RTK Verification

Fundamental in the determination of GNSS solutions is resolving the correct number of full cycles of the carrier signal (so-called fixing ambiguities) in order to determine the distances from the satellites to the receiver. These distances contain errors caused by inaccuracies in the satellite clock and by the ionosphere and troposphere. When a base station is used, these errors and errors in the satellite orbits are nearly identical to both the rover and base station receivers when the baseline distance is short. By removing these common errors through RTK processing, centimeter level accurate vectors can be calculated between the base station and the rover.

Multipath, the reflections of GNSS signals from nearby objects and structures, create their own *indirect* measurements

from the satellites to the GNSS receiver. It's as if your measuring tape is bent around an obstacle like a tree instead of a free and clear line of sight between two points. No calculator is going to improve that result. This sort of *indirect* measurement is analogous to the issue involved with GNSS signals when they're being reflected from nearby objects, including the ground. Worst case is when the receiver doesn't see the direct signal at all; e.g., the satellite is behind a building, but it's still receiving the signal reflected off of the nearby structure. Such *indirect* signals are usually strong, unhelpful and misleading.

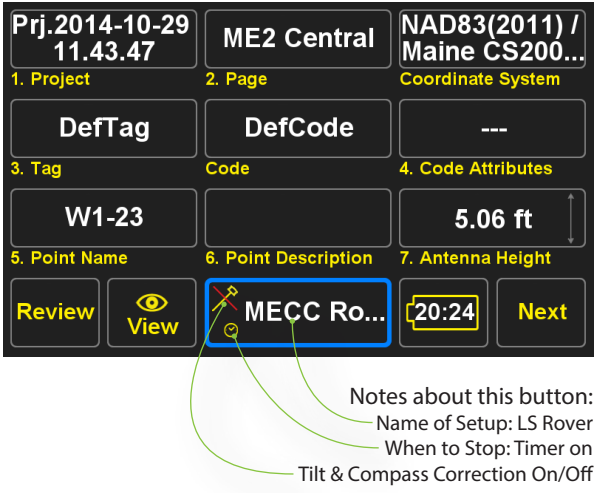
The other aspect impacting the veracity of a fixed solution is when there are weak GNSS signals. Frequently, weak signals are due to their penetration directly through tree canopy.

While ***J-Field*** can't move the obstacles that are creating multipath out of the way, its sophisticated engineering is designed to handle even the weakest signals like no other system with its ***RTK Verification System*** (patent pending).

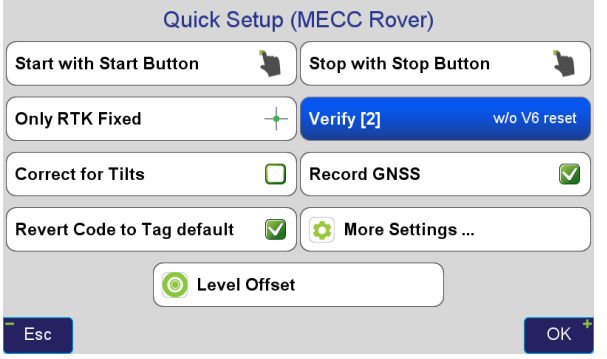
J-Field uses six RTK engines running in parallel and that are solely devoted to isolating the indirect signals by using different sets of satellites, each engine with its own and differing criterion. If too many of the signals are indirect, no solution may be found. Remember, indirect signals are analogous the bent measuring tape! ***J-Field***'s robust set of engines are tasked with finding these indirect measurements and then removing them. When you're doing RTK surveying, observe your environment and come to recognize that the structures around you are like mirrors for GNSS signals.

J-Field provides the option for you to specify the ***Minimum Number of Fixed RTK Engines*** in verifying solutions ***N*** times before a position is automatically accepted where ***N*** is a user defined value.

Procedure

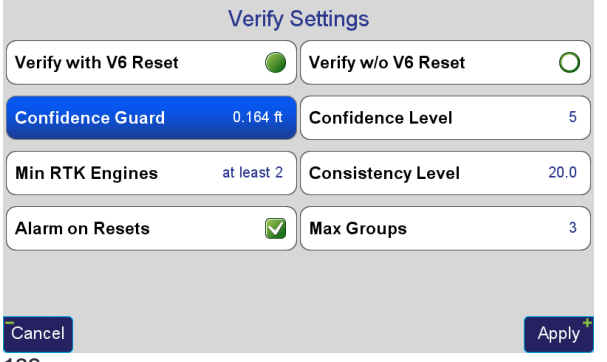


In Collect screen1 (***Collect_Prepare***), tap on the lower middle button shortcut to quickly modify details of your Setup by bringing up the ***Quick Setup*** screen. It's worth noting that this pertains to your currently active setup. In the example above the name of the setup is MECC Rover. The changes you make through the ***Quick Setup*** screen are retained (saved) automatically allowing for easy recall of other previously defined setups.



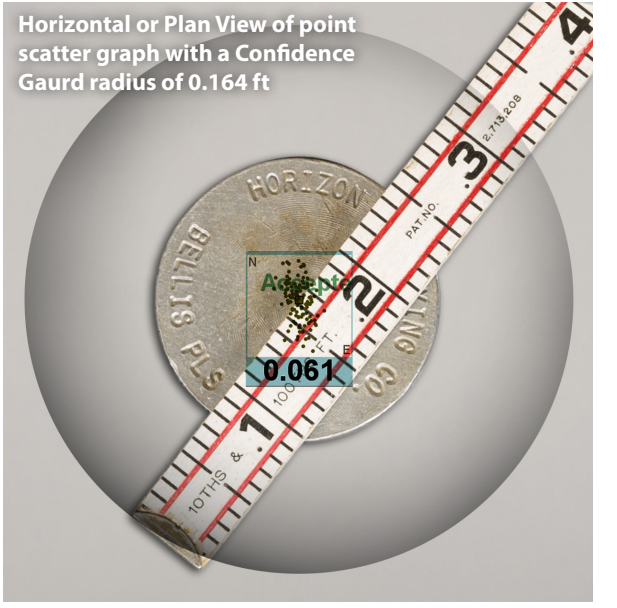
In this example, measurements will ***Start with Start Button*** and ***Stop with Stop Button***. The only type of acceptable RTK solution will be ***FIXED***. RTK Verification has been set to use a minimum of **[2]** engines and instructed that they not be reset. To change the minimum number of requisite engines as well as many other of the settings associated with Auto Verification, tap ***Verify***.

Verify Settings



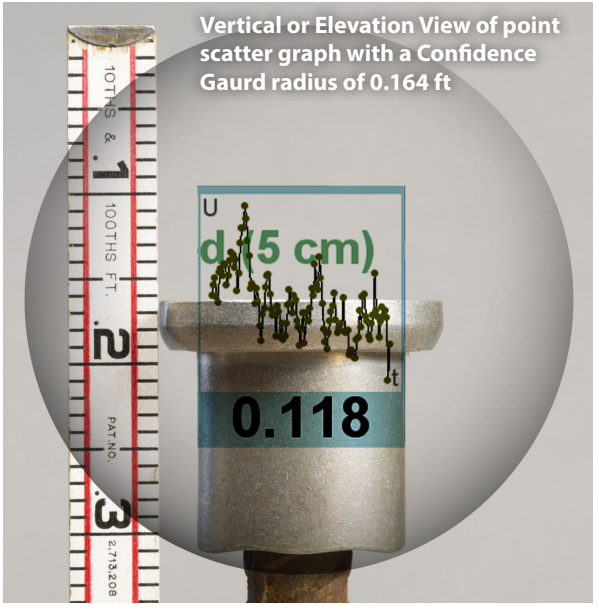
Verify with V6 Reset will recheck fixed ambiguities with deliberate reinitializations of the six engines during ***J-Field's*** Confidence Building and Smoothing steps. ***Verify w/o V6 Reset*** can provide faster results.

The ***Confidence Guard*** *spherical radius* value of 0.164 ft shown in this example is approximately the diameter of a surveyor's identification cap and determines the minimum spacing between ***Groups***.



Setting the Confidence Guard to a very low value will increase the precision of an observation but it should not be

thought of as a means to guarantee accuracy.



Min RTK Engines at least 2

If you want to change the required minimum number of fixed RTK engines, the Verify Settings screen makes that choice easy for you, just tap ***Min RTK Engines*** and choose from 1 to 6 engines. Usually you'll just have this set on one or two engines.

Alarm on Resets ✅

If you wish to be alerted with an audible alarm when the engines get reset, check the box labeled ***Alarm on Resets***.

Confidence Level 5

Applicable only with ***Verify with V6 Reset***, choosing a ***Confidence Level*** between 0 and 7 should be commensurate with the area that you're surveying; i.e., there is a direct relationship between the time spent on a given point and a desired ***Confidence Level*** with zero being the least amount of confidence and that it will accordingly be realized sooner than if the setting is on 1. ***J-Field***'s *Confidence Counter* increments each time that the engine(s) are reset: increments of 1.0, 1.25, 1.50, 1.75, 2.0, 2.5 for 1 to 6 engines respectively.

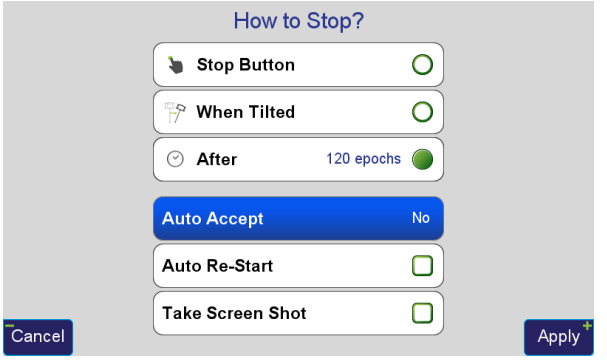
Consistency Level 20.0

The ***Consistency Level*** setting, shown here with a value of 20. Values between 10 to 30 are typical for most surveying needs. Higher ***Consistency*** values translate into longer occupations applies to both ***Verify*** cases; with and without engine resets. A value of 10 is the recommended minimum. When the engines are not reset the *Consistency Counter* increments in 0.0, 0.1, 0.25, 0.5, 1.0, 1.5 for epochs with 1 to 6 engines noting that one engine gets no credit and an epoch with 6 engines gets 1.5.

Max Groups 3

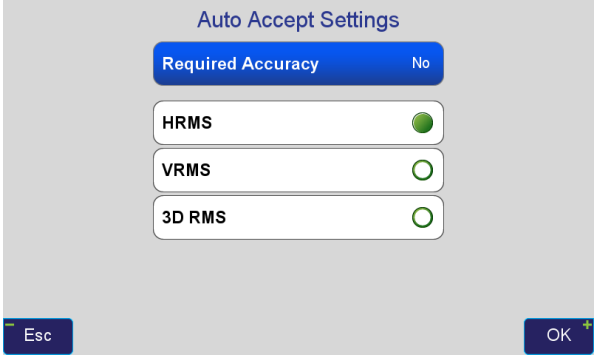
During ***Step One***, solutions are placed into ***Groups*** and it is possible that a given point can be included into more than one Group. During Verification, Groups are distinguished apart by color and points that are common to more than one group are red. The spherical radius specified for the ***Confidence Guard*** value and the ***Max Groups*** setting work together in achieving a single solution within the user defined tolerances. A ***Confidence Guard*** radius too small would be like having only the bullseye on a target without any of the outer rings while allowing a large number of Groups to result in multiple statistically valid final solutions.

How to Stop

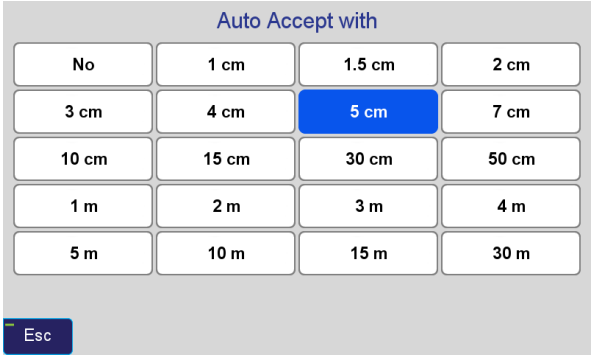


In this example, the timer has been set to stop the session after 120 epochs; the recommended minimum with ***Verify*** for control and boundary work, but you can choose any duration that suits your needs. To change this value, tap on ***After***

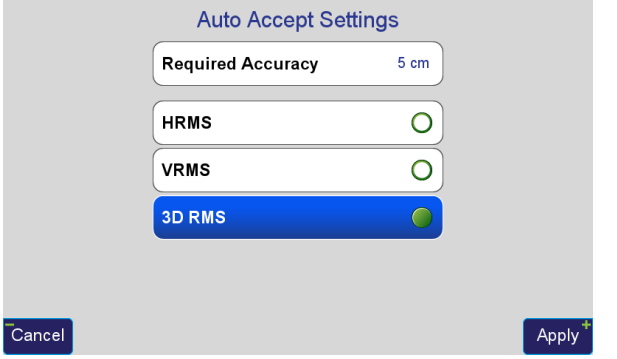
The ***How to Stop*** screen is also where you can enable ***Auto Accept*** by setting its criteria. Tap ***Auto Accept*** to begin.



Tap on ***Required Accuracy*** which brings up the Auto Accept with criteria.

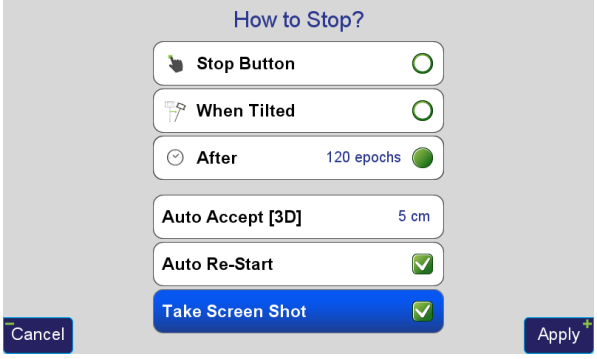


Tap on a value, in this example 5 cm has been chosen

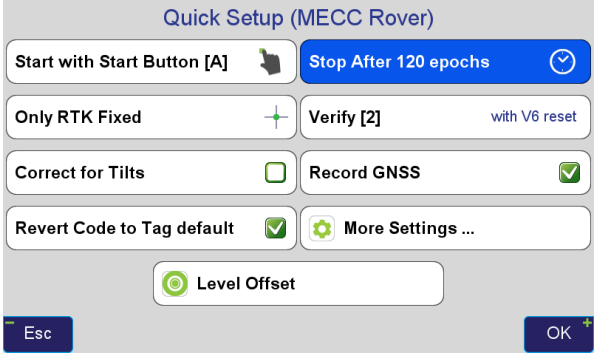


For an overall vertical and horizontal solution meeting your minimum acceptable accuracy target select ***3D RMS***; otherwise limit your selection to horizontally only or vertically only.

Tap ***Apply***



Once again at the ***How to Stop*** screen, you can select the options to ***Automatically Re-Start*** and with each automated acceptance, ***Take a Screen Shot***. Tap ***Apply***



The Quick Setup screen will indicate that the Timer has been set and if you've enabled it, that the next point location will begin automatically by the **[A]** appearing at the end of ***Start with Start Button***. Confirm that all of the other Auto Verification settings are as desired before tapping ***OK***.

Primary Concepts Behind Verify

The ***Verify*** feature of the ***RTK Verification System*** (patent pending) is designed and based upon building confidence each step of the way in arriving at the final solution. Regardless of the level of accuracy targeted by the user, the confidence level is built upon the (6) RTK working independently in two steps with every epoch. In the example shown on the left, the target accuracy was set at a ***3D RMS*** value of 5 cm (about 0.164 ft).

Step One is only applicable when ***Verify with V6 Resets*** and begins at ***Start***. Engines are reset once the first epoch has been collected. When ***J-Field*** reaches the first level of confidence, it then continues in ***Step Two*** to get the remaining epochs that the user has required. If you've enabled ***Take Screen Shot***, you'll have a screen shot at the end of Step One and another screen shot at the end of ***Step Two***. In this example, the required *Epoch Number* (EN) is 120.

During ***Step One,*** the *Confidence Guard* (CG) is built from the fixed engines' solutions which are placed into groups. The first fixed epoch is stored as a point and is placed into the first group. In ***Step One*** any and all RTK engines that acquire a fix are immediately reset after an epoch is stored. When the next fix is acquired, another epoch is stored. The point from this next epoch is placed into the first group if it is less than a specified distance, the Confidence Guard, away from the first group. If it falls outside the Confidence Guard then a second group is created. Again the fixed RTK engines are then immediately reset. This process continues until one group reaches the desired Confidence Level.

A point from a single fixed solution may fall within more than one group and every time a point does not fall within the Confidence Guard of an existing group, a new group is

created. The number of groups is limited by the Max Groups setting. If this number of groups is exceeded, ***Step One*** will reset and start over. While the auto verification is underway, the current best group will be displayed between the square brackets **[ ]** while the other groups are displayed between parenthesis **( )**.

Each group has its own *Epoch Counter* and *Confidence Counter*. Together they help in achieving the user defined *Confidence Level* (CL) which shown in this example is set at 5. A higher CL value means that you require greater confidence. In areas where there is a great deal of multipath present, a higher value may be warranted than in other areas with minimal multipath.

Once the requisite level of confidence has been achieved in ***Step One***, then during ***Step Two, J-Field*** will filter out any points that are greater than the Confidence Guard and thereby allowing the engines to resolve any remaining ambiguities. Points in both ***Step One*** and ***Step Two*** have equal weights in computing the average.

During ***Step Two***, the engines are no longer being reset and the solution gets smoothed out by gathering additional points. Points falling beyond the Confidence Guard are tossed out from any averaging but are kept track of and if there are more than 30% of points falling outside of the average during ***Step Two***, ***J-Field*** will reset the whole thing and start again with ***Step One***.

Once the required number of epochs have been recorded in ***Step Two***, the required epoch number (EN), the average number of engines, the final confidence counter and the RMS of the points are shown as previously required by the user; i.e., horizontal, vertical or 3D.

Recommended Settings

Control and Boundary

- ***Start with Start Button***
- ***Stop After: 120 epochs, may be reduced to 30 in open sky***
- ***Verify with V6 Reset***
- ***Confidence Level: 3***
- ***Consistency Counter: 20***
- ***Correct for Tilts: Off (Rover pole must be plumbed)***

Precise Topographic

- ***Start with Start Button or Start When Tilted***
- ***Stop After: 10 epochs***
- ***Verify without V6 Reset***
- ***Consistency Counter: 10***
- ***Correct for Tilts: On****

Quick Topo for use with Open Sky Environments

- ***Start with Start Button or Start When Tilted***
- ***Stop After: 2 epochs***
- ***Verify without V6 Reset***
- ***Consistency Counter: 0***
- ***Correct for Tilts: On****

In all cases

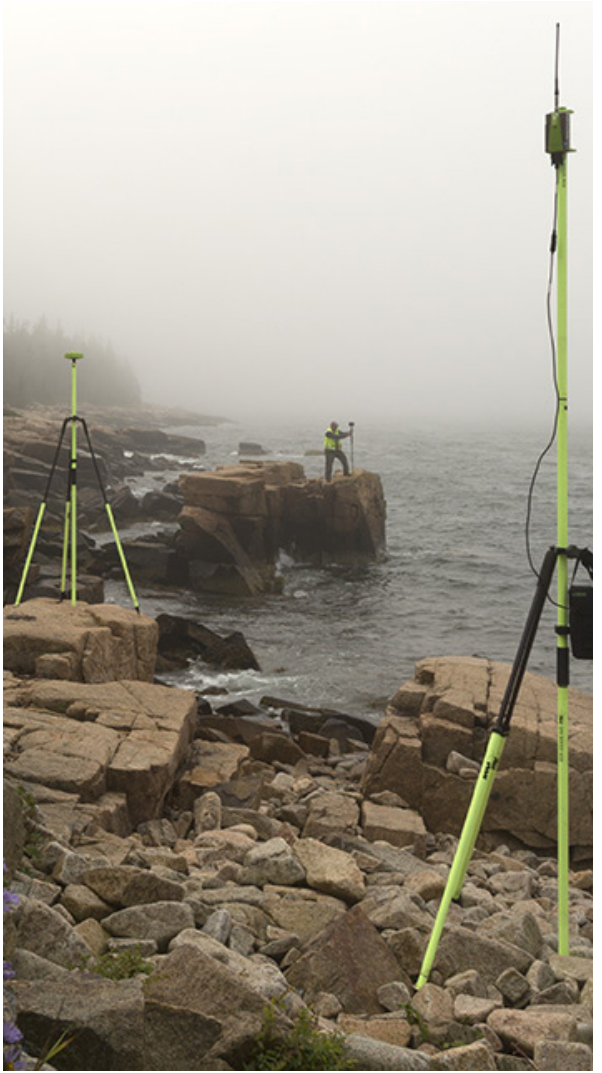
- ***Accept Fixed Only, RMS: All, DOP: All***
- ***Accept Number of Fixed RTK Engines: At least 2***
- ***Confidence Guard: 0.164 ft***

If you wish to review point statistics or if you wish to edit the Tag, Code, Description and/or Attributes fields after data collection, Auto Accept must be set to Off. If these fields do not need to be changed and you desire fast data collection with the Quick Topo settings, set Auto Accept to On.

If high accuracy is needed in areas of high multipath and areas with limited views of open sky (under full tree canopy and urban canyon environments), a ten minute (Stop After: 600 epochs) observation is recommended. Repeated observation can also be performed later (1 hour or more is recommended) to improve accuracy. These repeated points can then be averaged together with the Average function found in Cogo Tools.

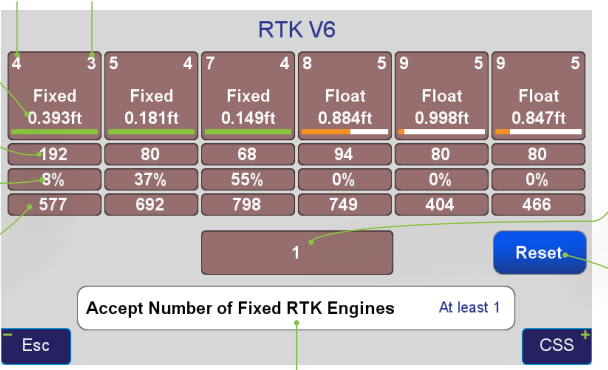
If the point you are attempting to locate is near the edge of a building, tree trunk or other obstruction, it is best to use one of the offset features. When the most accurate measurements are needed, the distance-distance offset is recommended.

*If Correct for Tilts is on, the Level Offsets must be calibrated frequently if accuracies greater than 0.10' are needed.




Start
Stop
RTK V6
Fixed 0.478ft
Float 2.179ft
Float 0.789ft
Float 1.194ft
Float 0.861ft
Float 0.855ft
137
33
241
113
300
1002
100%
0%
0%
0%
0%
0%
115
261
387
164
47
236
1
Reset
Accept Number of Fixed RTK Engines
At least 1
Esc
CSS
Set Up
Collect
Stake
On/Off
Mute
Light
User defined
U1
U2
U3
U4

Screen Anatomy - RTK V6



GNSS satellite count used in given engine

GPS GLON

HVRMS for current epoch in given engine

Number of seconds since the last reset for a given engine

Percentage of weight assigned to given engine in contributing to the overall solution

Number of fixed solutions with this engine since "Reset" button on the right side was used.

Use this value to evaluate and compare the performance of each engine.

Tap this button to change the Minimum Number of FIXED RTK Engines to use for automated verification

A user definable threshold showing delay in seconds in receiving corrections from base;

Values up to 30 seconds are acceptable (**OK**) causing only a few mm of error;

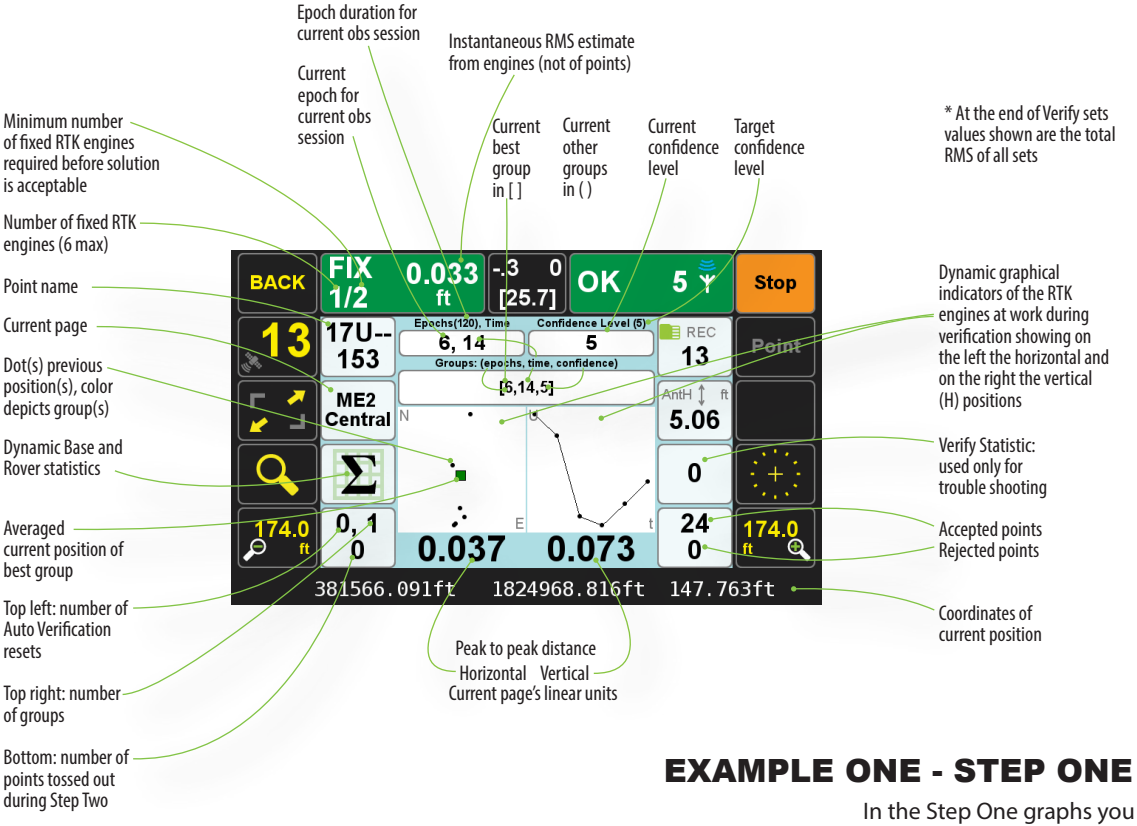
If you're broadcasting your FCC call sign, expect to see its brief interrupting effects every 15 minutes here and elsewhere; e.g. hand scanner, Action screen and UHF status screen

Manually reset engines to compel new fixed solutions when automatic verification is turned off (unchecked)

Screen Anatomy - Map Screen

a/k/a Action screen and Collect screen$_2$

Screenshot while Verify is underway during Step One



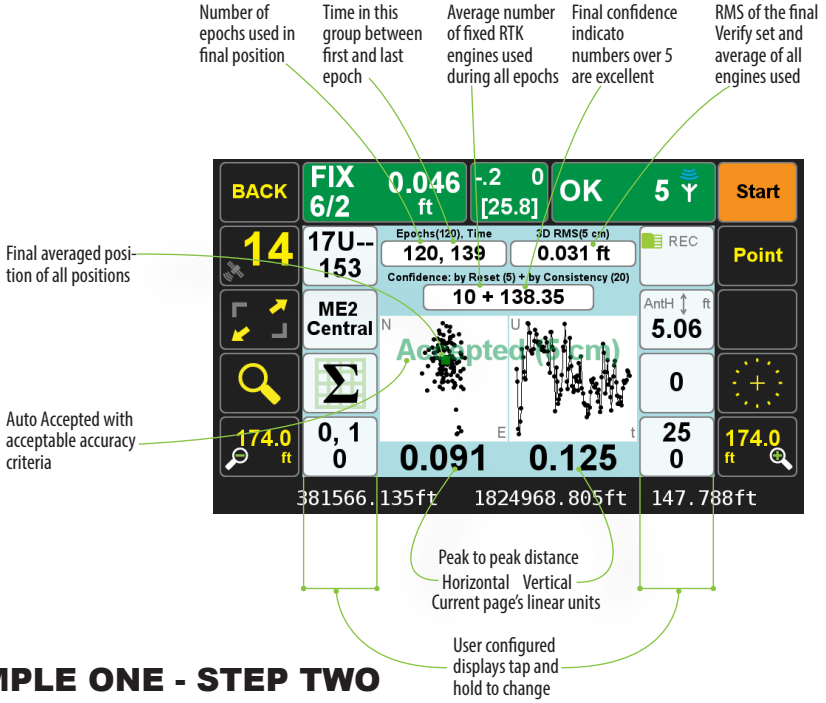
EXAMPLE ONE - STEP ONE

In the Step One graphs you see the bad fixes in different colors, if there are any.

Please refer to the section of the guide discussing the Collect screen for further detailed information (p. 124)

Screen Anatomy - Map Screen

a/k/a Action screen and Collect screen$_2$
Screenshot once Verify has completed Step Two



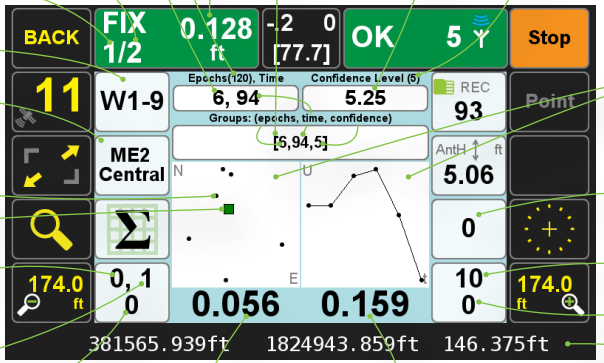
EXAMPLE ONE - STEP TWO

In Step Two the bad fixes are removed and continued with the good fixes.

Screen Anatomy - Map Screen

a/k/a Action screen and Collect screen$_2$

Screenshot while Verify is underway during Step One



Epoch duration for current obs session

Current epoch for current obs session

Instantaneous RMS estimate from engines (not of points)

Current best group in [ ]

Current other groups in ( )

Current confidence level

Target confidence level

* At the end of Verify sets values shown are the total RMS of all sets

Minimum number of fixed RTK engines required before solution is acceptable

Number of fixed RTK engines (6 max)

Point name

Current page

Dot(s) previous position(s), color depicts group(s)

Averaged current position of best group

Top left: number of Auto Verification resets

Top right: number of groups

Bottom: number of points tossed out during Step Two

Dynamic graphical indicators of the RTK engines at work during verification showing on the left the horizontal and on the right the vertical (H) positions

Verify Statistic: used only for trouble shooting

Accepted points

Rejected points

Coordinates of current position

Peak to peak distance

Horizontal Vertical

Current page's linear units

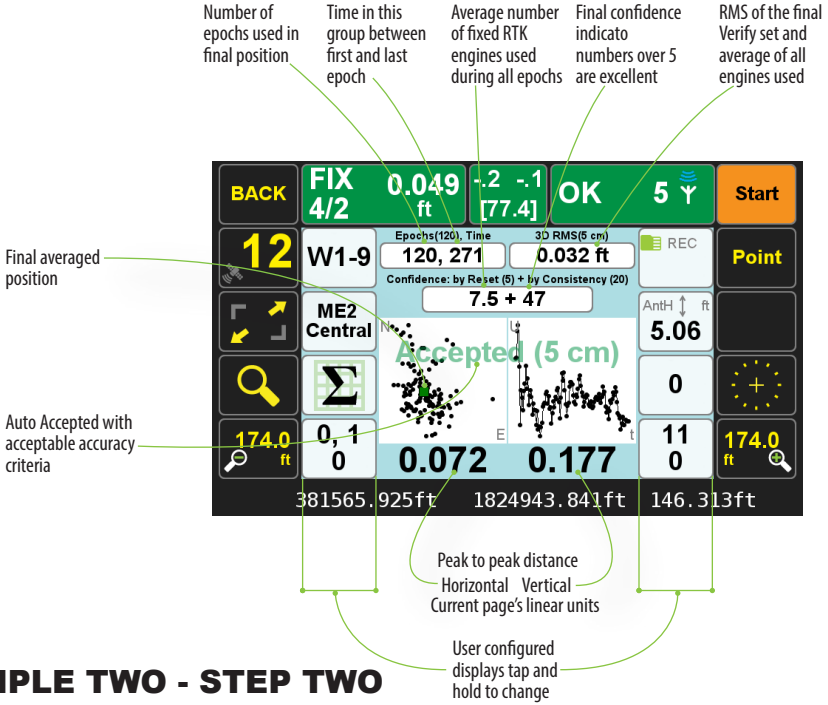
Please refer to the section of the guide discussing the Collect screen for further detailed information (p. 124)

EXAMPLE TWO - STEP ONE

In the Step One graphs you see the bad fixes in different colors if there are any.

Screen Anatomy - Map Screen

a/k/a Action screen and Collect screen$_2$
Screenshot once Verify has completed Step Two



EXAMPLE TWO - STEP TWO

In Step Two the bad fixes are removed and continued with the good fixes.