**A3 ORBIT-RELATIVE REFERENCE FRAMES**

This registry contains allowable values for specifying orbit-relative reference frames in the accompanying referenced standards. These frames can be used to specify maneuver and covariance data.

**Note that these orbit-relative local reference frames below are provided in two flavors: inertial and rotating. When transforming velocity terms between inertial and rotating frames, remember to properly incorporate the** $(\overbar{ω} × \overbar{r)} $**contribution.**

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| **Name** | **Description** | **Others have referred to this as** | **Reference** |
| EQW\_INERTIAL | Equinoctial Coordinate System, a quasi-inertial, right-handed, Cartesian frame with E aligned with the ascending node direction, W along the orbital angular momentum vector ($\overbar{ω} = \overbar{r}×\overbar{v}$) and Q completing the set ($\hat{Q} = \hat{W}×\hat{E}$). This system is quasi-inertial in the sense that it is treated as an inertial coordinate frame that is redefined at each time of interest. |  |  |
| LVLH\_ROTATING | ‘LVLH’ stands for ‘Local Vertical Local Horizontal’. The Z-axis of the rotating LVLH frame is a unit vector collinear and opposite sign of the gravicentric satellite position (planet center, spacecraft gravity center), the Y-axis is a unit vector collinear but with the opposite sign of the orbital kinetic momentum (normal to orbit plane), and the X-axis is the unit vector equal to   |  |  |
| LVLH\_INERTIAL | A quasi-inertial version of the LVLH\_ROTATING frame. This system is quasi-inertial in the sense that it is treated as an inertial coordinate frame that is redefined at each time of interest. |  |  |
| NSW\_ROTATING | “Nadir, Sun, Normal” – This rotating frame aligns the x-axis in the nadir direction, the y-axis as much as possible toward the Sun while still being normal to the x-axis, and the z-axis completing the right-hand set. |  |  |
| NSW\_INERTIAL | A quasi-inertial version of the NSW\_ROTATING frame. This system is quasi-inertial in the sense that it is treated as an inertial coordinate frame that is redefined at each time of interest. |  |  |
| NTW\_ROTATING | A local orbital coordinate rotating frame that has the y-axis along the Tangential (or inertial velocity) vector, z-axis (“W”) along the orbital angular momentum vector ($\overbar{ω} = \overbar{r}×\overbar{v}$), and N (the x-axis) completing the right handed system (i.e., for a circular orbit “N” generally points in the radial direction and for an eccentric orbit, “N” points as close to radial as possible while still being normal to the T-W plane). | * Transverse-Velocity-Normal (TVN) frame (e.g., CCSDS CDM Blue Book 508.0-B-1).
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| NTW\_INERTIAL | A quasi-inertial version of the NTW\_ROTATING frame. This system is quasi-inertial in the sense that it is treated as an inertial coordinate frame that is redefined at each time of interest. |  |  |
| PQW\_INERTIAL | Perifocal Coordinate System, a quasi-inertial frame with P axis pointing to periapsis, W along the orbital angular momentum vector ($\overbar{ω} = \overbar{r}×\overbar{v}$) and Q completing the set ($\hat{Q} = \hat{W}×\hat{P}$). This system is quasi-inertial in the sense that it is treated as an inertial coordinate frame that is redefined at each time of interest. |  |  |
| RSW\_ROTATING | A Radial, Along track, Cross track, local orbital coordinate rotating frame, where the R axis always points out from the satellite along the central body’s radius vector to the satellite as it moves through the orbit. The S axis is in the direction of (but not necessarily parallel to) the velocity vector and is perpendicular to the radius vector. The W axis is aligned with the orbit angular momentum vector.Note that the RSW\_ROTATING frame is also referred to as:* Gaussian Coordinate System
* ‘Radial, In-track, Cross-track” (**RIC**)
* ‘Radial, Transverse, Normal’ (**RTN**)
* The **QSW** frame

 | * Gaussian Coordinate System
* ‘Radial, In-track, Cross-track” (**RIC**)
* ‘Radial, Transverse, Normal’ (**RTN**)
* The **QSW** frame
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| RSW\_INERTIAL | A quasi-inertial version of the RSW\_ROTATING frame. This system is quasi-inertial in the sense that it is treated as an inertial coordinate frame that is redefined at each time of interest.  | * ‘Radial, Down-track, Cross-track’ (UVW)
* ‘Radial, Transverse, Normal’ (RTN), as interpreted by the US Air Force in generation of Conjunction Data Messages per CCSDS CDM Blue Book 508.0-B-1.
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| TNW\_ROTATING | A local orbital coordinate Tangential, Normal, Cross-track rotating frame that has the x-axis along the Tangential (or velocity) vector, z-axis (“W”) along the orbital angular momentum vector ($\overbar{ω} = \overbar{r}×\overbar{v}$), and N completing the right handed system (i.e., for a circular orbit “N” generally points in the Nadir direction and for an eccentric orbit, “N” points as close to Nadir as possible while still being normal to the T-W plane). Note that while this frame has the same axes defined as in the NTW frame, the ordering of axes is different (TNW). |  |  |
| TNW\_INERTIAL | A quasi-inertial version of the TNW\_ROTATING frame. This system is quasi-inertial in the sense that it is treated as an inertial coordinate frame that is redefined at each time of interest. |  |  |
| SEZ\_ROTATING | The South/East/Zenith (SEZ) topocentric horizon system. This system is a right-handed, Cartesian system rotating with the observing site. The local horizon forms the fundamental plane, with the S axis pointing due south from the site (even in the Southern Hemisphere). The E axis points east from the site and is undefined at the North or South Poles. The Z axis (zenith) points radially outward from the site, along the site’s geodetic local vertical.  |  |  |
| SEZ\_INERTIAL | A quasi-inertial version of the SEZ\_ROTATING frame. This system is quasi-inertial in the sense that it is treated as an inertial coordinate frame that is redefined at each time of interest. |  |  |
| VNC\_ROTATING | A local orbital coordinate Velocity, Normal, Co-normal rotating frame that has the x-axis along the Velocity (or tangential) vector, y-axis Normal to the orbit along the orbital angular momentum vector ($\overbar{ω} = \overbar{r}×\overbar{v}$), and z-axis is the “Co-normal” direction completing the right handed system (i.e., for a circular orbit “C” points in the radius vector direction whereas for an eccentric orbit, “C” points as close to radial as possible while still being normal to the V-N plane). Note that while this frame has the same axes defined as in the NTW frame, the ordering of axes is different (i.e., TWN). | * ‘Velocity, Normal, Bi-normal’ (**VNB**) x-axis along the Velocity (or tangential) vector, y-axis Normal to the orbit along the orbital angular momentum vector ($ \overbar{ω} = \overbar{r}×\overbar{v}$), and z-axis is the “Bi-normal” direction completing the right handed system.
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| VNC\_INERTIAL | A quasi-inertial version of the ‘Velocity, Normal, Co-normal’ VNC\_ROTATING frame. This system is quasi-inertial in the sense that it is treated as an inertial coordinate frame that is redefined at each time of interest. | * ‘Velocity, Normal, Bi-normal – quasi-inertial’ (**VNQ**), as used by NASA/JSC
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