Body Frame and IMU Orientation Reference

ESTIMATOR_PROFILE = STANDARD_IMU_DUAL_ANTENNA_HEADING

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1 Configuration

This profile fuses dual-antenna heading with IMU-propagated pose: it needs two antennas (PRIMARY, ALT1) for heading, plus an IMU for orientation and velocity between GNSS updates.

Note that the BASELINE_VECTOR_B is also relevant to the STANDARD_DUAL_ANTENNA_HEADING profile, while POS_IMU_B and ORIENTATION_IMU_B are specific to the STANDARD_IMU_DUAL_ANTENNA_HEADING profile.

```
[ESTIMATOR]
ESTIMATOR_PROFILE = STANDARD_IMU_DUAL_ANTENNA_HEADING
GROUPS = PRIMARY ALT1
BASELINE_VECTOR_B = <x> <y> <z>

[IMU]
IMU_TYPE = <your IMU model>
POS_IMU_B = <x> <y> <z>
ORIENTATION_IMU_B = <x> <y> <z> <w>
```

2 Body Frame

Every vector below must be expressed in the body frame, so the estimator can fuse the IMU calculated pose into the PVT solution.

- Right-handed, forward-left-up with respect to the platform.
- Origin: the PRIMARY antenna's phase center.
- $+X$ forward, $+Y$ left, $+Z$ up.

3 BASELINE_VECTOR_B

Vector from the PRIMARY antenna's phase center to the ALT1 antenna's phase center. Measure phase-center to phase-center, to millimeter precision. This is what the heading solution is computed from, so it must match the physical antenna geometry. IMU-aided pose needs the full antenna geometry, not just separation distance, so the scalar BASELINE_LENGTH_CONSTRAINT is not enough for this profile.

4 POS_IMU_B

Vector from the PRIMARY antenna's phase center to the IMU. This lever arm lets the estimator relate IMU motion to the antenna's known position, so IMU data fuses with GNSS at the correct physical location.

5 ORIENTATION_IMU_B

Quaternion rotating the IMU's axes onto the body frame. This lets the estimator take raw IMU measurements (accelerometer, gyroscope) and express them in the body frame before fusing them with GNSS.

- Identity [`0 0 0 1`] if the IMU's $X/Y/Z$ axes already point forward/left/up; otherwise set it to the mounting rotation.
- Use a quaternion library or your CAD tool rather than hand-deriving it.
- **Component order is** (x, y, z, w)**, scalar last:** most tools default to (w, x, y, z), so reorder before writing the config line.

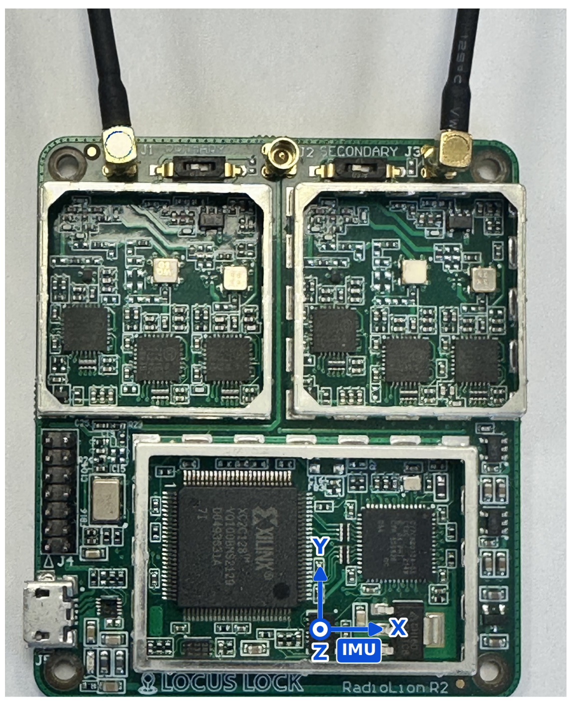

Figure 1: IMU location and axes, as photographed.

6 Worked Example

A car, for intuition: the roof antenna is PRIMARY, the second roof antenna is ALT1, and a console-mounted IMU is yawed 90° from forward.

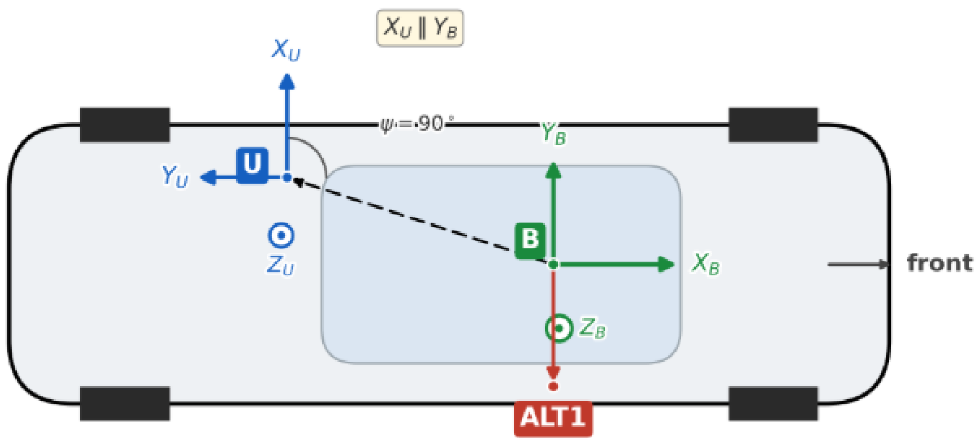

Figure 2: B (green): body origin at PRIMARY. ALT1 (red): baseline. U (blue): IMU, offset and yawed 90°; note $X_U \parallel Y_B$.

Baseline: ALT1 is 1.3 m right (in the negative Y direction) of PRIMARY:

`BASELINE_VECTOR_B = 0.00 -1.30 0.00`

IMU position: the IMU is 2.55 m behind (negative X direction) and 0.35 m left (positive Y direction) of PRIMARY:

`POS_IMU_B = -2.55 0.35 0.00`

Rotation: a 90° yaw gives, scalar-first, $q = (\cos 45°, 0, 0, \sin 45°) = (0.7071, 0, 0, 0.7071)$, with

$$R(q) = \begin{pmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix}, \qquad \texttt{ORIENTATION\_IMU\_B = 0 0 0.7071 0.7071}$$

Sanity check: an IMU reading of $(0.62, -0.05, 9.79)$ becomes $\mathbf{v}^B = R(q)\,\mathbf{v}^U = (0.05, 0.62, 9.79)$ in the body frame; the IMU's X reading shows up almost entirely as body Y (left), confirming the 90° swap.

```
[ESTIMATOR]
ESTIMATOR_PROFILE = STANDARD_IMU_DUAL_ANTENNA_HEADING
GROUPS = PRIMARY ALT1
BASELINE_VECTOR_B = 0.00 -1.30 0.00

[IMU]
IMU_TYPE = <your IMU model>
POS_IMU_B = -2.55 0.35 0.00
ORIENTATION_IMU_B = 0 0 0.7071 0.7071
```

7 Checklist

- `BASELINE_VECTOR_B` and `POS_IMU_B`: phase-center to phase-center/target, in meters, forward-left-up.
- `ORIENTATION_IMU_B`: (x, y, z, w), rotates IMU $\to$ body.

- IMU_TYPE: match your hardware.
- Confirm your forward direction against your install drawing.