



SightLine

APPLICATIONS

EAN-Target Tracking

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 **CAUTION:** Alerts to a potential hazard that may result in personal injury, or an unsafe practice that causes damage to the equipment if not avoided.

 **IMPORTANT:** Identifies crucial information that is important to setup and configuration procedures.

 *Used to emphasize points or reminds the user of something. Supplementary information that aids in the use or understanding of the equipment or subject that is not critical to system use.*



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1 Overview

This document provides guidelines for optimal target tracking and scene tracking performance, as well as a list of commands used for tracking.

Tracking scenarios are an exercise in judgment and understanding the tracking software limitations. What works best in one tracking case may not be ideal in another. The best way to learn and get better at target tracking is through experimentation.

In cases where the tracker is not tracking effectively, send SightLine [Support](#) a copy of the original video (without stabilization or overlays if possible) for review. This will help to improve and refine the tracking algorithms for future updates.

1.1 Associated Documents

[EAN-Detection-Modes](#): Provides information and guidelines on the parameters that primarily affect the detection modes.

[Interface Command and Control \(IDD\)](#): Describes the native communications protocol used by the SightLine Applications product line. The IDD is also available as a local download on the [Software Download](#) page.

Panel Plus User Guide: Provides descriptions of all the settings in the Panel Plus application. (Located in the Panel Plus application in the *Help* menu.)

1.2 SightLine Software Requirements

ⓘ IMPORTANT: The Panel Plus software version should match the firmware version running on the board.

1.3 Application Bit Requirements

The functions described in this EAN require Application Bits (app bits) purchased from SightLine. App bits reside on the hardware unit and are enabled with a license file provided by SightLine at initial unit purchase or during a license upgrade process. License files use a hardware ID that is applicable to a specific hardware serial number. For questions and upgrade support contact [SightLine Sales](#).

Table 1: Application Bits Requirement Table

Tracking Features	Minimum Software Version	Required Application Bit(s)
Vehicle Mode	ALL	Full Tracking. 0x0010
Stationary Mode	ALL	Full Tracking. 0x0010
Scene Mode	ALL	Full Tracking. 0x0010
No Registration Mode	ALL	Full Tracking. 0x0010
Static Mode	ALL	Full Tracking. 0x0010
Drone Mode	2.24.xx	Full Tracking. 0x0010
Acquisition Assist	2.22.xx	Full Tracking. 0x0010
Intelligent Assist	2.22.xx	Full Tracking. 0x0010



2 Target Tracking Best Practices

It is important to configure the system for the type of tracking that fits the conditions. Setting the size of the track box is important. It encompasses the area within the frame that the tracker is constantly attempting to track. This is only relevant to the Vehicle, Stationary, No Registration and Drone tracking modes (see [Tracking Modes](#) for descriptions).

The optimal size of the box should encompass the entire object being tracked. A slight (~10%) region around the object is optimal to provide a good foreground/background difference.


In certain situations, this may not always be possible. Users should focus on including features with high contrast within the track box. These include corners (for example windows in a car) or other edges.

Once a track has been initiated and the tracker is following the target, it is possible to nudge the track box to get better coverage of the entire target. It is also possible to resize the existing target. The tracker uses the existing target position and retrains a model on the new adjusted location and size.

Nudging and resizing the target is preferable to re-designating the target due to latency (user input) and pixel coordinates being received by the hardware. When nudging or resizing, ensure the object being tracked is completely visible to avoid retraining the model on something else.

Processing at a constant frame rate is important for tracking performance. The display processing load can be reduced by:

- setting a display frame step or capture frame step (see [EAN-Performance-and-Latency](#))
- turning off enhancement
- choosing a faster encoder (MPEG4 for 1500-OEM board) and smaller output frame size
- reducing registration search space (set Maximum Zoom to 0 and if there is no rotation, set Maximum Rotation to 0)

 *The Show Performance Graph in Panel Plus shows the time used by the processing steps. From the main menu Display » Show Performance Graphs.*



3 Tracking Modes

The following tracking modes are supported:

- **Vehicle Mode:** Used for tracking any type of moving object. The camera may be stationary or moving in this instance.
- **Stationary Mode:** Used for tracking a fixed object such as a house. The camera may be stationary or moving in this instance. If the object is sometimes stationary and sometimes moving, use Vehicle or Drone mode.
- **Scene Mode:** Keeps the entire scene in the frame. Also known as scene tracking. The camera platform is moving, and no single object is selected to track. Although it is a mode exposed by the tracker, it can also be implemented by using the scene translation results directly. Using scene translation results directly is the recommended implementation for an integrated gimbal scene tracker.
- **No Registration Mode:** Used to track moving or non-moving objects when it is difficult to accurately estimate frame-to-frame registration. For example, when attempting to track an airplane against a blue sky. It should only be used as needed since it can lead to additional track failures in cluttered environments.
- **Static Mode:** Not an object tracking mode. It is used to specify specific camera coordinates for temperature data reporting, for more details see the [EAN-Infrared Temperature](#).
- **Drone Mode (New in 2.24):** Optimized for fast and inconsistently moving objects such as quadcopters. It can handle objects that quickly change in size and appearance. Designed to work either as part of a ground based or aerial system.



4 Track Box Selection

The diagram below shows four examples of attempts to initialize a track. In all cases, the object being tracked is represented by the dark rectangle. The tracking box is depicted in red.

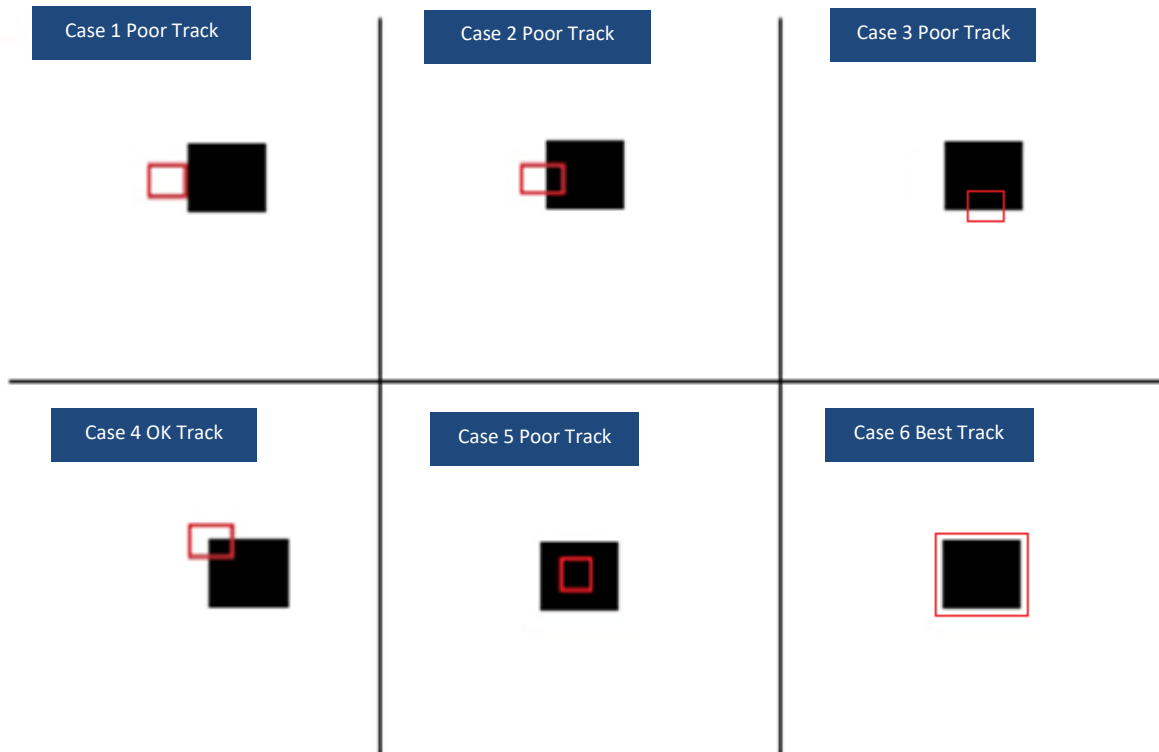


Figure 1: Designating Targets Example

Case 1: The tracking was not initialized on the object. The tracker stays on the edge of the object. If there are other good features in the background, the tracker may follow them instead of the tracked object. This often happens when there is a delay in the communication to the tracker or latency in the video because the object moves from the time the user sees it on the display to the time the track command reaches the tracker.

Case 2 and Case 3: A slightly better initialization of track. Notice that the only feature to track is a single edge. The tracker will likely drift up and down (or left and right) along that edge resulting in an erratic track.

Case 4: Better than Case 2. There are two edges (a corner) for the tracker to follow. Tracking should be good if the background has no stronger features.

Case 5: Since there are no visible features for the tracker to work with. The tracker will either fail to initialize altogether or it will drift to an edge or corner of the rectangle.

Case 6: Optimally, the tracking box is sized to encompass the entire object that is being tracked. This gives the tracker the most features to work with, and a minimum number of features from the background.



4.1 Vehicle Track Mode Examples

The examples shown in this section are real world examples.

In this example the car is not fully enclosed by the tracking box, but there are still good features with high contrast. This is not optimal but still works well.



Figure 2: Tracking Box too Small

In this example the tracking box is too large and encompasses more than the vehicle, but the tracking area contains enough good features and still tracks well.



Figure 3: Tracking Box too Large

In this example the tracking box is sized for optimal tracking performance. It includes the object and a small amount of background features allowing the track to persist through occlusions and background changes.



Figure 4: Tacking Box Optimal



4.2 Acquisition Assist (New in 2.22)

Acquisition assist mode is designed to help users select an optimal size and location for track boxes. When this mode is enabled through the Set Tracking Parameters (0x0C) message, an algorithm runs on track-start that will search an area around the initial track location for the optimal track box size and location. The size of the search region is based on the track box size setting, so it is still important to set the size and location. This algorithm is designed to be set close and still get good tracking results.

Tracking moving objects from a moving platform creates challenging issues. Over time, the optimal track box at initialization may not last. To resolve this, manually re-designate the track, nudge the track, or adjust the track size. Another option is to use Modify Track Index (0x17) message and send the *Reinitialize* command. This will rerun the acquisition assist logic. If successful, it will replace the current track box with the new optimal track box. Another option is to use intelligent assist to automatically readjust under certain conditions.

4.2.1 Acquisition Assist On

In this example the track box is centered on the car and contains enough background for optimal tracking.



Figure 5: Acquisition Assist On

4.2.2 Acquisition Assist Off

In this example the track box is centered but contains too much background content and will not track as well as [Figure 5](#).



Figure 6: Acquisition Assist Off



4.3 Intelligent Assist (New in 2.22)

Intelligent assist mode is designed to automatically reinitialize targets when changes are detected in the target appearance. These changes are currently limited to turning objects, but the intent is to expand this to cover other cases in the future.

Enabling this mode is designed to be low risk, instead of swapping out the old track for the new one it migrates to the new track over time. Intelligent assist requires acquisition assist to be enabled since it uses the acquisition assist algorithm to estimate the new optimal track box size and position.

Drone tracking mode can handle quickly changing target sizes. In most cases it is recommended to use intelligent assist to optimize the track box size while in drone mode. There are some cases where the background clutter is very high, which could negatively impact performance.

4.4 Reinitialize Primary (New in 2.22)

If acquisition assist does not provide the optimal track box size, reinitializing the track is a low risk way to update the track box size.

Sending the reinitialize command as part of the Modify Track Index (0x17) message causes the acquisition assist logic to run again. A new track will start in the background. If there is high confidence that this track is better than the original it will replace the original after ~1 second.

It is important to note that acquisition assist has limits and will not find an optimal track box size much different from the current size. In this case, adjusting the track box size is the best option. Adjusting the track box with acquisition assist enabled causes acquisition assist to run instantaneously instead of in the background.

4.5 Vehicle MTI (SV) - Detection Track Cueing

Vehicle Moving Target Indicator (MTI) is designed to assist in track initialization. This mode works well to highlight medium sized constant velocity and direction moving objects. Once highlighted it can be managed the same way as other tracks by designating them as primary, secondary, etc. More details about Vehicle MTI as well as the other MTI modes can be found in the [EAN-Detection-Modes](#) document.

5 Tracking Through Zoom and Rotation

The tracker works through slow changes in zoom and/or rotation. To track through faster changes the tracker must have an accurate estimate of the changes. Set the registration parameters *Maximum Zoom* and/or *Maximum Rotation* to non-zero values (5 is a good starting point). Increasing these values will increase the overall system processing load. Look at system performance in the Performance Graph before and after adjusting the parameters.



6 Additional Tracking Parameters

Panel Plus » *Tracking* tab » *Manual* tab.

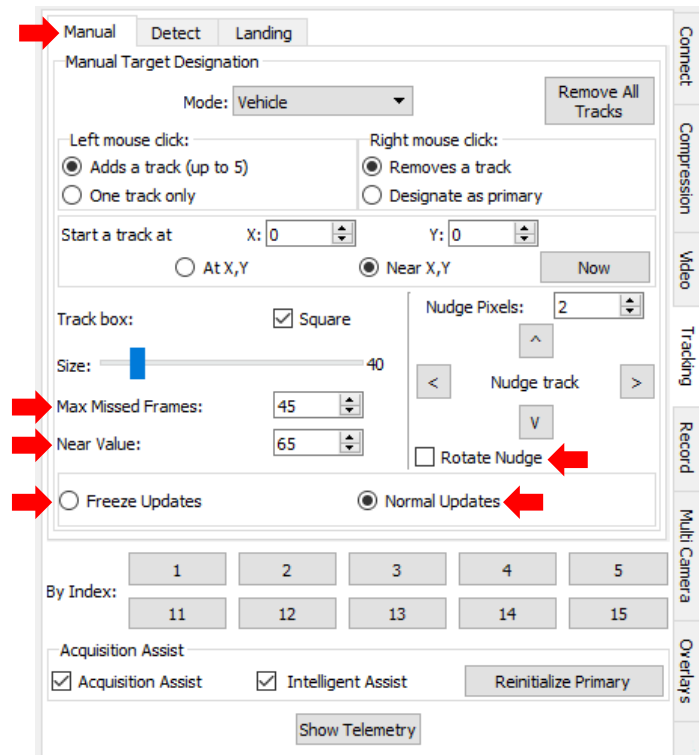


Figure 7: Manual Track Initialization

6.1 Max Missed Frames

Max Missed Frames controls the maximum number of frames to keep searching for a track after the software stops finding it. The default is 45 which corresponds to 1.5 seconds given 30 Hz video. Although this number can be set as high as 255 it is unlikely that the object can be found again after 45 frames unless the motion is very steady or slow.

6.2 Near Value

Near Value defines the radius of engagement used with the Modify Tracking (0x05) message. Once the radius has been set, clicking anywhere within this range of an existing target designates it as primary, stop the track, etc. A use case example would be running Vehicle MTI and using a large Near Value to designate tracks near the center of the frame as primary.

6.3 Rotate Nudge

Enable this option in the Nudge Track Coordinates (0x0A) message to send nudge commands in display coordinates instead of camera coordinates. For example, if a 180° rotation of the display is required because the camera is mounted upside down, this option ensures that the nudge commands are handled correctly.



6.4 Freeze Updates / Normal Updates (New in 2.24)

SightLine introduced a new tracking concept called Freeze Track Model Updates. This can be set or cleared from the Modify Track Index (0x17) packet. This change only affects one piece of the tracking behavior: It stops updating the model of the tracker while this flag is set.

How it works:

The software still searches for the object in every frame, updates its position and momentum, etc., but the model will not update as new data is obtained. In most cases using this feature will decrease tracking performance because model updates are required to maintain persistent tracks. However, there are cases where temporarily (~1 sec or less) stopping the updates can be beneficial. For example, if there is going to be a cloud of smoke between the camera and the target or some other known disturbance.

It can also be helpful to enter this mode prior to the target being partially occluded. This is not a recommended normal mode of operation to deal with full occlusion. The tracker is already designed to handle this type of situation.

For more information about whether this feature can help with specific use case scenarios, send a video to SightLine [Support](#) for review and follow up recommendations.

7 Tracker-Only Configurations


Tracker only configurations provide a solution for customers who need an object tracking algorithm and telemetry data, but do not need other video processing functionality.

Tracker-only configurations use the same tracking algorithms as the full featured SLA. There are two tracker-only options offered with differences outlined in the [Appendix](#). Because the tracker runs on the same low SWaP 1500-OEM and 1500-SOM hardware, units can be easily upgraded to full SLA functionality.



8 Command and Control

The following packets are used to setup and control the tracking algorithms. Details can be found in the web based [Interface Command and Control \(IDD\)](#).

 A downloadable PDF version is also available on the [Software Downloads](#) page.

8.1 IDD Menu

Within the IDD the main menu references Modules (a category sort of commands and data) and Classes (packets, structs, unions and interfaces in the form of SLA[*name of class*]_t).

8.2 Reporting Results

Telemetry data related to tracking.

Message Name (Class)	Message ID	Module
Tracking Position	(0x43)	Telemetry
Tracking Positions	(0x51)	Telemetry
Tracking Positions Extended	(0xA0)	Telemetry
Coordinate Reporting Mode	(0x0B)	Telemetry
Set Telemetry Destination	(0x64)	Telemetry

8.3 Display Related Commands

Message Name (Class)	Message ID	Module
Set Overlay Mode	(0x06)	Overlays

8.4 Tracking Related Commands

Message Name (Class)	Message ID	Module
Modify Tracking	(0x05)	Tracking
Modify Track Index	(0x17)	Tracking
Stop Tracking	(0x09)	Tracking
Set Tracking Parameters	(0x0C)	Tracking
Nudge Tracking Coordinates	(0x0A)	Tracking
Set Registration Parameters	(0x0E)	Stabilization



9 Trouble Shooting and FAQ

Question: It is too complicated to always switch tracking modes. Which tracking mode would work well for most tracking scenarios?

Answer: Although the tracking mode is important, using vehicle mode tracks moving or stationary targets in many different scenarios and is a good choice for many tracking applications. Choosing stationary mode would result in poor tracking performance on moving objects.

Question: What is the difference between scene tracking mode and using the registration results to implement a scene tracker?

Answer: The scene tracking mode is a simple implementation of a scene tracker that takes the registration information and outputs the results in the Tracking Position (0x43) packet in camera coordinates.

Using the registration results directly still requires looking at the Tracking Position (0x43) packet, but using the scene translations, and these would be offset from zero instead of positions in camera coordinates.

The benefit to using the registration results directly is having more control managing feed-forward user commands. For example, to drive the scene to the right in scene tracking mode using the nudge commands will result in a jumpy move. Using the registration results directly make it easier to incorporate commands in the control loop to provide smoother gimbal control.

Question: How can a track box be set up with a different width and height?

Answer: This now supported in 2.24. In previous versions use *Acquisition Assist* or *Vehicle MTI* to adjust the track box.

Question: When using Intelligent Assist mode, it seems that the Near Value is disregarded, is this true?

Answer: Yes. Near Value has nothing to do with Intelligent assist.

Question: What is the minimum size object that can be tracked?

Answer: SightLine has shown tracking to work with as few as 4 pixels (2 x 2 box). For more robust tracking, track objects that are at least 100 pixels (10x10 box).

9.1 Questions and Additional Support

For questions and additional support, please contact [Technical Support](#). Additional support documentation and Engineering Application Notes (EANs) can be found on the Support pages of the SightLine Applications [website](#).



Appendix: Tracking Only Options Comparison

Attribute	Tracker-Only Options		
	Full SLA	Advanced	Base
Application Bits	0x052 +	0xC010	0xC000
Tracker modes supported	Vehicle Stationary Scene No Registration Drone	Vehicle Stationary No Registration Drone	Vehicle
Maximum number of simultaneous tracks	5	1	1
Frame size processed	HD or SD	SD	SD
Track box size adjust	✓	✓	✓
Track box nudging	✓	✓	✓
Track through zoom and rotation	✓	✓	
Acquisition assist	✓	✓	
Intelligent assist	✓	✓	
Scene Tracking (aka Scene Steering and Scene Lock)	✓		
Detection Track Cueing	✓		
Hardware platforms supported	1500, 3000	1500 only	
Other video processing functions that can be added to the unit.	All SightLine's functions can be added.	None. Functions limited to tracking only. Units can be updated to full performance via license file purchase.	