Product Bulletin

GEOSPATIAL
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FINELOCK FOR TRIMBLE S SERIES INSTRUMENTS

Introduction

On S Series instruments, a great advantage of Autolock technology for searching, locking, and tracking a target is the large field of view of the tracker receiver. However, when measuring to prisms that are close together, this is no longer an advantage, for example when measuring deformation in a tunnel during construction, there will often be multiple prisms installed at regular intervals. If prisms are too close together, with an Autolock measurement, the instrument cannot lock onto the center of one single prism as the tracker receiver is getting multiple reflections.

Using FineLock technology, only the inner fine detector of the tracker receiver is used which has a very narrow field of view, removing the interfering reflections from other prisms, allowing the instrument to center on a single prism. This bulletin will explain the specifications and implementation of FineLock technology

FineLock Technology Availability on Trimble S Series Instruments
FineLock technology is available on selected models of Trimble S Series instruments.
Long Range FineLock is available on selected Trimble S9 instruments.

Autolock and FineLock Comparison

Autolock technology works with active and passive targets. FineLock technology can measure to passive reflectors only.

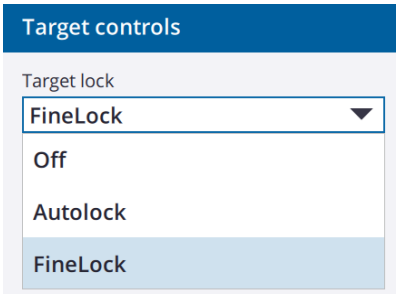
In Autolock mode, an active or a passive target can be:

- Searched
- Automatically recognized in the field of view
- Automatically locked
- Measured
- Tracked, as soon as the target is moving.

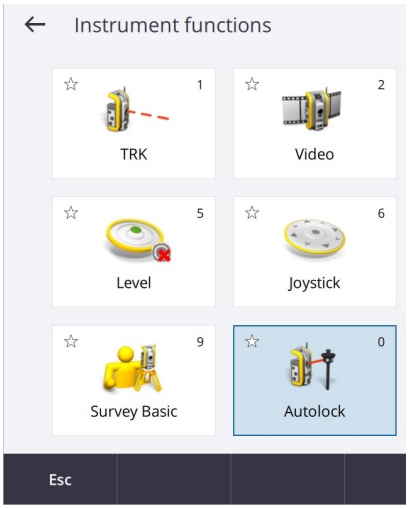
FineLock mode is purely for measuring.

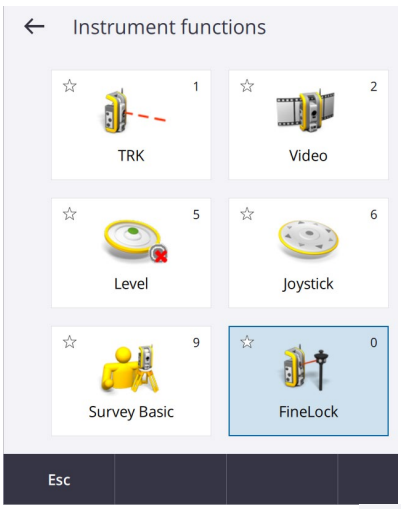
- A passive prism must be located in the field of view of the FineLock sensor to be measured.
- The instrument only locks onto the prism during the measurement. When not actively measuring, the system will not lock onto a prism. This means FineLock does not follow a moving target.

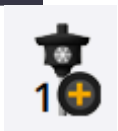
Autolock and FineLock are mutually exclusive and this setting is changed through Trimble Access. When connected to an instrument navigate via Instrument > Target Controls and then change the Target lock setting.



Instrument functions will show which mode the tracker is set to. Tap and hold on the Autolock/FineLock button in instrument functions will provide a shortcut to the target controls form.



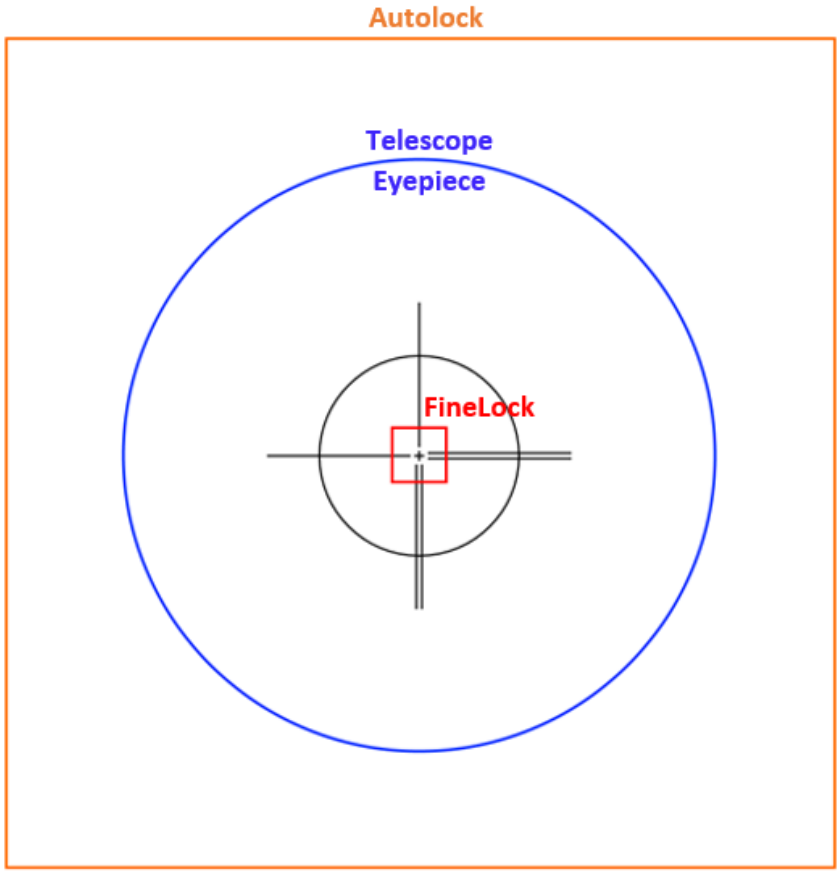


The target icon in the status bar will show a + symbol when FineLock is active. 

Field of View Comparison

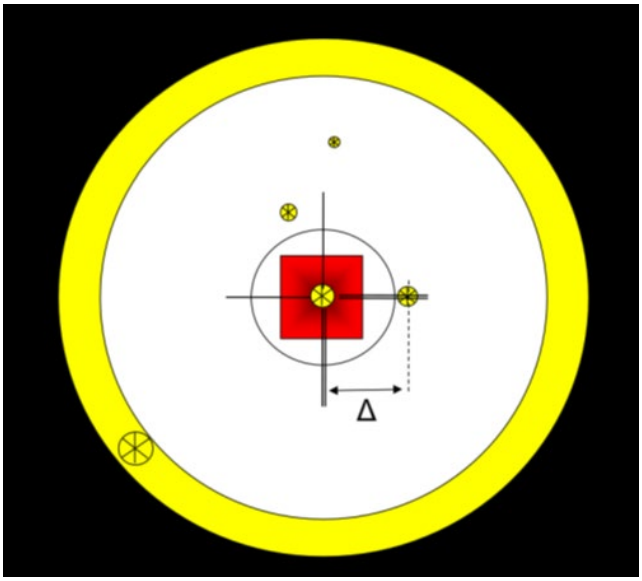
The diverging angles or “field of view” of the different units are as follows:

	Field of View Gon / Degree	Range
Telescope Eyepiece	1.5° / 1.7 gon / 26.7 mrad	N/A
Autolock Technology	2.1° / 2.3 gon / 36.1 mrad	0.2m - 800m (maximum range is target dependent)
FineLock Technology	0.14° / 0.16 gon / 2.5 mrad	20m - 700m
FineLock with Lens Aperture	0.14° / 0.16 gon / 2.5 mrad	5m - 60m
Long Range FineLock	0.14° / 0.16 gon / 2.5 mrad	250m - 2500m



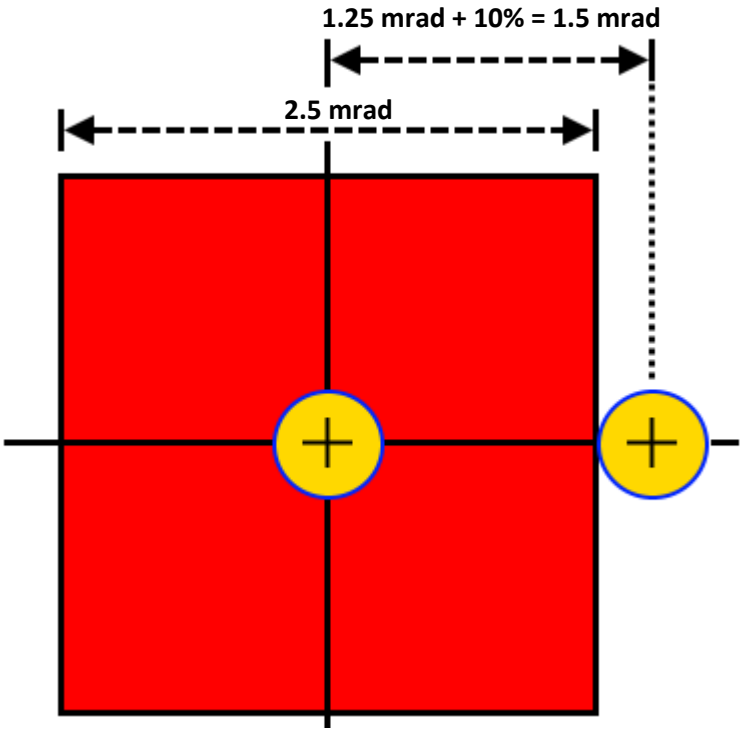
From the table above you can see that when using FineLock technology, to have an undisturbed measurement, the second prism needs to be outside of the 0.16 gon field of view. Defining the minimum offset as an angle is not practical for a user in the field, so instead, a minimum offset delta (as an offset or height difference) is used instead. This is the minimum delta required between the primary prism and other prisms, to ensure that the sighting to the desired prism is not influenced.

The telescope field of view in the image below shows the narrow field of view of the FineLock sensor in red and the delta Δ is the minimum offset required to other prisms to avoid interference.

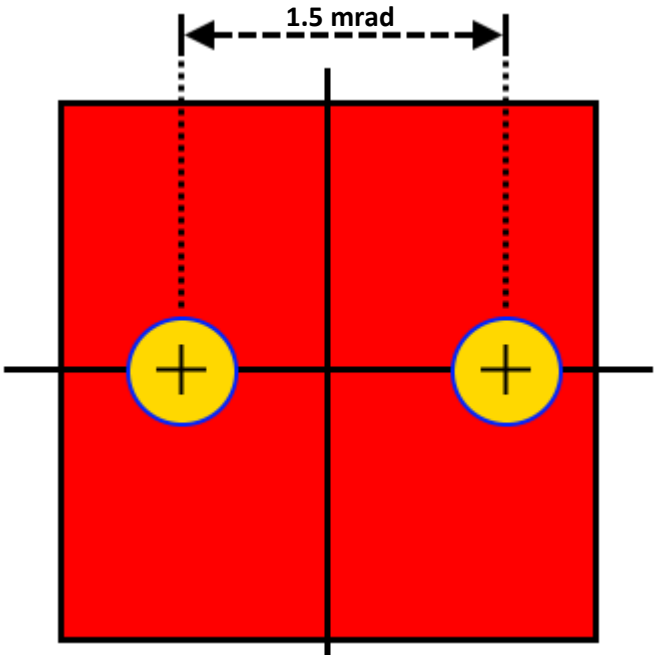


Minimum spacing between prisms

The minimum offset requires a larger angle than just using the field of view of the sensor. FineLock technology has a field of view of 2.5 mrad (0.16 gon; 0.14°). As a start for simplicity we will assume both prisms are at the same or very similar distance. The reflected beam of a prism at 10 m distance is projected on the FineLock receiver diode and with the attached FineLock aperture it generates a laser spot of 40 µm diameter. This is about 20% of the fine detector chip size. With a safety margin of 10%, the angle between 2 nearby prisms should be at least 1.5 mrad. As shown in the figure, the prism outside the field of view does not cause any interference:



However, this is a simplistic case, where the primary target is locked and in the center of the tracker, for example in Monitoring installations where the instrument is turning to a pre-programmed point with a known target. If the instrument is not turning to a specific point, a minimum target separation of 1.5 mrad can result in the situation shown below where both laser spots are projected on the receiver diodes.



So typically, the 1.5 mrad target distance is still not sufficient. A sufficient target separation is reached with an angle difference of 2.75 mrad which is slightly larger than the size of the FineLock receiver diode. However, this is still assuming that the two targets are at a very similar distance, which is often not going to be the case.

If the interfering prism is located at a shorter distance than the one to be measured, the situation is much more complex. A target at a shorter distance always generates a larger and more diffuse spot than a target at a longer distance, which in turn requires the angle difference to be larger in general.

Taking all of this into account, an angle difference of 4 mrad (0.23°/0.25 gon) is recommended which results in the specified minimum spacings shown below:

For General Survey Workflows

Distance to target	Minimum Angle "Δ" Expressed in m
5m	0.1m
50m	0.2m
100m	0.4m
200m	0.8m

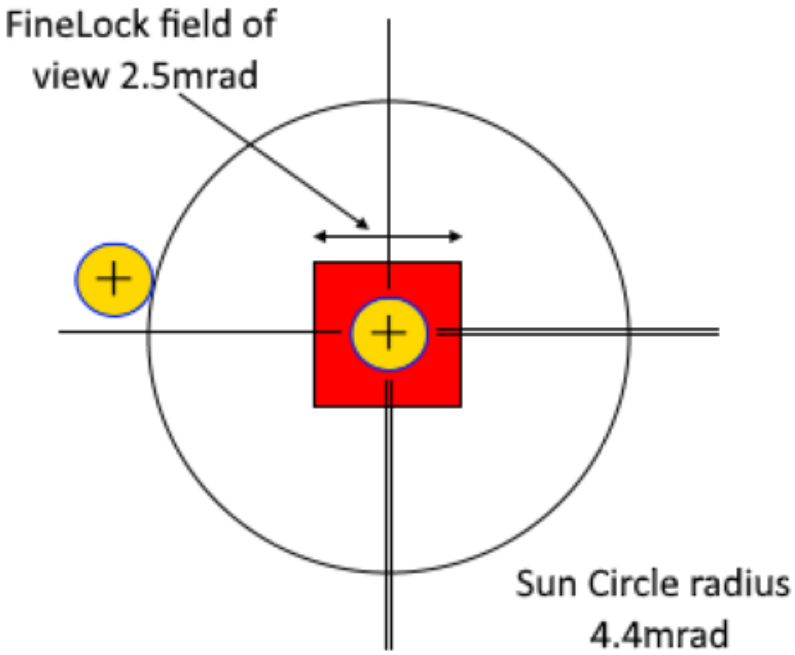
*Formula: Δ = 0.004*Distance*

For Monitoring Installations

Distance to target	Minimum Angle "Δ" Expressed in m
25m	0.04m
50m	0.08m
100m	0.15m
200m	0.30m

*Formula: Δ = 0.0015*Distance*

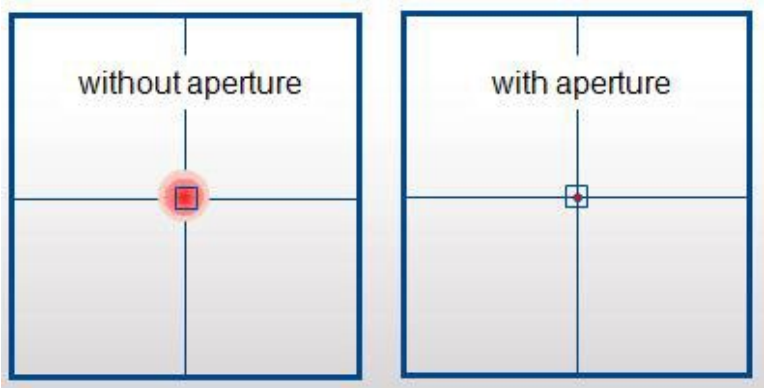
This difference can be visualised easily when viewing through the telescope because the radius of the sun circle on the cross hairs plate is 4.4 mrad. As a rule of thumb, the disturbing prism should always be outside the sun circle to avoid interferences:



FineLock Lens Aperture

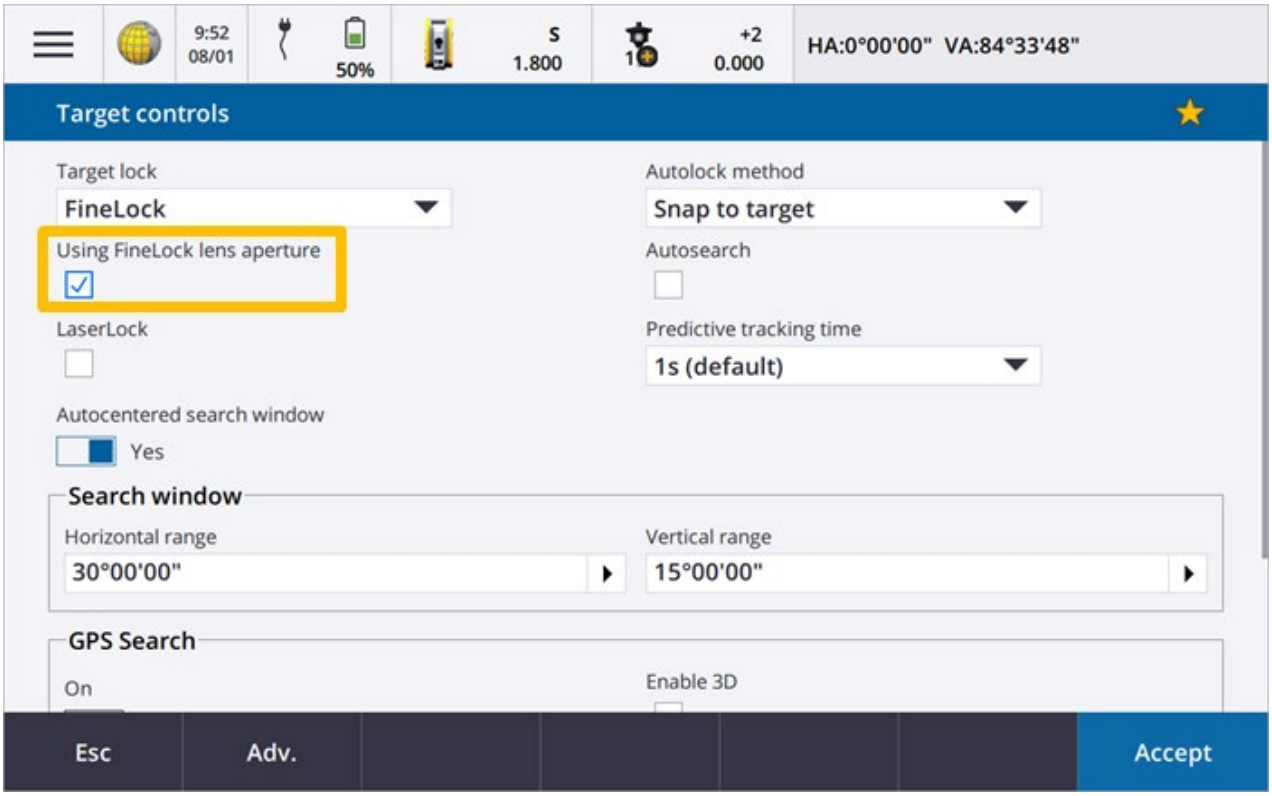
If you are measuring distances shorter than 20m then you need to use the FineLock lens aperture in order to get reliable and precise measurements.

The optical path of the tracker system does not pass through the focus lens of the instrument and therefore the tracker is focused to infinity. This means that as the target gets closer to the instrument, the size of the laser spot received back from the target grows and is more diffuse. When you measure with Autolock technology, the size of the laser spot is still small compared to the size of the coarse receiver, even at shorter distances. FineLock technology, however, works with the much smaller fine receiver, which results in a laser spot that is larger than the detector area when measuring at distances shorter than 20 m (left figure). If this is the case, the tracker cannot lock to the target in a reliable and precise way which is why FineLock without the Lens Aperture is only suitable for distances longer than 20 m. With the aperture in the plane of the front lens, the depth of focus increases, meaning the spot will be smaller and sharper and fit inside the fine receiver used for FineLock (right figure):



When you use the aperture, the minimum distance of FineLock technology is reduced to 5 m. The distance range of FineLock technology with the aperture is between 5 m and 60 m. You should measure shorter distances (< 5m) with Autolock technology.

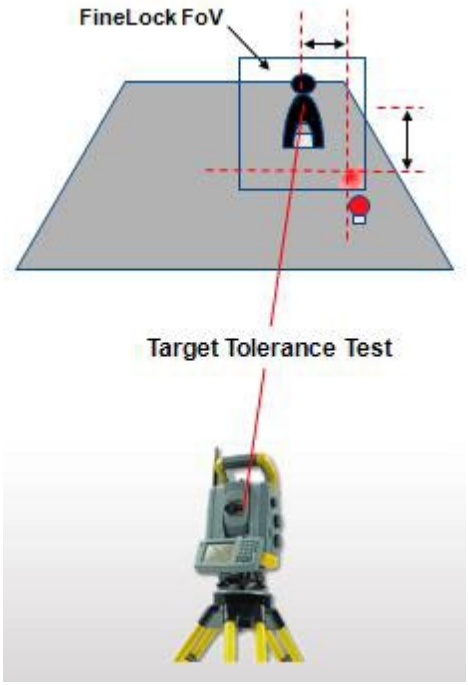
When using the FineLock lens aperture you need to ensure that you enable the corresponding option in the Trimble Access software. In General survey enable the “Using FineLock lens aperture” checkbox under *General Survey > Instrument > Target controls*

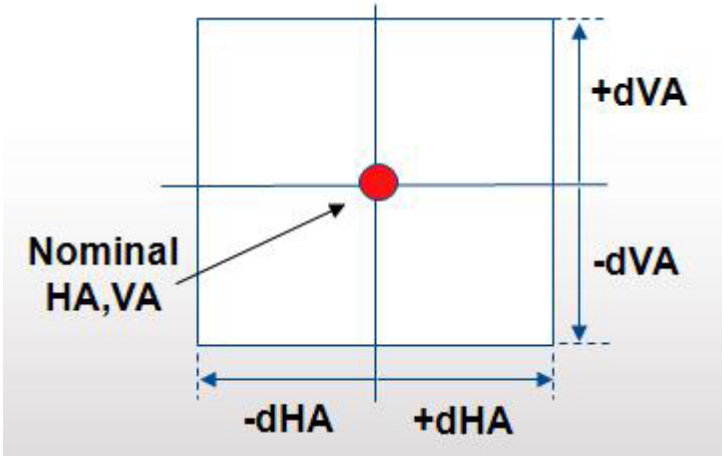


FineLock tolerance window

In the Trimble Access software you have the ability to set a FineLock tolerance window. This is the maximum amount the instrument will move from it's starting position in order to lock onto a target

When the instrument turns to the target position, if the tracker receives no signal, then it amplifies the sensitivity to try and locate a signal. If there is no signal being received due to an obstructed target, then amplifying the sensitivity may mean a weak signal from another target gets detected at the outer border of the tracker receiver. The instrument would then turn to this position and lock onto this incorrect target.





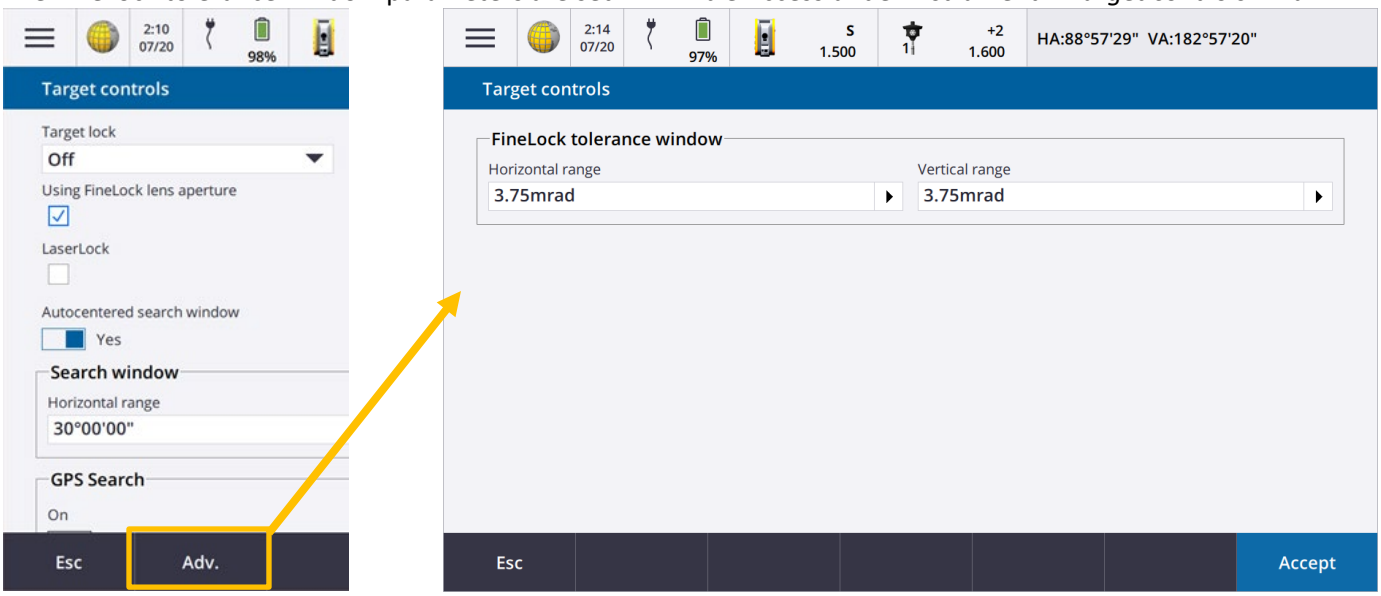
Using the parameters of the tolerance window, you can define how much the instrument may turn left/right or up/down. If the FineLock technology turns to a target and in doing so exceeds one or both of the tolerance window limits, it automatically turns back to the starting position.

The size of the tolerance window needs to match the environmental conditions. Important parameters are:

- Distance differences between nominal and disturbing targets
- Azimuth and zenith angle differences between the targets

The limits are between 1.25 mrad and 4.0 mrad. The tolerance window can be defined with narrower limits for longer distances because the laser spots are smaller and the angle offset between targets will be smaller. At shorter distances, the laser spots are larger and therefore they can influence nearby sightings more easily. For short range a minimum separation of 4 mrad is recommended, giving a desired maximum tolerance window of 3.75 mrad which is the default settings.

The FineLock tolerance window parameters are set in Trimble Access under *Instrument > Target controls > Adv.*

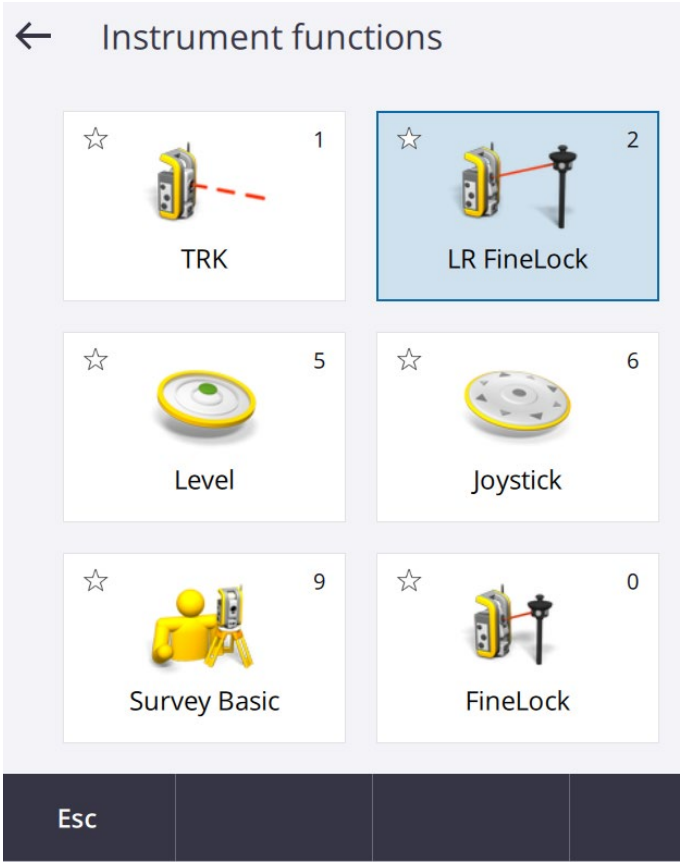


Long Range FineLock

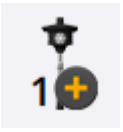
When you need FineLock functionality beyond the 700m range of standard FineLock there is the Long Range FineLock solution. This is a transmitter module that sits under the telescope on a Trimble S9 instrument, where you would otherwise have a Tracklight or Vision module.

The range for the LongRange FineLock is 250-2500m, though standard FineLock is available on LongRange FineLock instruments for measurements in the 20-700m range. When using LongRange FineLock you need to do 2 face measurements to get accurate height readings given that the transmitter module is offset below the telescope.

For instruments equipped with LongRange (LR) FineLock, this can be turned off and on under Instrument functions.



The prism icon will also indicate Long Range FineLock is activated with the following icon:



Mrad Units

In computer programs, the non-dimensional angle unit radiant is used instead of gon, grads, or degrees. 1 radiant is the angle where the relation of the length of the related arc and its radius equals 1.
As a result, arc A can be directly calculated by the angle α and the radius (r) by A = α.r.

Usually the fields of view of a total station, for example of the telescope, the tracker, the distance meter or even of the FineLock tolerance window are defined in mrad. 1 mrad is a thousandth of one rad and using the mrad value makes it easy to calculate an offset in meters.

At a distance of 100 m, an angle of 1 mrad (0.001 rad) equals an offset (arc) of α = 0.001rad*100m = 0.10 m.
Meaning, the size of the tolerance window of ±4 mrad covers, at a distance of 100 m, a window of ±0.4 m by ±0.4 m.

For more information

For more information contact your local Trimble representative.