bass normalization; automatically isolated to `Monitor Out` when dual outputs are patched
- **Acoustic Environment Modeling**: `Control Room` (`DRR ≈ +8.2 dB` , `150 Hz` `12 dB/oct` bass-trap HP, 4 cross-ear lateral reflection pairs, 2-stage Schroeder AP rear diffuser, `~155 ms` `2×2` Householder FDN decay, `±0.20 LU` loudness neutral) and `Studio Door` (`85% Mid / 15% Side` , `48 Hz` HP / `340 Hz` LP / `1.1 kHz` seal LP + 3-tap corridor slap)
- **Monitor Safety**: `+6.02 dBFS` (`|x| <= 2.0`) and DC (`>= 0.35`) Ear-Saver Fuse (bit-exact below threshold), `−18.0 dB` Dim, `5 ms` Cut, `−24.0` to `+12.0 dB` Level
- **Rear Connectivity (21 Jacks)**: 8 Audio Inputs (`Main Mix In` , `Ctrl Room In` , `Ext Ref 1` , `Ext Ref 2`), 10 Audio Outputs (`Main Out` , `Main Thru` , `Monitor Out` , `Scope Out` , `Ref Out`), 2 CV Inputs (`Source` , `Binaural`), 1 CV Output (`Ref Act`)
- **Factory Presets**: 8 `.repatch` control room presets with Reason 13+ `.rsmeta` browser metadata
- **Compatibility**: Reason 10.1 or later (macOS Universal Apple Silicon / Intel & Windows 64-bit)