SWARCO

CAIMAN-PRO

User Manual

CAIMAN-PRO

WIDE BEAM STOP+MOTIO
RADAR DETECTOR

CAIMAN-PRO_UserManual_BE_10

The Better Way. Every Day.

CONTENT

1 Introduction

1.1 Abbreviations

CAN	Controller Area Network
CSV	Comma Separate Value
EIRP	Equivalent Isotropically Radiated Power
ETM	Event Trigger Module
GUI	Graphical User Interface
PC	Personal computer
SM	Statistics Module
TBC	To be confirmed
TBD	To be defined
TMC	Traffic Management Configurator

1.2 Reference Documents

Quick Guides

- CAIMAN-PRO Installer Quick Reference Guide
- CAIMAN-PRO SRO Quick Reference Guide
- CAIMAN-Grounding-Recommendations

Descriptions and Manuals

- CAIMAN-PRO-Bracket Description
- CAIMAN-PRO-JunctionBox Description
- CAIMAN-PRO-JunctionBox-Installation Manual

Data Sheets

- CAIMAN / CAIMAN-PRO B
- CAIMAN / CAIMAN-PRO M
- CAIMAN / CAIMAN-PRO I
- CAIMAN / CAIMAN-PRO T

2 About the CAIMAN-PRO Radar Sensor

2.1 Fields of Application

The CAIMAN-PRO sensor family can be used for many applications. Among those are:

- **Intersection Management**
  - Stop Bar Detection
  - Combined Stop Bar and Advance Detection
  - Advance Detection
  - Queue Length Measurement

- **Arterial Management**
  - Traffic Counting and Classification
  - Wrong Way Vehicles detection
  - Incident Detection

Note:
Please note that the Radar system – like any other sensor system – although being well optimized and providing excellent performance, will not achieve a 100% detection probability and will not achieve a false alarm rate equal to zero.

2.2 Outstanding Features

- Truly Universal – serves a variety of applications
- The most Advanced Tracking Radar
- Lane Specific Detection
- Individual Object Tracking
- Flexible Installation
- Statistics and Event Trigger Modules
- Easy-to-use TMConfigurator Setup Software

2.3 Principle of Operation

Each individual CAIMAN-PRO sensor directly measures the following parameters of all moving objects simultaneously in the field of view: (relative to the sensor)

- Range
- Radial Relative Speed
- Azimut Angle

Those data are stabilized by tracking algorithms. Stopped objects are kept in the tracking memory. The true vector of the relative speed is calculated. A data transformation into Cartesian co-ordinates is performed. Those tracked and transformed data are transmitted over the chosen communication interface.

The radar system will thus detect objects in the field of view of the sensor and cyclically report the data ([x,y] position and relative speed vector) of those on an external interface. The interface to the superior system (detector card, PC or the like) is a list of tracked objects transmitted via RS485 or Ethernet[1] (or other) interface.

Each sensor comprises a RS485 interface for communication (standard interface) and an Ethernet or CAN interface (deactivated by default).

2.3.1 Network operation

A sensor can be operated standalone or in a network of sensors.

2.3.2 Flexibility of Radar Waveform

The CAIMAN-PRO supports a variety of stand-alone or combined radar waveforms. The operation mode can be determined by the radar firmware.

2.4 Tracked Object Interface

In a stationary application, usually the sensor output is a list of detected **targets** (reflectors) in the sensor data output with the parameters

- Range
- Horizontal Angle (to determine the Position)
- Vertical Angle (to determine the Height)
- Radial Speed
- Reflectivity level
- Type of Target (Reliability Figure)

In addition to that, status and diagnose data from the sensor are reported.

The result of the tracking is an **object** list with the following parameters:

- x position
- y position
- velocity magnitude and heading[2]
- size estimate or class estimate of the reflector

[1] Ethernet will be made available in a future software update.
[2] For compatibility reasons, an output of x speed and y speed is available as a option.

In any case, a visualization both of the **targets** and the **objects** is possible using the TMConfigurator software in any PC equipped with a CAN, RS485 or Ethernet interface[3].

For further information about the CAIMAN-PRO Sensor performance and communication options refer to the further documentation.

2.5 Statistics Module V2 (SM2)

The Statistics Module is an Application based on the Tracked Object Interface. While the Tracked Objects provide a high update rate of per vehicle data, the Statistics Module interprets and accumulates those data to reduce the data amount transferred to the user and at user selectable time intervals. The user can select to obtain the **Statistics Data** only.

The **basic features** provided are:

- Lane specific report
- Reports per measurement zone (32 measurement zones max.)
- Report of Statistical Data
    - Volume
    - Occupancy
    - Average Speed

The **extended features**[4] provided are:

- Reports per Vehicle class
- Report of Statistical Data
    - 85 percentile speed
    - Headway
    - Gap
- Capability to either polling or reporting activity

Figure 1 shows an example of the Statistics Module V2 output.

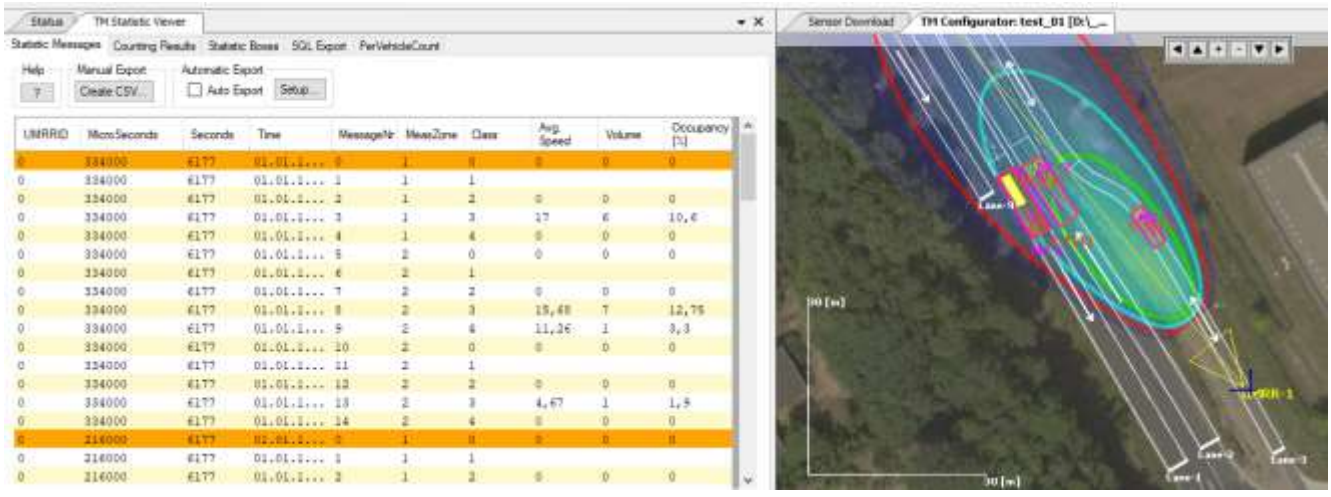


Figure 1:Statistics Module output example in TMConfigurator

[3] Depending on interfaces offered by the CAIMAN PRO purchased. Check TMConfigurator system requirements.
[4] Provided as a future software update

2.6 Event Trigger Module V2 (ETM2)

The Event Trigger Module V2 is an Application based on the Tracked Object Interface. With a focus on **events**, the user can define and select from a variety of trigger conditions on zones. Those triggers can be linked to Virtual Relays. Up to 64 Virtual Relays are supported per sensor. The user can select to obtain output from the Virtual Relay States conditions only. The output rate can be selected by the user.

Figure 2: Event Trigger Module example in TMConfigurator

The following features are provided:

- Lane specific report
- Reports per zone (32 zones max.)
- Up to 64 Virtual Relays are triggered
- Types of Trigger
  - Presence
  - Speed
  - Estimated Time of Arrival[5]
  - Vehicle Class[6]
  - Wrong Direction
  - Queue Length[7]
  - Custom Trigger
- Individual Delay and Extension of Trigger Signals

Figure 2 shows an example of the Event Trigger Module set-up and output.

[5] In the United States, a one-time ETA is provided.
[6] Provided as a future software update
[7] Provided as a future software update

2.7 Fail-Safe Capabilities

This capability is planned for a future software update.

The sensor offers diagnostics for different classes of failures. They are named “Error Diagnostic” conditions. It is clearly pointed out that not all possible failures can be detected by the onboard diagnostics, and that the diagnostic features do not have 100% detection rate and / or 0% false alarm rate.

The Error Detection triggers all assigned outputs both in communication protocol (and on hardware, where SRO equipped). The Error Detection triggers by default

- at critical sensor internal errors (detected by on-board diagnose) and
- on detection of heavy rain.

It is possible to disable or adjust the Error Detection operation. Please refer to section 5.2.

2.8 Communication Interfaces

2.8.1 Standard CAIMAN-PRO

The **Standard CAIMAN-PRO** supports the following interfaces:

- **RS485** full-duplex, 115kbps (default, selectable)
- **CAN 2.0b** (high-speed), 250kbps (default, selectable)
- **10/100** Mbps **Ethernet** (default, selectable)[8]

Those interfaces can be accessed through the rear sensor connector. Please refer to the CAIMAN-PRO sensor datasheets in the appendix for the pin-outs.

Figure 3: CAIMAN-PRO Traffic sensor – rear side

[8] Interface is present on the hardware. Future software update will activate this functionality.

2.8.2 Relay Output Option

The **Sensor Relay Option** (RD_CaimanPRO_Relay) adds to the back of the standard CAIMAN-PRO sensor. It can be ordered as a separate option to the CAIMAN-PRO sensor. **Eight contact pairs** together with **RS485 and Ethernet and CAN** are provided by the SRO-01xxxx. Furthermore, surge protection is offered on all signals.

For more details, please refer to the SRO Installer Quick Reference and to the Detector Data Sheet.

Figure 4: RD_CaimanPRO_Relay module mounted to an CAIMAN-PRO Sensor (rear side)

2.8.3 Wireless

Several GSM and HSDPA modems have been tested and validated to work with the CAIMAN-PRO sensor.

Among those are:

- Airlink Raven XE (World)[9]
- Sierra Wireless LS300[10]
- Moxa OnCell G3151
- Moxa OnCell G3150

Those devices are seamless integrated into SWARCO's TMConfigurator setup tool (refer to section 7 also).

[9] Ethernet Input to that modem is required.
[10] Ethernet Input to that modem is required.

2.9 Antenna overview

The table gives an overview for the latest antenna types and their preferred usage.

Table 2-1: CAIMAN-PRO Antenna overview

	Type I80 / M80 / B80	Type I36 / M36 / B36
Applications	**Stop Bar Detection**	**Stop Bar Detection Advance Detection**
Azimuth detection range	**-40° to +40°**	**-18° to +18°**
Azimuth measurement resolution	**No resolution. Digital RX beam forming is used for beam shaping and the resolution of simpler scenarios.**	
Elevation detection range	**-12° to +12°**	
Number Antenna beams on receive: (phase monopulse, fully overlapping)	**Four RX antennas, phase monopulse principle. Digital RX beam forming is applied.**	
Number Antenna beams on transmit: (covering Field of View in total)	**1, the full field of view given 4 lines above is illuminated.**	
Two way Azimut 3dB-beamwidth: xx°	**-21° to +21°**	**-7° to +7°**
Two way Elevation 3dB-beamwidth: xx°	**-5° to +5°.**	**-5° to +5°**
Sensitivity[11] (typical) on - Small car - Truck	**120m 250m**	**150m 320m**
Dimensions (WxHxD):	**Antenna size 97x79 mm plus housing**	

2.10 Sensor Description and Hardware ID

Every CAIMAN-PRO sensor housing is tagged with a type sticker containing the product description and the serial number. It also contains a mark which side of the sensor is top.

Figure 5: Type sticker example

[11] Assuming 20dBm EIRP output power.

For all standard housing versions, the cable outlet is on the rear side.

For special housing versions, when looking at the front of the sensor (radome), the cable outlet is on the right side. It may be required that the sensor is mounted Bottom Up. In that case the cable outlet is on the left side.

2.11 Coordinate System

The coordinate system of the CAIMAN-PRO sensor is illustrated in Figure 6 and Figure 7.

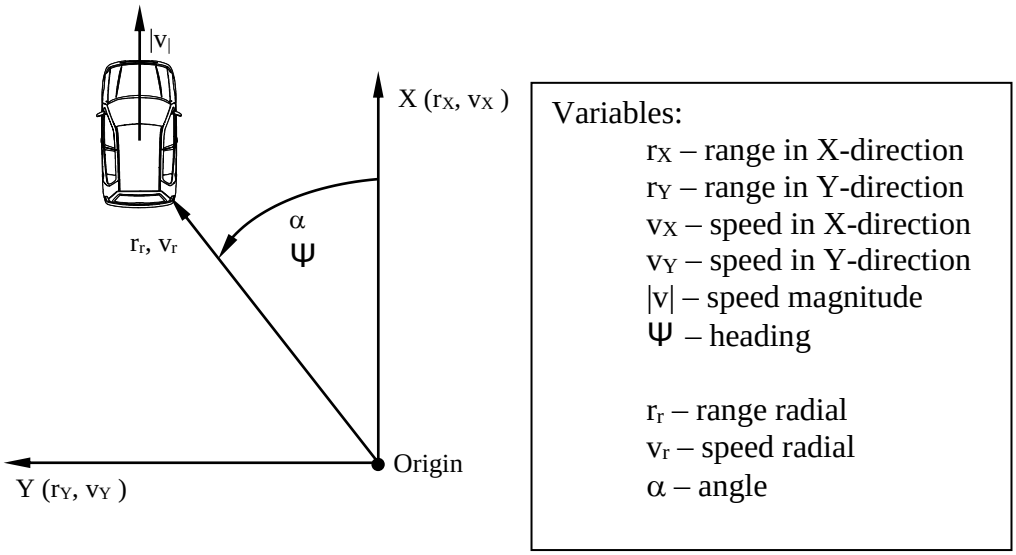


Figure 6: Drawing of coordinate system

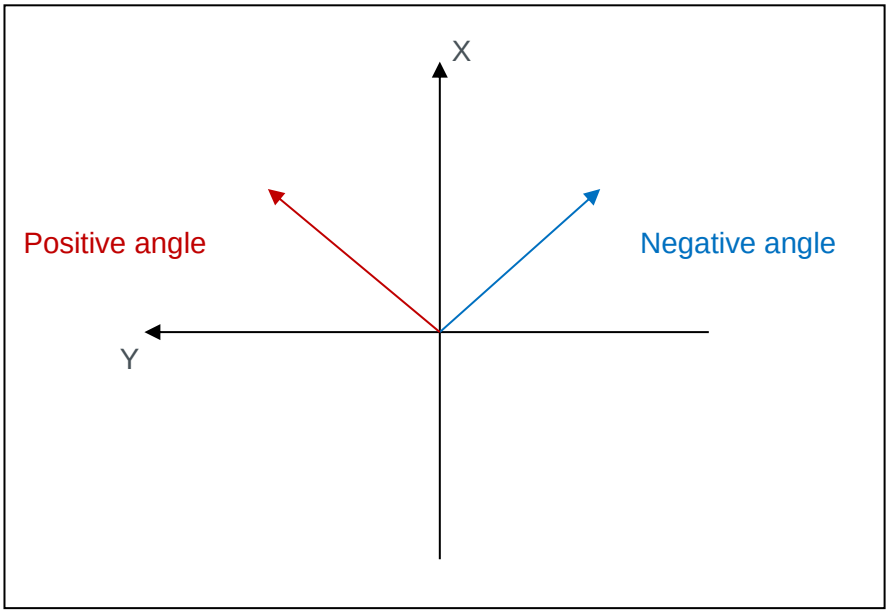


Figure 7: Angle sign in the coordinate system

2.12 Grounding Requirements

The housing of the CAIMAN-PRO sensor is not electrically floated. It is connected to the negative supply voltage instead. To assure correct operation of the sensor, please refer to CAIMAN-Grounding-Recommendations for grounding instructions.

2.13 Field Cable Specification

The minimum cable requirements for an infield installation of the CAIMAN-PRO sensor are:

CAIMAN-PRO:

- For use with Junction Box:
  - Outer diameter 9 mm to 13 mm
  - Cable outlet for 6.5 mm to 9.5 mm also available
- Power pair:
  - AWG18 / cross section 1 mm² or better recommended[12]
  - For all installations: the minimum voltage indicated in the data sheet has to be granted for the operating unit
  - For NEMA cabinet installations: less than 14 V of voltage drop
- Data pairs:
  - Twisted pair (CAN 2.0b; RS485 full-duplex)
  - Two data pairs each as twisted pair (RS485 full-duplex; 10/100 Mbps Ethernet)
  - Z = 100 Ohm to 120 Ohm @ 100 kHz / 1 MHz
  - AWG24 / cross section 0.22 mm² or better
  - Loop resistance better than 190 Ohm / 1000 m

Note:
SWARCO cannot provide a guarantee for cable types other than those verified by SWARCO testing and advertised as such. The customer is required to verify by testing the cable candidate for his particular purpose and installation variants, esp. with regard to communication capabilities.

2.13.1 Tested Field cables

The following field cables have been verified by testing:

- Lapp UNITRONIC BUS YV COMBI IBS 3x2x0.22 , 3x1.0 ROHS
- Manufacturer part no. 2170217; Rated for direct burial / natural UV resistance.
- Tested distance 161m / 528ft.
- Lapp UNITRONIC LAN 1000 s/FTP Cat. 7 (L) PE 4x2xAWG 23/1
- Manufacturer part no. 2170198; Cat.7 cable; Rated for direct burial
- Tested distance 100m / 328ft.
- Olympic Wire 61530B Manufacturer part no. OLY 6150B (https://www.olympicwire.com/)
- Tested distance up to 500ft. / 100+ installations.
- Tested by 3rd party using CAIMAN. SWARCO grants no guarantee for fit for purpose.
- Medikabel 9DB280431C01 (www.medikabel.de)
- UV rated cable for CAIMAN

[12] For use with JBOX: conductor reduction at clamp on 0.5 mm² is requested

2.14 Accessories

The CAIMAN-PRO sensor is enriched by a set of accessories to meet various customer needs. A selection is briefly displayed below. For the most recent products, please visit www.swarco.com.

2.14.1 Brackets

In order to mount and align the sensor the here described brackets can be used.

Standard Brackets (see Figure 8: BFW_Caiman_36S with sensor front Figure 8)

Standard brackets allow for adjustments of the elevation angle. They are designed for pole mount, wall mount and tripod usage. Please refer also to the Bracket Description.

Advanced Brackets (see Figure 9)

Advanced brackets allow for adjustments of both the azimuth and elevation angle. They are designed to further cover both horizontal and vertical bar mount as well as straight or angled orientation. Please refer also to the Bracket Description.

Figure 8: BFW_Caiman_36S with sensor front

Figure 9: BFW_Caiman_36Awith sensor front, straight orientation

2.14.2 Junction Box

The SWARCO **Junction Box** (RD_CaimanPRO_JB) offers a universal and easy to use field installable way of connecting and surge protecting a CAIMAN-PRO sensor to the home run cable. It can be easily added to the back of the standard CAIMAN-PRO.

Figure 10: RD_CaimanPRO_JB

2.14.3 RS485 to USB Converter

By means of the RS485 to USB converter, you can connect the CAIMAN-PRO sensor to a PC easily and at low cost. For 24/7 installations, an industrial solution like Moxa Uport 1130I is suggested.

Figure 11: RS485 USB converter – industrial solution: Moxa UPort 1130(I)

2.14.4 Other Accessories

Please find more accessories (and cables) for the Traffic Management CAIMAN-PRO on the SWARCO website: www.swarco.com.

3 Selecting the right CAIMAN-PRO Model and Sensor Location

Note:
Country dependent frequency regulations may require usage of the low power version.

3.1 Selecting the right antenna

- Select CAIMAN-PRO B32 / I32 / M32 if:
  - This is the default antenna
  - For large intersections (high distance to stop bar / extension)
  - Road is rather straight
  - # of lanes monitored is 1-4, but verify coverage of all lanes + allowance

- Select CAIMAN-PRO B80 / I80 / M80 if:
  - If type 32 cannot be applied
  - Distance to stop bar is short

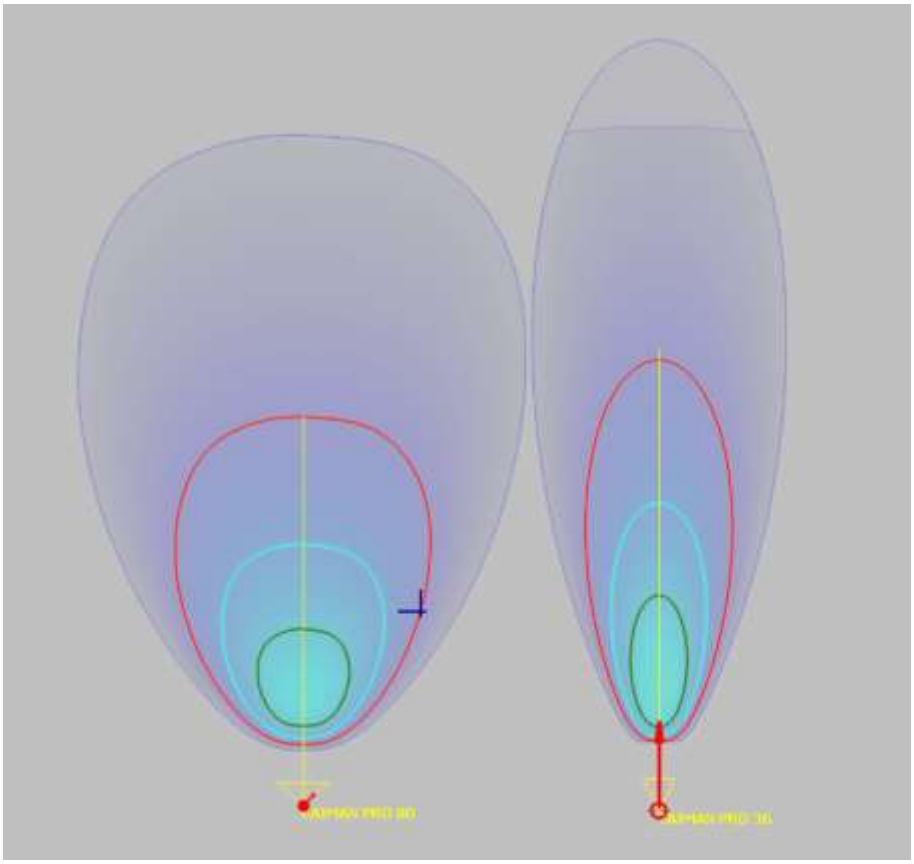


Figure 12: general characteristics of CAIMAN-PRO

3.1.1 Comparison low power vs. high power

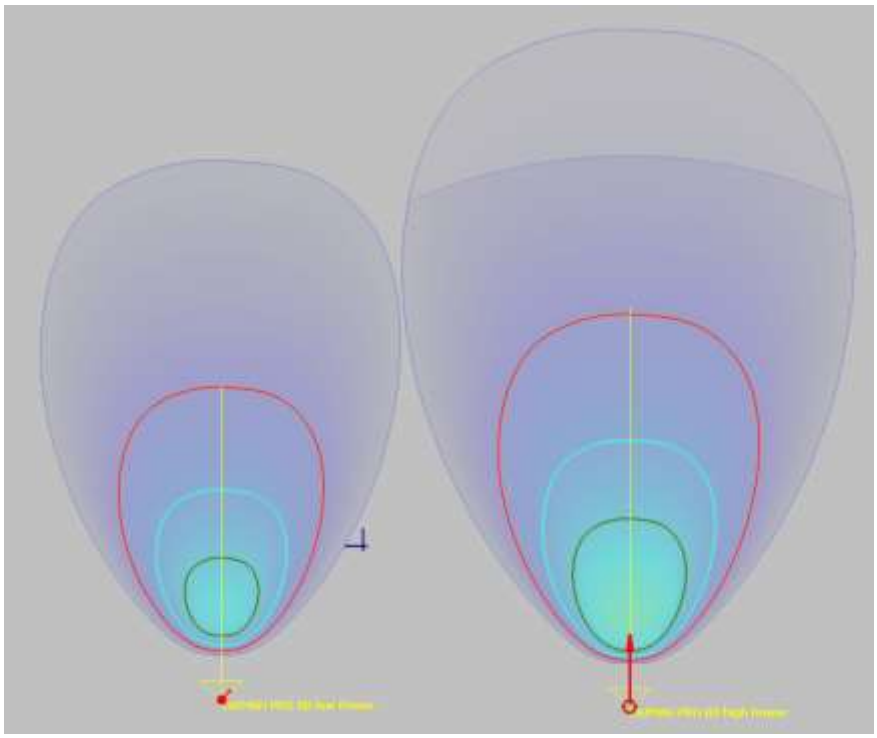


Figure 13: Type 80 low power vs. high power

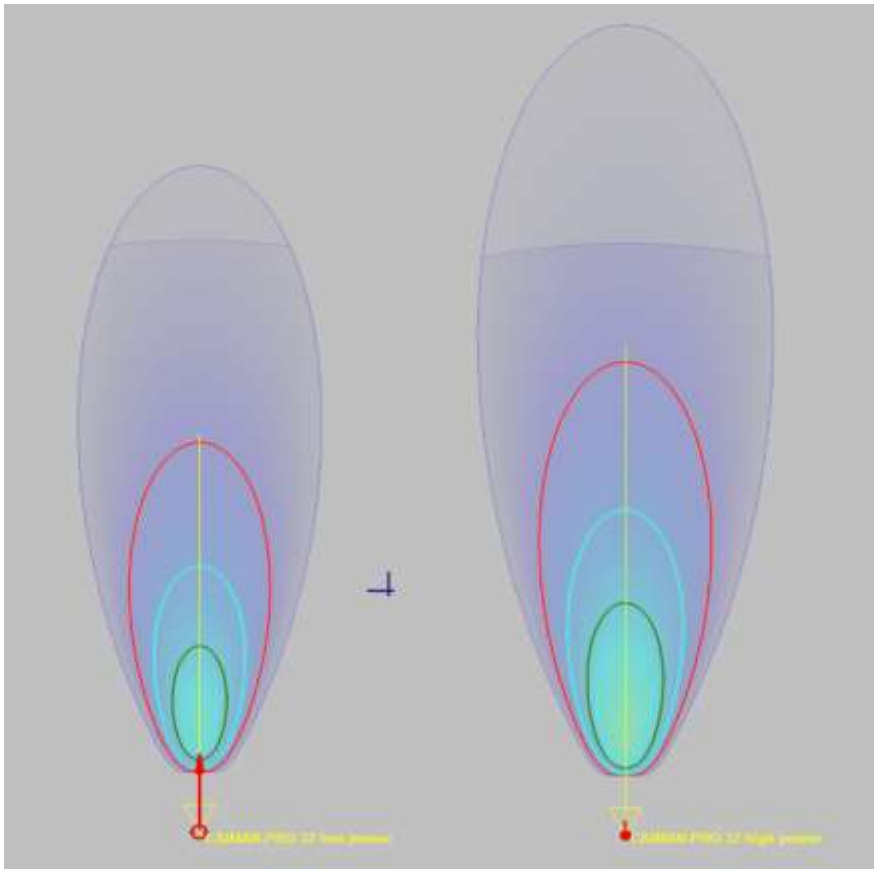


Figure 14: Type 32 low power vs. high power

3.2 Select Area of Interest

The following figure shows how Tracked Objects are built by the CAIMAN-PRO inside the sensor beam.

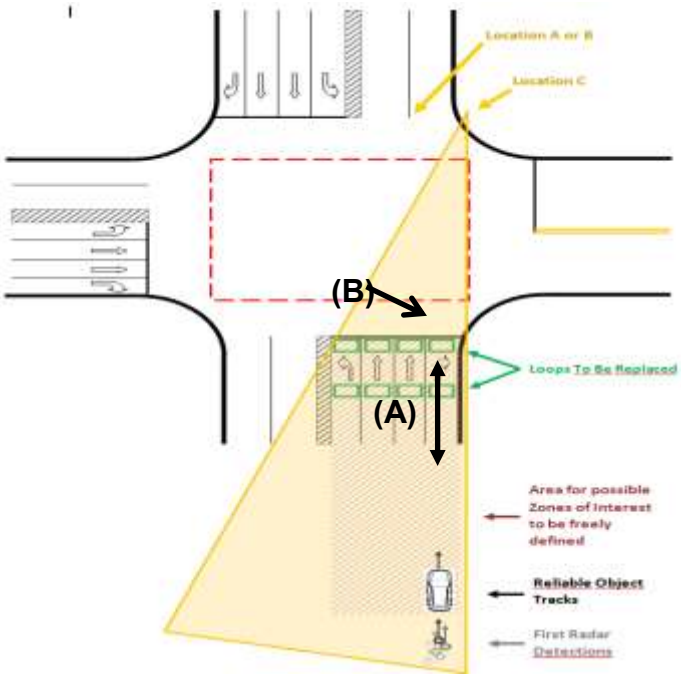


Figure 15: Select Area of Interest

The planner / installer has to check the following steps:

- Verify that there are 20+m (60ft) between max. range and area of interest
- Verify the lanes are fully covered
  Include some allowance at beam limits – example (B) is too tight
- Verify the horizontal angle to road is within -20 deg .. +20 deg
- Verify the horizontal angle to road is within -25 deg .. +25 deg
- Verify the vertical angle to ground is within -3 .. +3 deg typical,
  allowed are -9 .. +5 deg

3.3 Verify the Radar Beam covers your Area of Interest

The radar beam creates an oval shaped spot on the ground. The installer / planner has to verify that the measurement point lies inside the covered area.

Please check these points:

- Verify that there are 20m (60ft) covered by the beam between max. range and area of interest (on all lanes)
- Verify the lanes are fully covered by the beam; stop bar shall be fully covered by the green beam.
- Green beam shall not cover too much additional area right or left of stop bar. Use T45 if the stop bar area is small. Do not use CAIMAN-PRO 80 by default at every location. Include some allowance at beam limits (on all lanes)
- Recommended mounting parameters: see chapter 3.6.

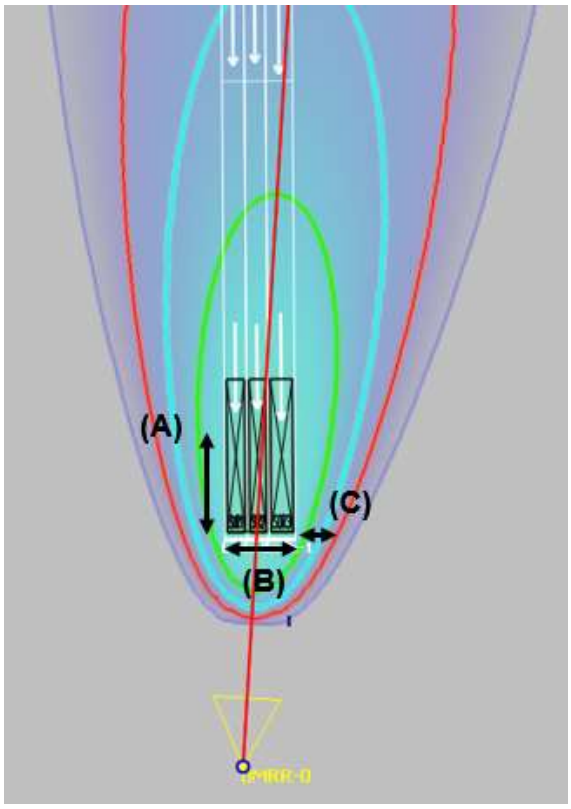


Figure 16: Verify Radar Beam coverage

3.4 Vertical Installation Angle

The radar beam has a limited vertical opening angle, as shown in the figure below.

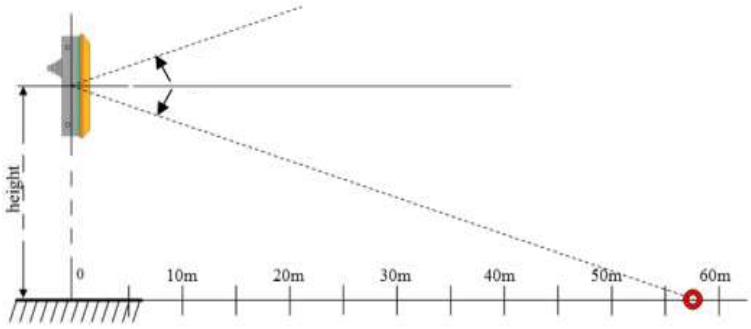


Figure 17: Vertical Opening angle of Radar Beam

The planner / installer has to check the following steps:

- Possible mounting heights are from 1m to 10m from the ground;
- The minimum detectable range is dependent on the mounting and elevation angle used
- Use Beam Simulation from TMC software to verify coverage of your area of interest.

The TMConfigurator PC software has been designed to **simulate**[13] the spot (radar beam) on the road according to height, vertical angle, horizontal angle, and selected antenna.

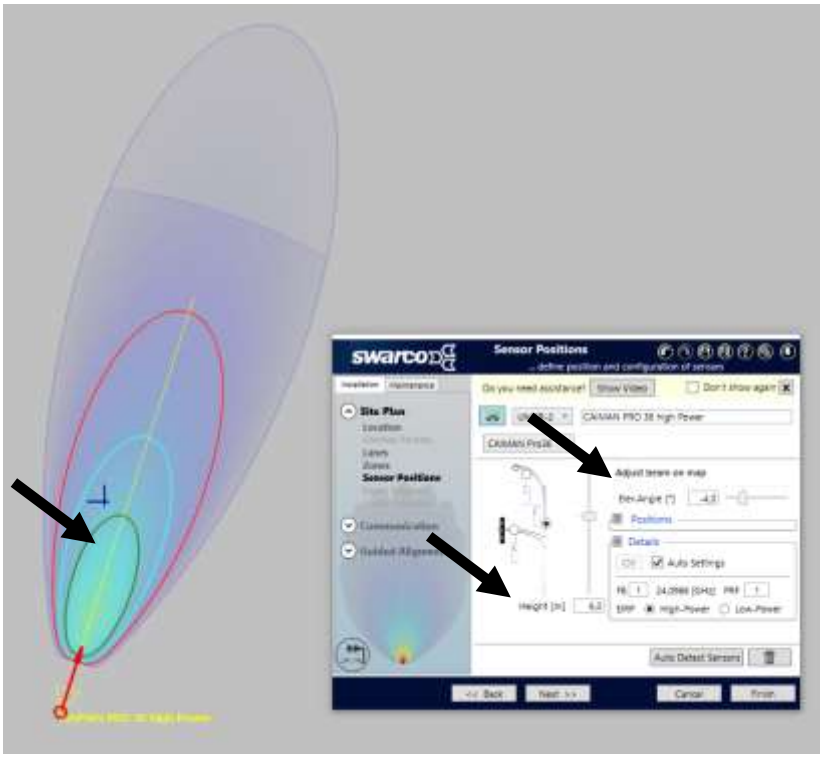


Figure 18: TMConfigurator Beam simulation

[13] Note: this is a simulation only, a help; and not a guarantee for detection in displayed areas.

3.5 Finding the optimal mounting position

The sensor should be mounted on a stiff location.

Stop Bar or Mast Arm? The smaller the angle towards the stop bar, the better. The sensor beam is then better used, and occlusion of vehicles in adjacent lanes is less likely. This means, **the mast arm is usually the better position**. However, the mast arm **must not move (wind).** If mast arm, then use a position where movement of mast arm is small.

Figure 19: Recommended mast arm position.

If you like to use the existing infrastructure, the following positions are possible:

A: On mast arm not too far out (optimal position)
B: Adjacent to Luminaire
C: On vertical pole

We recommend position A for best performance, as a stiff and motion-free mounting base is required, while a small angle towards the zones is desired. If the structural conditions of the luminaire or the mast arm allow a stiff attachment of the sensor, position B and C are also possible alternatives.

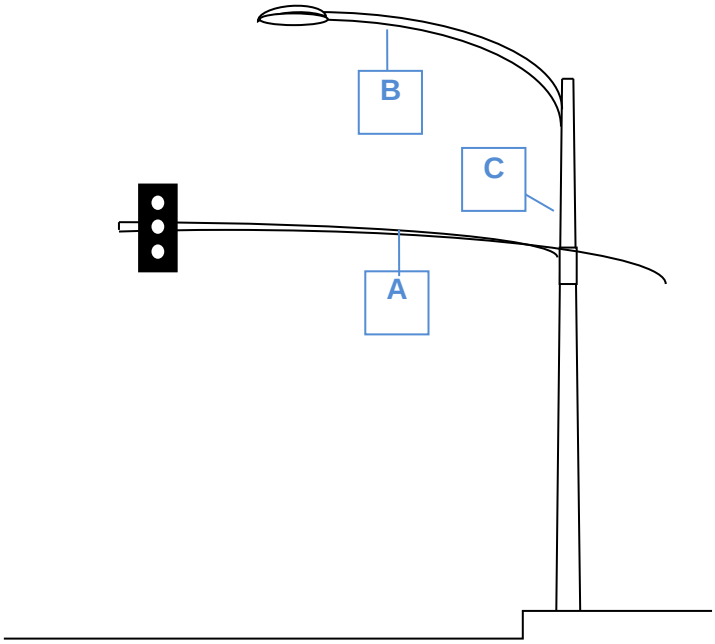


Figure 20: Mounting position

Please refer to the sensor datasheet to get a recommendation for your sensor and antenna about best distance to the stop bar or area of interest and the angles for best performance.

Note:
The sensor must be mounted on a stiff and solid support. Vibration, oscillation or any kind of movement will reduce sensor performance.

3.6 Standard Settings

The following Standard settings are recommended to obtain good performance.

3.6.1 Type 80 Standard Setting

- For optimum Counting and Classification, USE THESE SETTINGS
- Sensor height: 6m
  - Vertical Angle: -3 degrees (down to the road)
- Horizontal angle: -15..**0** degrees
- The measurement line shall be placed
  - At 30m distance for oncoming traffic
  - At 90m distance for receding traffic
- For optimum Stop Bar performance, a Horizontal angle close to 0 degrees is suggested.

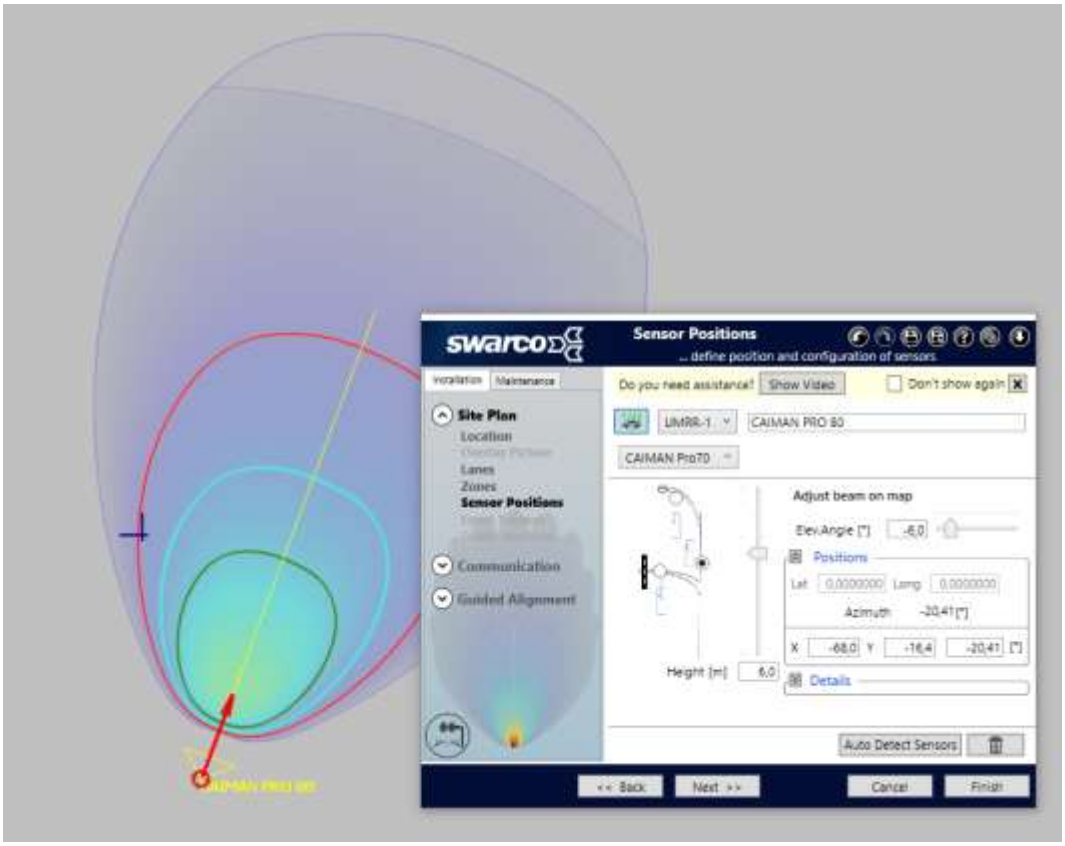


Figure 21: Type 80 Standard Settings

3.6.2 Type 32 Standard Setting

- For optimum Counting and Classification, USE THESE SETTINGS
- Sensor height: 6m
    - Vertical Angle: -3 degrees (down to the road)
- Horizontal angle: -8..0 degrees
- The measurement line shall be placed
    - At 30m distance for oncoming traffic
    - At 90m distance for receding traffic
- For optimum Stop Bar performance, a Horizontal angle close to 0 degrees is suggested.

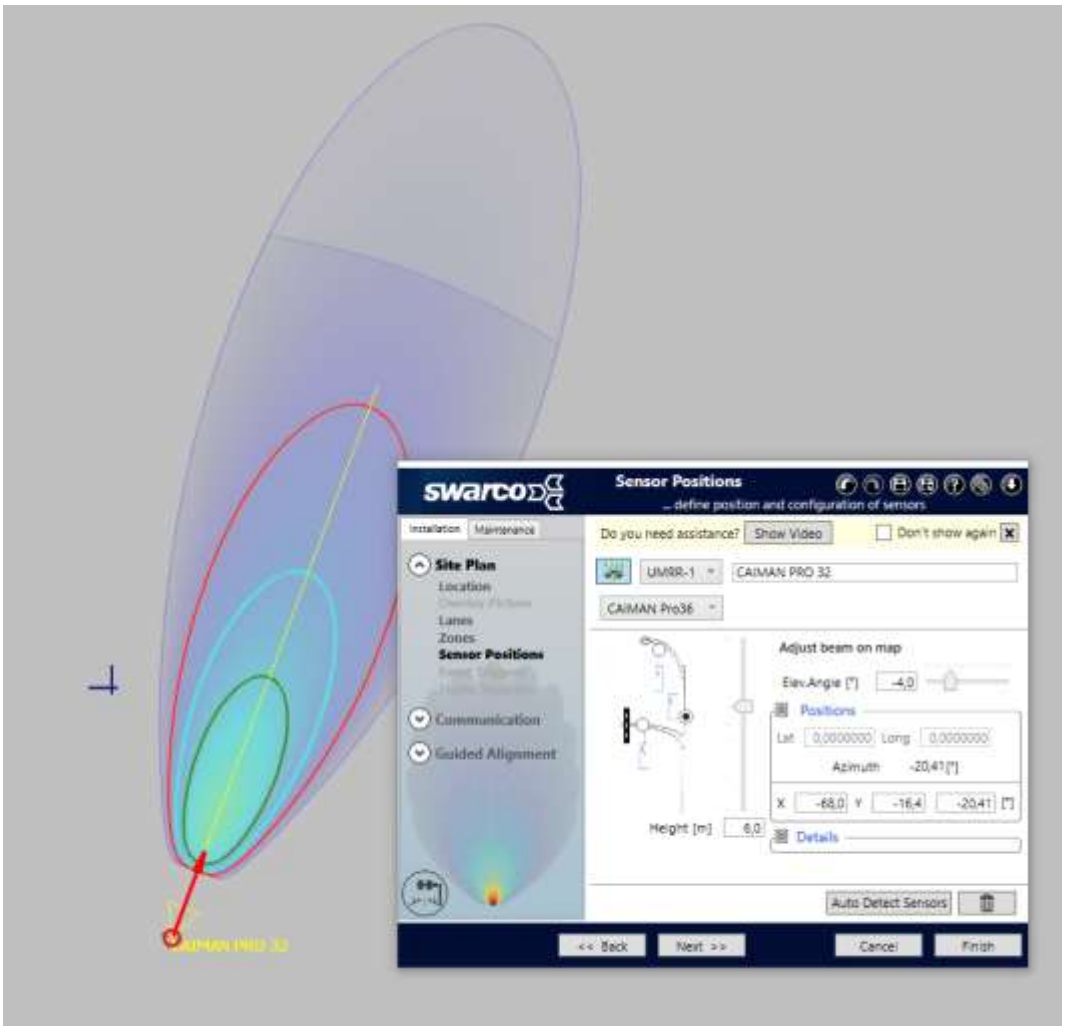


Figure 22: Type 32 Standard Settings

3.7 TMConfigurator Beam Simulation

The TMConfigurator (see section 7) provides a beam simulation[14] for the planner / installer to predict beam coverage on the road.

- Enter the Sensor model
  - CAIMAN-PRO 32 CAIMAN-PRO 80
- Extend “Details” to choose high / low power setting15.
- Enter Mounting height and Elevation Angle to Road
  - Elevation Angle to road should be within -9° to +3°
- TMC will draw the beam simulation
- Note: This is a simulation “only”.

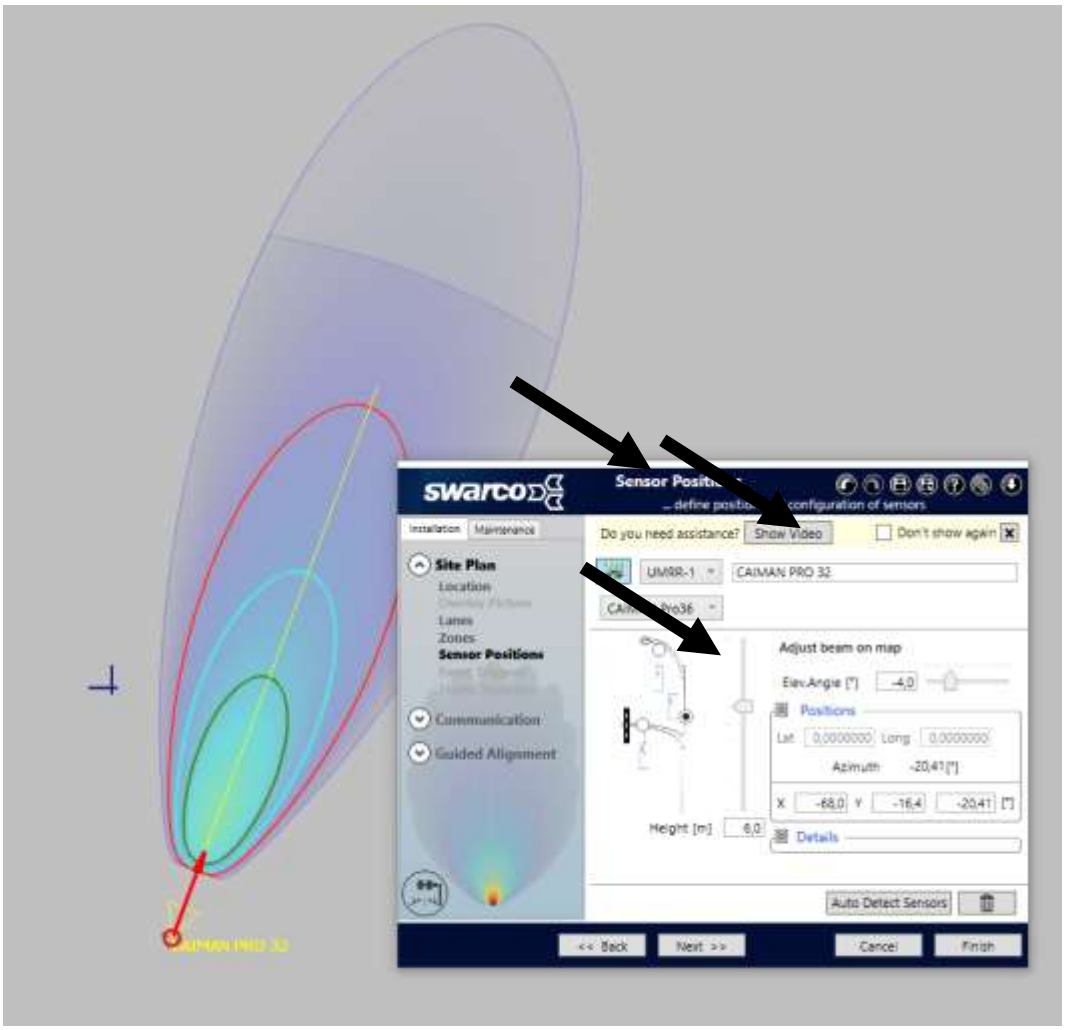


Figure 23: TMConfigurator Beam Simulation

[14] Note: this is a simulation only, a help; and not a guarantee for detection in displayed areas.
[15] Not all power levels are available for every country.

4 Getting Started

This section gives directions to perform the initial operation with the CAIMAN-PRO sensor.

4.1 Quick Reference Guides

To identify the CAIMAN-PRO sensor hardware, cables and accessories, please refer to the **Installer Quick Reference Guides**. For each sensor and supported interfaces, an adapted Quick Reference Guide has been compiled:

- CAIMAN-PRO-Installer QuickRef
- CAIMAN-PRO-SRO-Installer QuickRef

If the Junction Box is used, a step-by-step example installation can be found in the CAIMAN-PRO Junction Box-Installation.

4.2 TMConfigurator set-up software

The TMConfigurator software (TMC) provides easy set-up as well as installation planning aids. The TMC has been designed for the inexperienced user, but offers also advanced diagnostics for the expert. Please proceed with section 7 for installation and usage of the TMC.

4.3 HOW TOs

Please refer to section 6 for a number of HOW TOs.

5 Data Communication

5.1 Parameters

The user can parameterize the sensor by setting parameter commands.

All Commands for CAIMAN-PRO are UATV4 command type. Be sure to check the UATV4 box in the Command window (see Figure 24).

5.1.1 TMConfigurator to send a Command

The TMConfigurator software (TMC) (see also section 7) is suggested to transmit command messages to the sensor.

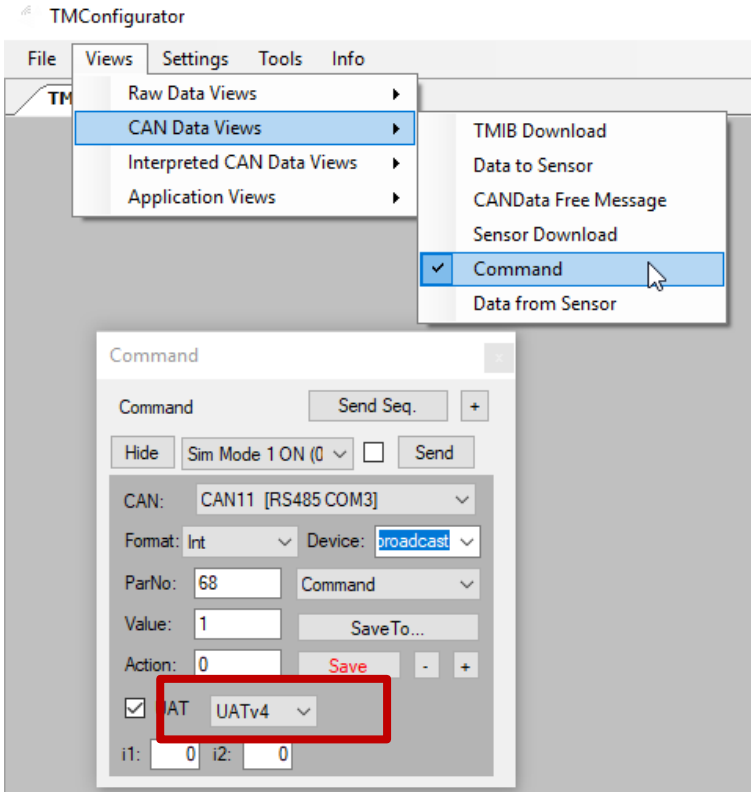


Figure 24: Command View (UATV4)

5.1.2 Basic Commands

The **bold** commands are required as user input. The TMConfigurator software (TMC) (see also section 7) is sets those commands in Alignment mode. Blue marked entries are required for managing multi CAIMAN-PRO installations. Grey marked entries are suggested to experienced users only.

Table 5-1: Basic Commands

Name	Description	ParNo.	Default Value	Action	Type	Typical values
Set Unix time	Set a new unix time as sensor time	950	0	1000	cmd	1234567890= Feb.13, 23:31:30
Simulation Mode 1 (Target Simulation)	Activates the target simulation mode	410	0	2000	rw	0 = deactivated 1 = activated
Simulation Mode 4 (Output Simulation)	Activates the relay (or output) simulation mode	3	0	3017	rw	0=off 1= Mode 1 Sub1 2= Mode 1 Sub2

Table 5-2: Tracking Commands

Name	Description	ParNo.	Default Value	Action	Type	Typical values
Max_hold_time	Max time to hold a object	0	180	249	rw	0..65535s
Min_age_for_hold	Min. age of cycles to hold an object	7	35	249	rw	0..65535cycles
max_truck_speed	Max speed of a truck	76	31.944	211	rw	0.0…88.0m/s
max_pedestrian_speed	Max speed of a pedestrian	79	2.778	211	rw	0.0..88.0m/s
max_bicylce_speed	Max speed of a bike	80	9.167	211	rw	0.0..88.0m/s

Table 5-3: Mounting Parameter

Name	Description	UAT Version	ParNo.	Default Value	Action	Type	Typical values
xPos	[m] X position of the sensor in Cartesian coordinate system	4	50	0.0	2000	IEEE Float	-300.0m … +300.0m
yPos	[m] Y position of the sensor in Cartesian coordinate system	4	51	0.0	2000	IEEE Float	-300.0m … +300.0m
zPos	[m] Z position of the sensor in Cartesian coordinate system	4	52	5.0	2000	IEEE Float	-20m … +20m
xy Orientation	[deg] azimuth angle	4	53	0.0	2000	IEEE Float	-180.0° … 180.0°
xz Orientation	[deg] elevation angle	4	54	0.0	2000	IEEE Float	-90.0° … 90.0°
yz Orientation	[deg] turned upside-down	4	55	0.0	2000	IEEE Float	0.0° … 180.0° 0.0° = not turned 180.0° = turned

5.1.3 Special Commands

There are three ways to reboot or reset the sensor by parameter command.

Table 5-4: Reset HW/SW by command

Name	Description	ParNo.	Default Value	Action	Type	Typical values
Sensor Reset	Sensor Reset and Restart	342	0	1000	Cmd	
Save Parameter Setup	Writes current Parameter image into the EEPROM	344	0xffffffff	1000	Cmd	0xffffffff = all sections
Reset Parameter	Set all volatile Parameters back to EEPROM default	345	0xffffffff	1000	Cmd	0xffffffff = all sections
Default Parameter	Factory default	346	0xffffffff	1000	Cmd	0xffffffff = all sections

5.2 Fail-Safe Capabilities

This functionality will be introduced in a future firmware update.

The sensor offers diagnostics for different classes of failures. They are named “Error Diagnostic” conditions. It is clearly pointed out that not all possible failures can be detected by the onboard diagnostics, and that the diagnostic features do not have 100% detection rate and / or 0% false alarm rate.

The event trigger relay module can be configured to activate all virtual relays of the sensor simultaneously under certain conditions detected by the sensor diagnostic and self-test module. The Error Diagnostic conditions can be configured by command.

Table 5-5: possible parameter values (bitwise OR)

Error Diagnostic condition	description	value
disabled	Error Diagnostic output is not active	0
precipitation	falling rain or snow (default)	1
interference	interference by another sensor or other radar sensor[16]	2
general error	any detected error, even minor issues (not recommended)	4
critical error	errors that can decrease sensor performance (default)	8
sensor blind	material detected in front of the sensor antenna, that significantly reduces sensor’s detection capabilities.	16

The value is a bitwise OR. For example, the default value 9 means that the Error Diagnostic output is activated for rain and critical errors only.

[16] Note: Passing cars equipped with radar sensors may trigger the interference detection without decreasing the radar performance. Therefore, it is not recommended to use the interference feature as Error Diagnostic condition.

6 How to…

6.1 How to use the Simulation-Modes

The CAIMAN-PRO sensor has different simulation modes for sending synthetic simulated traffic objects or triggers. They can be activated and configured using the Command view of the TMConfigurator software. Described here are only the relevant simulation modes for your sensor generation.

Table 6-1: Simulation Modes

Simulation Mode	Function	Benefit	Available for CAIMAN-PRO
1	Generate Targets and Objects on lanes	Simulate Targets Simulate Objects Simulate speeds and driving direction Test Trigger Zones Test Statistic Zones	Yes
2	Generate Objects on Lanes	Simulate Objects on Lanes Test Trigger Zones Test Statistic Zones	No
3	Synthesize ADC Data	Verify function of complete signal processing chain	No
4	Trigger Outputs	Verify reception of digital triggers at Intersection Controller, PLC etc.	Yes

6.1.1 Simulation Mode 1: Targets and Objects

The Simulation Mode 1 generates radar reflector targets as a simulated input for the tracking algorithm. The behavior of the calculated objects will also depend on the polygon and tracking hypothesis method settings.

This simulation will be provided in a future firmware update.

Table 6-2: Simulation Mode 1 Commands

Name	Description	ParNo.	Default Value	Action UAT V4	Type	Typical values
Simulation Mode 1 (Target Simulation)	Activates the target simulation mode	410	0	2000	rw	0 = deactivated 1 = activated
Target Simulation number of lanes	Number of simulated lanes	411	0	2000	rw	0 … 6 lanes 0 = deactivated
Target Simulation number of targets per lane	Number of simulated targets	412	2	2000	rw	1 … 10 targets per lanes

Example:
The following picture shows the simulated output from the sensor with 6 lanes and 2 targets per lane. That means that the sensor generates 6 approaching objects and 6 objects in departing direction.

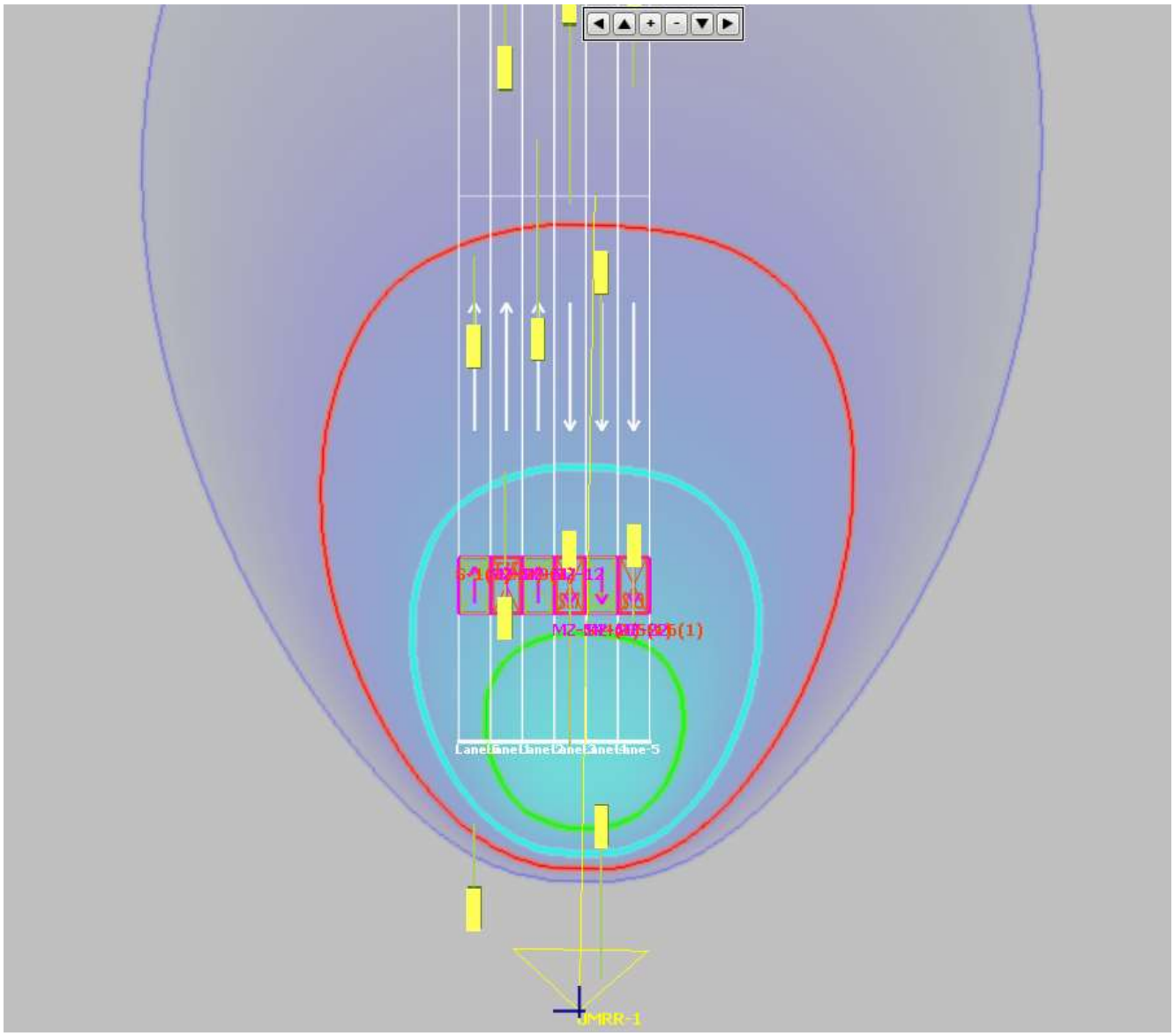


Figure 25: 12 simulated objects in both directions

6.1.2 Simulation Mode 4: Trigger Output Simulation

This mode, aka “relay simulation”, is only available with the statistic and event trigger module of the CAIMAN-PRO sensor.
Simulation Mode 4 generates triggered outputs (i.e. digital binary signals) to test the reception in the Intersection controller, PLC or other connected host.

The Tigger Output Simulation has two sub modes:

1) Set individual Triggers
2) Automated scheme in a “knight-rider” style (i.e. trigger running from 1 to 32 and from 32 back to 1).

Table 6-3: Trigger Simulation parameters

Name	Description	Par. No	Action UAT V4	Type	Typical values
Relay Simulation (Simulation Mode 4)	Trigger Output simulation	440	2000	Int	0: simulation off 1: submode 1 (individual trigger setting) 2: submode 2 (running trigger, knight-rider)
active_relays_part1	defines active relays (bit-coded) for relay simulation 1 (relay1…32)	441	2000	Int	Default: 1
active_relays_part2	defines active relays (bit-coded) for relay simulation 1 (relay33…64)	442	2000	Int	Default: 0
Number of simulated Relays	Defines number of simulated relays for relay simulation 2	443	2000	Int	Default: 8

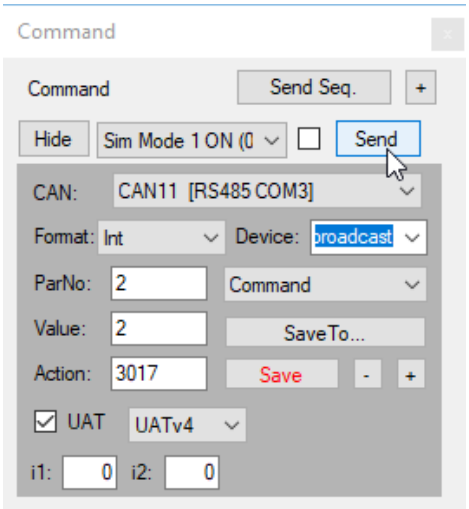


Figure 26: Command example to enable “knight-rider” Trigger Output Simulation

6.2 How to change the frequency band

The frequency band can be set by firmware. Especially, if you want to use multiple CAIMAN-PRO, special care is needed to avoid interference influence among the sensors. The available frequency bands depend on the configuration and are listed in Table 6-4 through Table 6-5. The allowed transmit power level and frequency bands depends on the used regions.

Regions for frequency approvals:

A1: EU (incl. Belgian, Latvia), Norway, Iceland, Switzerland, Korea, Japan
B1: USA, Canada
C1: China
D1: Turkey

Table 6-4: Frequencies for CAIMAN-PRO – max. range resolution configuration T44, T45

f [GHz]	PRF Set ID	Frequency ID	Transmit Power (EIRP)	Approval for Region
24.055 - 24.245	0 … 1	0	default	A1, B1, C1

Table 6-5: Frequencies for CAIMAN-PRO – max. range configuration T44, T45

f [GHz]	PRF Set ID	Frequency ID	Transmit Power (EIRP)	Approval for Region
24.055 - 24.145	0 … 1	1	default	A1, B1, C1
24.155 - 24.245	0 … 1	2	default	A1, B1, C1, D1
24.080 – 24.170	0 .. 1	3	default	A1, B1, C1

To limit the effects of interference for two sensors facing each other, you should use different Frequency IDs for each sensor on same PRF set ID. For a second pair of sensors facing each other, the PRF set has to be increased by one. TMConfigurator PC software performs this task for you. See Table 6-6 and Figure 28 for the basic principle with max. range configuration.

Table 6-6: Parameters for CAIMAN-PRO frequency change

Description	UAT V4 Action	ParNo.	Value	UAT	Format	Device
Frequency ID	2000	100	0 … 3[17]	UATv4	Int	0
PRF Set ID	2000	101	0 … 1	UATv4	Int	0

These **changes are volatile** and will be reset to default after power down unless you save them in the EEPROM by sending the “Save Parameter Setup” command:

[17] Please note: Not all frequency bands might be available for your region / software configuration.

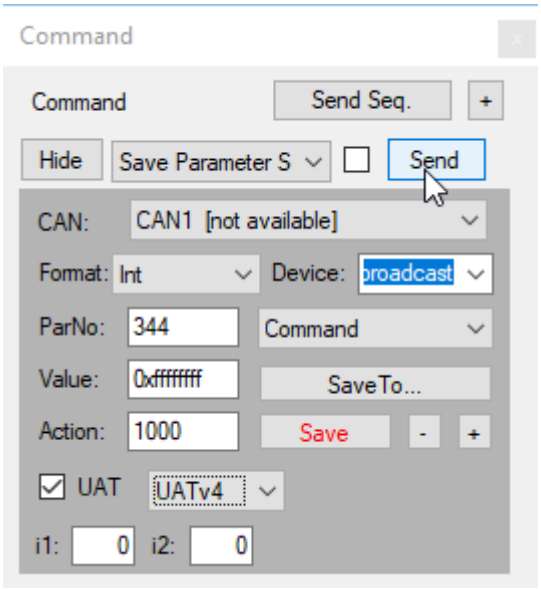


Figure 27: Save all parameters

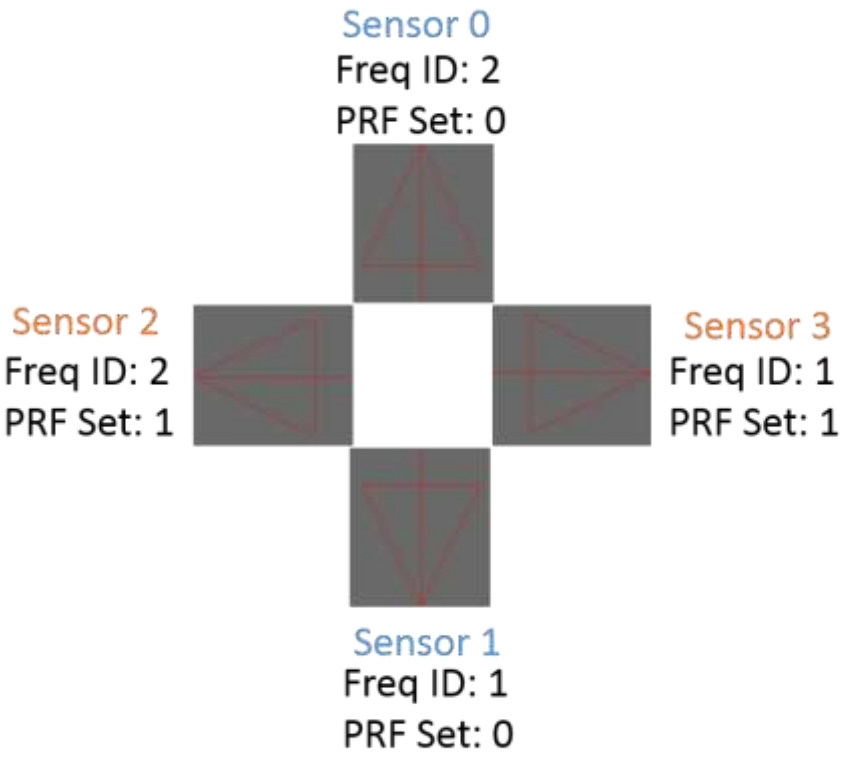


Figure 28: Parameter Setup Example for four type 32 or type 80 sensors, max. range configuration

6.3 How to read and change sensor parameters (experts only)

You can easily read and change the sensor parameters with the SMSCommand tool of the TMConfigurator software. To open the SMSCommand window select “Views -> CAN Data Views -> SMSCommand”.

To **read the current value of a parameter** enter the parameter number (ParNo) and the action number in the Command window. Check UATv4. Select “read only” in the drop-down list and the number format (Int or Float) of the parameter. By clicking “Send” the “ReadParameter” view in the “SensorTargetList” window will show the parameter as in Figure 29.

Figure 29: Reading a sensor parameter

To **change the value of a parameter** (e.g. the orientation angle of the sensor) enter the parameter and the action number and the new value in the Command window. Check UatV4. Select “write” in the drop-down list and send it to the sensor by clicking “Send”. The parameter has changed as you can see in Figure 30 under f_value.

Figure 30: Changed sensor parameter

6.3.1 Request Status

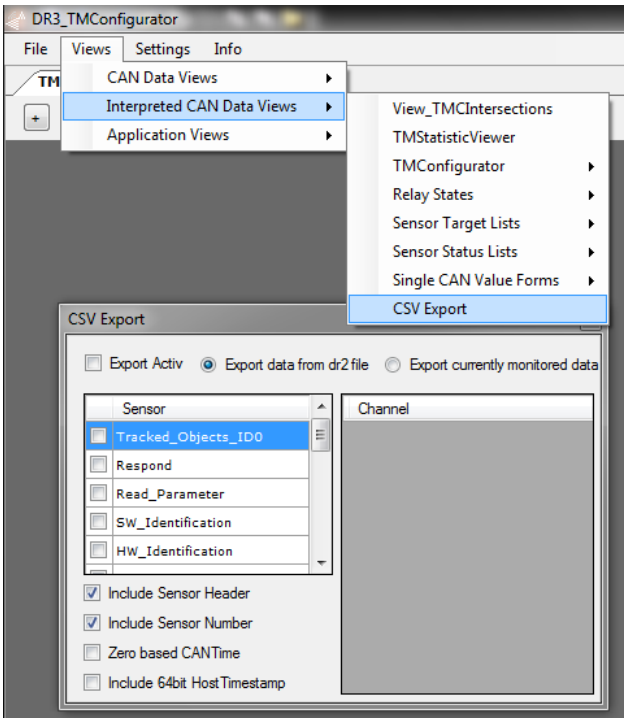
To **read the status**, enter the parameter number (ParNo) and the action number in the Command window. Check UATv4. Select “read only” in the drop-down list and the number format (Int or Float) of the parameter. By clicking “Send” the “ReadParameter” view in the “SensorTargetList” window will show the parameter as in Figure 31.

Figure 31: Reading a sensor parameter

6.4 How to export data to CSV format

Select Views → Interpreted CAN Data Views → CSV Export. Refer to picture below to setup “CSV Export”.

- To log the Tracked Object data select “Tracked_Objects_ID0”.
- To log the Statistics Data select “TMStatistics_ID0”.
- To log the Event Triggers select “Relays_ID0”.



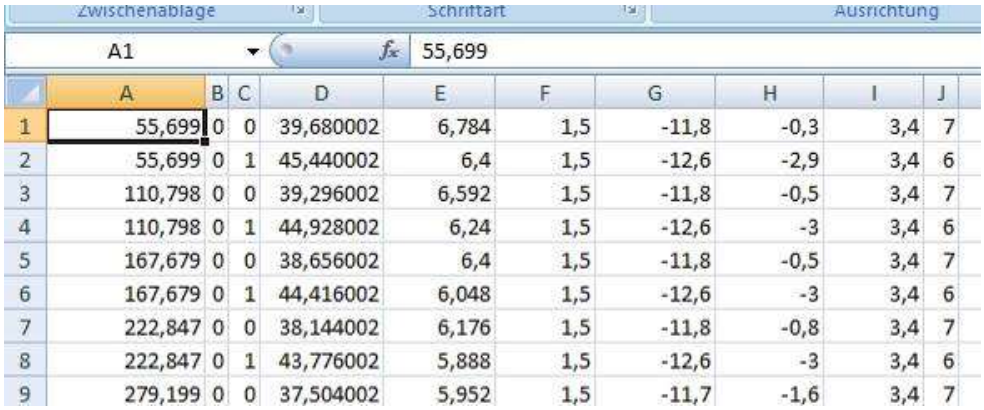
The export function can be activated by clicking the “Export Active” checkbox in the upper left corner. The csv-file will be named after the dr2-file and placed in the same location.
If “Include Sensor Header” is selected, there will be an additional txt-file with the column headlines.

CSV Export options:

- Include Sensor Header: Include the header information in the CSV-file. These are the CAN ID 0x500, 0x501.
- Include Sensor No.: Include the Sensor Number in the CSV-file.
- Zero based CanTime: Set the Can Time to zero at start of the CSV-file.

Figure 32: CSV Export

Example for a csv file:
After export a .CSV file and a .TXT file is generated. The txt file contains the description of the exported data. In the following picture you see a CSV file in Excel. With the .TXT file you can see which meaning the values in the columns have.



	A	B	C	D	E	F	G	H	I	J
1	55,699	0	0	39,680002	6,784	1,5	-11,8	-0,3	3,4	7
2	55,699	0	1	45,440002	6,4	1,5	-12,6	-2,9	3,4	6
3	110,798	0	0	39,296002	6,592	1,5	-11,8	-0,5	3,4	7
4	110,798	0	1	44,928002	6,24	1,5	-12,6	-3	3,4	6
5	167,679	0	0	38,656002	6,4	1,5	-11,8	-0,5	3,4	7
6	167,679	0	1	44,416002	6,048	1,5	-12,6	-3	3,4	6
7	222,847	0	0	38,144002	6,176	1,5	-11,8	-0,8	3,4	7
8	222,847	0	1	43,776002	5,888	1,5	-12,6	-3	3,4	6
9	279,199	0	0	37,504002	5,952	1,5	-11,7	-1,6	3,4	7

Figure 33: CSV Export Example

In the following picture you can see the information's for the columns in the csv file.

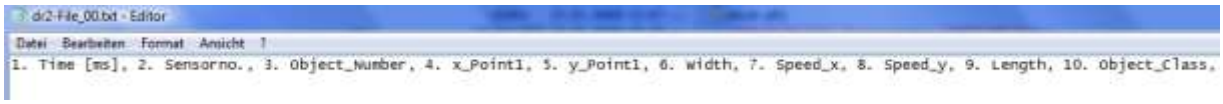


Figure 34: CSV Export description

Example for line 1:

- Sensor Time: 55.699 ms
- Sensorno.: 0
- Object Number: 0
- X_Point: 39,680 m
- Y_Point: 6,784 m
- Width: 1.5 m
- Speed_x: -11,8 m/s
- Speed_y: -0,3 m/s
- Length 3,4 m
- Object Class: 7

6.5 How to use the polygon feature (experts only)

With the polygon feature of the CAIMAN-PRO you can define up to 8 zones and configure them separately, what kind of objects are to be processed in the algorithm.

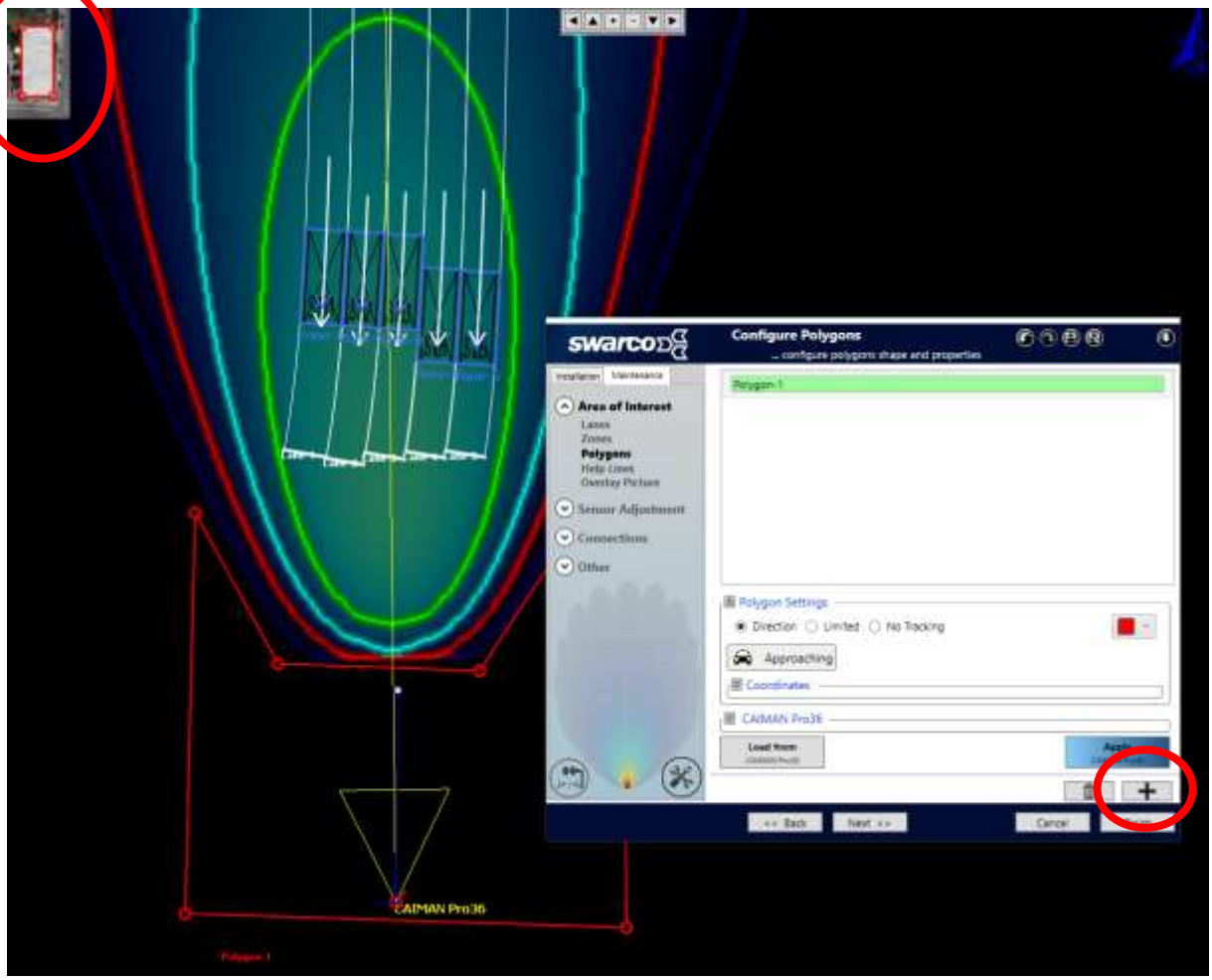


Figure 35: Polygon Feature

6.5.1 Configure Polygons

- Go to the MAINTENANCE tab → “Area of Interest” → Polygons
- You can add and delete polygons by dragging them from the left or by pressing “+”
- To change the corner points of a polygon select it in the polygon list and move the points with the mouse or manipulate them in the point list.
- Polygon Settings determines the behavior of the polygon.
- Polygons need to be assigned to sensors individually (e.g. to “CAIMAN-PRO 36”)

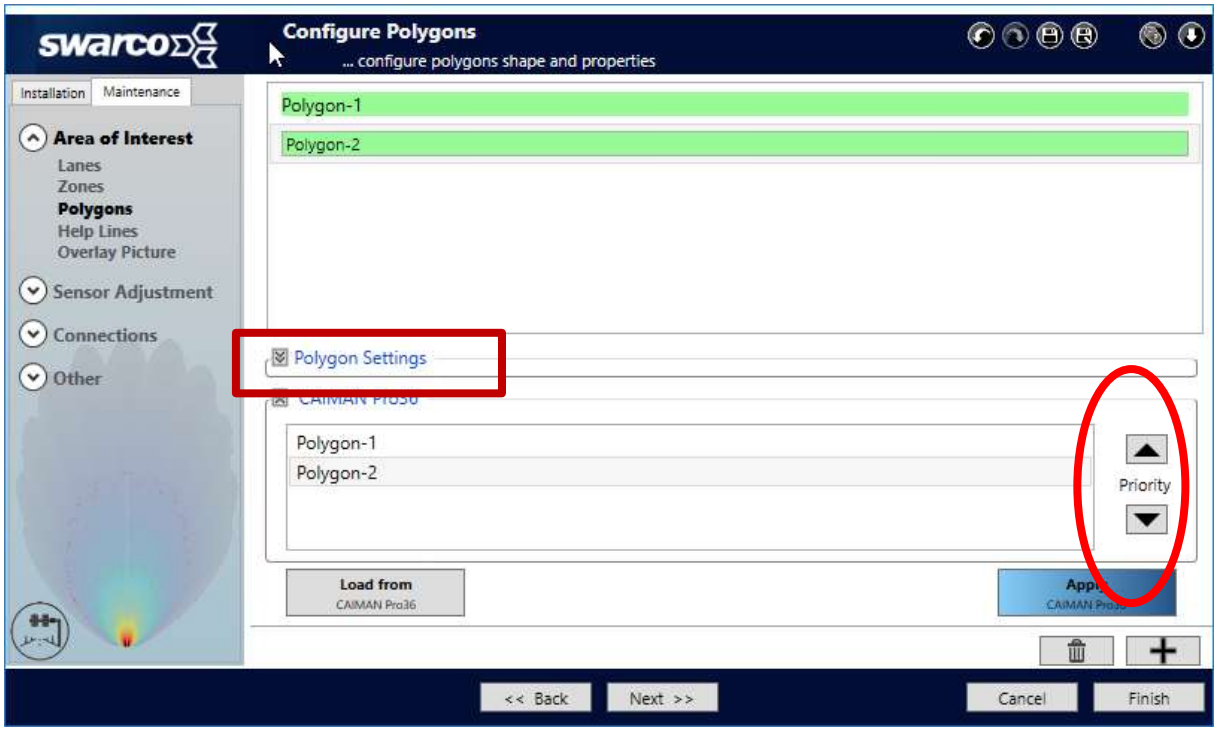


Figure 36: Polygon Priority

- Polygon Settings determine the behavior of the polygon.

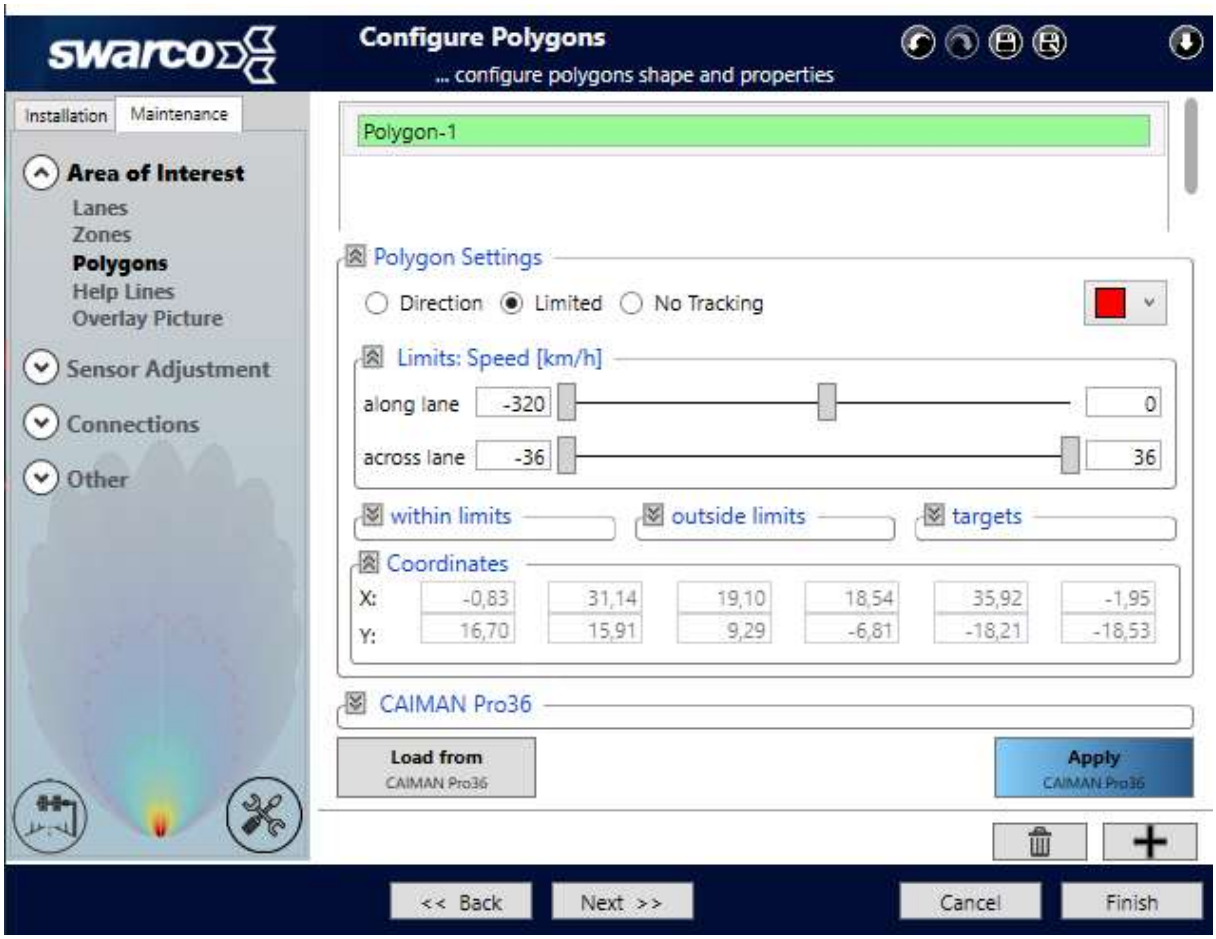
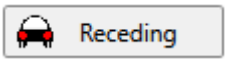


Figure 37: Polygon Settings

6.5.2 Polygon settings

There are three use cases:

1) **Direction.** The polygon will let the set direction, 

or 

, pass. The other direction will be blocked (not reported by the sensor).

2) **Limited.** The polygon will let all vehicle reports pass for the set speed limits. “Within limits”, “outside limits” and “target options” are for the experience user only.

3) **No Tracking.** Not Tracking is performed inside the polygon.

To make the polygons effective, press **Apply All** to send all polygons to all sensors, or **Apply <name>** to send the polygon settings to one selected sensor.

6.5.3 Expert Options for “Limited” polygon

For the experienced user. Do not play.

Within limits / outside limits:

- Delete tracks
  - Object tracks will be deleted.
- Deactivate object tracking
  - The object tracking will be completely deactivated. That causes, that vehicles will open up a new track after they leave the polygon area.
- Don’t transmit tracks
  - The object tracking will work normally but no tracked object are reported.
- Tracked objects can hold
  - Tracks will not be deleted after a full stop.

Target Handling:

- Don’t initiate tracks
  - Targets cannot open new tracks
- Don’t associate with tracks
  - Keep the default settings
- Stationary targets can init track
  - Irrelevant for traffic management applications

7 The TMConfigurator software

The SWARCO TMConfigurator (TMC) software is the most convenient way to set up CAIMAN-PRO sensor(s) using a Windows based PC.

7.1 TMConfigurator software installation and registration

Find a detailed description in the following documents for how you can connect the sensor and download the Firmware into the device, refer to the Quick Start Guide CAIMAN-PRO Installer QuickRef.

7.2 Usage of the TMConfigurator software

7.2.1 TMC window (former Easy Mode)

This view provides the visualization and graphic user interfaces for the sensor setup and most traffic management applications. It contains a traffic data visualization where the objects/vehicles are represented as rectangles. The lines on the rectangles are the speed vectors.

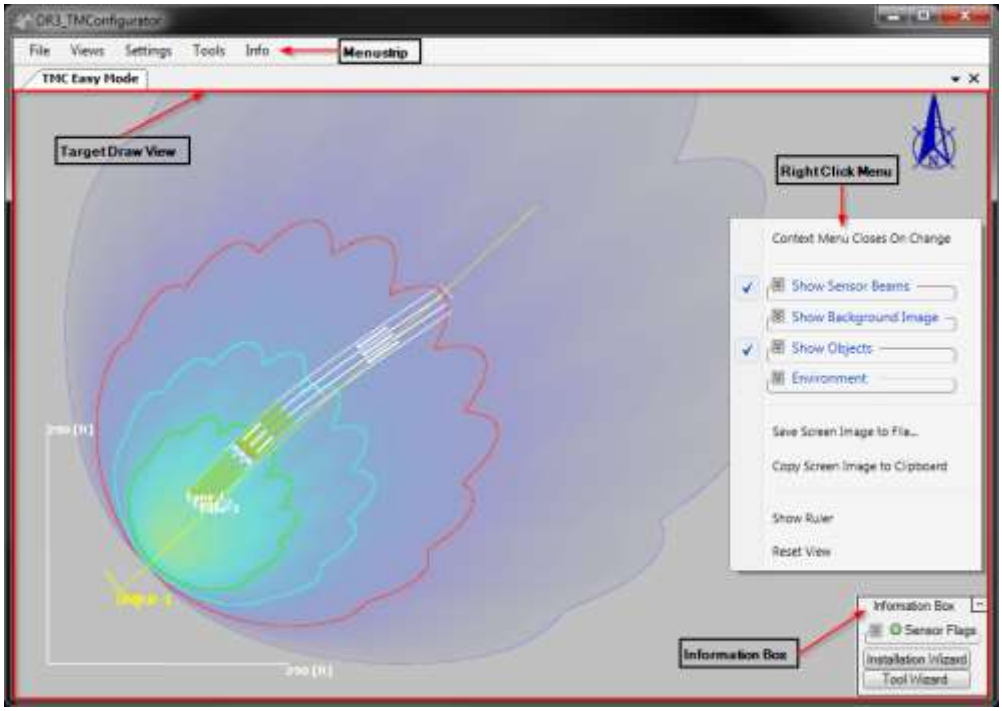


Figure 38: Target Draw View

The Wizard makes planning and field installation of sensors simple, as an intuitive step-by-step guide starting with site planning over sensor selection and configuration to physically installing the radar at an intersection.

Figure 39: Wizard

7.2.2 Create a new project

The following options are provided:

1) **New Single Sensor.** Intersection setup of **one sensor** and **max. one** TMIB or TMIB2.
2) **New Intersection.** Intersection setup using one more more sensor.
3) **New Arterial.** Setup of one Statistics Gathering sensor.
4) **New Enforcement.** Setup of one enforcement sensor.
5) **Existing.** Select a project file (TISF or SET) to edit.

7.3 Setup Process

7.3.1 Step 1: Find Intersection or Highway location

Find your intersection or highway location by using the search function like you do in Google Maps. Type "City A road B corner road C" or enter lat & long co-ordinates directly. Easy Mode will load a map from different providers. Some maps are high definition, already include lanes and stop bar positions.

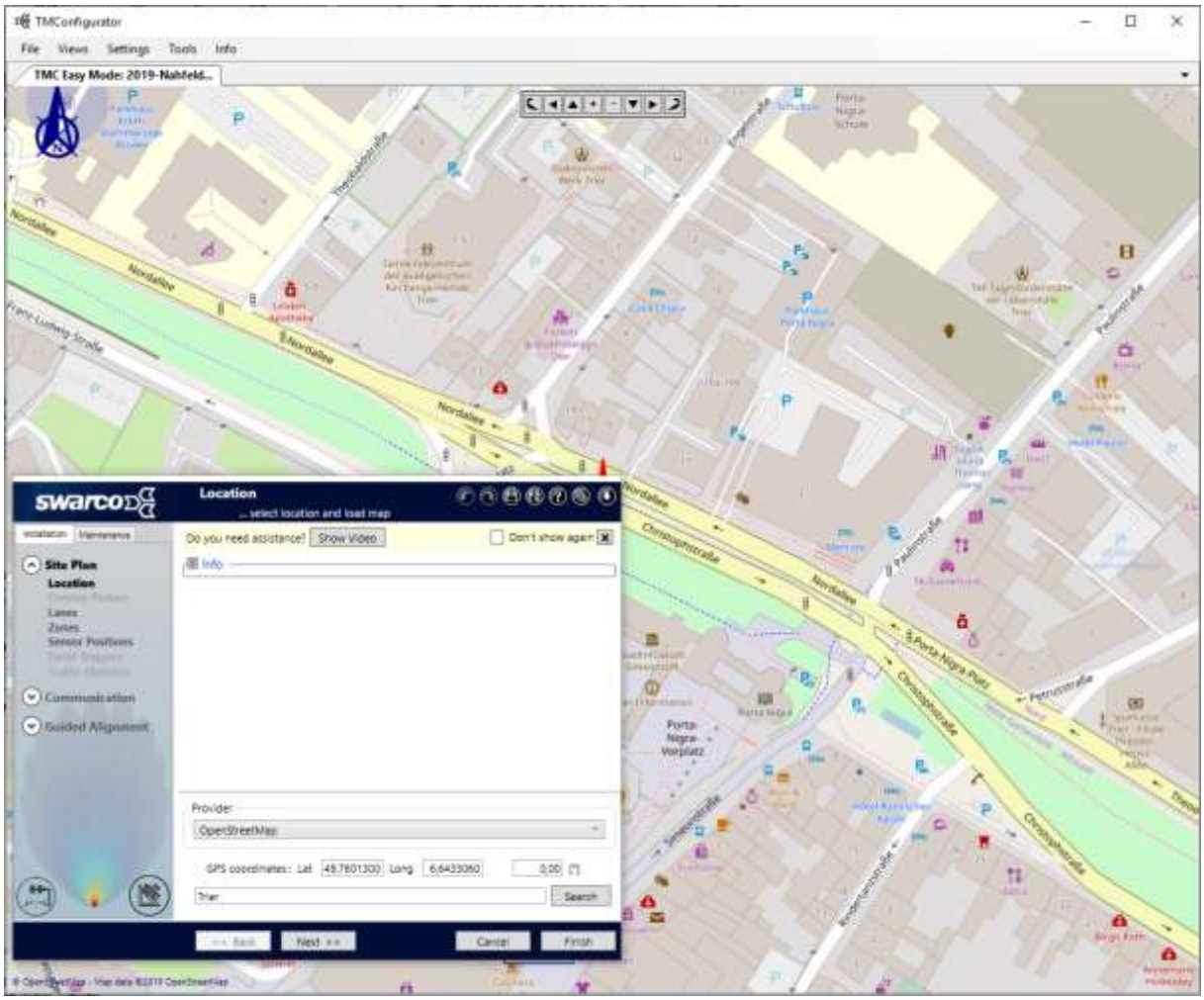


Figure 40: Easy Mode Step 1 Location

7.3.2 Step 2: Load Satellite Map

Load a satellite image or a cartographic image to overlay it with the map.

Figure 41: Easy Mode Step 2

7.3.3 Step 3: Add a Sensor

Add radar sensors to the image, drag and drop, from a list of auto-proposed sensor types. Each sensor is preconfigured. You can see field of view and detection range immediately. Adjust each sensor that the sensor beam covers all lanes. For Stop bars detection it's recommend that the Stop bars are in the green spot of the sensor beam. Further Information for default values for each application, look into the corresponding Sensor data sheet.

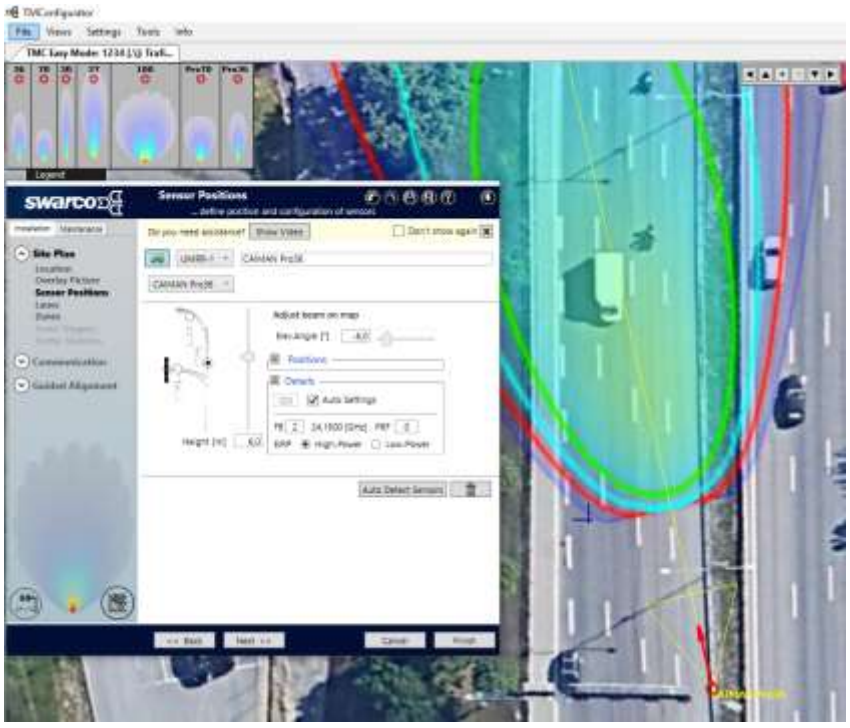


Figure 42: Easy Mode Step 3

7.3.4 Step 4: Configure lanes, detection Zones and Stop bars

First, create the lanes based on what you see on the satellite image. After this, add Stopbars, detection Zones and counting areas to the location. To get default values for each application have a look into the corresponding sensor data sheet.

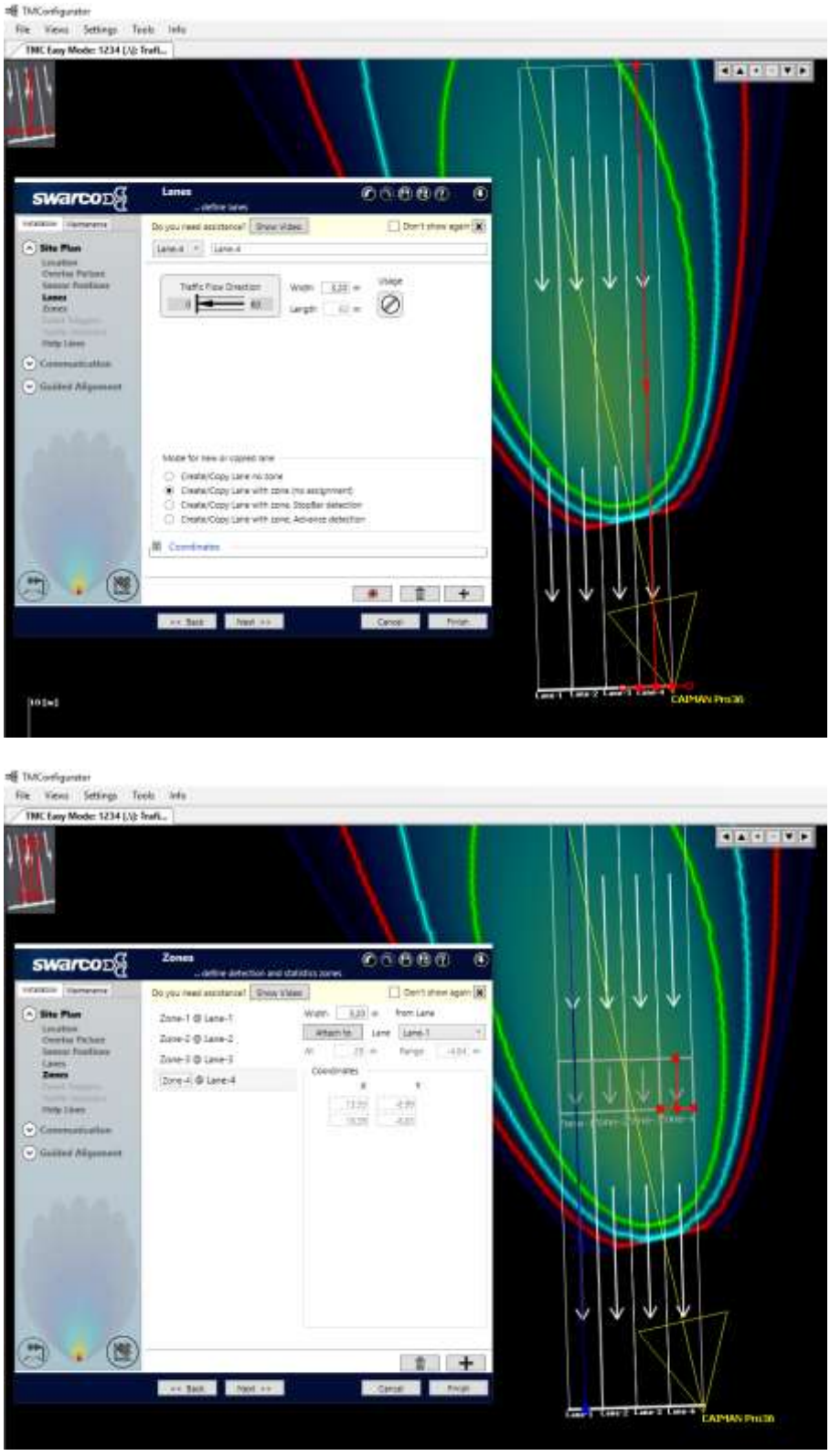


Figure 43: Easy Mode Step 4

7.3.5 Step 5: Assign Relays (Event Triggers)

For each sensor, make the assignment for the detection zones, set trigger configurations and assign relays. Make sure that the detection zones have at least a range offset from 20m.

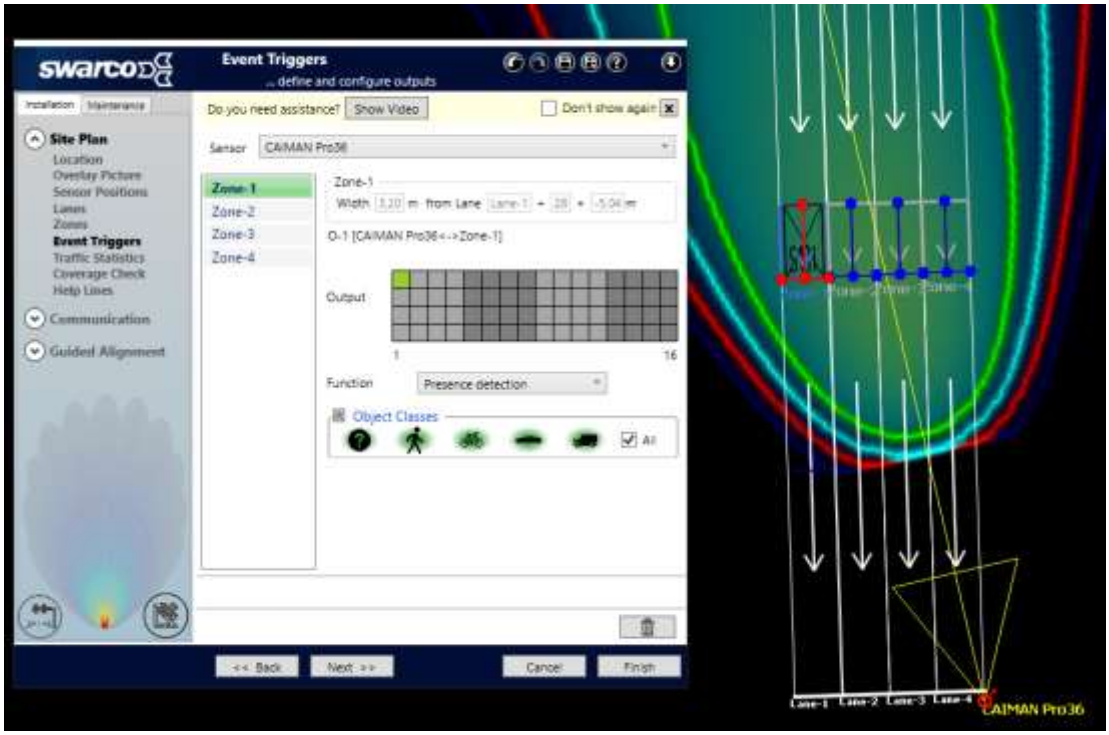


Figure 44: Easy Mode Step 5

7.3.6 Step 6: Traffic Statistics

Assignment of zones to

- Statistics
- Object Classes
- Report Interval [s]

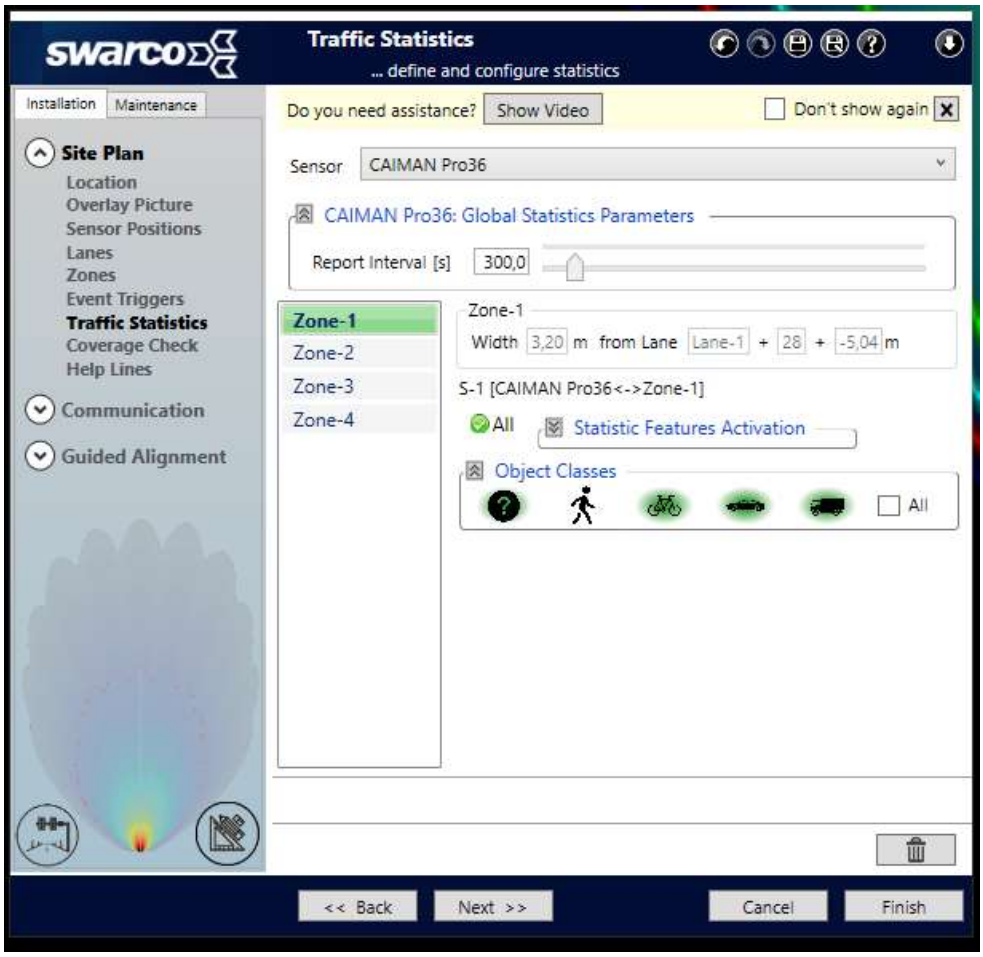


Figure 45: Easy Mode Step 6

7.3.7 Step 7: Coverage Check

After adding the lanes, sensors and detection/counting zones to the project, Easy Mode checks the sensor beam coverage. Is there a misplacement you get a hint how you can fix this.

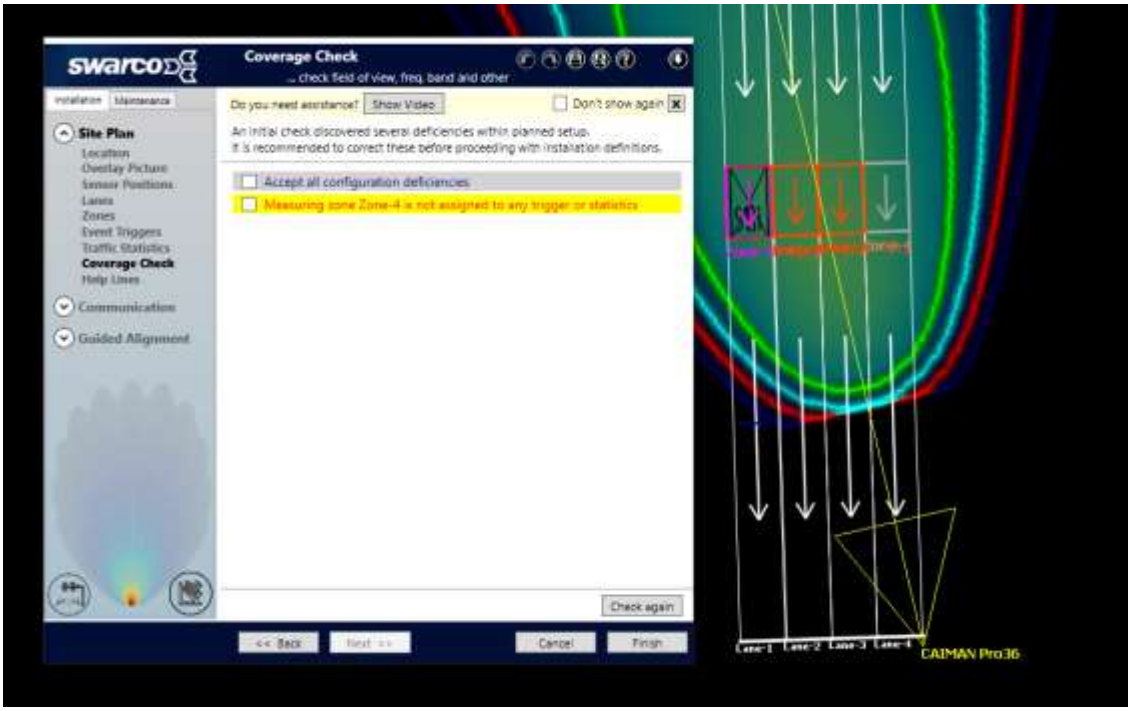


Figure 52: Easy Mode Step 7

7.3.8 Step 8a: Check communications

Physically connect all sensors and TMIB, auto-establish communication to all Radar devices. TM Easy Mode checks the communication. If necessary, they change the sensor ID automatically to avoid interference.

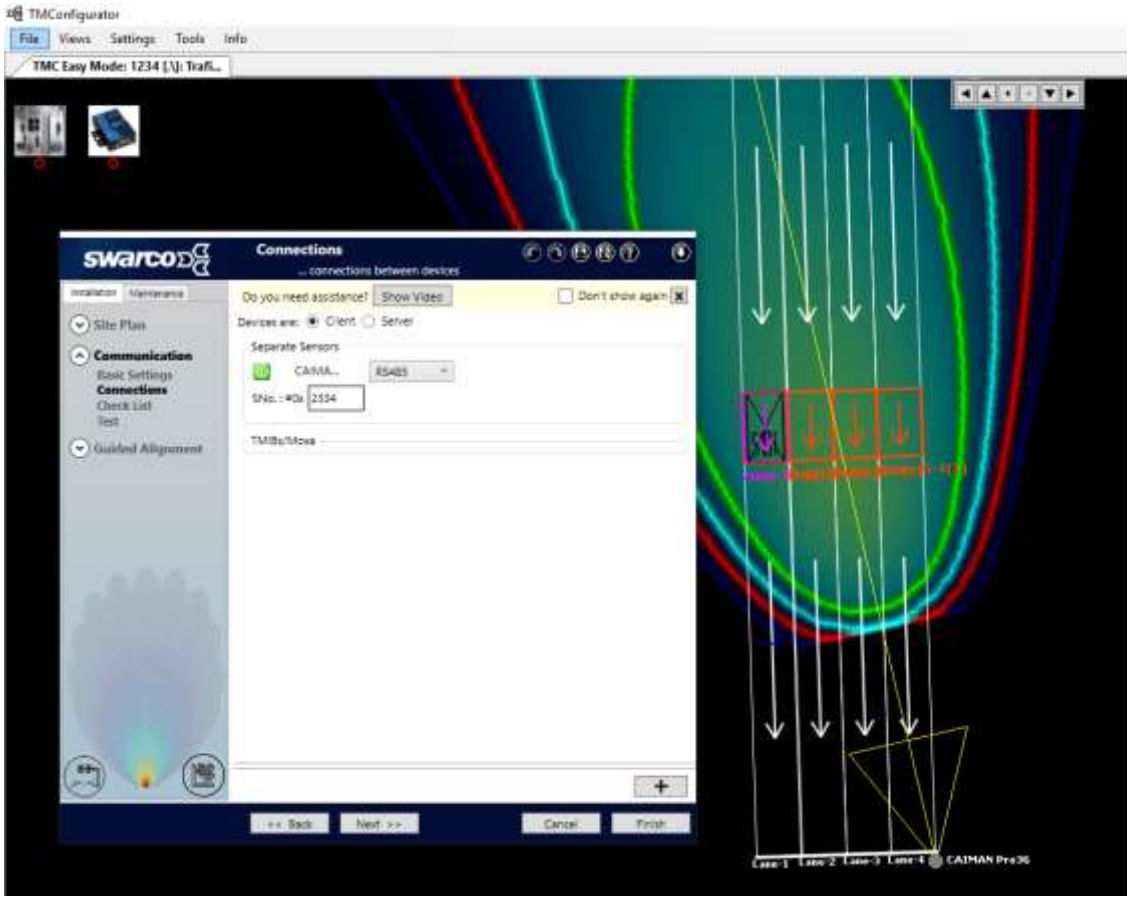


Figure 3: Easy Mode Step 8a

7.3.9 Step 8b: Elevation and Roll

The Easy Mode give the installer feedback, if the sensor has the correct roll and pitch angle. The installer can physically adjust the sensor position and get immediately feedback from the software if the angel is correct.

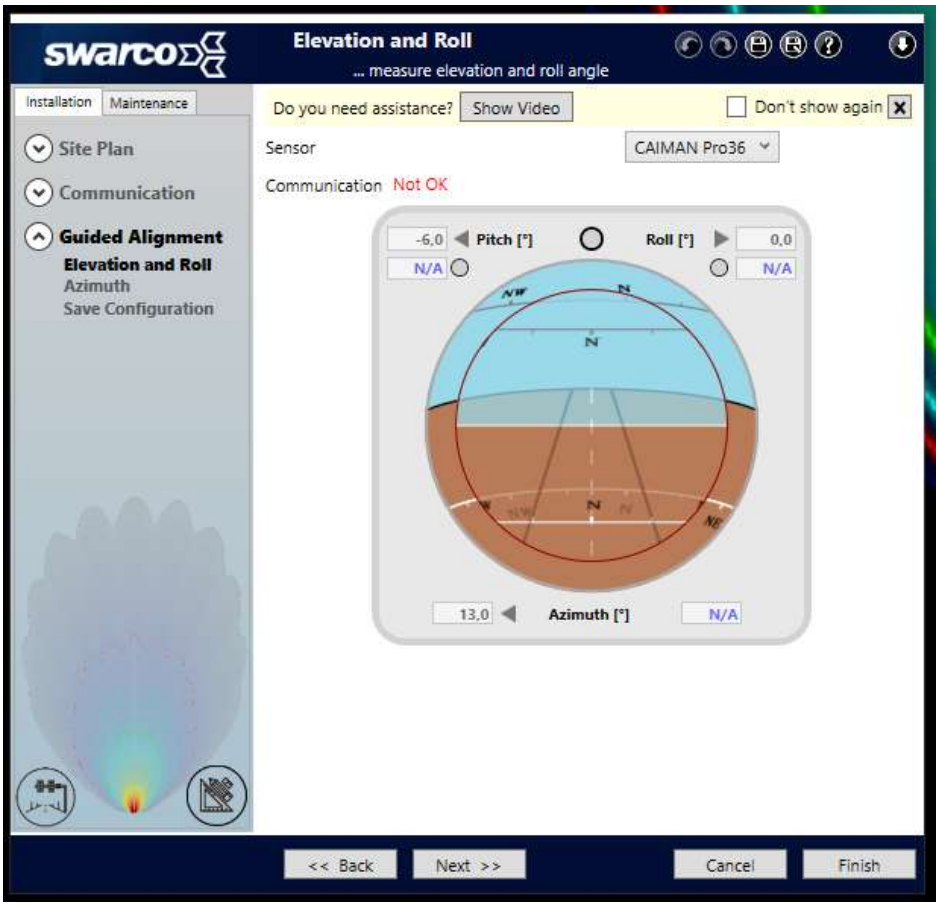


Figure 4: Easy Mode Step 8b

7.3.10 Step 9: Guided alignment

In the field: install the sensors at the intersection. For each sensor start the “Check orientation” test. The Easy Mode analyze the traffic flow, based on this, it gives a recommendation to adjust the azimuth and elevation angle.

Figure 5: Easy Mode Step 9a

7.4 Firmware Update

Use the TM Easy Mode software to perform firmware/software updates to any CAIMAN-PRO. The firmware update comes as .CBX or .XML file.

Close the Wizard and click on File->Load Desktop

Browse to the Installation Folder of the TM Easy Mode and load the DOWNLOAD_2G.dsk file.

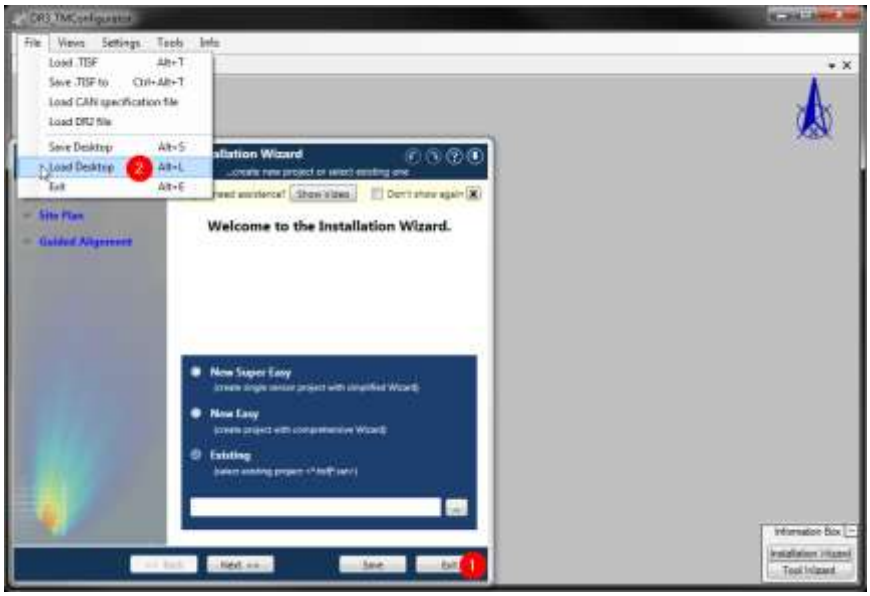


Figure 46: Load Desktop

Find a detailed description in the following documents for how you can connect the sensor and download the Firmware into the device:

- CAIMAN-PRO Installer Quick Reference Guide
- CAIMAN-PRO SRO-Installer Quick Reference Guide
- How to_download firmware

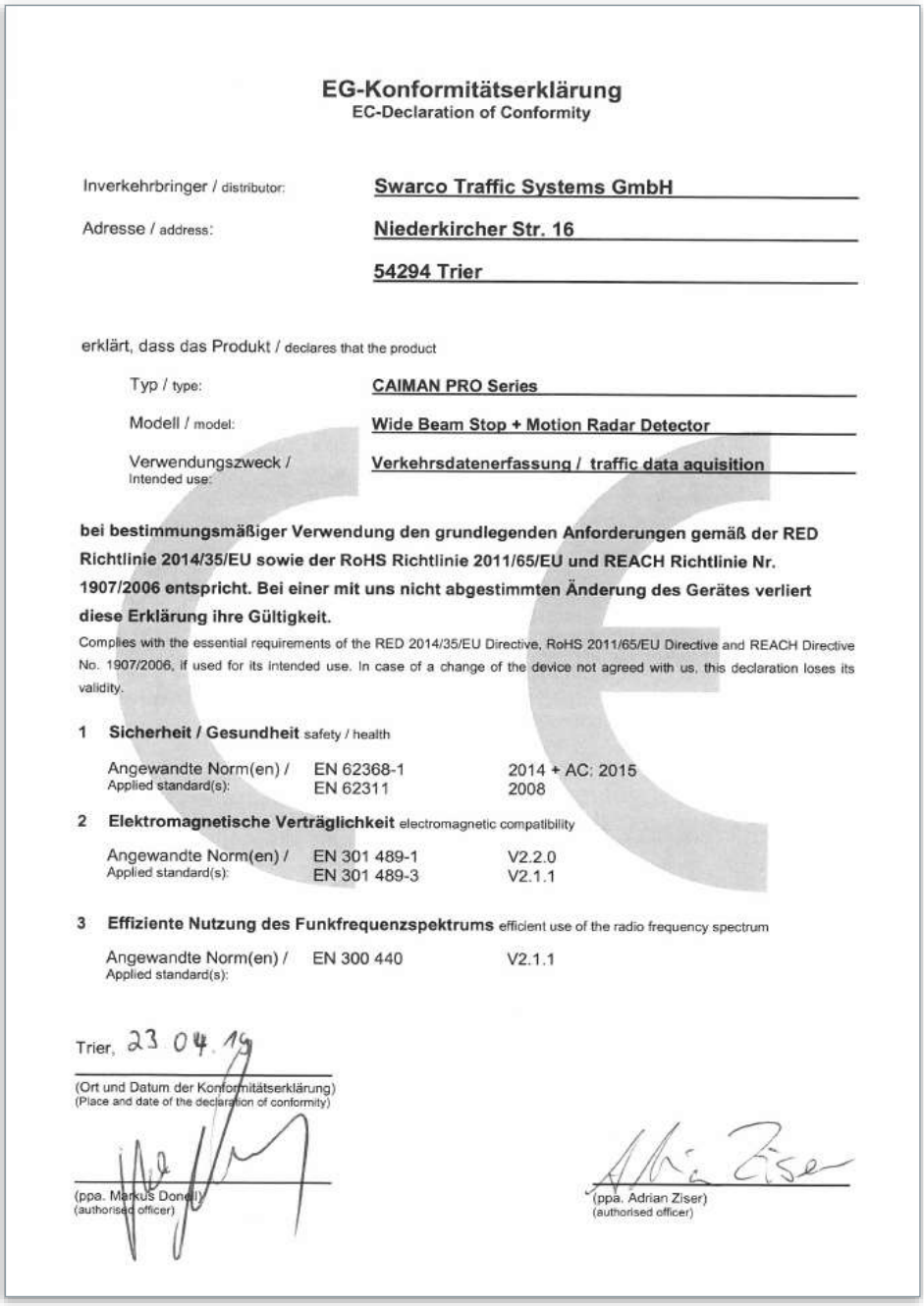
8 Frequency Approval

CAIMAN-PRO sensors are compliant with FCC, EU and other regulations and notified in many European and other countries – please check model specific notification status at time of purchase.

CAIMAN-PRO: European Standards (Type 32, 80) ETSI EN 300-440

8.1 Declaration of Conformity for Europe

The CAIMAN-PRO has been marked with the CE mark. This mark indicates the compliance with the EC Directive 2014/53/EU.



EG-Konformitätserklärung
EC-Declaration of Conformity

Inverkehrbringer / distributor: **Swarco Traffic Systems GmbH**

Adresse / address: **Niederkircher Str. 16**
54294 Trier

erklärt, dass das Produkt / declares that the product

Typ / type: **CAIMAN PRO Series**

Modell / model: **Wide Beam Stop + Motion Radar Detector**

Verwendungszweck / Intended use: **Verkehrsdatenerfassung / traffic data aquisition**

bei bestimmungsmäßiger Verwendung den grundlegenden Anforderungen gemäß der RED Richtlinie 2014/35/EU sowie der RoHS Richtlinie 2011/65/EU und REACH Richtlinie Nr. 1907/2006 entspricht. Bei einer mit uns nicht abgestimmten Änderung des Gerätes verliert diese Erklärung ihre Gültigkeit.

Complies with the essential requirements of the RED 2014/35/EU Directive, RoHS 2011/65/EU Directive and REACH Directive No. 1907/2006, if used for its intended use. In case of a change of the device not agreed with us, this declaration loses its validity.

1 **Sicherheit / Gesundheit** safety / health

Angewandte Norm(en) / Applied standard(s):	EN 62368-1	2014 + AC: 2015
	EN 62311	2008

2 **Elektromagnetische Verträglichkeit** electromagnetic compatibility

Angewandte Norm(en) / Applied standard(s):	EN 301 489-1	V2.2.0
	EN 301 489-3	V2.1.1

3 **Effiziente Nutzung des Funkfrequenzspektrums** efficient use of the radio frequency spectrum

Angewandte Norm(en) / Applied standard(s):	EN 300 440	V2.1.1

Trier, 23.04.19
(Ort und Datum der Konformitätserklärung)
(Place and date of the declaration of conformity)

(ppa. Markus Donell)
(authorised officer)

(ppa. Adrian Ziser)
(authorised officer)

9 Important Legal Disclaimer Notice

This document is subject to change without notice.

The Installation Procedure/Field Test or other Procedure described herein (“Manual”) is a mere recommendation or proposal by SWARCO for installing and/or implementing and/or otherwise using the Product in generic/general applications. The recommendations and proposals contained herein are believed to be accurate as of the date hereof.

SWARCO disclaims any and all liability for any errors, inaccuracies or incompleteness contained in this manual or in any other disclosure relating to the manual. In particular, the Manual was designed for generic/general applications and has not been adapted to a particular/specific purpose of use of the Products.

Since the Installation Procedure/Field Test or other Procedure may vary due to the specific applications and surroundings, SWARCO makes no representations or warranties in relation to this manual or the information and test procedures provided herein.

The Manual is provided solely for informational purposes. It is the customer/user’s own responsibility to validate that the application of the Product is suitable for the customers/users particular/specific purpose. The Installation Procedure /Field Test or other procedure for the Products may due to specific applications and due to specific surroundings deviate from the statements made herein. It is important that customer/user invents and certifies its own installation, test or other procedures to validate the performance of the Products in the particular/specific application before commercialization. Although Products are well optimized to be used for the intended applications stated herein, it must also be understood by the customer/user that the detection probability may not be 100 % and the false alarm rate may not be zero. In case of uncertainties with the installation, test or other procedures, the customer/user shall consult SWARCO, a certified distributor, subsidiary or appropriate professional.

To the extent permitted by applicable law, SWARCO disclaims (i) any and all liability arising out of the application or use of the manual or product (ii) any and all liability of damages exceeding direct damages, including - without limitation – indirect, consequential or incidental damages.

Please note that the application of the Product may be subject to standards or other regulations that may vary from country to country. We do not guarantee that the use of Products in the applications described herein will comply with such regulations in any country. It is the customer/user’s responsibility to ensure that the use and installation of Products complies with the regulatory requirements of their markets.

If any provision of this Disclaimer is, or is found to be, void or unenforceable under applicable law, that will not affect the validity or enforceability of the other provisions of this Disclaimer.

10 Appendix I: CAIMAN-PRO 32 Detector Data Sheet

10.1 User Safety Warning Information

Read the instructions carefully before you start to work.

Installation

Please observe the following advices when installing and connecting the sensors:

- Only use provided or approved equipment for installation. Use stainless screws with metric thread M3x8. Screw length must be adapted if the customer uses own brackets.
- Only skilled and instructed persons shall install and connect the devices. Proper experience in working with mains voltage, electrical and electronic devices is required.
- Don’t connect the devices directly to mains voltage, instead use the voltage given in the manual.
- Don’t wire any connections while power is applied to the device.
- Ground the devices carefully to prevent electrical shock.
- All connectors are pin-coded and fit in only one position. Also note the arrows indicating the top side of the sensor.
- Only use fully functional equipment (ladders, aerial work platform, …) when working above ground. Staff shall be capable of working at heights.
- Use caution when installing the devices on or around active roadways. Pay attention to moving traffic.
- Mount the devices carefully to prevent them from shifting or dropping.
- The devices must be mounted to a stiff and solid support. Vibration, oscillation or any kind of movement will reduce the sensor performance.
- Make sure that your installation methods are in accordance with local safety policy and procedures and company practices.

Technical service

Only use provided or approved equipment for operation.
Persons other than authorized and approved electrical technicians shall NOT attempt to connect this unit to a power supply, Traffic Management Interface Board and/or other controllers, as there is a risk of electrical shock by unsafe handling of the power source.
Do not attempt to service or repair this unit.

- No user-maintainable parts are contained within the device.
- To avoid electrical shock, do not remove or open the cover.
- Unauthorized opening will void all warranties.
- SWARCO is not liable for any damages or harms caused by unauthorized attempts to open or repair the device.

Radiation

This product has been tested and found to comply with the European RED directive, or other national rules, depending on the country where it may be in use.

Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

This device generates radio frequency energy.
There are strict limits on continuous emission power levels. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.

- Human exposure to transmitted waves from this device is generally considered as safe.
- Nevertheless, it is considered good practice that humans are not subject to higher radiation levels than necessary.
- This device may interfere with other devices using the same frequency band.

Operation

Transmission of radio frequency waves starts after the sensor is powered up and stops when disconnecting it from power.

Using a Junction Box or Sensor Relay Option (SRO) does not influence sensor performance.

For testing purposes, the sensor may be laid on its face when it is powered up, given that the surface or connectors will not be damaged by doing so. Please note that this position is not intended for permanent use.

It is recommended that only one connection interface is used at a time.

Do not operate the device if the device itself or any cables are damaged.

The sensors may become hot during operation, so proper hand protection is recommended for maintenance work.

10.2 Sensor Data Sheet

SWARCO offers a family of traffic Radar sensors called CAIMAN-PRO – Wide Beam Stop+Motion Radar Detector.

CAIMAN-PRO-11 is a high definition multi-lane, multi-object tracking traffic radar and features capabilities for true-presence detection.

CAIMAN-PRO-11 is the replacement for CAIMAN (1st Generation).

For each radar generation, a number of different antennas are available - so the permanent fixed field of view and max. range can be selected by the customer.

This data sheet describes the CAIMAN-PRO 32 antenna model (all model specific values are highlighted). Type 32 antenna aims at medium range with wide horizontal angular coverage.

CAIMAN-PRO 32 replaces CAIMAN 36 (1st generation) and exceeds its properties.

10.2.1 Sensor Photograph

Figure 47: CAIMAN-PRO 32 - front.

Figure 48: CAIMAN-PRO 32 - rear.

10.3 Function Description

The sensor is a robust 24GHz Radar for traffic management applications.
It works in adverse conditions, almost unaffected by weather, and independent of sunlight, in a wide temperature interval.

The customer can select from a number of antenna and housing models which determine the permanent fixed field of view and range. type 32 antenna aims at long range with wide horizontal angular coverage.

One individual sensor measures range, radial speed, horizontal angle, vertical angle, reflectivity and other parameters of multiple stationary and moving reflectors (targets) simultaneously. The following detection principle is integrated:

CAIMAN-PRO Doppler based radial motion detection (> 0.1m/s), including:

- Direct Doppler measurement
- Direct Range measurement
- Direct Azimuth Angle measurement
- Direct Elevation Angle measurement

Reflectors having a radial speed component of typ. abs. >0.1m/s are detected.

Having multi target capability, the sensor may detect many reflectors at a time (128 or max. 256) (depending on configuration) being within the field of view. Depending on the selected communication interface, the number of reported targets may be limited. Targets are sorted by range and short range targets are reported first.

Additional filter algorithms are implemented for the tracking of all detected reflectors over time, those tracking algorithms are integrated in the sensor. **Multiple objects** (64 or max. 126) (depending on configuration) are tracked simultaneously. Depending on the selected communication interface, the number of reported objects may be limited, for example when using RS485 interface. Objects are sorted by range, short range objects are reported first.

The result of the tracking is an **object** list with the following parameters:

- - x position
- y position
- x component of the velocity
- y component of the velocity
- other…

Hence the sensor reports such a list of all tracked objects inside its field of view in every measurement cycle of typ. 75ms or 58ms duration (depending on configuration).

The field of view typically covers up to four lanes.

The sensor is capable of detecting stationary objects.

Object Separation Performance

Measuring object co-ordinates of multiple objects simultaneously in four dimensions , i.e. range speed, azimuth and elevation angle, or x, y and speed vector, is state of the art.

However, what counts even more is the object separation capability where many vehicles are closely spaced, i.e. in multi-lane scenarios with dense traffic, like traffic jams, stop-and-go traffic and busy intersections

The sensor provides excellent target/object separation capabilities.
Individual reflectors are separated in the detection algorithms by:

- having a different radial speed value (difference > 0.3m/s) OR
- having a different range value by 2m or 4.5m (depending on selected bandwidth) having a different range value by 6.5ft or 14.8ft (depending on selected bandwidth)

Tracking algorithms and data base further support the separation of objects.

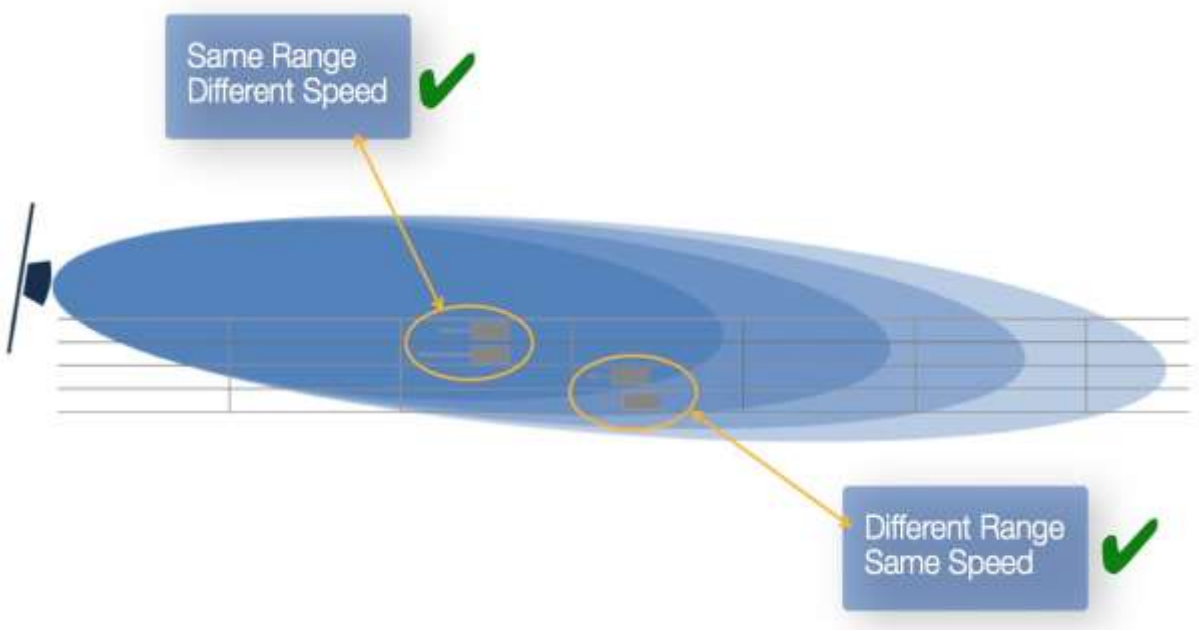


Figure 49: Object Separation Capability.

CAIMAN-PRO features a four dimensions technology. For each reflector, there is a true measurement of the **four dimensions** range, Doppler, horizontal and vertical angle.

CAIMAN-PRO can now accomplish range gate specific detection of moving and even stationary vehicles. In each of these gates a separate Doppler detection is possible, including stationary detectors. Figure 3 explains the principle.

10.4 Application Characteristics

10.4.1 Intersection Management

At intersections, the sensor is typically used for combined stop bar and advance detection.

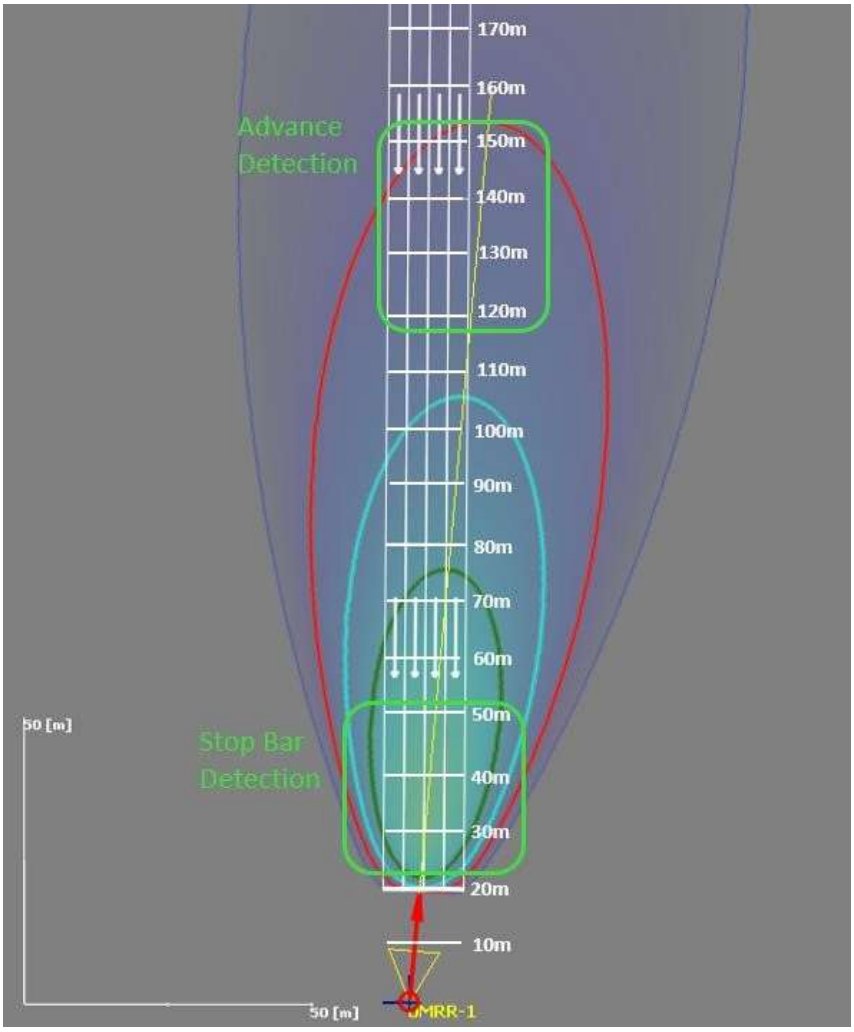


Figure 50: Stop Bar+Advance Detection CAIMAN-PRO 32 (High Power)

The sensor is usually mounted at the corner of an intersection on a vertical pole. Other mounting positions (gantry, mast arm, luminaire) may be possible. The **standard configuration** for Type 32 sensor for intersection applications is shown in Figure 4 and its parameters are given in Table 1.

Table 1: Standard Configuration for Stop Bar + Advance Detection CAIMAN-PRO 32

Parameter	Value
Traffic Direction	Typ. Approaching
Mounting Height	Typ. 6m (1...10m)[I] Typ. 20ft (3...33ft)[I]
Sensor Azimuth angle	Typ. -8° (-15 ...+15 deg.)[II]
Sensor Elevation angle	Typ. -4° (-9…0 deg.)[II, III]
Stop Bar Distance	Typ. 35m (20m … 50m)[IV] Typ.115ft (66 … 164ft)[IV]
Advance Detection Distance	Typ. 145m (50m … 180m)[IV] Typ.476ft (164 … 591ft)[IV]

[I] May affect max. detection range. The best performance is typically achieved for mounting heights between 28m. Occlusion needs to be considered.

[II] Smaller absolute angles allow longer detection range along a road.

[III] Application specific. Gantry mount: steeper e. angle possible, with limitations of maximum range. Negative elevation angle means sensor pointing towards road.

[IV] Typical value for stop bar + advance applications; may be different for other applications.

Up to four sensors can usually be mounted at or around an intersection using separate configurable frequency channels, avoiding mutual interference.

The cycle time is set to 75ms.

Sensor Variants and Features

CAIMAN-PRO M32	• **Stop bar detection** (true presence detection) • Lane specific **Advance detection** (exploiting the long range) • **Loop replacement** (non-intrusive detection) • **Queue length** measurement • **Custom trigger** conditions (e.g. location, vehicle speed, classification) • **ETA** measurement • **Speed** measurement
CAIMAN-PRO B32	• **Stop bar detection** (true presence detection) • Lane specific **Advance detection** (exploiting the long range) • **Loop replacement** (non-intrusive detection)

10.4.2 Arterial Management

On highways and country roads, the sensor is typically used to count and classify traffic. Usually are selected and reported in configurable counting /statistics intervals.

The sensor delivers the following data:

- Volume
- Occupancy
- Average Speed
- Vehicle Presence

The data can be retrieved in Push Mode

a) in low data volume as aggregated statistics output
b) as per vehicle record (PVR)

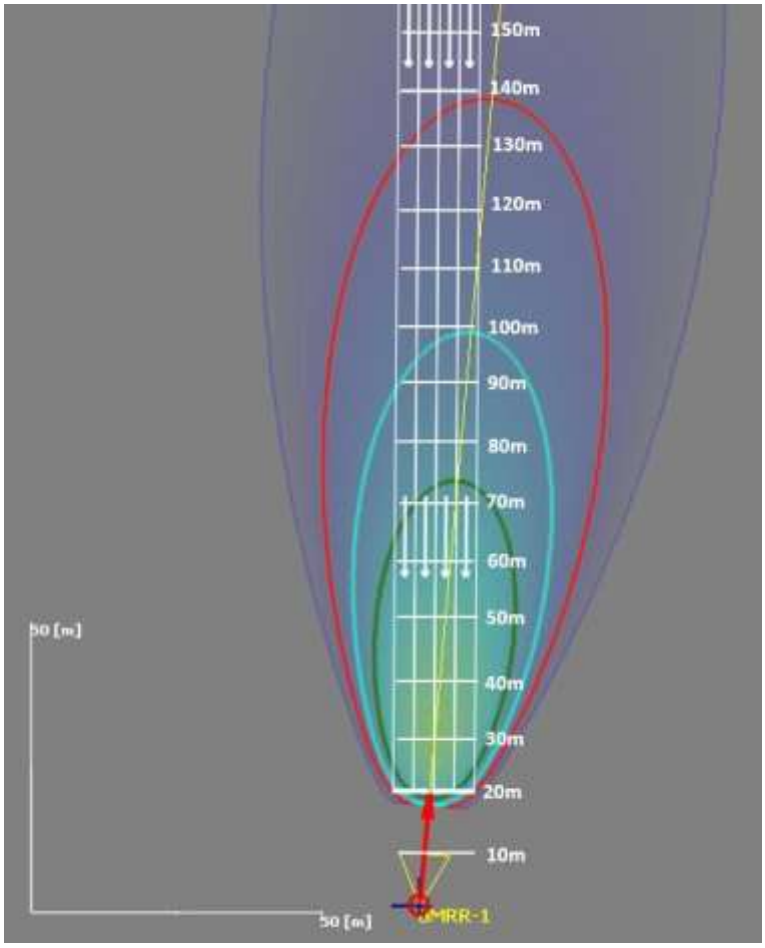


Figure 51: Standard Configuration CAIMAN-PRO 32 (High Power)

Because of the forward looking principle, the sensor provides the significant higher speed accuracy / general speed based information, compared to other traffic counting equipment. The sensor is usually mounted at the roadside on a vertical pole. No setback is required. Other mounting positions (gantry, mast arm, luminaire) may be possible. The **standard configuration** for Type 32 sensor for counting applications is shown in Figure 5 and its parameters are given in the table below.

Table 2: Standard Configuration for Counting and Statistics Type 32

Parameter	Value
Traffic Direction	Typ. Approaching & Receding
Mounting Height	Typ. 6m (4...10m)[I] Typ. 20ft (13...33ft)[I]
Sensor Azimuth angle	Typ. -8° (-15 ...+15 deg.)[II]
Sensor Elevation angle	Typ. -4° (-9…0 deg.)[II, III]
Counting Zone Extent (Approaching)	Typ. 25m-45m (20m … 50m)[IV] Typ. 82ft-148ft (66 … 164ft)[IV]
Counting Zone Distance (Receding)	Typ. 80m-100m (50m … 105m)[IV] Typ. 262ft- 328ft (164 … 345ft)[IV]
Setback	Typ. 1m (0… 10m) Typ. 3ft (0 … 33ft)
Counting Accuracy	Typ. > 95%[V]
Classification Accuracy	Typ. > 80%[V]
Classes	Usually the following 7 classes are supported: Pedestrian, Bicycle, Motorbike, Passenger Car, Transporter, Truck/Bus, Long Truck

[I] May affect max. detection range. Occlusion needs to be considered.

[II] Smaller absolute angles allow longer detection range along a road.

[III] Application specific. Gantry mount: steeper el. angle possible, with limitations of maximum range. Negative elevation angle means sensor pointing towards road.

[IV] Typical value for counting applications; may be different for other applications.

[V] Typical value when properly installed at suitable location. The counting and classification accuracy typically depends on the following main (and other) factors: mounting height, traffic density

The sensor is typically used standalone. Multiple (up to four) sensors may however be used in close vicinity using separate configurable frequency channels, avoiding mutual interference.

The cycle time is set to 75ms.

Sensor Variants and Features

CAIMAN-PRO I32	• **Counting and Classification** • **Wrong Way Detection** (vehicle moving opposite to the defined direction of traffic) • **Incident Detection** supported • **Speed** measurement

10.5 General Performance Data

Parameter	Value	Unit
Sensor Performance		
Max. Range on Passenger Car	160[I] (@20dBm) / 130[I] (@12.7dBm) 525[I] (@20dBm) / 426[I] (@12.7dBm)	m ft
Max. Range on Truck	180[I] (@20dBm) / 180[I] (@12.7dBm) 590[I] (@20dBm) / 590[I] (@12.7dBm)	m ft
Instrumented Range	180 (low bandw.) 170 (high bandw.) 590 / 558	m ft
Minimum Range	2m (stopped), 1m (moving) 6ft (stopped), 3ft (moving)	m ft
Range accuracy	Typ. < ±2.5% or < ±0.25m (bigger of) Typ. < ±2.5% or < ±0.82ft (bigger of)	%, m %, ft
Radial Speed Interval	-88.8…+88.8 -320…+320	m/s km/h
Minimum abs. Radial Speed	0.1 0.36	m/s km/h
Speed accuracy	Typ.< ±0.28m/s or ±1% (bigger of) [II] Typ.< ±1km/h or ±1% (bigger of) [II]	m/s km/h
Angle Interval (total field of view)	-12 ...+12 (El.); -22 ...+22 (Az.)[III]	degree
Angle Accuracy (horizontal)	< 1[IV]	degree
Update time	<75 or <58ms dep. on mode	ms
Environmental		
Ambient Temperature	-40 ... +85	degree C
Shock	100	grms
Vibration	14	grms
IP	67V	
Pressure / Transport altitude	0…10.000 0…32800	m ft
Mechanical		
Weight	360 12.70	g oz
Dimensions	See 3.6	
General		
Power Supply	8 ... 32[VI] <5VII	V DC W
Frequency Band	24.0…24.25	GHz
Bandwidth	< 250	MHz
Transmit Power (EIRP)	<12.7 / <20 depending on country	dBm
Interfaces [VIII]	CAN V2.0b (passive) RS485 full duplex 10/100 Ethernet	
Connector	12 Pin plug Hirose LF10WBRB-12PD	CAN, Power, RS485, Eth.

I Typical values; may vary to higher or lower values depending on clutter environment. All values given for bore sight. Please note that the Radar system – like any other sensor system – although being well optimized and providing excellent performance, will not achieve a 100% detection probability and will not achieve a false alarm rate equal to zero.

II Measured on object having const. radial speed, at bore sight.

[IV] Typical value; measured at target output level at bore sight, for a point reflector showing >23dB SNR. Error may increase towards larger angles. In addition to this angle error, angle may drift over temperature, typically 1deg to + 1deg over specified operation temperature interval.
[III] Total field of view is angle interval where reflectors can be detected; 3dB field of view is narrower.
[V] IP 67 only when connector or cap attached.
[VI] measured at connector.
[VII] Power consumption at 20°C.
[VIII] It is recommended to use an external surge protection for power, CAN, RS485, Ethernet and other interface ports.

10.5.1 Start-up time

After power up or reset, the sensor readings are within specified performance within <4s.

10.5.2 Self-Diagnose

The CAIMAN-PRO sensor cyclically reports a status message providing the following information

- Sensor run time
- Sensor cycle time
- Sensor mode
- Diagnose information

The sensor features certain self-diagnose to allow limited fail-safe capabilities:

- Detection of sensor blindness
- Detection of rain
- Misalignment in roll- or pitch angle
- Detection and suppression of interference

Note that there is no completely fail-safe operation available.

10.5.3 Sensor Network

The sensor is typically used standalone.

10.5.4 Ethernet connection

The sensor supports UDP over Ethernet in a Local Area Network (LAN). Communication over low bandwidth environments or routed networks e.g. the world wide web is not supported.

Features:

1. Ethernet standards IPv4, ARP, IGMP, IP multicast and UDP
2. Supports DHCP
3. SWARCO proprietary communication protocol “sms Transport” with:
    - IP/UDP Multicast based discovery protocol
    - Client ID based setup
    - Sensor data transmission

10.5.5 Compliance and Certifications

The sensor model complies with the following EU directives:

- RED 2014/53/EU
- RoHS 2011/65/EU
- EC 1907/2006 REACH

Applied Standards:

- Spectrum Usage:
  - EN 300 440 V2.1.1 - EMC:
  - EN 301 489-1 V2.2.0 ○ EN 301 489-3
- V2.1.1 - Health and Safety:
  - EN 62311: 2008
  - EN 62368-1: 2014 + AC: 2015

With regard to spectrum usage, this sensor model was tested and certified by independent test labs:

- EU RED directive (formally approved by test lab or notified body),

This sensor model is also generally compliant with the following regional regulations (but may not be formally tested/approved):

- SRRC,
- KCC,
- MIIT,
- NCC.

Note:
This statement of compliance means that the sensor device allows operation compliant to the listed standards. However, not all standards are certified through test labs and not for all countries formal frequency approval/registration is accomplished.

In certain countries or regions a customer-specific local frequency approval is reasonable. SWARCO supports customers for this process.

10.6 Sensor Dimensions

All values given in mm.

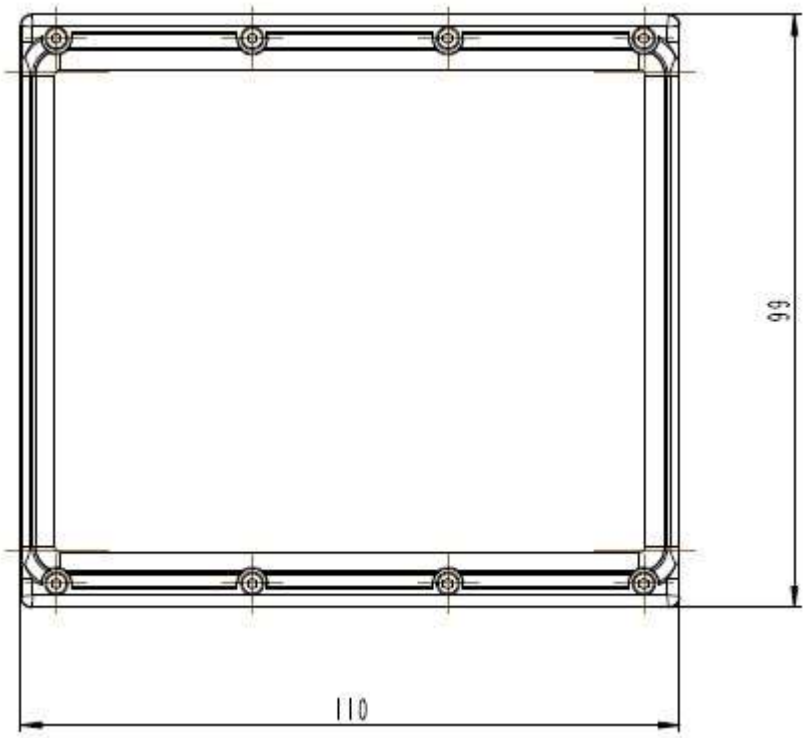


Figure 52: Sensor Front side.

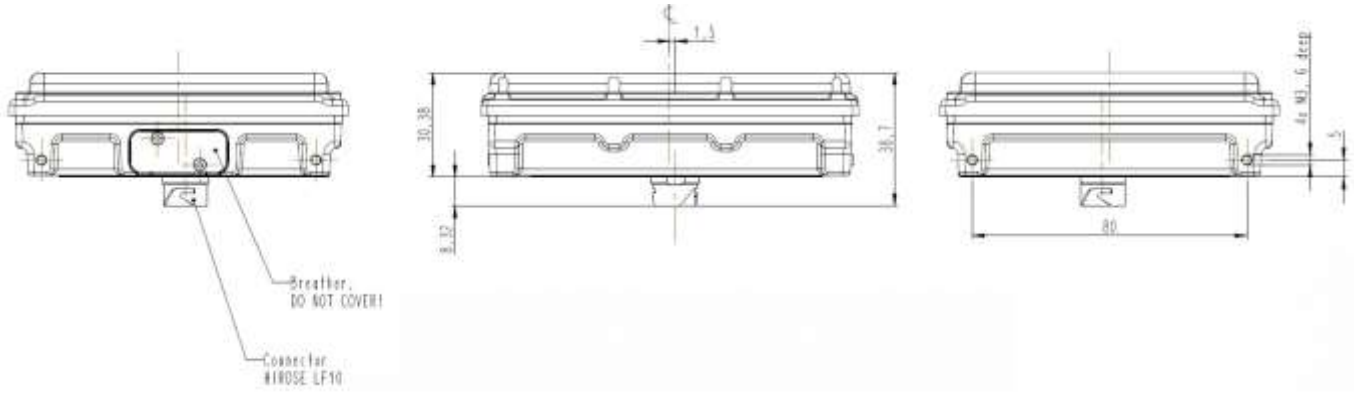


Figure 53: Sensor Top, Left and Right Side.

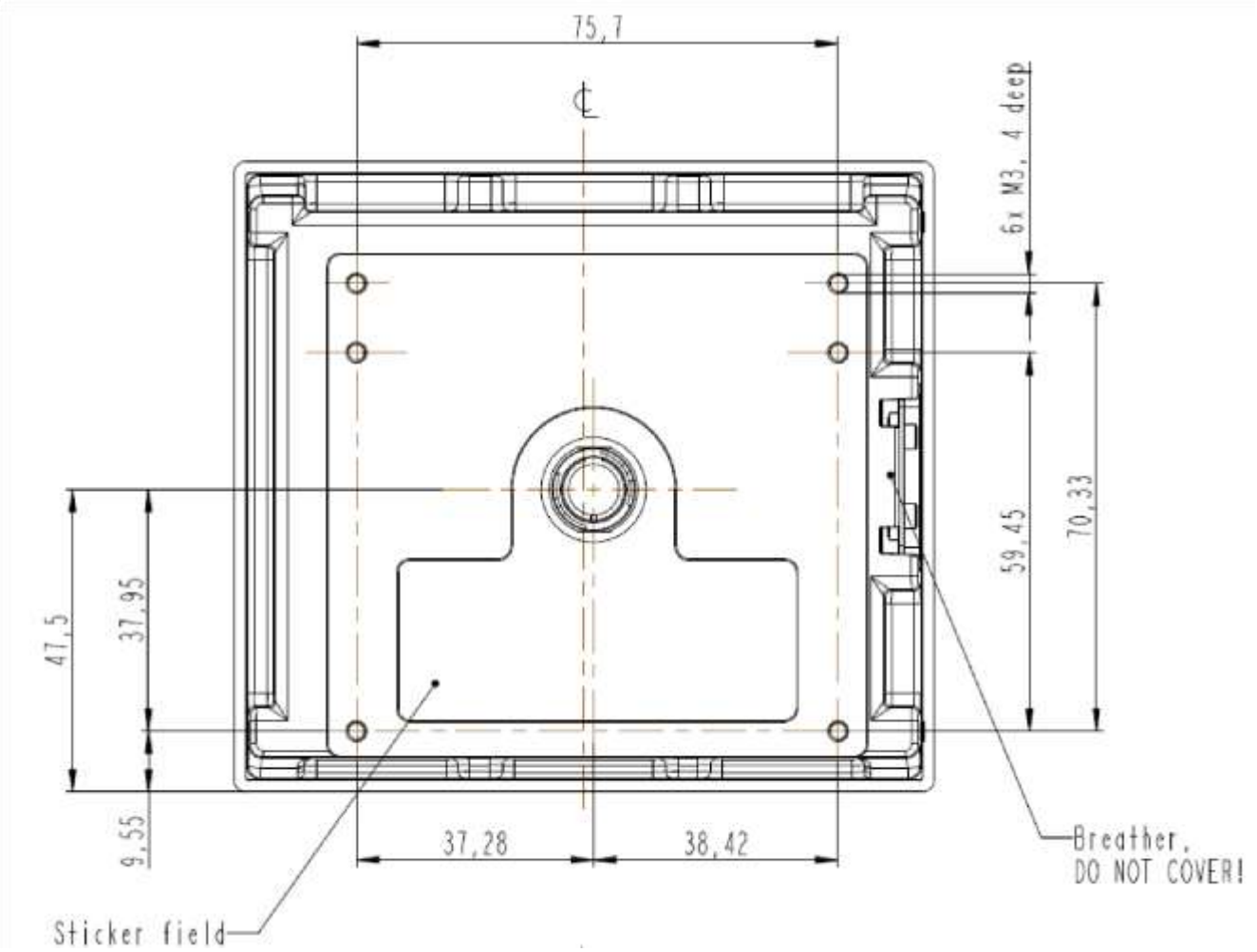


Figure 54: Sensor Rear Side.

10.7 Connector

The sensor connector is a 12-pin male (plug) circular bayonet type connector (water proof IP67, series LF10WBRB-12PD, manufacturer Hirose, Japan). A female counterpart (socket), e.g. LF10WBP-12S, has to be used to connect to the sensor. The pin numbering of the socket is shown in Figure the pin description is given in Table 3.

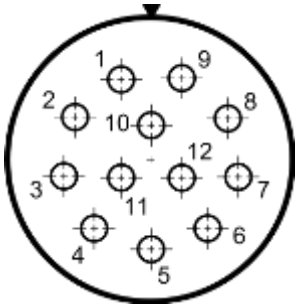


Figure 13: View on solder cup side of socket (rear view of female counterpart to be connected to sensor)

Table 3: Sensor connector pin out model CAIMAN-PRO

Pin No.	Function	Wire Color (MEDI type #KU110C12J002)
1	Sensor Ethernet TX H	gray / red
2	Sensor Ethernet TX L	red / blue
3	Sensor RS485 RX L	pink
4	Sensor RS485 RX H	gray
5	Sensor RS485 TX L	brown
6	Sensor RS485 TX H	white
7	Sensor_GND	blue
8	Sensor_Vcc	red
9	Sensor Ethernet RX L	black
10	Sensor Ethernet RX H	purple
11	CAN H	green
12	CAN L	yellow

Note:
Please note that in the standard configuration the sensor has no 120 Ohms resistor on board (CAN bus termination between CAN L and CAN H). The resistors are nevertheless required at either end of a CAN / RS485 bus and is in most cases integrated in the cable delivered along with the sensor (if cable is manufactured by SWARCO).

For the RS485 data interface there is a 120 Ohms resistor on board of the sensor.

A number of cable sets for initial operation and test purposes are offered by SWARCO, to deliver a fast set-up of a sensor system. Among those preconfigured ready-to-run cables as well as cable stumps (pig tail cables or various lengths) which carry the connector on one side and open wires on the other.

11 Appendix II: CAIMAN-PRO 80 Detector Data Sheet

11.1 User Safety Warning Information

Read the instructions carefully before you start to work.

Installation

Please observe the following advices when installing and connecting the sensors:

- Only use provided or approved equipment for installation. Use stainless screws with metric thread M3x8. Screw length must be adapted if the customer uses own brackets.
- Only skilled and instructed persons shall install and connect the devices. Proper experience in working with mains voltage, electrical and electronic devices is required.
- Don’t connect the devices directly to mains voltage, instead use the voltage given in the manual.
- Don’t wire any connections while power is applied to the device.
- Ground the devices carefully to prevent electrical shock.
- All connectors are pin-coded and fit in only one position. Also note the arrows indicating the top side of the sensor.
- Only use fully functional equipment (ladders, aerial work platform, …) when working above ground. Staff shall be capable of working at heights.
- Use caution when installing the devices on or around active roadways. Pay attention to moving traffic.
- Mount the devices carefully to prevent them from shifting or dropping.
- The devices must be mounted to a stiff and solid support. Vibration, oscillation or any kind of movement will reduce the sensor performance.
- Make sure that your installation methods are in accordance with local safety policy and procedures and company practices.

Technical service

Only use provided or approved equipment for operation.
Persons other than authorized and approved electrical technicians shall NOT attempt to connect this unit to a power supply, Traffic Management Interface Board and/or other controllers, as there is a risk of electrical shock by unsafe handling of the power source.
Do not attempt to service or repair this unit.

- No user-maintainable parts are contained within the device.
- To avoid electrical shock, do not remove or open the cover.
- Unauthorized opening will void all warranties.
- SWARCO is not liable for any damages or harms caused by unauthorized attempts to open or repair the device.

Radiation

This product has been tested and found to comply with the European RED directive, or other national rules, depending on the country where it may be in use.

Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

This device generates radio frequency energy.
There are strict limits on continuous emission power levels. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.

- Human exposure to transmitted waves from this device is generally considered as safe.
- Nevertheless, it is considered good practice that humans are not subject to higher radiation levels than necessary.
- This device may interfere with other devices using the same frequency band.

Operation

Transmission of radio frequency waves starts after the sensor is powered up and stops when disconnecting it from power.

Using a Junction Box or Sensor Relay Option (SRO) does not influence sensor performance.

For testing purposes, the sensor may be laid on its face when it is powered up, given that the surface or connectors will not be damaged by doing so. Please note that this position is not intended for permanent use.

It is recommended that only one connection interface is used at a time.

Do not operate the device if the device itself or any cables are damaged.

The sensors may become hot during operation, so proper hand protection is recommended for maintenance work.

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CAIMAN-PRO is a High Definition multi-lane, multi-object tracking traffic Radar and features capabilities for true-presence detection.

CAIMAN-PRO is the replacement for CAIMAN (1st Generation).

For each Radar generation, a number of different antennas are available - so the permanent fixed field of view and max. range can be selected by the customer.

This data sheet describes the CAIMAN-PRO 80 antenna model (all model specific values are highlighted). Type 80 Antenna aims at medium range with wide horizontal angular coverage.

CAIMAN_PRO 80 replaces CAIMAN 70 (1st Generation) and exceeds its properties.

11.2.1 Sensor Photograph

Figure 55: CAIMAN-PRO 80 - front.

Figure 56: CAIMAN-PRO 80 - rear.

11.3 Function Description

The sensor is a robust 24GHz Radar for traffic management applications.
It works in adverse conditions, almost unaffected by weather, and independent of sunlight, in a wide temperature interval.

The customer can select from a number of antenna and housing models which determine the permanent fixed field of view and range. Type 80 Antenna aims at medium range with wide horizontal angular coverage.

One individual sensor measures range, radial speed, horizontal angle, vertical angle, reflectivity and other parameters of multiple stationary and moving reflectors (**targets**) simultaneously. The following detection principle is integrated:

CAIMAN-PRO Doppler based radial motion detection (> 0.1m/s), including:

- Direct Doppler measurement
- Direct Range measurement
- Direct Azimuth Angle measurement
- Direct Elevation Angle measurement

Reflectors having a radial speed component of typ. abs. >0.1m/s are detected.

Having multi target capability, the sensor may detect many reflectors at a time (128 or max. 256) (depending on configuration) being within the field of view. Depending on the selected communication interface, the number of reported targets may be limited. Targets are sorted by range and short range targets are reported first.

Additional filter algorithms are implemented for the tracking of all detected reflectors over time, those tracking algorithms are integrated in the sensor. **Multiple objects** (64 or max. 126) (depending on configuration) are tracked simultaneously. Depending on the selected communication interface, the number of reported objects may be limited, for example when using RS485 interface. Objects are sorted by range, short range objects are reported first.

The result of the tracking is an **object** list with the following parameters:

- x position
- y position
- x component of the velocity
- y component of the velocity
- other…

Hence the sensor reports such a list of all tracked objects inside its field of view in every measurement cycle of typ. 75ms or 58ms duration (depending on configuration).

The field of view typically covers up to six lanes.

The sensor is capable of detecting stationary objects.

Object Separation Performance

Measuring object co-ordinates of multiple objects simultaneously in four dimensions, i.e. range speed, azimuth and elevation angle, or x, y and speed vector, is state of the art.

However, what counts even more is the object separation capability where many vehicles are closely spaced, i.e. in multi-lane scenarios with dense traffic, like traffic jams, stop-and-go traffic and busy intersections

The sensor provides excellent target/object separation capabilities.
Individual reflectors are separated in the detection algorithms by:

- having a different radial speed value (difference > 0.3m/s) **OR**
- having a different range value by 2m or 4.5m (depending on selected bandwidth)
  having a different range value by 6.5ft or 14.8ft (depending on selected bandwidth)

Tracking algorithms and data base further support the separation of objects.

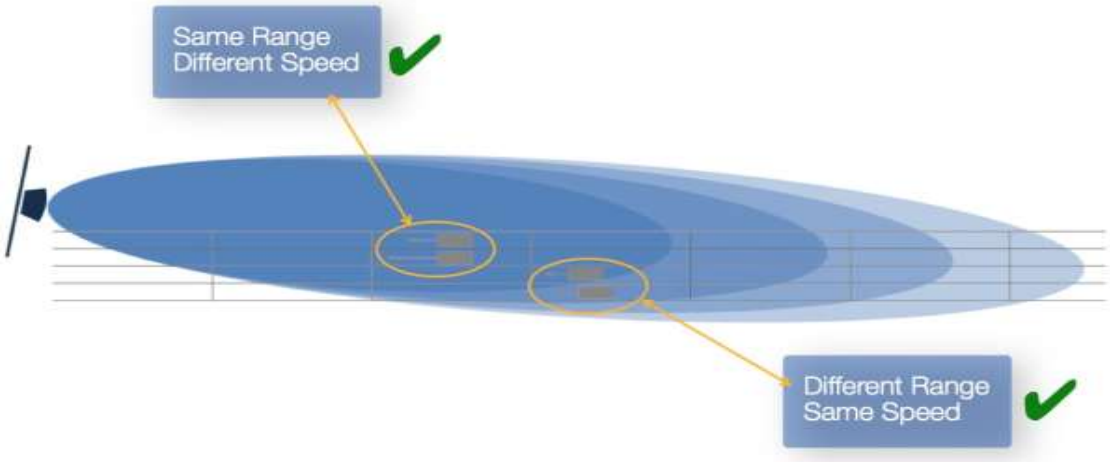

Figure 57: Object Separation Capability.

CAIMAN-PRO features a four dimensions technology. For each reflector, there is a true measurement of the **four dimensions** range, Doppler, horizontal and vertical angle.

CAIMAN-PRO can now accomplish range gate specific detection of moving and even stationary vehicles. In each of these gates a separate Doppler detection is possible, including stationary detectors. Figure 3 explains the principle.

11.4 Application Characteristics

11.4.1 Intersection Management

At intersections, the sensor is typically used for combined stop bar and advance detection.

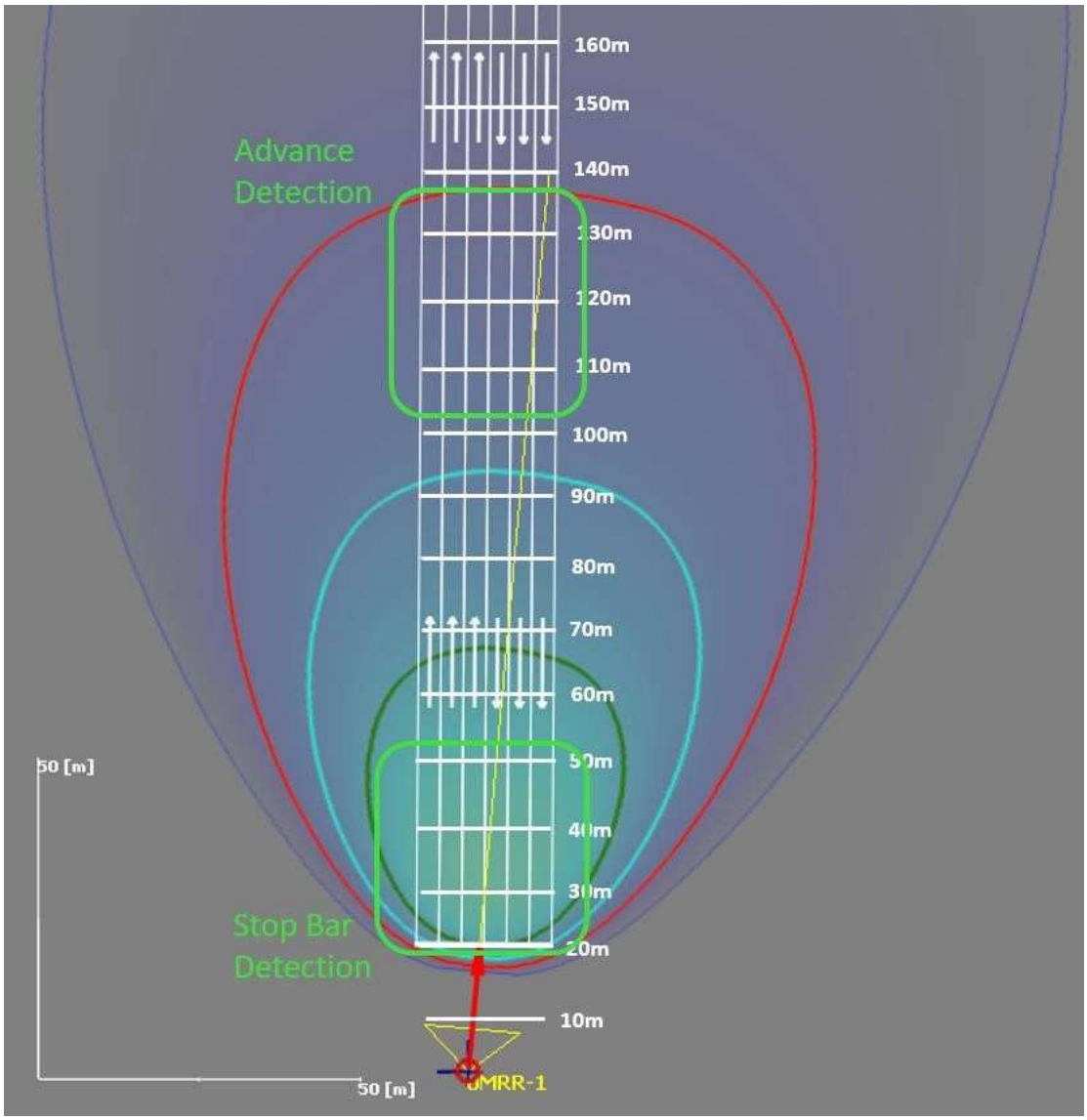

Figure 58: Stop+Advance Detection CAIMAN-PRO 80 (High Power)

The sensor is usually mounted at the corner of an intersection on a vertical pole. Other mounting positions (gantry, mast arm, luminaire) may be possible. The **standard configuration** for Type 80 sensor for intersection applications is shown in Figure 4 and its parameters are given in Table 1.

Table 1: Standard Configuration for Stop Bar + Advance Detection CAIMAN-PRO 80

Parameter	Value
Traffic Direction	Typ. Approaching
Mounting Height	Typ. 6m (1...10m)[I] Typ. 20ft (3...33ft)[I]
Sensor Azimuth angle	Typ. -12° (-15 ...+15 deg.)[II]
Sensor Elevation angle	Typ. -4° (-9…0 deg.)[II, III]
Stop Bar Distance	Typ. 30m (20m … 50m)[IV] Typ. 98ft (66 … 164ft)[IV]
Advance Detection Distance	Typ. 120m (50m … 180m)[IV] Typ. 394ft (164 … 591ft)[IV]

[I] May affect max. detection range. The best performance is typically achieved for mounting heights between 28m. Occlusion needs to be considered.

[II] Smaller absolute angles allow longer detection range along a road.

[III] Application specific. Gantry mount: steeper e. angle possible, with limitations of maximum range. Negative elevation angle means sensor pointing towards road.

[IV] Typical value for stop bar + advance applications; may be different for other applications.

Up to four sensors can usually be mounted at or around an intersection using separate configurable frequency channels, avoiding mutual interference.

The cycle time is set to 75ms.

Sensor Variants and Features

CAIMAN-PRO M80	• **Stop bar detection** (true presence detection) • Lane specific **Advance detection** (exploiting the long range) • **Loop replacement** (non-intrusive detection) • **Queue length** measurement • **Custom trigger** conditions (e.g. location, vehicle speed, classification) • **ETA** measurement • **Speed** measurement
CAIMAN-PRO B80	• **Stop bar detection** (true presence detection) • Lane specific **Advance detection** (exploiting the long range) • **Loop replacement** (non-intrusive detection)

11.4.2 Arterial Management

On highways and country roads, the sensor is typically used to count and classify traffic. Usually are selected and reported in configurable counting /statistics intervals.

The sensor delivers the following data:

- Volume
- Occupancy
- Average Speed
- Vehicle Presence

The data can be retrieved in Push Mode

a) in low data volume as aggregated statistics output
b) as per vehicle record (PVR)

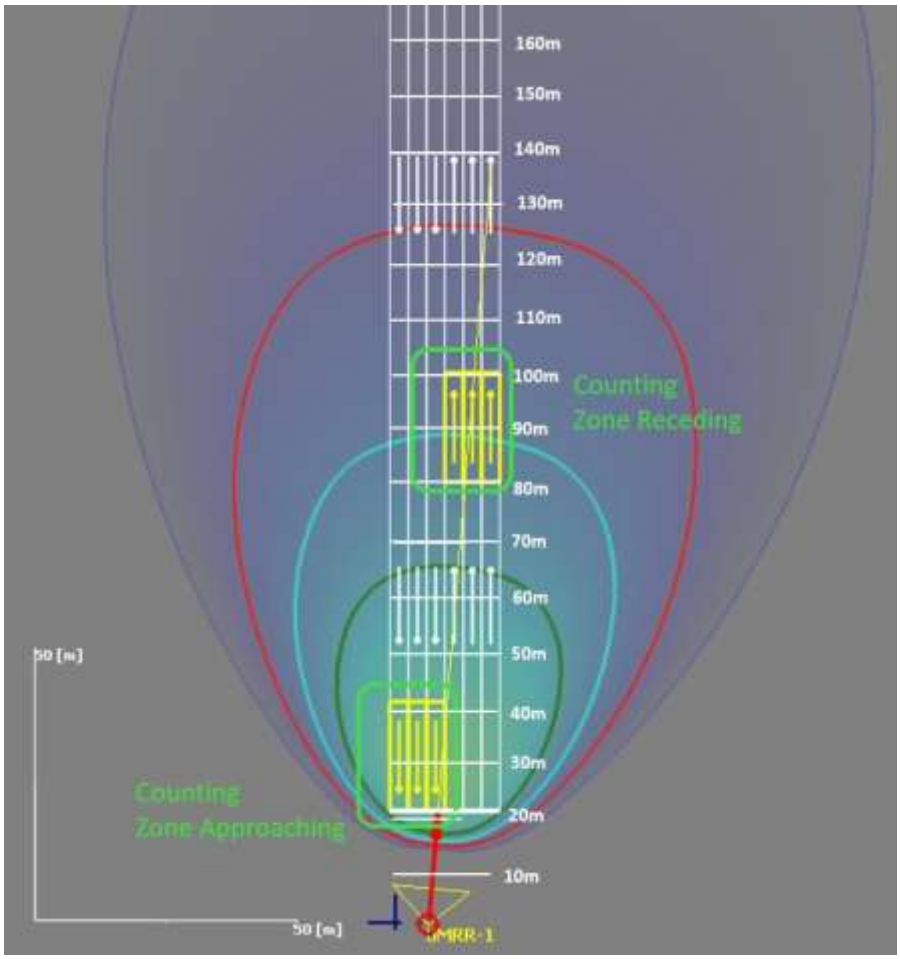

Figure 59: Standard Configuration CAIMAN-PRO 80 (High Power)

Because of the forward-looking principle, the sensor provides the significant higher speed accuracy / general speed based information, compared to other traffic counting equipment. The sensor is usually mounted at the roadside on a vertical pole. No setback is required. Other mounting positions (gantry, mast arm, luminaire) may be possible. The **standard configuration** for Type 80 sensor for counting applications is shown in Figure 5 and its parameters are given in the table below.

Table 2: Standard Configuration for Counting and Statistics Type 80

Parameter	Value
Traffic Direction	Typ. Approaching & Receding
Mounting Height	Typ. 6m (4...10m)[I] Typ. 20ft (13...33ft)[I]
Sensor Azimuth angle	Typ. -12° (-15 ...+15 deg.)[II]
Sensor Elevation angle	Typ. -4° (-9…0 deg.)[II, III]
Counting Zone Extent (Approaching)	Typ. 20m-40m (20m … 50m)[IV] Typ. 66ft-131ft (66 … 164ft)[IV]
Counting Zone Extent (Receding)	Typ. 80m-100m (50m … 105m)[IV] Typ. 295ft (164… 344ft)[IV]
Setback	Typ. 1m (0… 10m) Typ. 3ft (0 … 33ft)
Counting Accuracy	Typ. > 95%[V]
Classification Accuracy	Typ. > 80%[V]
Classes	Usually the following 7 classes are supported: Pedestrian, Bicycle, Motorbike, Passenger Car, Transporter, Truck/Bus, Long Truck

[I] May affect max. detection range. Occlusion needs to be considered.

[II] Smaller absolute angles allow longer detection range along a road.

[III] Application specific. Gantry mount: steeper el. angle possible, with limitations of maximum range. Negative elevation angle means sensor pointing towards road.

[IV] Typical value for counting applications; may be different for other applications.

[V] Typical value when properly installed at suitable location. The counting and classification accuracy typically depends on the following main (and other) factors: mounting height, traffic density

Multiple (up to four) sensors may however be used in close vicinity using separate configurable frequency channels, avoiding mutual interference.

The cycle time is set to 75ms.

Sensor Variants and Features

CAIMAN-PRO I80	• **Counting and Classification** • **Wrong Way Detection** (vehicle moving opposite to the defined direction of traffic) • **Incident Detection** supported • **Speed** measurement

11.5 General Performance Data

Parameter	Value	Unit
Sensor Performance		
Max. Range on Passenger Car	140[I] (@20dBm) / 110[I] (@12.7dBm) 459[I] (@20dBm) / 361[I] (@12.7dBm)	m ft
Max. Range on Truck	180[I] (@20dBm) / 180[I] (@12.7dBm) 590[I] (@20dBm) / 590[I] (@12.7dBm)	m ft
Instrumented Range	180 (low bandw.) 170 (high bandw.) 590 / 558	m ft
Minimum Range	2m (stopped), 1m (moving) 6ft (stopped), 3ft (moving)	m ft
Range accuracy	Typ. < ±2.5% or < ±0.25m (bigger of) Typ. < ±2.5% or < ±0.82ft (bigger of)	%, m %, ft
Radial Speed Interval	-88.8…+88.8 -320…+320	m/s km/h
Minimum abs. Radial Speed	0.1 0.36	m/s km/h
Speed accuracy	Typ.< ±0.28m/s or ±1% (bigger of) [II] Typ.< ±1km/h or ±1% (bigger of) [II]	m/s km/h
Angle Interval (total field of view)	-12 ...+12 (El.); -50 ...+50 (Az.)[III]	degree
Angle Accuracy (horizontal)	< 1[IV]	degree
Update time	<75 or <58ms dep. On mode	ms
Environmental		
Ambient Temperature	-40 ... +85	degree C
Shock	100	grms
Vibration	14	grms
IP	67V	
Pressure / Transport altitude	0…10.000 0…32800	m ft
Mechanical		
Weight	360 12.70	g oz
Dimensions	See 3.6	
General		
Power Supply	8 ... 32[VI] <5VII	V DC W
Frequency Band	24.0…24.25	GHz
Bandwidth	< 250	MHz
Transmit Power (EIRP)	<12.7 / <20 depending on country	dBm
Interfaces [VIII]	CAN V2.0b (passive) RS485 full duplex 10/100 Ethernet	
Connector	12 Pin plug Hirose LF10WBRB-12PD	CAN, Power, RS485, Eth.

I Typical values; may vary to higher or lower values depending on clutter environment. All values given for bore sight. Please note that the Radar system – like any other sensor system – although being well optimized and providing excellent performance, will not achieve a 100% detection probability and will not achieve a false alarm rate equal to zero.

II Measured on object having const. radial speed, at bore sight.
III Total field of view is angle interval where reflectors can be detected; 3dB field of view is narrower.
IV Typical value; measured at target output level at bore sight, for a point reflector showing >23dB SNR. Error may increase towards larger angles. In addition to this angle error, angle may drift over temperature, typically 1deg to + 1deg over specified operation temperature interval.
V IP 67 only when connector or cap attached.
VI measured at connector.
VII Power consumption at 20°C.
VIII It is recommended to use an external surge protection for power, CAN, RS485, Ethernet and other interface ports.

11.5.1 Start-up time

After power up or reset, the sensor readings are within specified performance within <4s.

11.5.2 Self-Diagnose

The CAIMAN-PRO sensor cyclically reports a status message providing the following information

- Sensor run time
- Sensor cycle time
- Sensor mode
- Diagnose information

The sensor features certain self-diagnose to allow limited fail-safe capabilities:

- Detection of sensor blindness
- Detection of rain
- Misalignment in roll- or pitch angle
- Detection and suppression of interference

Note that there is no completely fail-safe operation available.

11.5.3 Sensor Network

The sensor is typically used standalone.

11.5.4 Ethernet connection

The sensor supports UDP over Ethernet in a Local Area Network (LAN). Communication over low bandwidth environments or routed networks e.g. the world wide web is not supported.

Features:

1. Ethernet standards IPv4, ARP, IGMP, IP multicast and UDP
2. Supports DHCP
3. SWARCO proprietary communication protocol “sms Transport” with:
    - IP/UDP Multicast based discovery protocol
    - Client ID based setup
    - Sensor data transmission

11.5.5 Compliance and Certifications

The sensor model complies with the following EU directives:

- RED 2014/53/EU
- RoHS 2011/65/EU
- EC 1907/2006 REACH

Applied Standards:

- Spectrum Usage:
  - EN 300 440 V2.1.1 - EMC:
  - EN 301 489-1 V2.2.0 ○ EN 301 489-3
- V2.1.1 - Health and Safety:
  - EN 62311: 2008
  - EN 62368-1: 2014 + AC: 2015

With regard to spectrum usage, this sensor model was tested and certified by independent test labs:

- EU RED directive (formally approved by test lab or notified body),

This sensor model is also generally compliant with the following regional regulations (but may not be formally tested/approved):

- SRRC,
- KCC,
- MIIT,
- NCC.

Note:
This statement of compliance means that the sensor device allows operation compliant to the listed standards. However, not all standards are certified through test labs and not for all countries formal frequency approval/registration is accomplished.

In certain countries or regions a customer-specific local frequency approval is reasonable. SWARCO supports customers for this process.

11.6 Sensor Dimensions

All values given in mm.

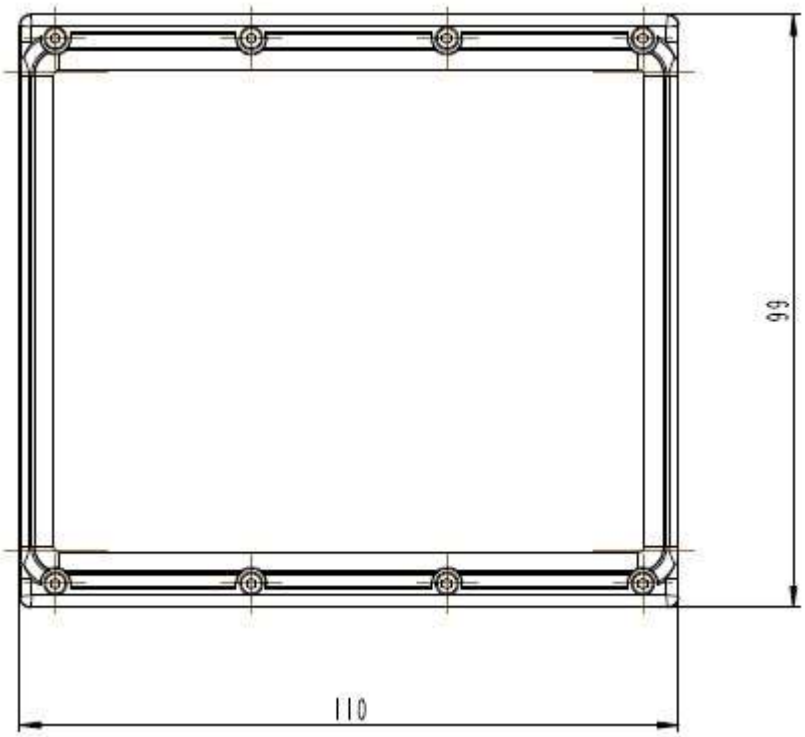

Figure 10: Sensor Front side.

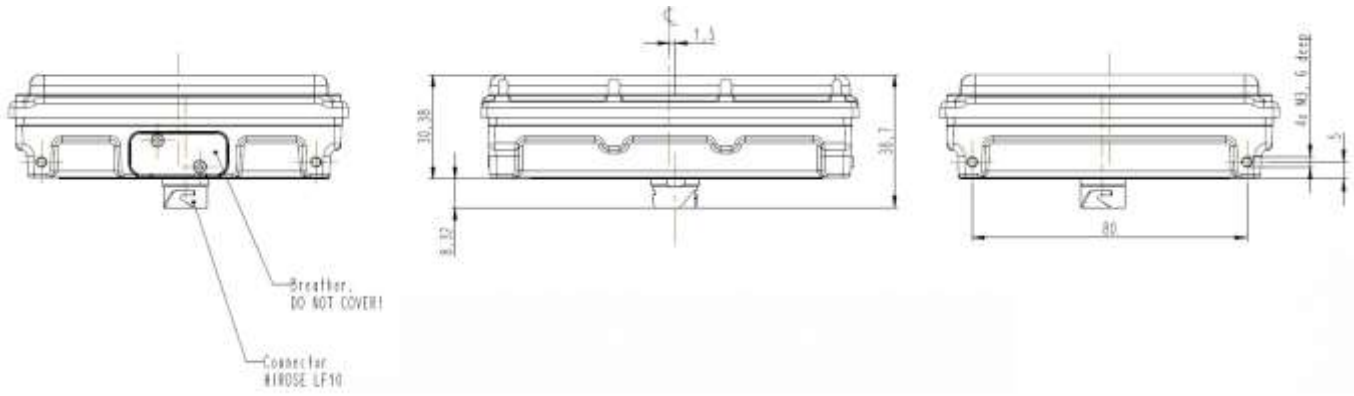

Figure 60: Sensor Top, Left and Right Side.

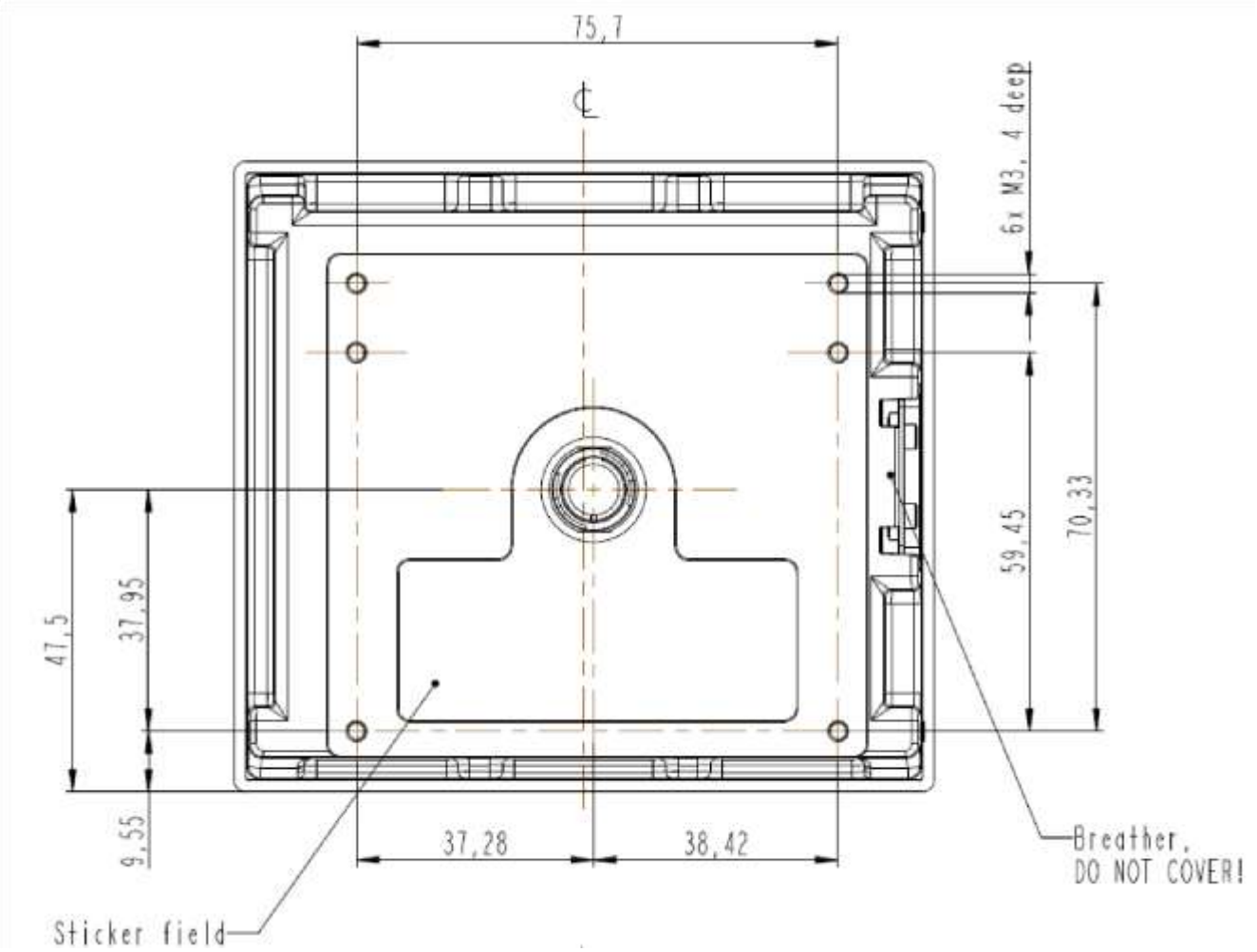

Figure 61: Sensor Rear Side.

11.7 Connector

The sensor connector is a 12-pin male (plug) circular bayonet type connector (water proof IP67, series LF10WBRB-12PD, manufacturer Hirose, Japan). A female counterpart (socket), e.g. LF10WBP-12S, has to be used to connect to the sensor. The pin numbering of the socket is shown in Figure the pin description is given in Table 3.

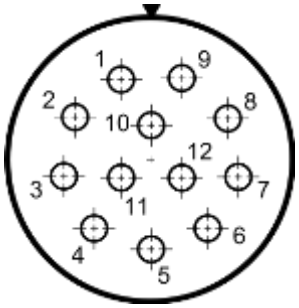

Figure 62: View on solder cup side of socket (rear view of female counterpart to be connected to sensor)

Table 3: Sensor connector pin out model CAIMAN-PRO

Pin No.	Function	Wire Color (MEDI type #KU110C12J002)
1	Sensor Ethernet TX H	gray / red
2	Sensor Ethernet TX L	red / blue
3	Sensor RS485 RX L	pink
4	Sensor RS485 RX H	gray
5	Sensor RS485 TX L	brown
6	Sensor RS485 TX H	white
7	Sensor_GND	blue
8	Sensor_Vcc	red
9	Sensor Ethernet RX L	black
10	Sensor Ethernet RX H	purple
11	CAN H	green
12	CAN L	yellow

Note:
Please note that in the standard configuration the sensor has no 120 Ohms resistor on board (CAN bus termination between CAN L and CAN H). The resistors are nevertheless required at either end of a CAN / RS485 bus and is in most cases integrated in the cable delivered along with the sensor (if cable is manufactured by SWARCO).

For the RS485 data interface there is a 120 Ohms resistor on board of the sensor.

A number of cable sets for initial operation and test purposes are offered by SWARCO, to deliver a fast set-up of a sensor system. Among those preconfigured ready-to-run cables as well as cable stumps (pig tail cables or various lengths) which carry the connector on one side and open wires on the other.