

What does the CQ really mean?

When a System 500 sensor is configured as a rover and is displaying a code or phase fixed solution, an estimate of the **Co-ordinate Quality (CQ)** can be computed.

How is the CQ value computed? What does a CQ value of .02m mean? Do you know why the height quality is never as good as the position quality?

Different Quality Types

If you configure the sensor as a rover, one of two types of quality indicators can be chosen: **DOP** and **Quality**.



A **DOP** value reflects only the current satellite constellation and does not provide information about the quality of the observations. Generally, DOP-values below 8 should deliver satisfactory results. However as described later, the **CQ** value additionally reflects different environmental conditions.

Depending on the accuracy status, the quality will be at the cm level (**High Precision Navigation** 📶) or around 0.4 – 5m (**Precision Navigation** 📶). If the rover has lost, or not yet received the reference data, a **Navigation solution** 📶 is computed. In the case of a navigation solution, Sys500 automatically switches from displaying a CQ value to a DOP value. (Since May 1st, 2000 when Selected Availability was turned off, the navigation accuracy has improved and is now about 10m).

So how is the CQ in Sys500 value actually computed?

General Introduction...

A **least-squares adjustment** is a well-known technique to process sets of redundant observations in all fields of surveying (photogrammetry, survey networks...). The processing of GPS measurements also uses similar least-squares techniques. Besides the determination of the unknowns (including the rover co-ordinates in this case), the least-squares adjustment also delivers **standard deviations (stds)** of the unknowns according to mathematically defined rules.

The stds of the computed co-ordinates are simply derived by multiplying the a **posteriori variance of unit weight** (also called **RMS**) with the elements of the **co-factor matrix**, which are themselves products of the least-squares adjustment.

The **RMS** is an indicator of the measurement noise and environmental conditions. All error sources such as diffraction, multipath, ionospheric and tropospheric disturbances are reflected in the RMS. The **co-factor matrix** reflects the influence of the different constellations of the satellites on the co-ordinate components.

But remember, that statistically, there is only a 39,3% probability (2D) that the computed position deviates from the true position by less than the std. This is why the computation of the **CQ-value** in Sys500 is not based only on these basic algorithms...

The CQ-Value in Sys500

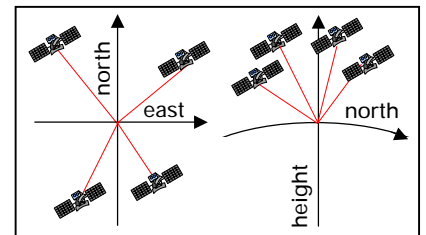
One drawback of just using the **std** is that this value is often too optimistic. This is particularly true for low

redundancy situations such as a 4-satellite constellation. In such a case the **RMS** converges to zero and the std would show an unrealistically small value.

The CQ-value in Sys500 is based on the std, but additional, empirical assumptions are also taken into consideration. The CQ is derived such that there is at least a two third probability that the computed position deviates from the true position by less than the CQ value.

Height CQ versus Position CQ

All GPS computed positions are almost twice as accurate in plan than in height. Why? Consider the position and height determination as a 2D-problem.



The figure above illustrates that for the position determination, satellites can appear in all 4 quadrants. However, for the determination of the height, satellites can only ever appear in 2 quadrants. It is therefore clear that the height position is much weaker than the plan position.

Remember...

- Use the CQ, not the DOP to take into account the environmental conditions during RTK.
- There is at least a 2/3 probability that the computed position deviates from the true position by less than the CQ value.
- The height CQ is always worse than the plan CQ.