
JAVAD
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Front

## Spoofer Detection

With 864 channels and about 130,000 quick acquisition correlators in our TRIUMPH chip, we have resources to assign more than one channel to each satellite to find ALL signals that are transmitted with that GNSS satellite PRN code.

If we detect more than one reasonable and consistent correlation peak for any PRN code, we know that we are being spoofed and can identify the spoofed signals.

When we detect that spoofing is in effect, we use the position solution provided by all other clean signals (L1, L2, L5, etc... GPS, GLONASS, Galileo, Beidou, etc...) to identify the spoofer signal and use the real satellite measurement. If all GNSS signals are spoofed or jammed, then we alarm you to ignore GNSS and use other sensors in your integrated system.

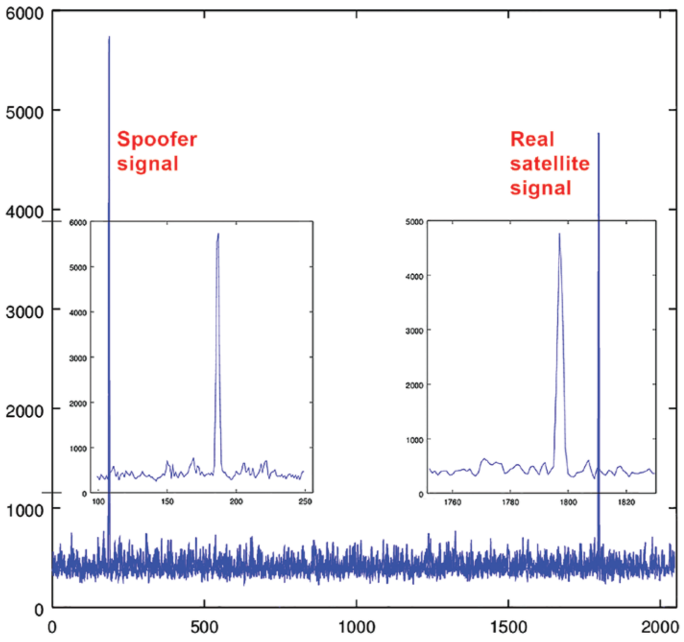



***Figure 1***
*shows an example of a spoofer signal and a real satellite signal received at GNSS receiver.*

## Satellite and Spoofer Peaks

The screenshots below are from a real spoofer in a large city. The bold numbers are for the detected peaks. The gray numbers represent highest noise, not a consistent peak. "*" symbol next to the CNT numbers indicate that signal is used in position calculation. Each CNT count represent about 5 seconds of continuous peak tracking.

| SAT | EL | S... | Range 1 | Dopp... | CNT 1 | S... | Range 2 | Dopp... | CNT 2 | dRng | dDop | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GPS5 | 33 | 16 | 61.14 | 1382 | 184* | 4 | 25.95 | 181 | 1 | 29.32 | 1201 | 29 |
| GPS7 | 51 | 21 | 14.39 | 1146 | 184* | 4 | 18.21 | -453 | 1 | 2.80 | 1599 | 29 |
| GPS8 | 30 | 18 | 65.10 | -918 | 184* | 4 | 4.26 | -1318 | 1 | 3.68 | 400 | 29 |
| GPS9 | 12 | 14 | 40.46 | 2966 | 184* | 4 | 2.08 | 3765 | 1 | 26.13 | -799 | 29 |
| GPS13 | 40 | 16 | 46.92 | -3525 | 184* | 4 | 8.21 | -4325 | 1 | 25.80 | 800 | 29 |
| GPS15 | 12 | 14 | 12.46 | -4336 | 30* | 5 | 33.00 | -1536 | 1 | 19.52 | -2800 | 28 |
| GPS20 | 24 | 12 | 13.19 | -1707 | 107* | 4 | 29.32 | -3307 | 1 | 15.11 | 1600 | 29 |
| GPS27 | 16 | 11 | 10.26 | 1264 | 184* | 4 | 43.55 | 63 | 1 | 31.22 | 1201 | 29 |
| GPS28 | 53 | 19 | 9.41 | -2724 | 184* | 4 | 7.93 | -4724 | 1 | 0.46 | 2000 | 29 |
| GPS30 | 81 | 22 | 13.79 | -332 | 184* | 5 | 34.16 | 1266 | 1 | 19.35 | -1598 | 28 |
| GLN-4 | 54 | 20 | 62.08 | 1498 | 1158* | 5 | 21.72 | 2697 | 1 | 24.16 | -1199 | 25 |
| GLN5 | 46 | 20 | 18.04 | -2897 | 524* | 4 | 26.26 | -3697 | 1 | 7.20 | 800 | 25 |
| GLN0 | 37 | 18 | 30.37 | 2355 | 1469* | 4 | 38.37 | 1554 | 1 | 6.98 | 801 | 25 |
| GLN-1 | 82 | 18 | 34.92 | -776 | 189* | 4 | 12.54 | -1576 | 1 | 21.35 | 800 | 25 |
| GLN-2 | 26 | 12 | 30.96 | -4358 | 229* | 4 | 11.80 | -3158 | 1 | 18.13 | -1200 | 25 |
| GLN2 | 21 | 10 | 59.73 | 288 | 551* | 4 | 47.55 | 1087 | 1 | 11.16 | -799 | 25 |
| GLN4 | 22 | 15 | 30.59 | -3361 | 208* | 4 | 11.74 | -5361 | 1 | 17.83 | 2000 | 25 |
| GLN-5 | 21 | 14 | 20.17 | 276 | 187+ | 3 | 25.45 | 2275 | 1 | 4.26 | -1999 | 25 |

Esc    Sat: 10 7 6 4 4 0    dPos: 19.0m    Age: <1s

***Figure 2*** *No spoofer. Only one reasonable peak for each satellite.*

Elevation Angle; Satellite Name; First Peak: Signal above noise level, Range mod 1 ms, Doppler, 5 sec count; Second Peak: Signal above noise level, Range mod 1 ms, Doppler, 5 sec count; Delta range; Delta Doppler; Noise level

| SAT | EL | S... | Range 1 | Dopp... | CNT 1 | S... | Range 2 | Dopp... | CNT 2 | dRng | dDop | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **GPS1** | **14** | **14** | **231.08** | **-2627** | **140*** | **9** | **155.13** | **-2627** | **60** | 74.93 | 0 | 28 |
| GPS10 | 9 | 12 | 267.44 | -2078 | 74* | 4 | 238.41 | -3278 | 1 | 28.01 | 1200 | 28 |
| GPS11 | 22 | 13 | 297.36 | -847 | 301* | 3 | 6.45 | 1151 | 1 | 289.89 | -1998 | 29 |
| **GPS13** | **55** | **21** | **136.95** | **1154** | **301*** | **9** | **21.70** | **1153** | **73** | 114.23 | 1 | 28 |
| **GPS15** | **49** | **20** | **278.00** | **-453** | **301*** | **9** | **168.03** | **-453** | **73** | 108.95 | 0 | 29 |
| **GPS17** | **41** | **22** | **83.28** | **-3212** | **301*** | **10** | **277.41** | **-3212** | **69** | 193.11 | 0 | 28 |
| **GPS19** | **23** | **14** | **133.13** | **-4590** | **164*** | **7** | **19.06** | **-4590** | **69** | 113.05 | 0 | 29 |
| GPS20 | 5 | 8 | 170.96 | 2215 | 36* | 3 | 50.73 | 614 | 1 | 119.21 | 1601 | 29 |
| **GPS24** | **22** | **15** | **54.25** | **-4022** | **177*** | **9** | **250.43** | **-4022** | **82** | 195.16 | 0 | 29 |
| GPS28 | 58 | 18 | 50.14 | 1040 | 301* | 3 | 268.62 | 1439 | 1 | 217.46 | -399 | 29 |
| GPS30 | 23 | 17 | 290.02 | 2593 | 301* | 3 | 214.66 | 4592 | 1 | 74.34 | -1999 | 28 |
| GLN-7 | 30 | 22 | 159.09 | 2505 | 213* | 7 | 274.16 | 2104 | 1 | 114.05 | 401 | 28 |
| GLN-4 | 39 | 18 | 72.21 | -450 | 282* | 7 | 220.15 | -3250 | 1 | 146.92 | 2800 | 28 |
| GLN-1 | 34 | 18 | 92.17 | -3838 | 259* | 6 | 299.41 | -1838 | 1 | 206.22 | -2000 | 28 |
| GLN0 | 72 | 23 | 271.81 | 147 | 283* | 7 | 78.08 | 2146 | 1 | 192.71 | -1999 | 28 |
| GLN1 | 23 | 15 | 297.65 | 3244 | 129* | 6 | 8.21 | 2443 | 1 | 288.42 | 801 | 28 |
| GLN2 | 42 | 18 | 200.78 | -742 | 282* | 6 | 234.83 | 2056 | 1 | 33.03 | -2798 | 28 |
| GLN3 | 17 | 18 | 158.51 | 2584 | 282* | 6 | 44.03 | 4583 | 1 | 113.46 | -1999 | 28 |

Esc    Used: 11+9+4+8+0+1=33    1    2    dPos: 21.2m    Age: <1s

GPS GLN GAL BDU IRN QZ ◂ Number of satellites used in position calculation

***Figure 3***
*In the screenshot all GPS satellites have two peaks and all are spoofed. We were able to distinguish the spoofer signal and use the real satellite signals in correct position calculation as indicated by the "*" next to the CNT numbers.*

PATENTS PENDING

# VB-RTK

Get on the Grid with VB-RTK. For over a decade American surveyors have been using the National Geodetic Survey's Online Positioning User Service. Surveyors employing RTK have been a significant share of the user segment of OPUS.

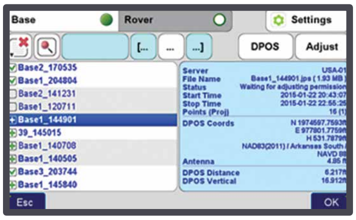
**A significant share of OPUS users are surveyors using RTK.** Often a surveyor will set up his base on a new, unknown position and allow an autonomous (or standalone) position to be used for the base coordinates. While he is performing his RTK work with fixed vectors between his base and rover, he stores data at the base to be submitted at a later time to OPUS. Once he is finished with his work, he downloads this file to his computer, converts the file if necessary, and submits it to OPUS. He then receives an email response back with a precisely determined coordinate for his base station. He then must take this coordinate, relate the coordinate to his project coordinate system, and then translate the work from the autonomous (or standalone) position he used in the field to this new coordinate. This procedure can produce excellent results and anchors the survey to the NSRS. The down side to this is that there are several steps that must be carefully observed and each of these error prone steps costs time.

With J-Field data collection software, Javad has been automating many tasks that surveyors have been doing for years, making the tasks more efficient and reducing sources of potential error. One example, **"Verify RTK with V6 Resets"**, is being recognized by surveyors across the country as the most accurate and efficient way to confidently determine RTK positions. Rather than taking a shot, manually resetting (or dumping) the receiver and taking a second shot for comparison, Verify RTK does this automatically with a user defined number of reset iterations.

Javad has continued this automation philosophy by dramatically simplifying the process of translating a survey from an autonomous base position to precise geodetic coordinates with **VB-RTK (Verify Base – RTK)**. Using the Javad GNSS, Data Processing Online Service (DPOS), which is powered by the proven Javad GNSS Justin processing engine. **This multi-level process is done in J-Filed completely automatically.**

Once an RTK session has been completed, the user returns to his Javad base receiver and presses "Stop Base" on the Triumph-LS. **At this point, the raw data file that has been recording at the base during the session, is wirelessly downloaded from the base to the Triumph-LS. When the download is complete, the user returns to his office and connects the Triumph-LS to the internet.**

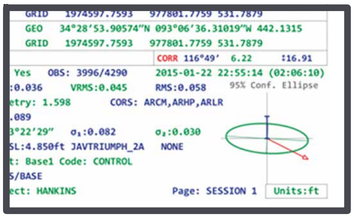
When internect connection is made, the file is automatically transmitted to one of the Javad GNSS servers for post processing. Once data and ephemerides are available for the session, **DPOS** processes the file and returns results to the waiting Triumph-LS. This all takes place within minutes.



Once results are returned, the new coordinates for the base are shown related to your coordinate system (including localization systems).

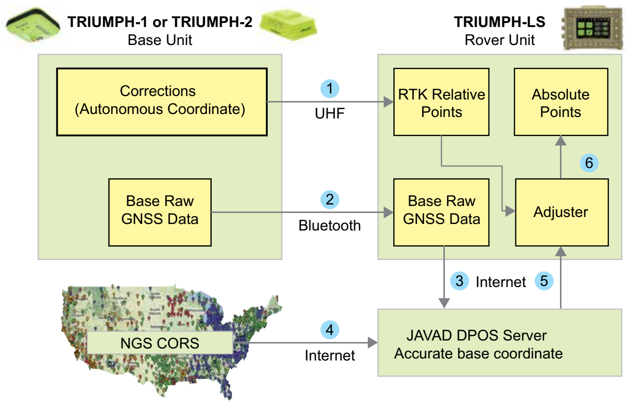
The horizontal and vertical differences between the base coordinates used and the DPOS determined coordinates are shown. **This provides for an instant check of the base coordinates and instrument height** if the base were set up on a known position.

All rover points associated with that base session translate automatically in seconds. Only those rover points associated with that base session translate.

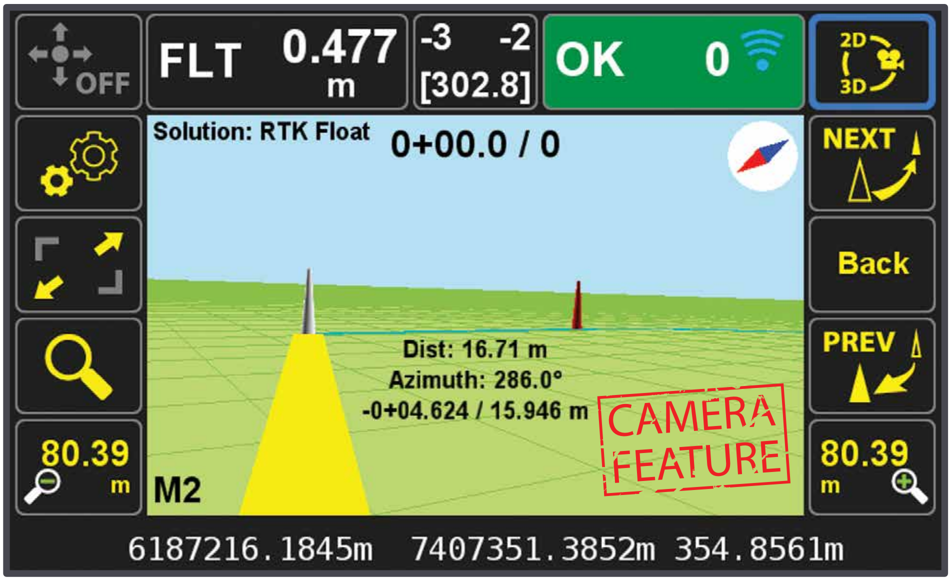


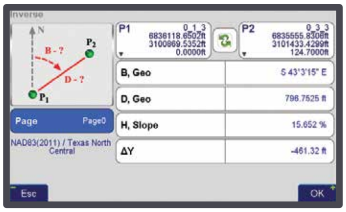
If the user is not satisfied with the results of the DPOS solution and wants to revert back to the original RTK positions, he simply clicks **"Undo"**. This process is immune to base instrument height errors because the internal vectors between base to rover are related to the antenna, not the ground point. So, an accidental entry for the base height of 543' instead of 5.43' can be resolved by VB-RTK.

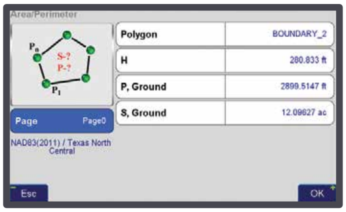
**In addition to the advantages of having your RTK base station near your work area, which gives you much more accurate and faster fixes, especially in difficault areas, and saving you the RTN fees; perhaps most important of all, your work is now precisely related to one of the most accurate geodetic control networks in history – the NGS CORS.** Every rover point is only two vectors removed from the CORS (CORS to base, base to rover). This means that you can return again someday to find your monuments easily and accurately. This makes your records incredibly more valuable to both you and future surveyors. J-Field also has the unique ability to load and view every point you have ever surveyed from all the projects in its system. By combining this feature with a **distance filter** in its advanced set of filters, you can easily view all the points you have previously surveyed within a given distance of a point in your current project. Having an easily accessible record of nearby georeferenced coordinates is very beneficial as you may have previously located monuments in past surveys that are beneficial in your current project. J-Field allows you to easily copy these selected points into your current project, eliminating the need for you to resurvey them. All of this is available automatically on the world's most advanced RTK rover – **the Triumph-LS**.

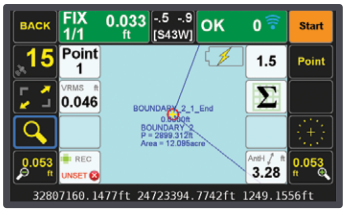


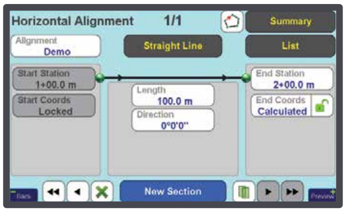

**You do 1, the rest is automatic**




## Store and Stake

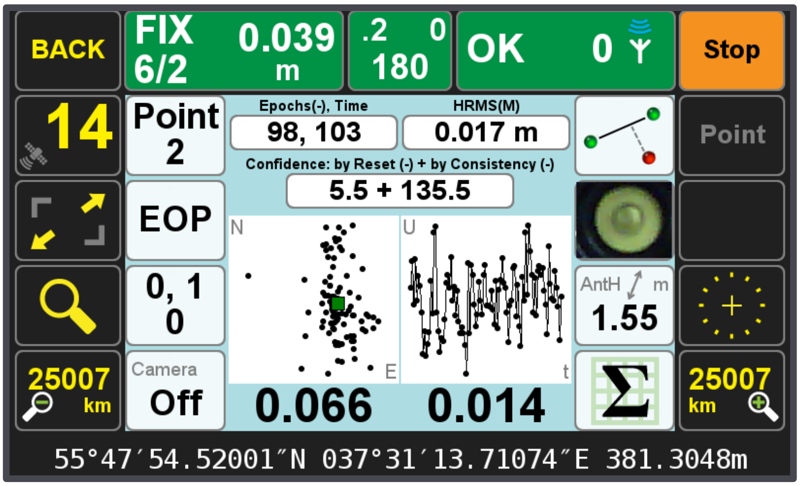
Introducing GUIDE data collection in the TRIUMPH-LS. Visual Stake-out, navigation, six parallel RTK engines, over 3,000 coordinate conversions, advanced CoGo features, rich attribute tagging on a high resolution, large, bright 800x480 pixel display. Versatile attribute tagging, feature coding and automatic photo and voice documentation.

The TRIUMPH-LS automatically updates all firmware when connected to a Wi-Fi internet connection.

## View and Document your level

The downward camera of TRIUMPH-LS scans and finds the liquid bubble level mounted on the pole. Then focuses on the circular bubble automatically and shows its image on one of the eight white buttons of the Action Screen. You can:

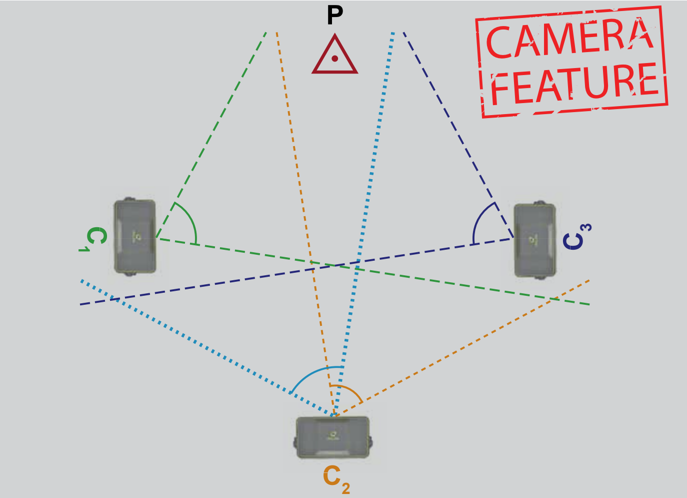
- View the liquid bubble level on the screen.
- Document survey details including the leveling by taking automatic screen shots of the Action Screen, as shown here.
- Calibrate the electronic level of TRIUMPH-LS with the liquid bubble level for use in Lift and Tilt and automatic tilt corrections.

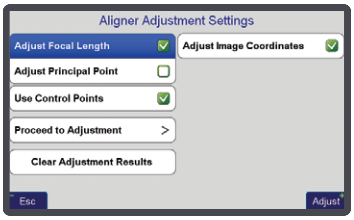

**All these camera features are possible only in TRIUMPH-LS where camera, and GNSS antenna are co-located and all other modules integrated.**

## Offset Survey with built in camera

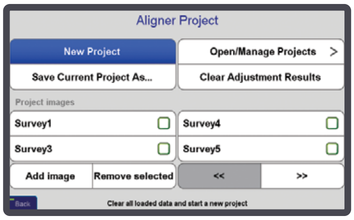
You can survey points with internal TRIUMPH-LS camera with accuracy of about 2 cm. Take pictures from at least  three points. Leave a flag on points that you take pictures from, otherwise accuracy will be about 10 cm.





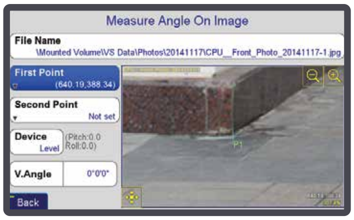



## Visual Angle Measurement with Triumph LS

The new Visual Angle Measurement function of the TRIUMPH-LS allows measuring angles between points by using photos taken by the TRIUMPH-LS camera and use in CoGo tasks with the Accuracy of about 10 angular minutes.

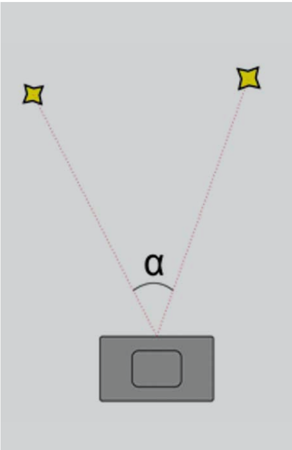
**To measure an angle:**

- just take an image containing both objects of interest and open it in the Measure Angle screen
- select first and second point (using zoom to focus on necessary features)
- The angle between points is immediately displayed on the screen.

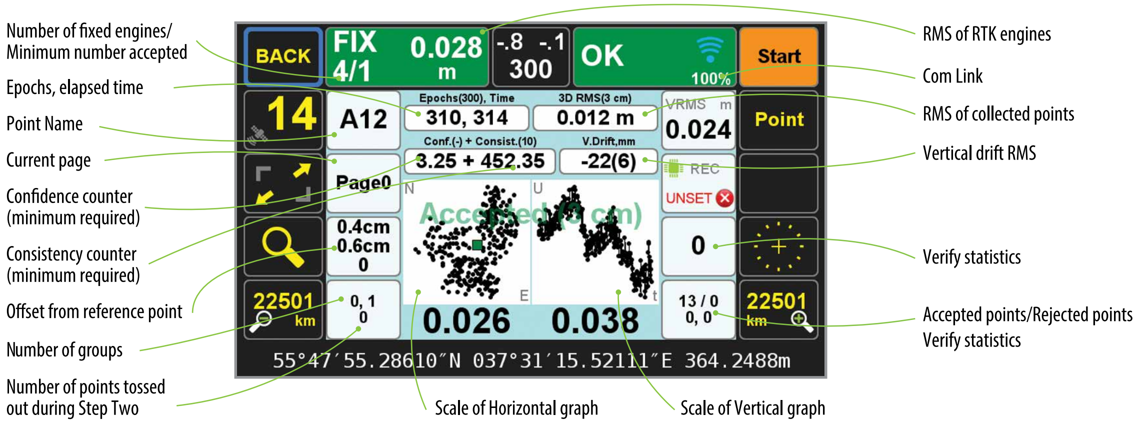




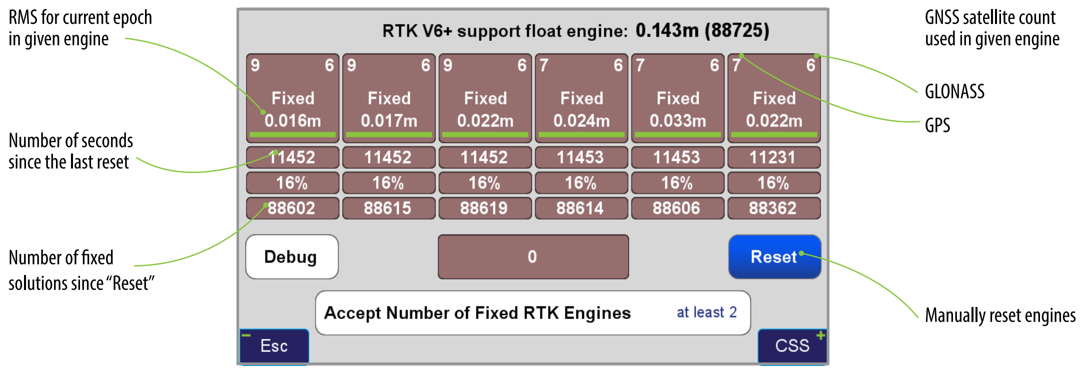


# RTK V6+

## six engines plus one support




## Auto Verify... Auto Validate...



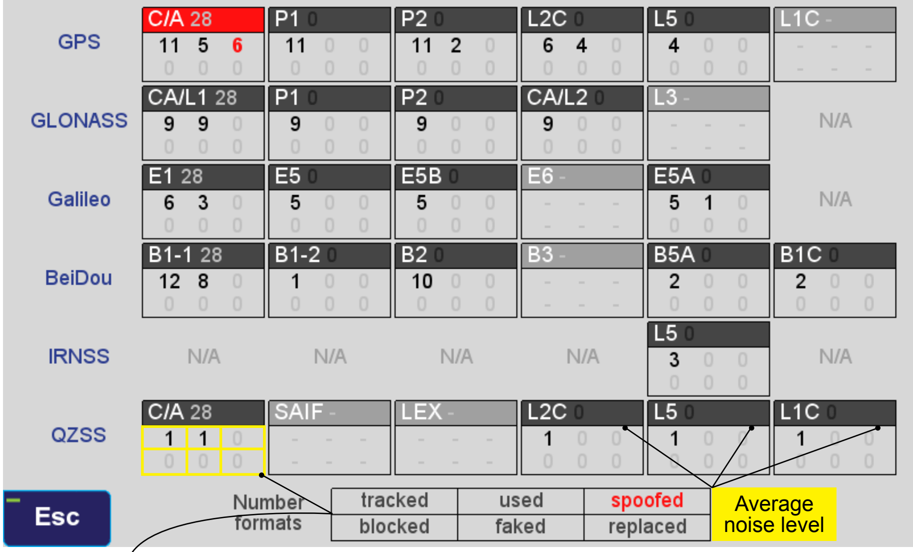

This vigorous, automated approach to verifying the fixed ambiguities determined by TRIUMPH-LS gives the user confidence in his results and saves considerable time compared to the methods required to obtain minimal confidence in the fixed ambiguity solutions of other RTK rovers and data collectors on the market today. The methods required by other systems are not nearly so automated, often requiring the user to manually reset the single engine of his rover, storing another point representing the original point and then manually comparing the two by inverse, all to achieve a single check on the accuracy of the fixed ambiguities. Acquiring more confidence requires manually storing and manually evaluating more points. Conversely, J-Field automatically performs this test, resetting the multiple engines, multiple times (as defined by the user), provides an instant graphic display of the test results, and produces one single point upon completion.

Read details inside and compare with other receivers that require Multiple Point survey, Manual Evaluation, Single Engine, and Single Ambiguity Check per Point.

With TRIUMPH-LS you have Single Point survey, Automated Evaluation, Multiple Engines, and Multiple Ambiguity Checks per Point.

## GNSS Overall View

The format and the signal definitions are explained below.




GPS L2C: L+M
GLN L3: I+Q
GAL E1: B+C
GAL E5: alboc
GAL E5B: I+Q
GAL E5A: I+Q
BeiDou B2: B5B
QZSS L2C: L+M
QZSS L1C: I+Q

***Figure 4***
*The screenshot shows the status of all GNSS signals.*

Definitions for the number of signals:

**Tracked:** Tracked by the tracking channels and has one valid peak only.

**Used:** Used in position calculation.

**Spoofed:** Has two peaks. Good peak is isolated, if existed.

**Blocked:** Blocked by buildings or by jamming. If jammed, shows higher noise level.

**Faked:** Satellite should not be visible, or such PRN does not exist.

**Replaced:** Real signal is jammed and a spoofed signal put on top of it. Because of jammer, it shows higher noise level.

## Spoofer Orientation

When you detect that spoofers exist, you can also try to find the direction that the spoofing signals are coming from. For this, hold your receiver antenna (e.g. TRIUMPH-LS) horizontally and rotate it slowly (one rotation about 30 seconds) as shown in the picture and find the direction that the satellite energies become minimum. This is the orientation that the spoofer is behind the null point of the antenna reception pattern.

After one or more full rotations observe the resulting graph that shows approximate orientation of the spoofer as shown in figure 5.

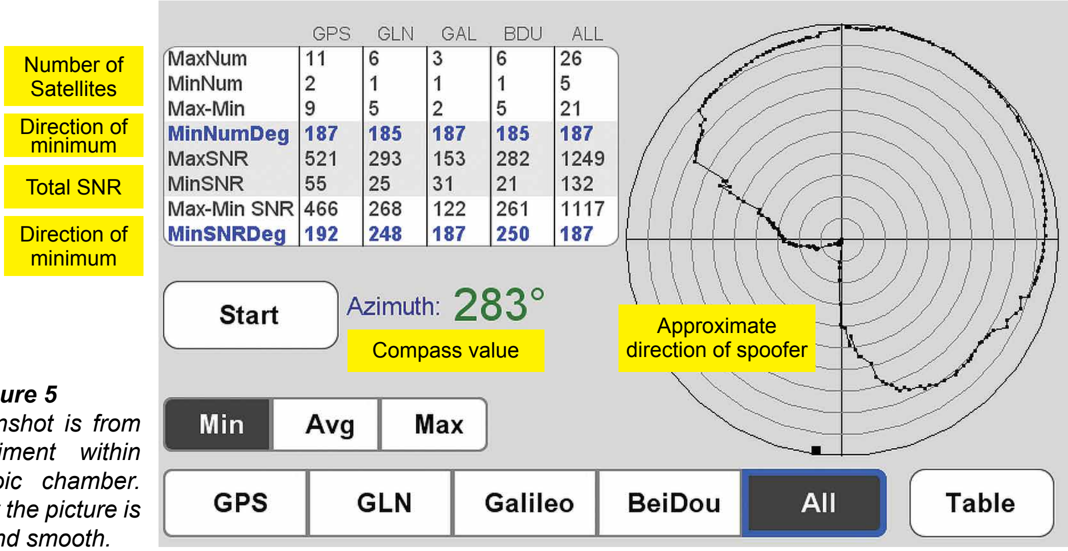



***Figure 5***
*This screenshot is from the experiment within an anechoic chamber. That is why the picture is clean and smooth.*

$850

# J-Tip

## Integrated Magnetic Locator

No need to carry heavy magnetic locators any more. The J-Tip magnetic sensor replaces the tip on the bottom of your rover rod/monopod. Its advanced magnetic sensor send 100 Hz magnetic values to the TRIUMPH-LS via Bluetooth. TRIUMPH-LS scans the field and plots the 2D, 3D and time view of magnetic characteristics. It also shows the shapes and the centres of the objects under the ground and guides you to it.

**J-Tip advantages:**

- J-Tip does not have “null” points around the peak and will not produce false alarms.
- J-Tip is fully automatic for all levels of magnets. Audio tones self adjust. There is no “Gain” button to adjust.
- J-Tip senses the mag values in all directions. You don’t need to orient it differently in different searches.
- J-Tip gives a 2D and 3D view of the field condition when you have RTK and will guide you to the object. You can actually see the shape of buried object.
- J-Tip, In Time View, shows positive and negative mag values of the last 100 seconds and the Min and the Max since Start.
- J-Tip shows the instantaneous magnetic vector in horizontal and vertical directions.
- J-Tip works as a remote control for the TRIUMPH-LS
- J-Tip weighs 120 grams and replaces the standard pole tip. In balance, it weighs almost nothing.
- The built in camera of the TRIUMPH-LS documents the evidence after digging.
- And... you don’t need to carry another bulky device.