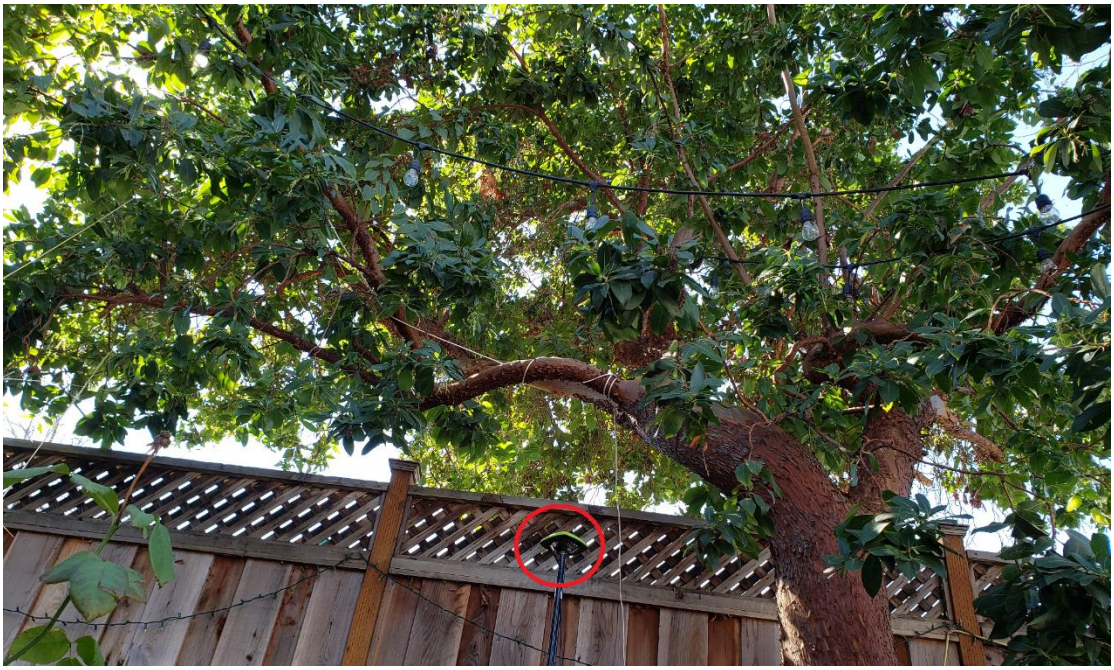
RTK Verification in Seconds with Signals Variety: A Guide to Using Signals Variety

Javad GNSS, Inc. is excited to announce a new parameter that can be used to dramatically decrease the time it takes to verify RTK observations.

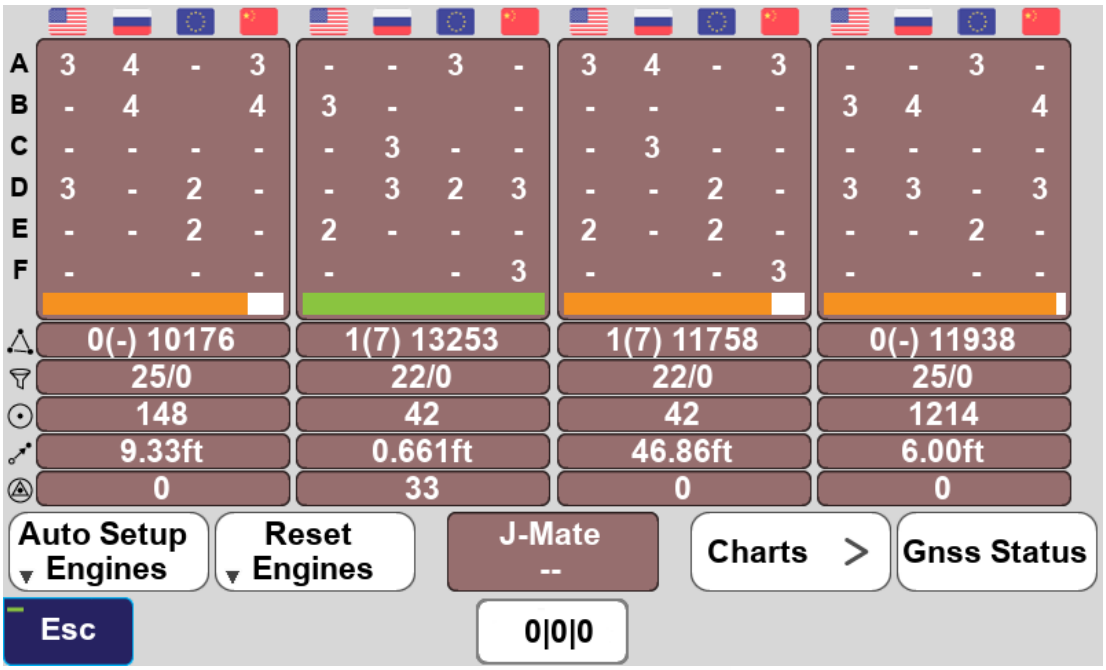
Signals Variety Explanation and Test Results

Signals Variety is a parameter that increases as the differences in the GNSS signals (GPS C/A, GPS P2, GPS L2C, GLO P1, etc.) used between the different RTK engines increases. Typical *Signals Variety* values can range from 0 to 4. Higher values equate to more engines that have fixed with unique signals being used. The higher this value is, the less likely it is that this RTK solution in a "bad fix" (typically a "bad fix" is defined by the RTK coordinate being in error by more 0.20' horizontally). A more detailed explanation of the *Signals Variety* calculation is provided in the Appendix at the end of this article.

To determine the likelihood of a "bad fix" a test in a bad location for GNSS signals was conducted. An external antenna connected to a TRIUMPH-LS PLUS was used. The external antenna was located under a tree and beside a wood fence.

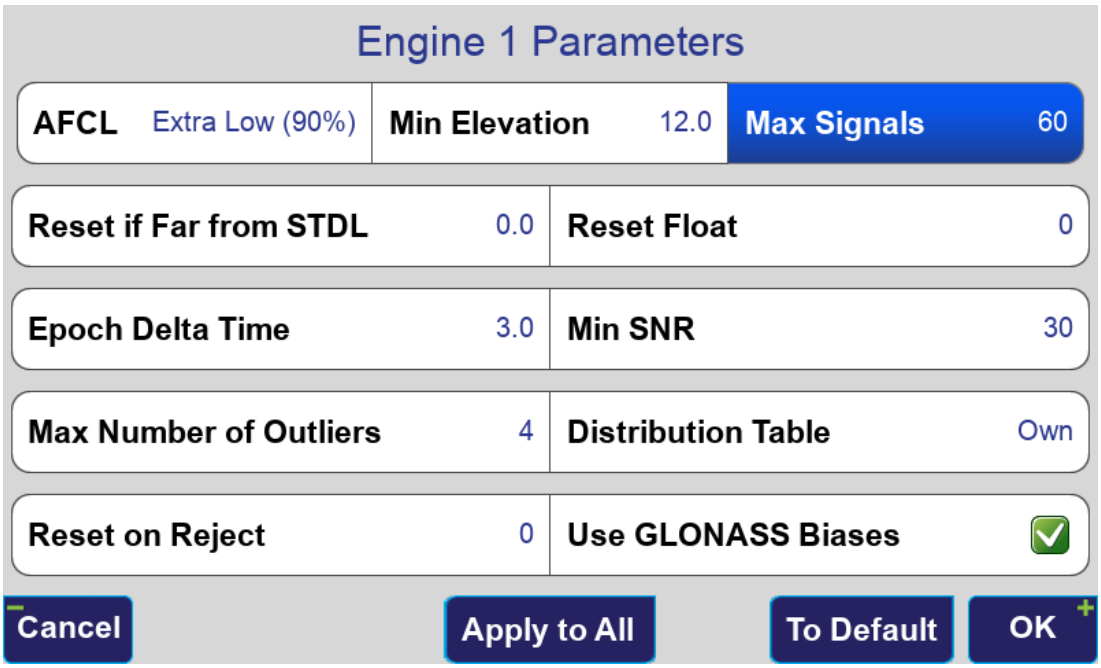


The only requirement to stop observing points in this test was the *Signals Variety* level. Each RTK engine in the TRIUMPH-LS PLUS can support data from up to 8 different GNSS signals. The RTK engines were manually configured so that each engine has two signals from each of the four constellations available (GPS, GLONASS, Galileo and BeiDou). This strategy was used because it was found that the RTK engines fix the fastest in poor locations when they are provided data from all the available constellations and satellites. To maximize the *Signal Variety* each GNSS signal (there are 19 available signals with the four constellations) was used no more than twice in the 4 RTK engines. To configure an RTK engine, long click on the engine in the *Engine Signal* screen and select the desired signals.



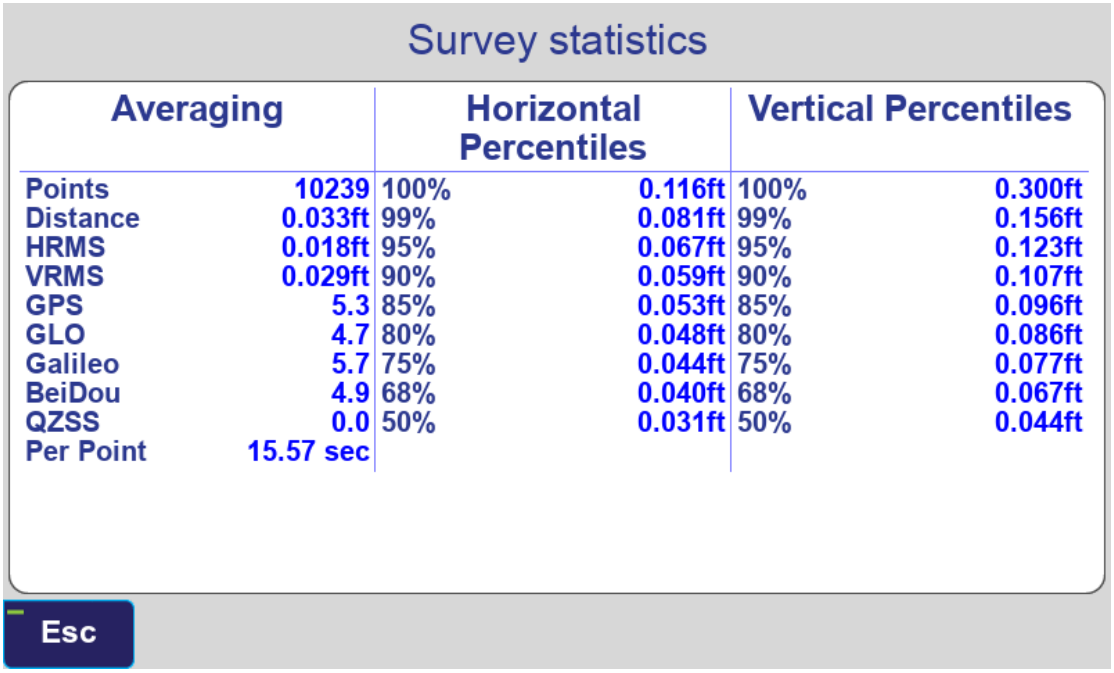
Optimal Engine Configuration with 2 Signals per Constellation

For 8 signals per engine to be utilized, the “Max Signals” that can be used per engine needs to be increased. This setting can be found Setup > General > RTK/DGPS > Advanced RTK Setting > Engine 1-4. Note that increasing the Max Signals will increase the demand on the GNSS processor and will decrease the RTK rate below 5 Hz when in the open where many satellites are visible. It is more desirable and beneficial to maximize the number of signals being used rather than to maximize the RTK rate.



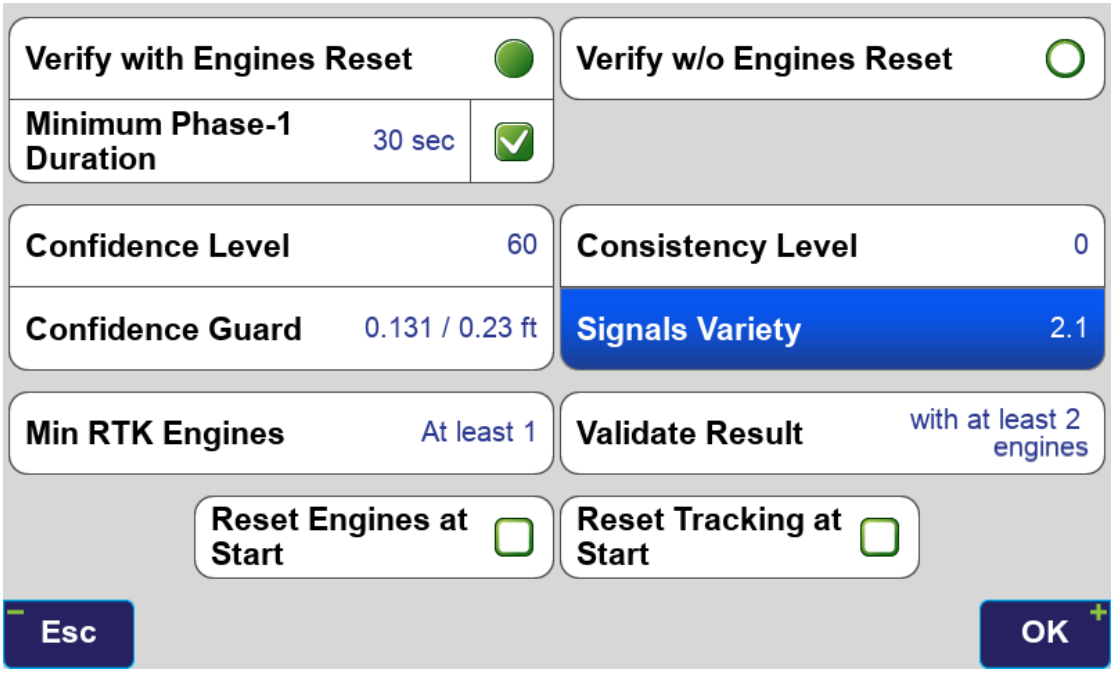
Engine 1 configured with 60 signals per engine

The first test required the *Signals Variety* reach a level of at least 1.1 before stopping the point. There were 6215 points collected with 8 outliers (horizontal error greater than 0.20'). The average duration (defined as the time span between the first epoch of the saved group and the last epoch of that group) was 14 seconds. The second test required the *Signals Variety* reach a level of at least 2.1 before stopping the point. There were **over 32,000 points collected with no outliers** and the average duration was only 16 second.



A screenshot of the Survey Statistics after more than 10,000 points were collected with a Signals Variety requirement of 2.1

The *Signals Variety* parameter is found in the *Verify* settings of the *Action Group* profile.



Signals Variety can be used to speed up the Phase-1 of RTK Verification process (RTK engines are reset immediately after fixing and collection 1 epoch during Phase-1) the verification process. If the *Signals Variety* requirement is greater than 0 and the value is met or exceeded while a point is being collected, the RTK Verification process will advance to Phase-2 (RTK engines are not reset during Phase-2) even when the *Confidence Level* requirement has not been met. In this case the *Confidence Level* requirement does not have to be met before Accept/Reject are displayed. If the Confidence Level requirement is met before the *Signals Variety* requirement is met it will also advance to Phase-2 but the *Signals Variety* requirement must be met before Accept/Reject will be displayed.

Appendix A: Signal Variety Calculation

Signals Variety is calculated based on symmetric difference and it get the signal's set from each RTK engine for each epoch and clusterizes it by maximum symmetric difference. The maximum number of clusters is 6. With N clusters, the distance between clusters is the symmetric difference between signals. If max number of clusters is reached then the

closest one is found and replaced it by the new signal's set if the new signal's set will create a cluster with greater weight. The weight of a cluster is sum of distances to all other clusters.

Signals Variety = Averaged_Clusters_Weight / Signals_Per_Engine
Averaged_Clusters_Weight is calculated
Signals_Per_Engine is constant (8)

Simple Example: We have 2 solutions (signal's set) from the same or different RTK engines (time is not involved in the formula) and the symmetric difference is 6 signals between each. It will create 2 clusters with each cluster will having a weight 6. The averaged weight of 2 cluster is (6+6)/2 = 6. The *Signals Variety* = 6/8 = 0.75.

Some theoretical values are provided in the table below. For example in this table if there are 3 fixed engines and each engine has 5 unique signals being used then the Signal Variety is 1.88.

Signal Variety Values					
	Symetric Difference Between Each Engine				
Number of Fixed Engines	**4**	**5**	**6**	**7**	**8**
2	0.5	0.63	0.75	0.88	1
3	1.5	1.88	2.25	2.63	-
4	3	3.75	-	-	-

Cells that don't have values are not possibe due to there not being enough signals