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User Manual

Ibeo ScaLa B2® Laserscanner

PASSION FOR SCANNING

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Version History

Date	Version	Changes
26-Nov-2013	0.1	Initial, only including sensor adjustment chapter
17-Feb-2014	0.2	Added Connector and Pinning
13-Jun-2014	1.0	First release
20-Jun-2014	1.1	Added ILV visualization chapter
02-Jul-2015	1.2	Added heating information

Table 0.1: Version History

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Contents

1 About this document

Please read this chapter carefully before working with the documantation and the Ibeo ScaLa B2®.

1.1 Principle of the document

This User Manual contains all information required for transport, storage, mounting, installation, commissioning, and operation. The User Manual is a part of the technical documentation of the Ibeo ScaLa B2®.
This User Manual does not include instructions for operation of the vehicle into which the Ibeo ScaLa B2® is integrated. For information about that, refer to the User Manual of the vehicle.
This User Manual shall help you to avoid improper use. Strict adherence to the instructions given in this User Manual ensures the function of the Ibeo ScaLa B2®. Therefore always keep this User Manual in the vehicle.

1.2 Target group

This User Manual is written for trained and qualified staff who will integrate, commission or configure the Ibeo ScaLa B2® into a vehicle.
The following conventions apply in this User Manual:

- The text uses abbreviations. In each chapter, abbreviations appearing the first time are explained. The abbreviation is written in parenthesis behind the term. Example: User Manual (UM)
- The pages of each chapter are numbered subsequently.
- Tables and figures are numbered consecutively within each chapter.
- Links in the text lead you to supplementary or more detailed information.

In chapter 2 "Safety", page 10, you find general safety notes about possible dangers when operating the Ibeo ScaLa B2®. Additionally, specific safety notes are printed directly before instructions which, if not followed properly, could result in danger for persons or the vehicle.
This OM is subject to changes. If the Ibeo ScaLa B2® is changed as a result of technical advancement, you must include the additional or changed pages at the corresponding place.

1.3 Symbols and notes

This User Manual uses different symbols for notes on safety and information.
The notes on safety include the source of the danger, possible or probable results as well as means to stop the hazard.

DANGER

This symbol indicates an immediate danger which could lead to severe bodily harm or to death.

WARNING

This symbol indicates a pssible danger which could lead to severe bodily harm.

CAUTION

This symbol indicates a possible danger which could lead to bodily harm.

CAUTION

This symbol indicates a possible danger which could lead to property damage.

NOTE

This symbol indicates special information about key functions or special usage tips which shall help you to use all functions optimally.

1.4 Terms and definitions

1.4.1 Operator

The operator uses the Ibeo ScaLa B2® as owner or hirer. He is responsible for

- proper operation of the Ibeo ScaLa B2®,
- intended use of the Ibeo ScaLa B2®,
- the appointment of suitable trained staff to mount, install, configure, adjust, commission and clean the Ibeo ScaLa B2®.

1.4.2 Trained Stuff

Trained staff has undergone a specific training and is thus able to perform the assigned tasks and to detect possible dangers. The trained staff must be qualified for handling

- mechanic and electric assemblies
- control and feedback control systems.

1.4.3 Administrator

An administrator is a specifically trained employee of the customer or an accordingly qualified employee of ibeo. An administrator can access all software functions. The administrator may

- open, delete or lock user accounts,
- change the configuration of the Ibeo ScaLa B2®,
- reset the devices connected to the Ibeo ScaLa B2®,
- launch or shut down the software of the Ibeo ScaLa B2®.
- update new software for the Ibeo ScaLa B2®.

An administrator has the highest rank of permissions in the user administration.

1.5 Warranty

The Ibeo ScaLa B2® has not yet been constructed according to all required legal requirements and safety-related rules. It is not yet state-of-the-art nor does it fulfill the requirements of the EC conformity.

CAUTION
The Ibeo ScaLa B2® including its software and the OM are still in the development and prototype state. Therefore, its usage is limited to test purposes only.

In case of using the Ibeo ScaLa B2® and its connected components and software for other purposes than the intended use, ibeo will not assume any responsibility nor be liable to third parties; this applies to direct, indirect or exceeding damages, accidental damages or consequential damages.These include:
The Ibeo ScaLa B2® is

- not used as intended,
- not used according to the instructions in this OM,
- modified in terms of construction or functions without written consent by ibeo,
- equipped with spare parts not delivered or approved in writing by ibeo,
- repaired improperly,
- repaired by trained staff not authorized in writing by ibeo,
- damaged by an "act of God".

Ibeo does not assume any liability for external devices connected to the system which cause faults and thus damages.

2 Safety

2.1 Intended Use

The Laserscanner Ibeo ScaLa B2® serves for detecting and identifying objects around a vehicle under a specific angle. It is integrated into the vehicle, for further information refer to chapter 7 "Technical data", page 45.
The area for intended use is the area of the vehicle.

NOTE
Any other use is only permitted after consulting Ibeo.

2.2 Improper use

Every use other those listed above is considered improper. Ibeo is not liable for damages to persons and property resulting from such improper use.

2.3 General notes on safety

DANGER
The Ibeo ScaLa B2® must be immediately switched off by removing the power supply in any case of technical fault!

The Ibeo ScaLa B2® can cause danger for persons and property if handled or used improperly. Therefore the operator must ensure that every person working with the Ibeo ScaLa B2® has read and understood this User Manual.
For installation and usage of the Ibeo ScaLa B2® as well as for commissioning and regular technical inspection, national/international legal requirements apply.
The operator of a vehicle equipped with an Ibeo ScaLa B2® is responsible for consulting the responsible authorities about applicable safety rules and regulations, and adhere to them.
The notes, especially the inspection notes of this User Manual (e.g. usage, mounting, installation or integration into the vehicle control system) must be observed.
Adhere to the following safety notes in order to prevent dangers for persons and/or property:

- The operator must ensure by suitable instructions and inspections that the Ibeo ScaLa B2® is always clean.
- Additionally, the local safety and accident prevention regulations apply for operating the Ibeo ScaLa B2®.
- A defect of the control functions can cause danger for human life or property damage at the Ibeo ScaLa B2®.

2.3.1 Laser class

DANGER

The Ibeo ScaLa B2® must be immediately switched by removing the power supply in any case of technical fault!

The Ibeo ScaLa B2® fulfills the requirements of laser class 1 of the European laser standard EN 60825-1: 2007-10. The Ibeo ScaLa B2® is equipped with a safety device that interrupts the laser emission in case of a failure of the scan mechanism.

2.3.2 Operation

The operator must

- provide a permanently perfect operating state of the Ibeo ScaLa B2®,
- take measures for antistatic protection,
- make sure that only trained staff modifies the Ibeo ScaLa B2®.

The trained staff must report any relevant modifications in the functional sequence of the Ibeo ScaLa B2® immediately to the operator.

2.3.3 Disposal

The Ibeo ScaLa B2® is designed to burden the environment as little as possible and to consume a minimum of energy and resources.

3 Product overview Ibeo ScaLa B2®

3.1 System variants

Depending on usage and purpose, the Ibeo ScaLa B2® can build a system in combination with different components. This user manual describes only the system of standard individual components The Ibeo ScaLa B2® is operated by itself, without further processing components. This system is reduced to the basic required components and uses a ScaLa standard connecting cable. It serves for applications which use an Ethernet connection as only interface.

System of standard individual components

The system of standard individual components is used if an Ethernet connection shall serve as only interface.

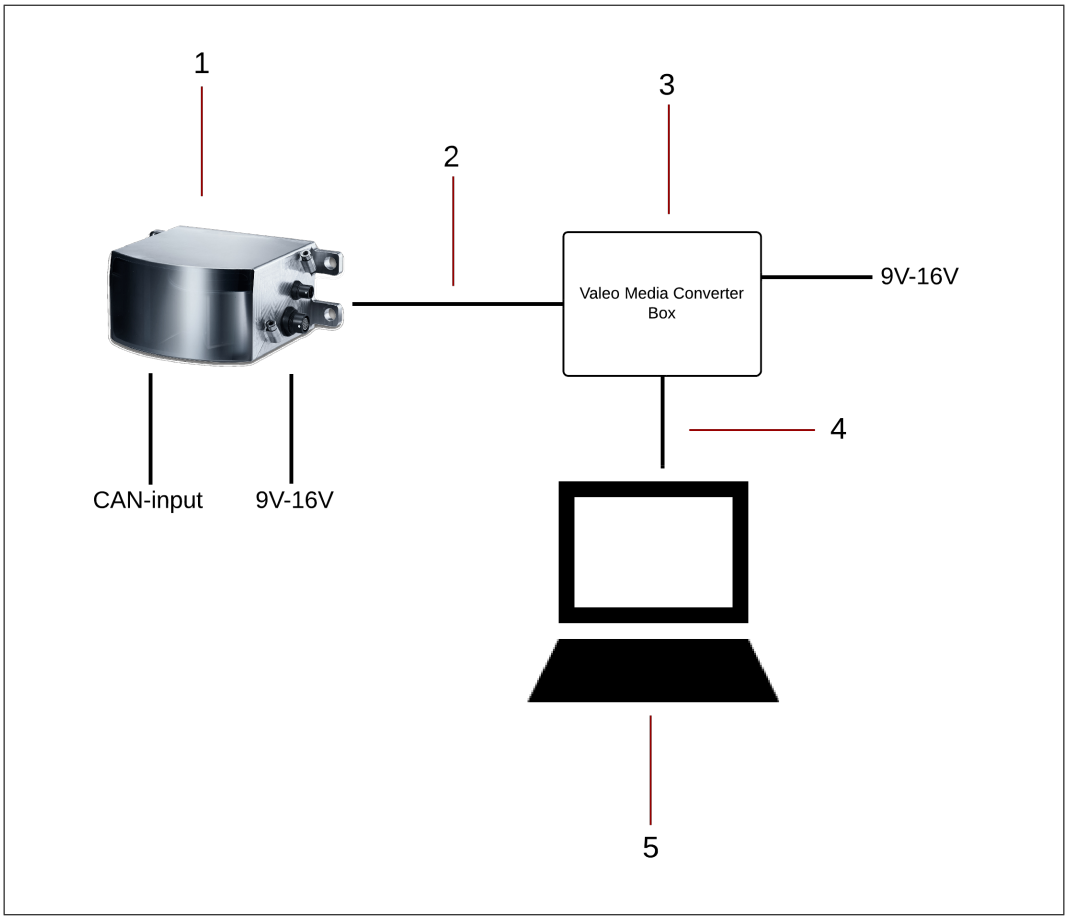

Figure 3.1: System of standard individual components

1. Ibeo ScaLa B2®
2. BroadR-Reach standard connection
3. Valeo Media Converter box - The Media Converter box converts BroadR-Reach standard to standard Ethernet protocol
4. Standard Ethernet connection to network or PC
5. PC with ILV

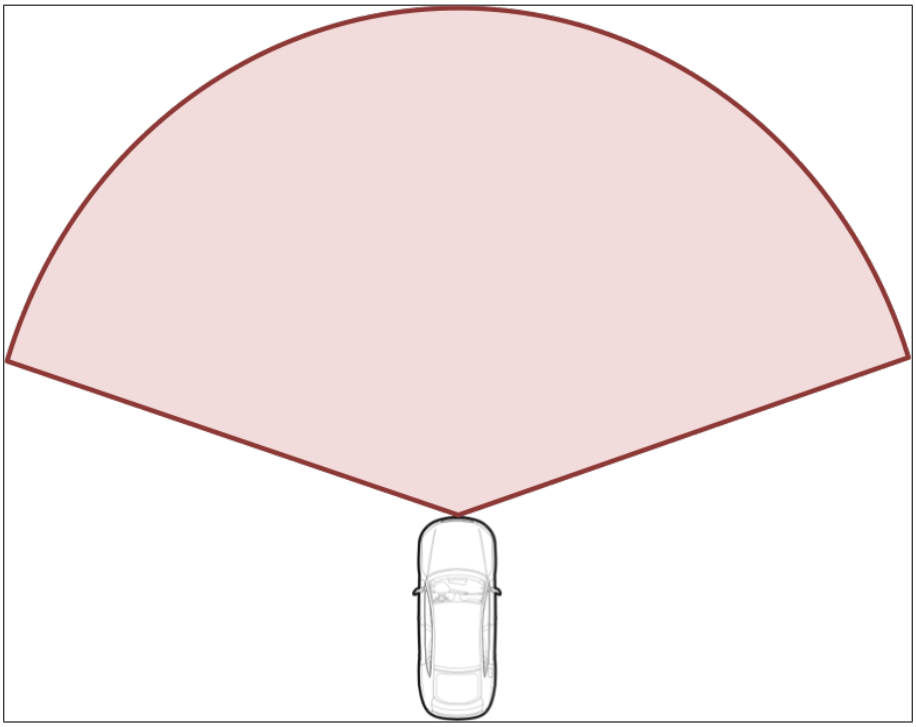

Figure 3.2: Ibeo ScaLa B2® with standard components integrated in a vehicle

Figure 3.2 illustrates an example for using the Ibeo ScaLa B2® in the front area of a vehicle with a horizontal field of view of 145°.

3.2 Ibeo ScaLa B2®

3.2.1 Function

The function of the Ibeo ScaLa B2® bases on a process to detect the surrounding of the sensor and/or the objects located within the field of view.
For this purpose, laser beams are sent from the Ibeo ScaLa B2® over four levels and measure the distance and the direction (the angle in relation to the Ibeo ScaLa B2®) of the objects.
This yields the position of the object in the sensor or vehicle coordinate system.
The resulting profiles of the different levels are called scans, see chapter 4 , Scan and object data, page 27.
The Ibeo ScaLa B2® provides two different kinds of information:

- Scan data
- Object data

The scan data are the initial information, i. e. information in which area of the field of view of the Ibeo ScaLa B2® the transmitted pulse has been reflected.
The data contain exact angle information (horizontal and vertical), a distance value and information about the pulse width of the reflected pulse.
Scan data are provided via Ethernet.
The object data provide information on a higher level. The information is issued as a set of objects to which certain properties like size, position, speed and type can be assigned. These data is sent via the interface Ethernet and can be reused, if necessary, see Interfaces chapter 3.3 page 24.
To transform scan data into object data, different processes are performed in the Ibeo ScaLa B2®. For a detailed description see chapter 4 Scan and object data, page 27.
The Ibeo ScaLa B2® is pre-configured by default, however, the customer can adjust some parameters, see chapter 5 Configuration, page 33.

3.2.2 Measuring process and measuring properties

The Ibeo ScaLa B2® is a measuring instrument basing on Light Detection And Ranging (LIDAR) technology, i. e. the Ibeo ScaLa B2® detects objects and their distance by means of laser beams.
It scans the surroundings with several rotating laser beams, receives the echoes with a photo diode receiver, processes the data by means of a time of flight calculation and issues the processed data via the interface Ethernet.
By the permanent rotation of the mirror in connection with the laser beam, it is possible to build a complete profile of the surroundings within the working range of the Ibeo ScaLa B2®. The scan data of the Ibeo ScaLa B2® consist of the distance, the angle and the echo pulse width.
The measurement properties base on

- time-of-flight measurement
- multi-layer technology
- multi-target capability

- the working range and the relation of angle to range
- the angle resolution and the scan frequency

Time-of-flight measurement

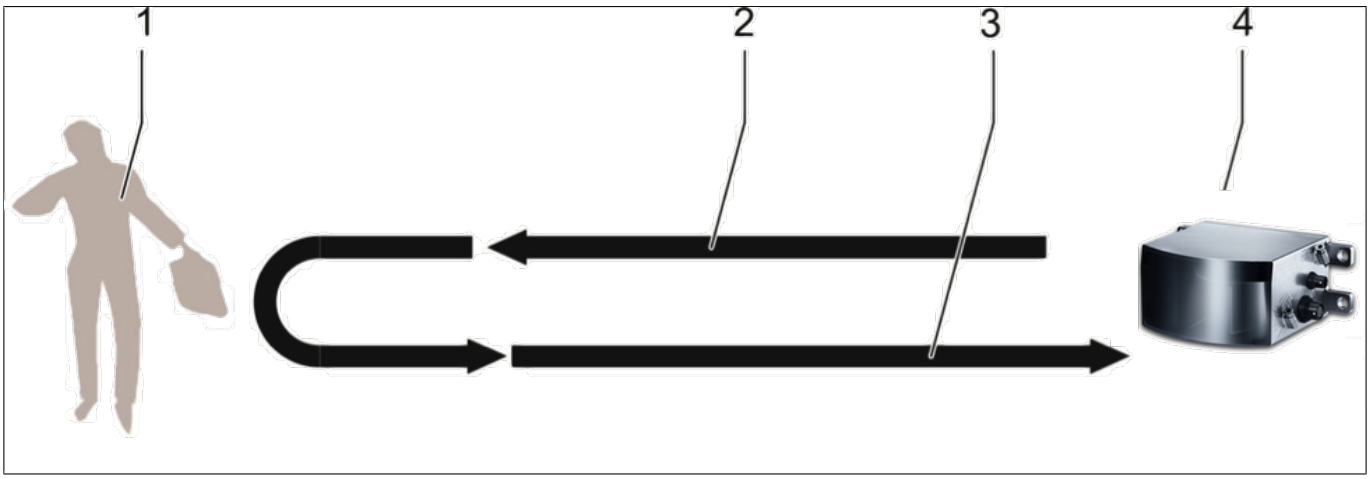

Figure 3.3: Principle of time-of-flight measurement

1. Object
2. Laser pulse, transmitted
3. Laser pulse, reflected
4. Ibeo ScaLa B2®

The laser pulses transmitted by the Ibeo ScaLa B2® are reflected by the objects in the surrounding area.
The Ibeo ScaLa B2® gathers the reflection of the laser pulse, processes the information, and sends the data to the customer via Ethernet.
The distance is calculated from the time-of-flight of the laser pulse and the speed of light.
The rotating mirror deflects the laser pulses. The angular position of the mirror during deflection yields the direction of the detected object.
The combination of these values builds the basis for a complete profile of the surroundings in the working range of the Ibeo ScaLa B2®.

Multi-layer technology

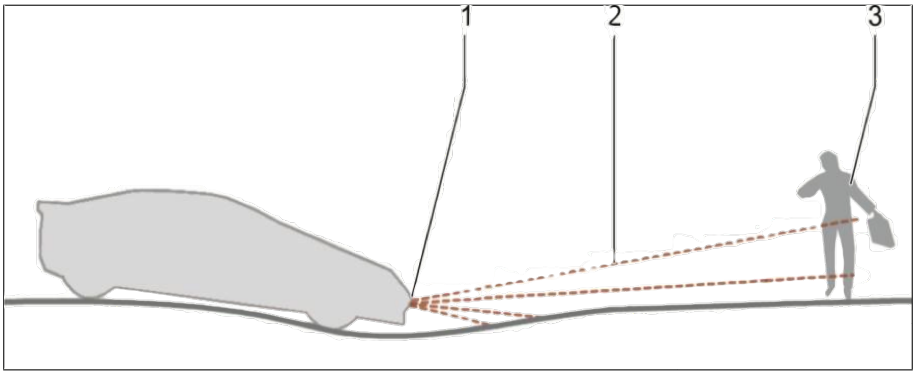

Figure 3.4: Principle of multi-layer technology

1. Ibeo ScaLa B2®
2. Scan level
3. Object

The multi-layer technology of the Ibeo ScaLa B2® allows for pitch angle compensation by means of four scan levels with different vertical angles of the vehicle.
This enables the Ibeo ScaLa B2® to detect the object better, also if the vehicle is e. g. accelerating or braking.

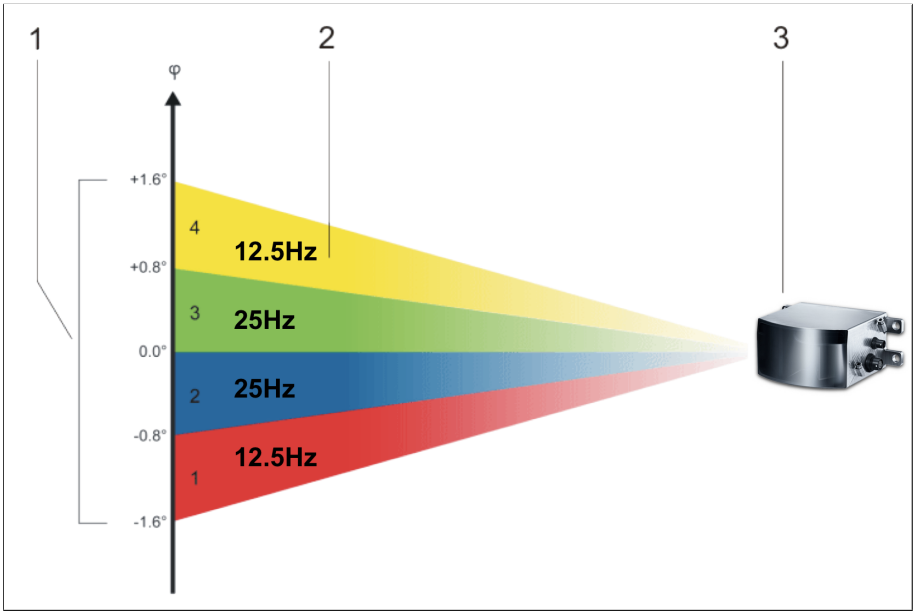

Figure 3.5: Scan level

1. Vertical opening angle (φ)
2. Scan level
3. Ibeo ScaLa B2®

The photo diode receiver of the Ibeo ScaLa B2® consists of three independent receivers arranged in a line. These three receivers enable the multi-layer technology.
Because of the mirror mounting angle, these three scan levels are scanned interlaced and the Ibeo ScaLa B2® is capable of receiving four layers. This means that the combination of three levels is always scanned simultaneously (first e. g. the yellow, the green and the blue level, then the green, the blue and the red level), compare Figure 3.10. Both centered layers (blue and green) are receiving data at 25Hz and the both outer layers (red and yellow) at 12.5 Hz.

Multi-target capability

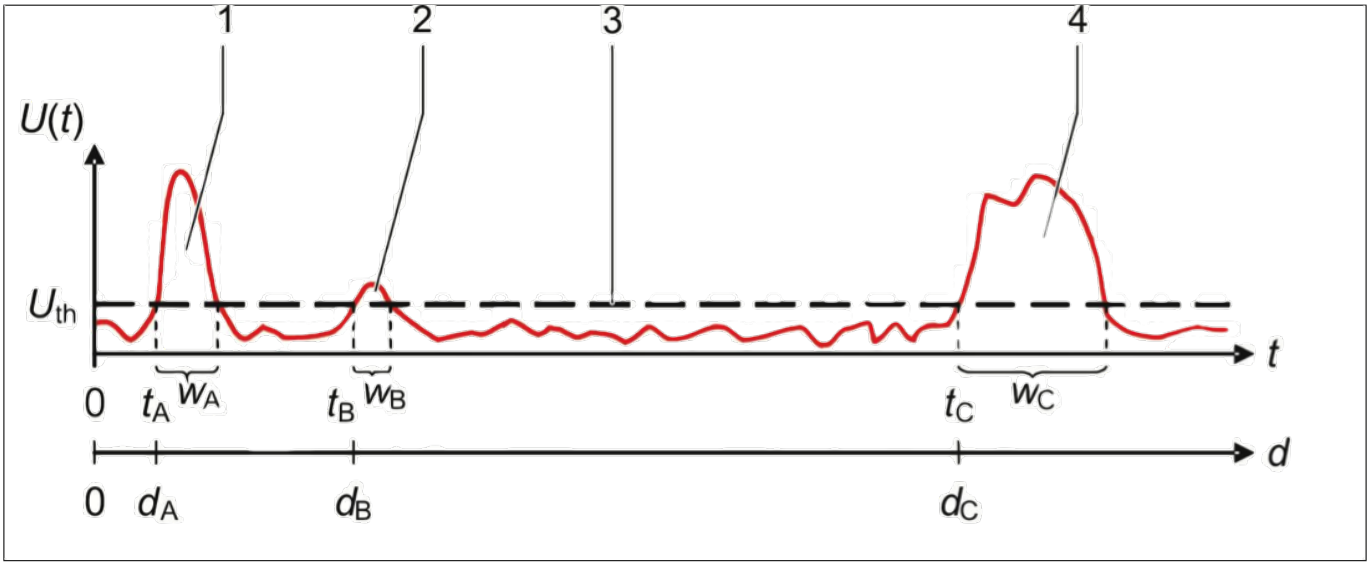

Figure 3.6: Multi-target capability

1. Example: echo of a window pane
2. Example: echo of a rain drop
3. Threshold voltage
4. Example: echo of an object

V(t): Output voltage

t: Time

d: distance

W: echo pulse width

A: Window pane

B: Rain drop

C: Object

U_{th}: Threshold voltage

The Ibeo ScaLa B2® is capable of processing multiple targets. Thus, it can gather and evaluate up to three echoes per transmitted laser pulse.
Once the echo reaches the photo diode receiver of the Ibeo ScaLa B2®, the received intensity is transformed into a voltage.
The example in figure 3.6 shows that a reflected echo of a window pane yields a very high voltage over a short period of time. The echo of a rain drop, however, yields a very low voltage over a short period of time. The echo of an object yields a high voltage over a longer period. All three echoes are generated by reflections of a single transmitted pulse. The threshold voltage V_{th} separates the system noise from the relevant echoes. This threshold value prevents to interpret system noise as an object.
The Ibeo ScaLa B2® uses the two threshold passages to analyze the echo pulse widths $w_{A/B/C}$.

In this way the Ibeo ScaLa B2® is able to gather up to three echoes for each of the four scan levels. By default the attribution of scan level and echo is as follows:

Level	Echo 1	Echo 2	Echo 3
4 -yellow			
3- green			
2 - blue			
1 - red			

Figure 3.7: Naming convention

Color hues visualize the levels and color saturation of the echoes. Figure 4.2 lists the specified naming conventions for the levels and their preset colors used for the visualization.

Example for a case with three echoes, see figure 3.6

If a laser beam hits a window pane, for example, a part of the light is reflected and triggers a measurement (echo 1). Most of the light passes the window pane and might hit a rain drop which then again reflects a part of the light (echo 2).
The remaining light is then reflected by an object, which then results in the third measurement value (echo 3).

Constant angle resolution

The Ibeo ScaLa B2® has a constant angle resolution of 0.25°.

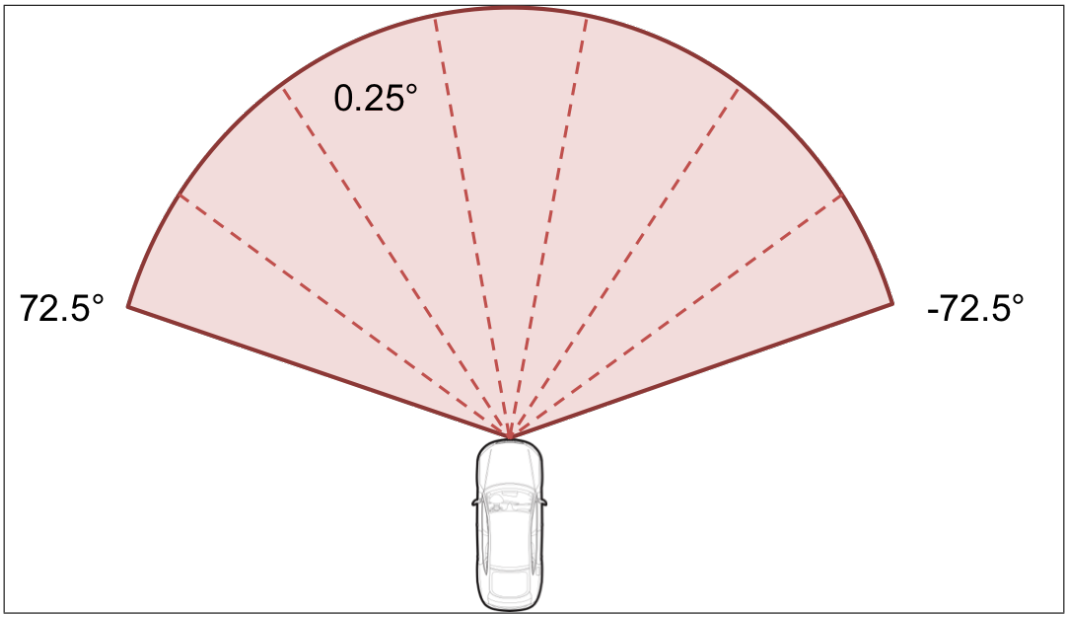

Figure 3.8: Scan frequency 25 Hz, constant angle resolution of 0.25°

Working range and relation of angle to range

Due to the optical design of the Ibeo ScaLa B2®, the working range depends on the angle, refer to Figure 3.9
The measurement range depends on the optical design and inhibits a dependency on the scan angle. Figure 3.9 illustrates the schematic range over scan angle. The scan points are assigned dependent on the scan angular. Please keep in mind, this illustration is just a schematic representation.

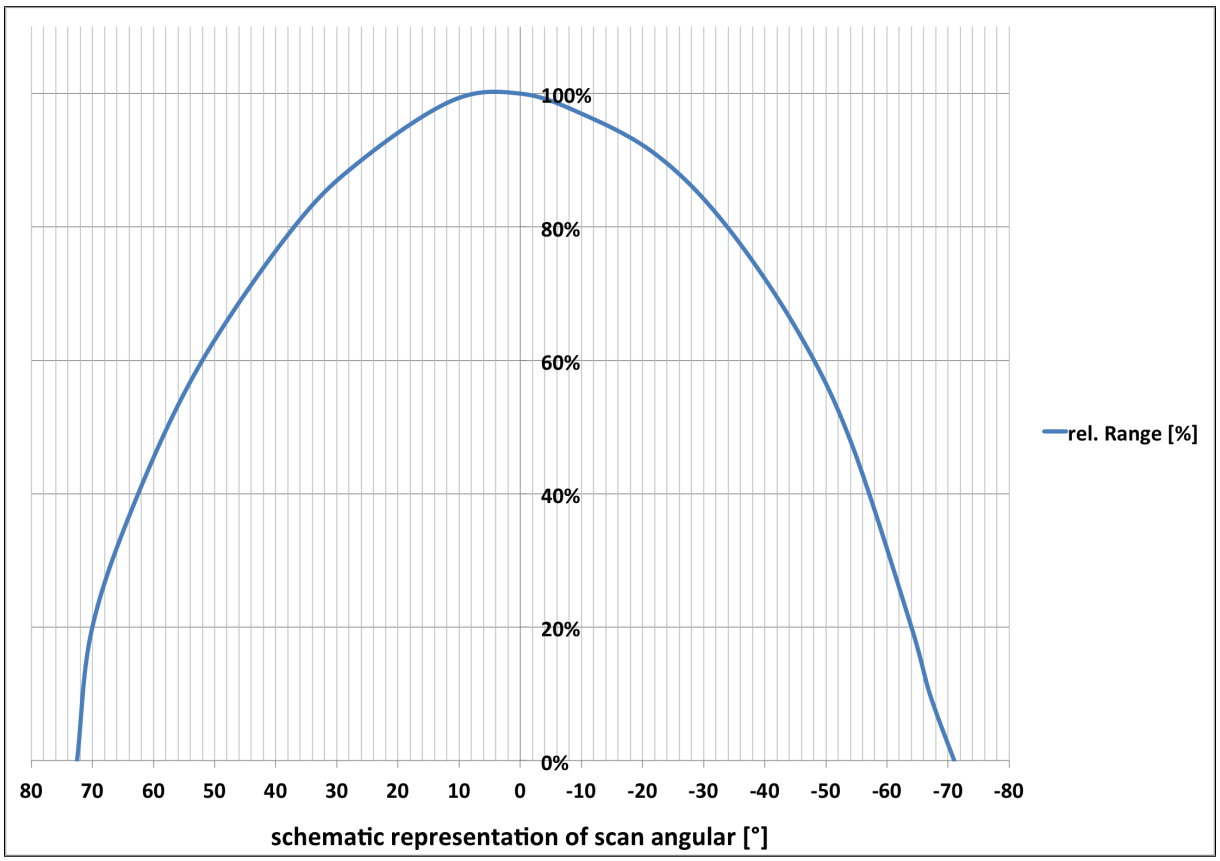

Figure 3.9: Measurement range dependent on the scan angular

Scan frequency

The Ibeo ScaLa B2® operates with a scan frequency of 25Hz. Three scan levels (Figure 3.5) are measured simultaneously on each mirrorside (top and bottom). Since the rotating mirror has a inclination of 0.3° it results in 4 scan layers. Both inner layers (blue and green) with an update rate of 25Hz and both outer layers (red and yellow) with an update rate of 12.5Hz. The angular resolution is constant 0.25°.

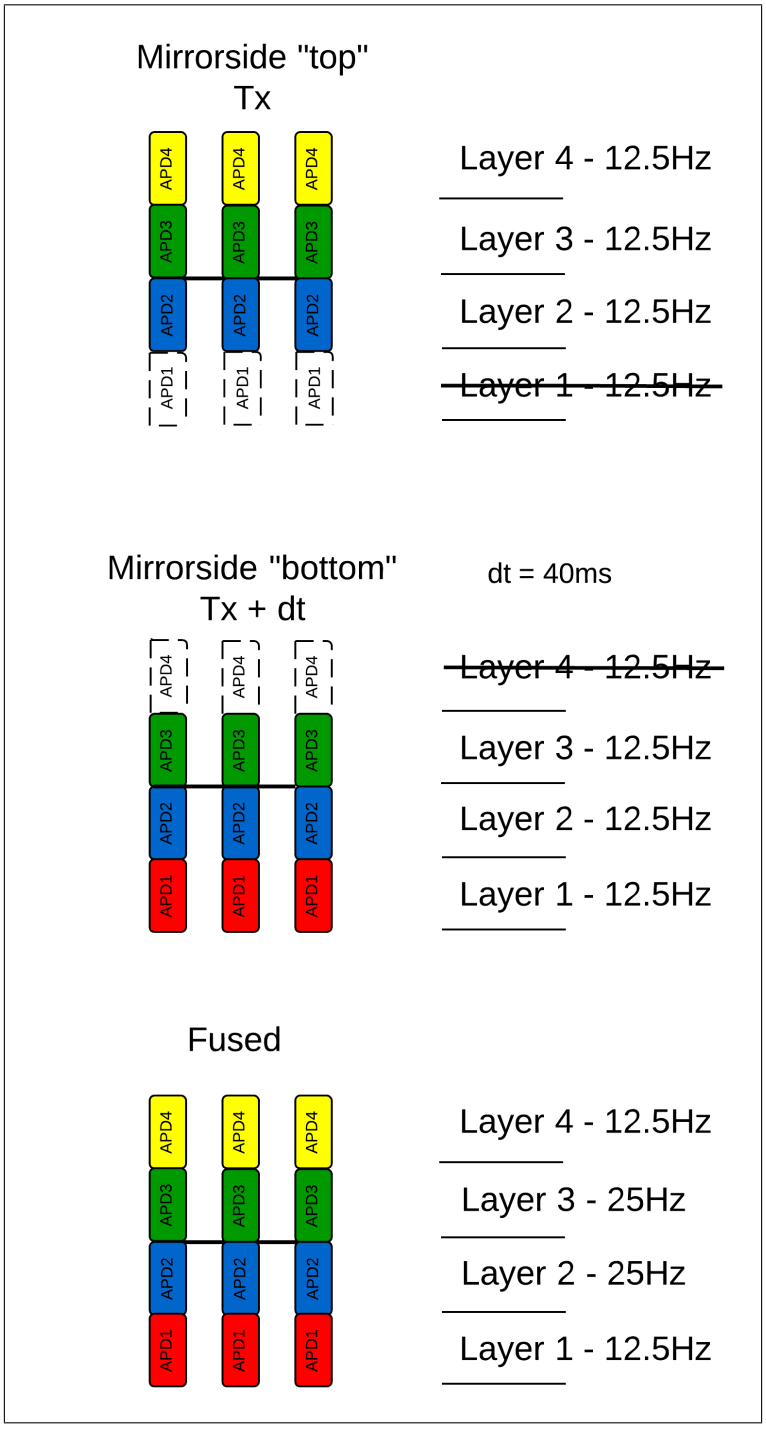

Figure 3.10: Scan frequency

3.2.3 Available data interfaces and data types

CAUTION

The bending radius of the connecting cable of the Ibeo ScaLa B2® must be at least 6 cm. Else the connecting cable could be damaged.

At the connecting cable of the Ibeo ScaLa B2®, the Ibeo ScaLa B2® provides the following data interfaces and data types via the interface Sensor:

- Ethernet (all data types sent are in the Ibeo LUX format)
  - Output of scan data
  - Output of object data
  - Output of warnings and fault messages
- CAN
  - Reception of information about the vehicle's movement
- Voltage

  Voltage supply 9 ... 16 Volt DC

NOTE

Please refer to the ScaLa Ethernet Customer Documentation for more detailed information.

3.2.4 Heating

The Ibeo ScaLa B2® (available only for ≥B2.3) has got a built in front window heating to prevent the front window from icing and snow covering. On default this feature is **deactivated**. It might be activated by Ibeo with additional costs on request and requires a customer specific adaptation and configuration. Contact the Ibeo Sales Team for further details.
The max. heating power is 40W. It is based on the ambient temperature, driving velocity and several more parameters which are updated continuously.

DANGER

Activating the heating on the Ibeo ScaLa B2® without Ibeo approval may destroy the sensor!

3.3 Interfaces

3.3.1 Interface Ethernet

NOTE

Make sure that the Ethernet interface of the computer you are using for receiving the Ibeo data is not blocked by other data transmissions.

The Ibeo ScaLa B2® and the Switch use Ethernet interfaces with 100 MBit/s. Therefore the cables used must meet the requirements of category 5 or better.
Depending on the system configuration, the interface Ethernet provides different data types:

- Scan data (see chapter 4 Scan and object data, page 27)
  - Ibeo ScaLa B2®: data type 0x2202 for ScaLa firmware version $<$ X027
  - Ibeo ScaLa B2®: data type 0x2208 for ScaLa firmware version $\geq$ X027
- Object data (see chapter 4 Scan and object data, page 27)
  - Ibeo ScaLa B2®: data type 0x2270 for ScaLa firmware version X026 - X030
  - Ibeo ScaLa B2®: data type 0x2271 for ScaLa firmware version $\geq$ X031

NOTE

Please refer to the ScaLa Ethernet Customer Documentation for more detailed information. Please also refer to chapter 4 Scan and object data, page 27. That chapter describes the differences between the data types and their basing coordinate systems.

3.3.2 Interface CAN

The Ibeo ScaLa B2® use CAN interfaces with 500 kBit/s. The CAN interface is only used to receive the ego motion data such as ego speed and ego yaw rate.
CAN participants try to establish a connection to the CAN bus over branch lines which should be as short as possible.

NOTE

Make sure to design and to terminate the CAN bus correctly.

3.4 Valeo Media Converter Box

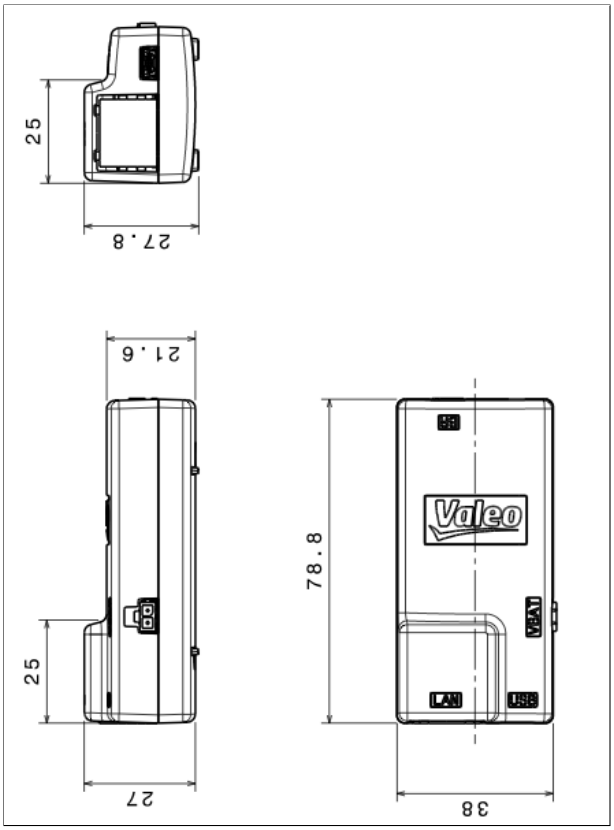

Figure 3.11: Valeo Media Converter Box

As in Figure 3.1 shown, the Ibeo ScaLa B2® System contains the Valeo Media Converter box. The Media Converter box converts BroadR-Reach standard to standard Ethernet protocol.
The Valeo Media Converter Box requires/ provides following connections:

- requires 9V to 16V power supply, at the VBAT-Connector (this cable is provided by Ibeo; see Figure 3.13)
- requires BroadR-Reach connection from the Ibeo ScaLa B2® (this cable is provided by Ibeo; see Figure 3.12)
- provides standard ethernet output (RJ45)

The standard ethernet output provides the scan and object data of the Ibeo ScaLa B2®.

BroadR-Reach cable

Figure 3.12: BroardR-Reach cable

Figure 3.12 shows the BroadR-Reach cable for the connection between the Ibeo ScaLa B2® and the Valeo Media converter Box.

Power Cable

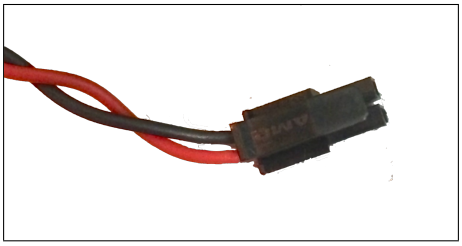

Figure 3.13: Power cable

Figure 3.13 shows the Power cable of the Valeo Media Converter Box.

4 Scan and object data

DANGER

With incorrect mounting position, the calculation of object speed can be incorrect or objects can even be missed. Applications working with these object data may not function properly.

4.1 Required input signals

In order to perform the object detection and tracking, the Ibeo ScaLa B2® requires some input signals. These are mainly the motion data of the host vehicle.
The required signals are:

Parameter	Data type	Description
Velocity	float	The speed of the host vehicle in m/s
Yaw rate	float	The turn rate of the host vehicle in rad/s

Table 4.1: Required Input Signals

For a robust function of the object detection and tracking these input signals should be provided at an update rate of more than 50Hz.

NOTE

The accuracy of the provided the input signals is directly influences the motion estimation of detected objects. Therefore the accuracy as well as the latency of these signals has major influence on the object detection performance.

4.2 Ibeo ScaLa B2® embedded Object Tracking

The scanning of the surroundings of the scan in the working range of the Ibeo ScaLa B2® is called scan process. The total set of measured data (= scan data) of a scan process, consisting of individual scan points, are called scan.
The transmitted laser pulses are reflected by objects within the measuring range. These echo pulses are received and analyzed by the Ibeo ScaLa B2®. Every detected echo pulse is represented by a scan point with the following main properties:

- Position of the point
- Width of the echo pulse
- Scan level and echo number

The Ibeo ScaLa B2® generates a two-dimensional profile of the surroundings, with additional height information (three-dimensional information) resulting from the multi-layer technology, see figure 3.5. This information usually only serve for adjusting the pitch movement of the vehicle to which the device is mounted, and they are used e. g. for masking the ground while the scan data are processed.
The typical representation of scan data is the bird's view, the view top view of the measuring level, which represents in a simplified way the border between the two middle scan levels.

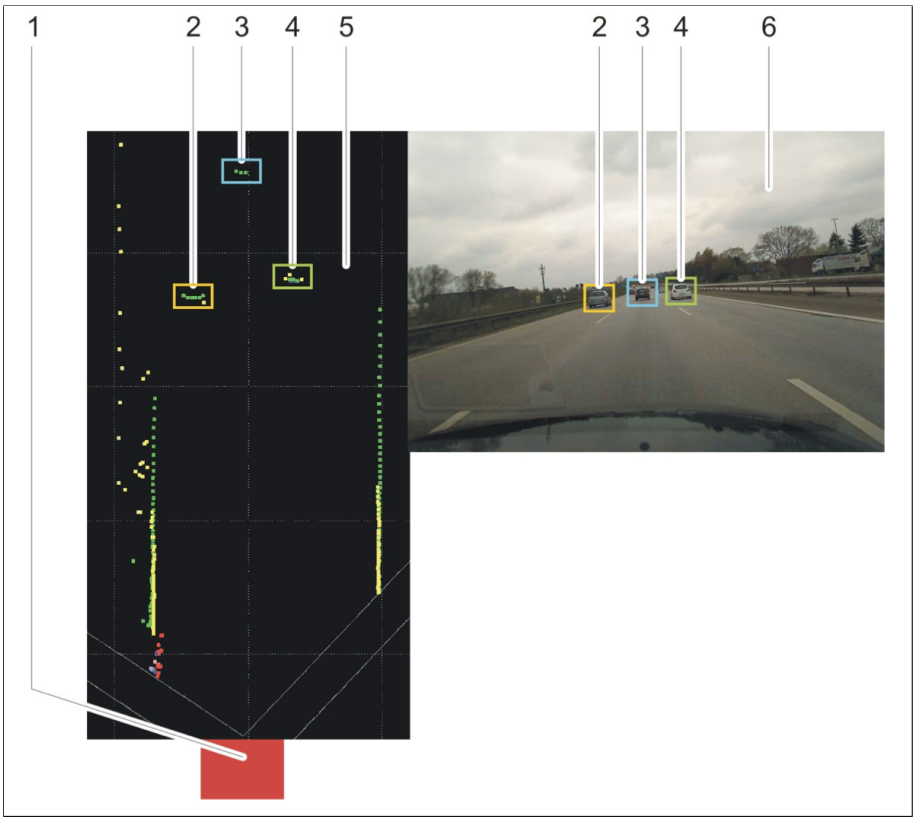

Figure 4.1: Scan data and video image

Description of items in figure 4.1:

1. Ibeo ScaLa B2®
2. Vehicle on the left lane
3. Vehicle on one's own lane
4. Vehicle on the right lane
5. Scan data image
6. Video image

Figure 4.1 shows a picture with excerpts from scan data (5) taken while driving on the highway. The scan points are displayed as colored dots. In the video image (6), which shall only serve for illustration, and in the scan data image, three vehicles (2, 3 and 4) each are marked with rectangles in different colors to make them easier to assign.
In the scan data image, the roadside border lines left and right are clearly visible. In this illustration, the colors of the points match the respective scan level.

Level	Echo 1	Echo 2	Echo 3
4 -yellow			
3- green			
2 - blue			
1 - red			

Figure 4.2: Naming convention

Color hues visualize the levels and color saturation of the echoes. Figure 4.2 lists the specified naming conventions for the levels and their preset colors used for the visualization.

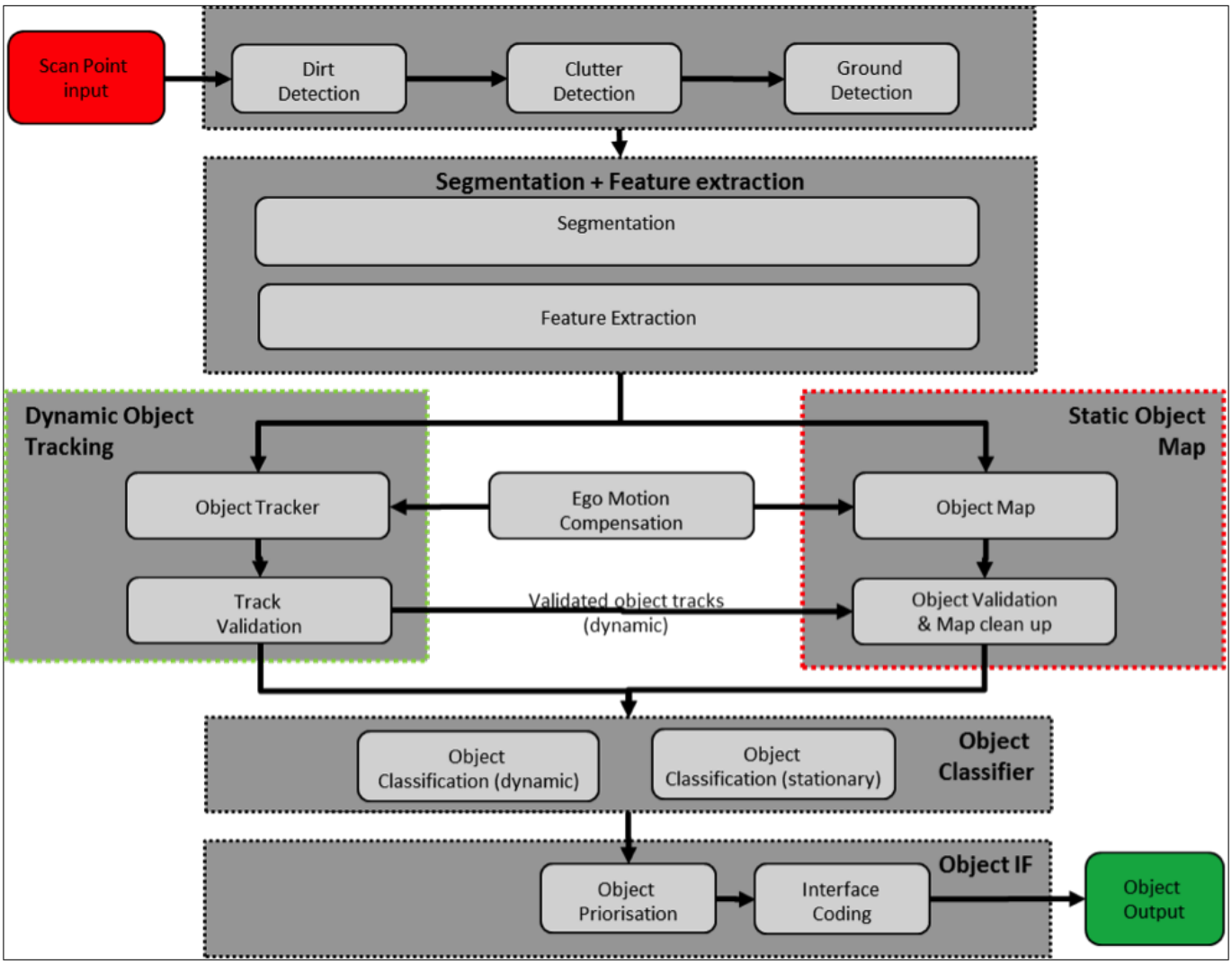

Figure 4.3: Scheme

The scheme, figure 4.3 gives an overview of the steps from scan data processing all the way to classified objects.

1. Scandata preprocessing
2. Segmentation and Feature extraction
3. Dynamic Object Tracking
4. Static Object Mapping
5. Object Classification
6. Object Output Interface

Scandata preprocessing

Scandata preprocessing assesses measured scanpoints with respect to their validity. Several sources, which can induce measurements on non relevant objects are taken into account:

- Dirt Detection: classifies points with respect to the probability to be induced by dirt on the sensor front window
- Clutter detection: classifies point with respect to the probability to be induced by atmospheric disturbances like rain, spray, fog, etc.
- Ground detection: classifies point with respect to their probability to be measured on the ground plane.

Segmentation and Feature Extraction

The segmentation process clusters neighboring scan points into clusters. Clusters are the basis for the object tracking and mapping - hence typically a single cluster of measurements belongs to one object, however an object can consist of multiple clusters.
From the clusters features are extracted. Features consist of a contour derived from the cluster of scan points.

Object Tracking /Object Mapping

The generation of objects is separated into two parallel running processing components. Dynamic object tracking is responsible to identify and track dynamic objects in the environment. The dynamic object tracking is based on a Kalman Filter tracking the object state (== object position, velocities, orientation and size). The geometrical object model is an orientated bounding box describing the estimated width and length of an object. Object velocities are calculated and provided in Cartesian coordinates.
A dedicated track validation is performed, to assure that only moving and movable objects (objects moved during observation time, but now are stationary again) are provided as dynamic objects.
All other objects are maintained, accumulated and validated in a static object map. By interfacing the validated dynamic object tracks to the map component, dynamic objects are removed from the map.
Static objects from the map are provided as a polyline description. A polyline description is best suited to describe unstructured environment for which a box description often lead to modelling errors.

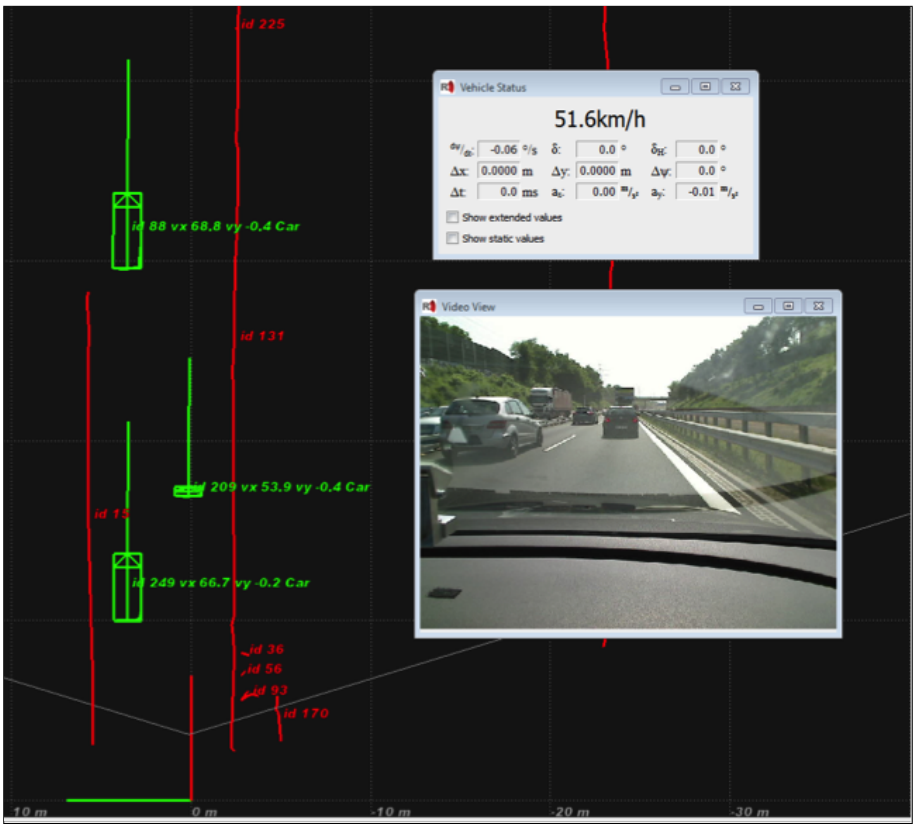

Figure 4.4: Object Tracking/ Object Mapping

Object Classification

Objects are classified based on their size, shape and absolute velocities. Distinguished classes are:

- Passenger Cars
- Trucks
- Pedestrians
- Bikes
- Unknown small
- Unknown big

Dynamic objects are classified into the classes car, truck, bike pedestrian. Static objects are only classified into unknown small and unknown big.

5 Configuration

5.1 CAN-Interface

The Ibeo ScaLa B2® uses the CAN-Bus for an input of the vehicle motion data such as velocity, yaw rate and driving direction. These information has to be provided to the Ibeo ScaLa B2® in a specific format on the CAN-bus.

Velocity

- **CAN-Msg id:** 0x100; Cycle Time: 20ms; DLC: 8Bit
- **Velocity lsb:** BYTE4-Bit0
- **Velocity msb:** BYTE5-Bit7
- **Format:** 16Bit unsigned, Intel format
- **Unit:** 0.01km/h
- **Velocity QBit:** BYTE6-Bit7, 1Bit boolean; '0': velocity is valid, '1': velocity is invalid
- **Example:** 0x00 00 00 00 B8 0B 00 00 = 30km/h

Yaw rate

- **CAN-Msg id:** 0x101; Cycle Time: 20ms; DLC: 8Bit
- **Yaw rate lsb:** BYTE5-Bit0
- **Yaw rate msb:** BYTE6-Bit5
- **Yaw rate sign bit:** BYTE6-Bit6, 1Bit bool, '0' : left turn (+), '1': right turn (-)
- **Format:** 14Bit unsigned, Intel format
- **Unit:** 0.01°/s
- **Yaw rate QBit:** BYTE1-Bit4, 1Bit boolean; '0': yaw rate is valid, '1': yaw rate is invalid
- **Example:** 0x00 00 00 00 00 F4 01 00 00 = 5.00°/s; 0x00 00 00 00 00 F4 41 00 00 = -5.00°/s

Driving direction

- **CAN-Msg id:** 0x116; Cycle Time: 20ms; DLC: 8Bit
- **Driving direction lsb:** BYTE7-Bit4
- **Driving direction msb:** BYTE7-Bit5
- **Format:**2Bit enum, 0b00: forwards, 0b01: backwards
- **Example:** 0x00 00 00 00 00 00 00 00 = forwards; 0x00 00 00 00 00 00 00 10 = backwards

5.2 Ibeo ScaLa B2® Configuration Tool ScaLaCom

For the best possible tracking in the Ibeo ScaLa B2® it is necessary to set the mounting positions of the Sensor. The mounting information has to be provided as precise as possible.
To do so the ScaLaCom Configuration Tool has to be used. The ScaLaCom Tool connects to the Ibeo ScaLa B2® via CAN.

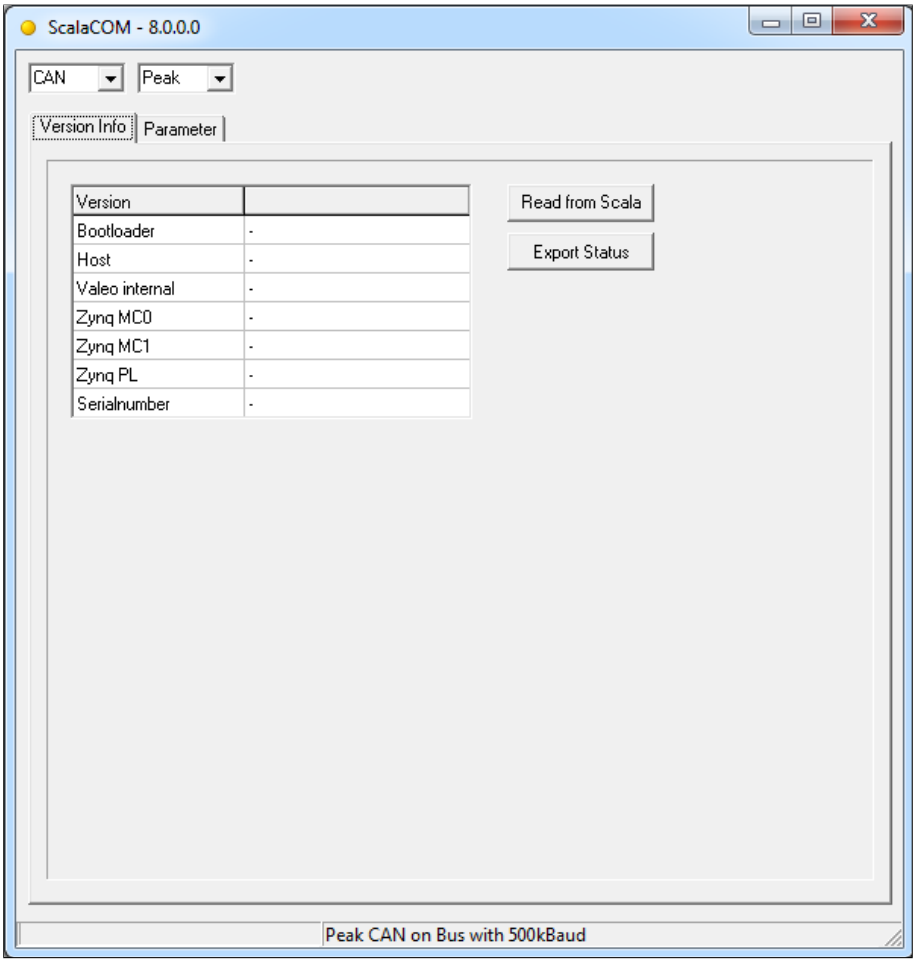

Figure 5.1: ScalaCom - First Screen

Figure 5.1 show the first screen when the Tool is started. On the top left side of the window is a field which sets the used CAN Device. It is possible to either use Peak or Vector.
To get the current status of the Ibeo ScaLa B2® or to write any data to it, the **Read from Scala** Button on the Version Info tab has to be pressed.
The **Export Status** Button will export the current status and configuration to a file. This is a very important functionality in case the Ibeo ScaLa B2® is not working properly. When contacting the Ibeo Support, please make sure this file is available for Ibeo.

Once the "Read from Scala" button is pressed, the ScalaCom Tool is reading the current data from the Sensor. Figure 5.2 and 5.3 are showing an example of an unconfigured Sensor.

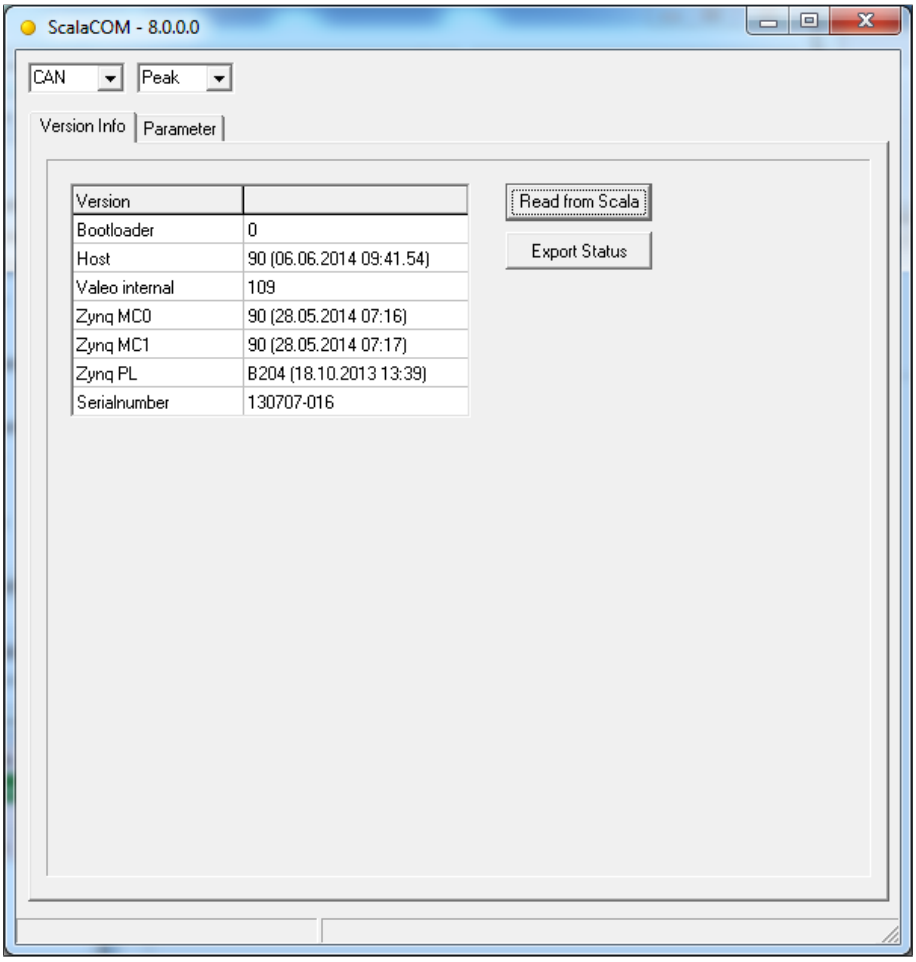

Figure 5.2: Read from Scala - Version Info

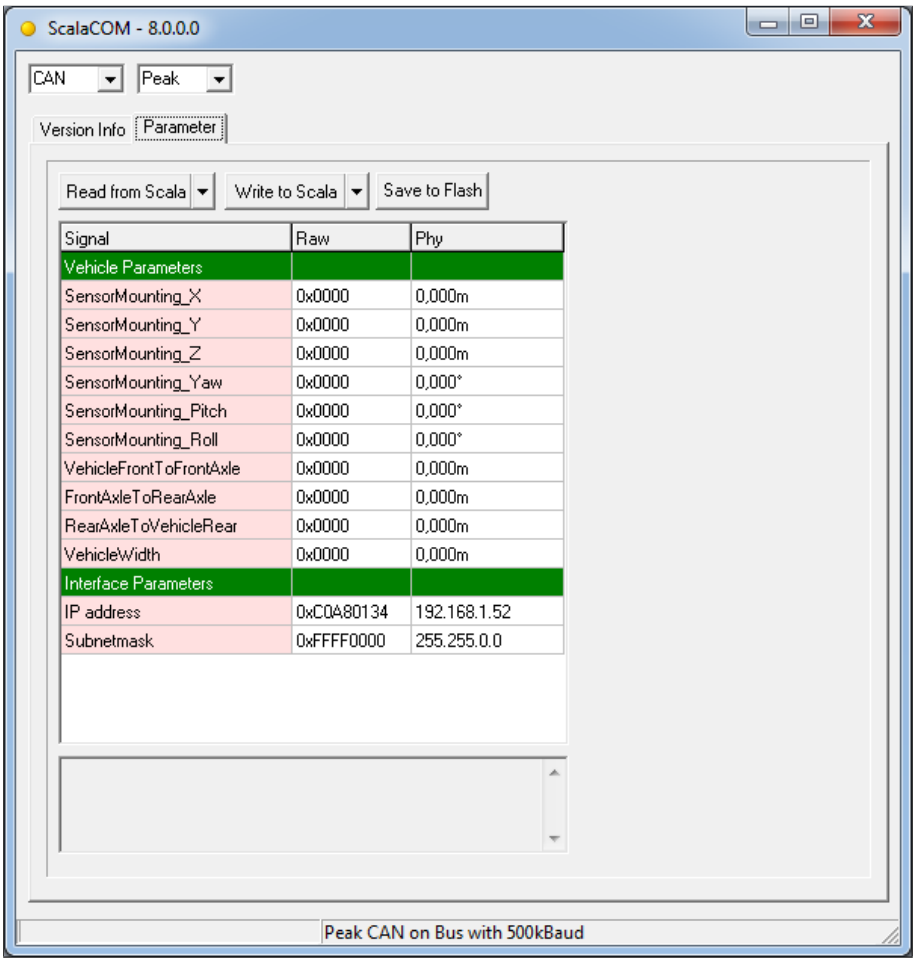

Figure 5.3: Read from Scala - Parameter

The Parameter tab has the following buttons:

- **Read from Scala:** As already mentioned this button reads the current configuration and needs to be pressed before configuring the Sensor
- **Write to Scala:** This Button will write the parameters that had beed entered into the ScalaCom to the Ibeo ScaLa B2®. Please keep in mind, this button will only write the data into a volatile memory.
- **Save to Flash:** When pressing this button, the parameters will be saved into the flash memory of the Ibeo ScaLa B2®. So the data will be kept even when the power supply of the Sensor is cut off.

Figure 5.4 shows an example of a configuration for the Ibeo ScaLa B2®.

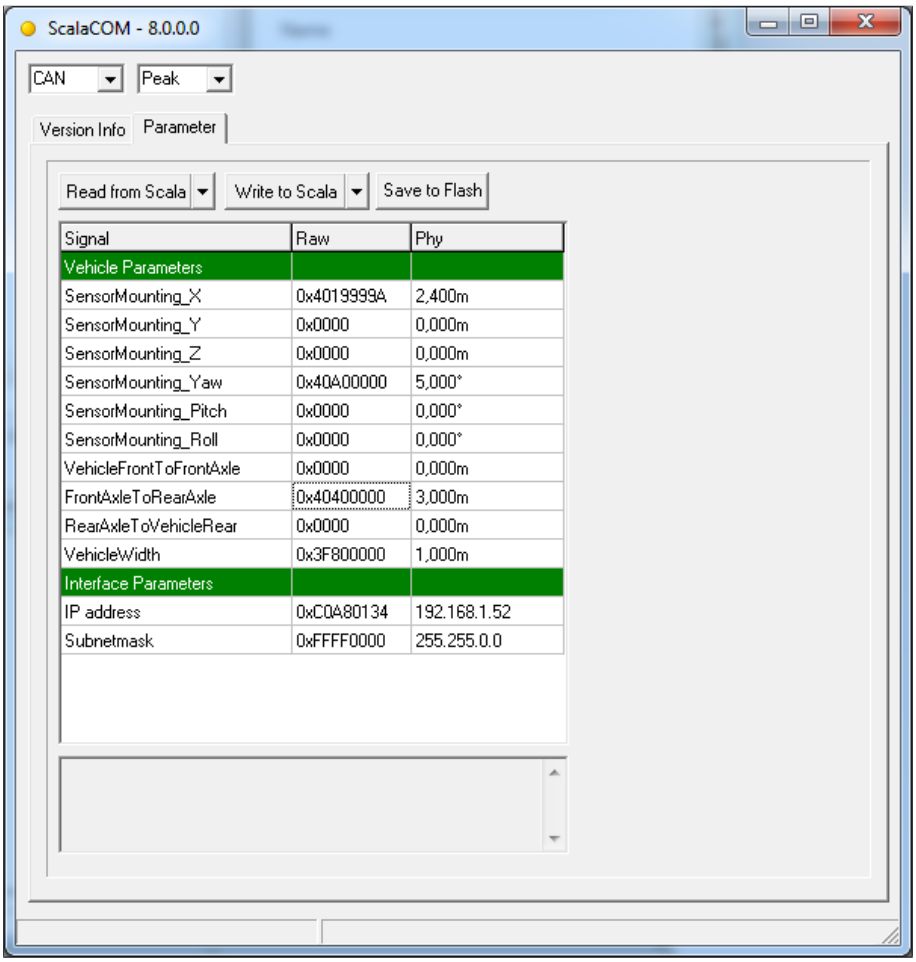

Figure 5.4: Example - Configured Ibeo ScaLa B2®

NOTE

Please keep in mind, the origin of the coordinate system is always the center of the rear axle on the ground! All mounting positions have to be referenced to this point.

5.3 ILV visualisation

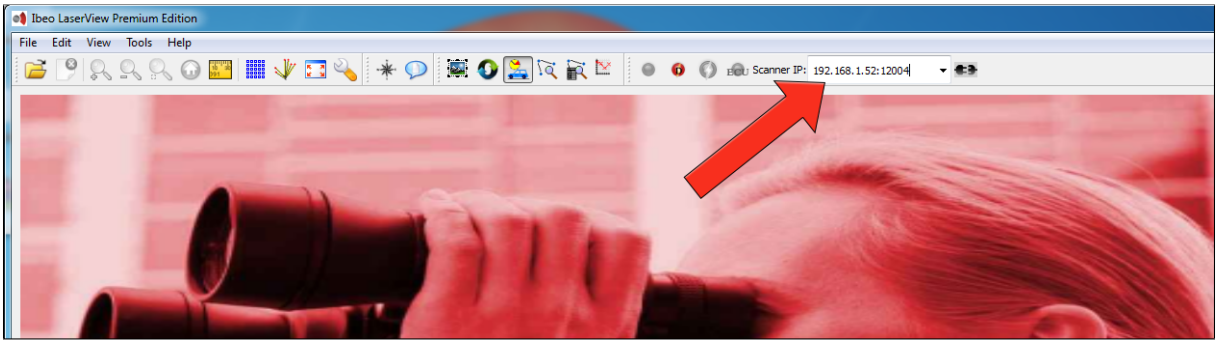

Figure 5.5: ILV connection

To connect the Ibeo ScaLa B2® via ILV, please type the right IP address with the appropriate port number in the connection field of ILV (refer to Figure 5.5). This is for the Ibeo ScaLa B2®: **192.168.1.52:12004**
The scan and object data will appear once the connect button is then activated. For a description of the ILV-Premium software, please refer to the ILV customer manual.

NOTE
To be able to connect the Ibeo ScaLa B2®, please make sure the machine ILV is running on is in the same network as the Sensor

6 Mounting and installation

DANGER

Opening the Ibeo ScaLa B2® is strictly forbidden. Some parts inside the Ibeo ScaLa B2® are under high voltage.

DANGER

Opening the Ibeo ScaLa B2® is strictly forbidden. If the housing is open, the safety of your eyes cannot be ensured because direct eye contact with the laser is possible.

6.1 Sensor adjustment

In order to ensure proper function of the system, the Ibeo ScaLa B2® needs to be configured and adjusted after mounting.

6.1.1 Coordinate system

Top view

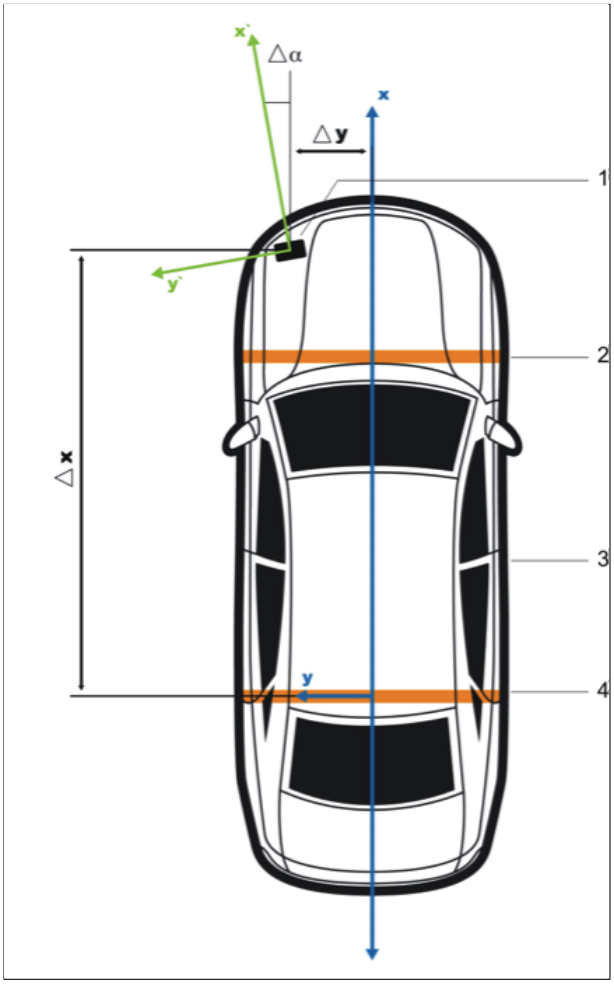

Figure 6.1: Top view

1. Ibeo ScaLa B2®
2. Front axle
3. Vehicle
4. Rear axle

$\Delta\alpha$ Sensor mounting yaw angle

Δx Sensor mounting x

Δy Sensor mounting y

x x-axis of the vehicle coordinate system

y y-axis of the vehicle coordinate system

x' x-axis of the sensor coordinate system

y' y-axis of the sensor coordinate system

Side view

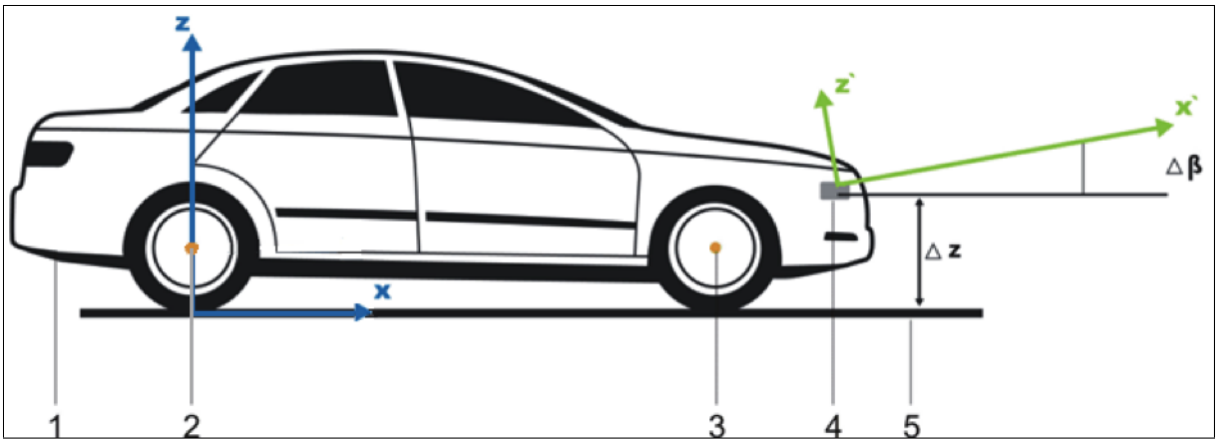

Figure 6.2: Side view

1. Vehicle
2. Rear axle
3. Front axle
4. Ibeo ScaLa B2®
5. Level surface

Δz Sensor mounting z

Δß Sensor mounting pitch angle

z z-axis of the vehicle coordinate system

z' z-axis of the sensor coordinate system

6.2 Sensor mounting

CAUTION
Danger of slight hand injuries during mounting. Be very careful and wear gloves, if necessary, to avoid injuries.

6.2.1 Mounting bracket

Figure 6.3: Valeo Scala B2 mounting bracket

For best tracking and classification results, please use following recommendations:

- 0° mounting roll angle
- 0° mounting yaw angle
- 30cm-50cm mounting height above ground
- 0° mounting pitch angle

This recommendation determination is based on the fact that all algorithms are developed and tested for these mounting positions.
With the standard mounting bracket, the mounting roll angle cannot be changed after installation, make sure the bracket mounting roll angle is very close to 0°. The same goes for the mounting yaw angle, but the yaw angle can be configured in a software parameter.

6.2.2 Sensor Roll Angle

As there is currently no known procedure based on optics, there is no other way than to determine a 0° roll angle during mounting, use a spirit level when the vehicle is placed on a leveled surface.

6.2.3 Sensor mounting configuration

The sensor can be configured with software parameters:

- Mounting x
- Mounting y
- Mounting z
- Mounting yaw

However the current state of the software does not take into account the Mounting Roll and Pitch. So mounting with roll and pitch angle other than 0° can lead to poor performance.

6.3 Connector and Pinning

Please see chapter 3.4 on page 25 for the connections on the Valeo Media Converter Box.
The Ibeo ScaLa B2® connector is of type Tyco C-114-18063-34.

Figure 6.4: Connector and Pinning

Pin No.	Signal
1	CAN Hi
2	Reserved
3	Reserved
4	GND
5	CAN Lo
6	ETH P
7	ETH N
8	Terminal 15/ Power

Table 6.1: Connector and Pinning

7 Technical data

Technical data	
Wave length	905nm
Laser class	1
Range min - max	0.3m - 327m
Distance resolution	0.04m
Field of view (hor)	145° (4L)
Angular resolution (hor)	0.25°
Field of view (vert)	3.2°
Angular resolution (vert)	4 layers @ 0.8°
Distance error	$<$ 0.1m
Velocity accuracy (v_x, v_y)	0.25m/s
Update rate	25Hz (40ms)
Processing latency	$<$ 40ms
Dimensions WxDxH [mm]	108x100x60
Weight	510g
Power consumption (without Heating)	$<$ 7W
Power consumption of Heating	40W
CAN interface	yes, only used for Input of Vehicle Data
Other interfaces	ETH
embedded object tracking	$>$ 30 tracks, static map

Table 7.1: Technical data