ibeo LUX

Operating Manual

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1. About this document

Please read this chapter carefully before working with the documentation and the ibeo LUX®.

1.1 Principle of the document

This operating manual (OM) contains all information required for transport, storage, mounting, installation, commissioning, and operation. The operating manual is a part of the technical documentation of the ibeo LUX®.

This operating manual does not include instructions for operation of the vehicle into which the ibeo LUX® is integrated. For information about that, refer to the operating manual of the vehicle.

This operating manual shall help you to avoid improper use. Strict adherence to the instructions given in this operating manual ensures the function of the ibeo LUX®. Therefore always keep this operating manual in the vehicle.

1.2 Target group

This operating manual is written for trained and qualified staff who will integrate, commission or configure the ibeo LUX® into a vehicle.

The following conventions apply in this operating 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: Operating Manual (OM)

- 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. Links to the figures are structured as follows:
  4-1/2
  item number
  consecutive number of the figure
  chapter number

In chapter 2 Safety, page 2-1, you find general safety notes about possible dangers when operating the ibeo LUX®. 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 LUX® 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 operating 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 possible 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 LUX® as owner or hirer. He is responsible for

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

1.4.2 Trained staff

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.

Additionally the trained staff must know the applicable regulations, accident prevention regulations and the specific operating conditions. Responsible for the required training is the operator, who has to determine the suitability of the trained staff. Trained staff mount, install, configure, commission, adjust, and clean the ibeo LUX®.

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 LUX®,
- reset the devices connected to the ibeo LUX®,
- launch or shut down the software of the ibeo LUX®.
- update new software for the ibeo LUX®.

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

1.5 Manufacturer

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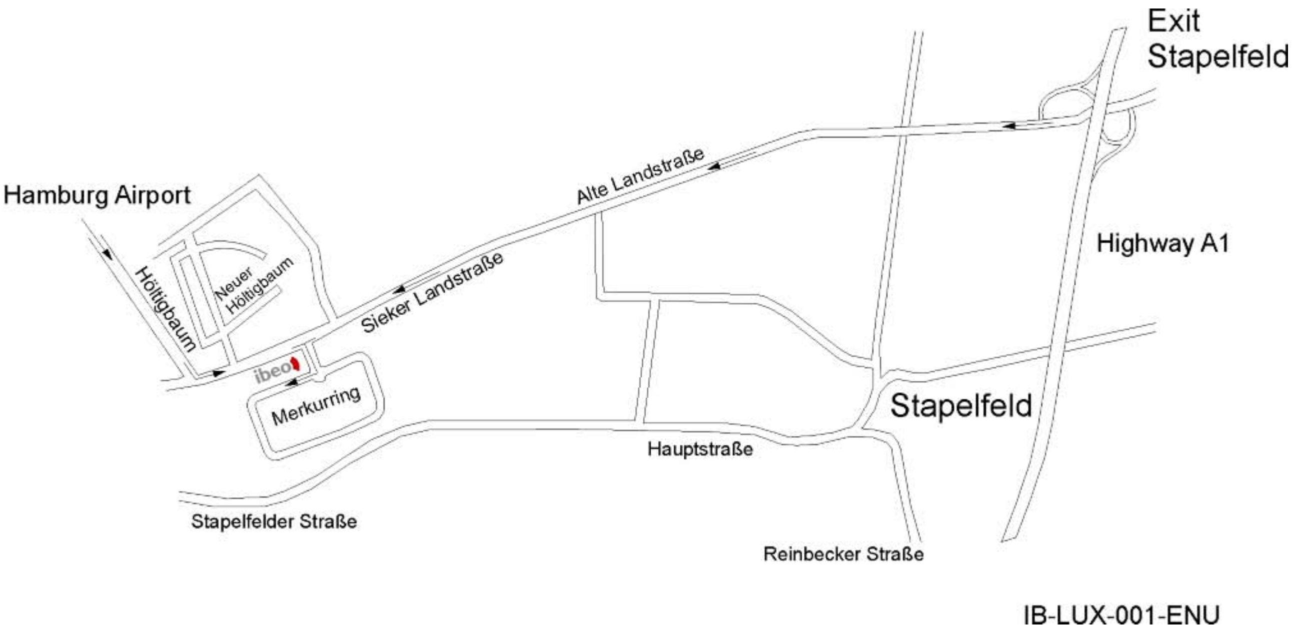

Figure 1-1: *Directions*

1.6 Warranty

CAUTION

The ibeo LUX® including its software and the OM are still in the development stage and this in the prototype state. Therefore, its usage is limited to test purposes only.

The ibeo LUX® 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.

In case of using the ibeo LUX® 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 LUX® 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 LUX® 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 14 Technical data, page 14-1.

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

The ibeo LUX® can cause danger for persons and property if handled or used improperly. Therefore the operator must ensure that every person working with the ibeo LUX® has read and understood this OM.

For installation and usage of the ibeo LUX® as well as for commissioning and regular technical inspection, national/international legal requirements apply.

The operator of a vehicle equipped with an ibeo LUX® 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 operating 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 LUX® is always clean.
- Additionally, the local safety and accident prevention regulations apply for operating the ibeo LUX®.
- A defect of the control functions can cause danger for human life or property damage at the ibeo LUX®.

2.3.1 Laser class

The ibeo LUX® fulfills the requirements of laser class 1 of the European laser standard EN 60825-1:1994 + A1:2002 + A2:2001.

The ibeo LUX® 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 LUX®,
- take measures for antistatic protection,
- make sure that only trained staff modifies the ibeo LUX®.

The trained staff must report any relevant modifications in the functional sequence of the ibeo LUX® immediately to the operator.

2.3.3 Disposal

The ibeo LUX® is designed to burden the environment as little as possible and to consume a minimum of energy and resources.

3. Product overview

3.1 System variants

Depending on usage and purpose, the ibeo LUX® can build a system in combination with different components. The four most common cases are described in detail below:

- System of standard individual components
  The ibeo LUX® is operated by itself, without further processing components.
  This system is reduced to the basic required components and uses a LUX standard connecting cable. It serves for applications which use an Ethernet connection as only interface.
- ibeo LUX Single System
  This system also uses the ibeo LUX® by itself, without further processing components, enjoying the advantages of integrated measuring data evaluation.
  By using the LUX-Connector, you can access several interfaces.
- ibeo LUX Fusion System
  Two ibeo LUX® are operated in combination with a processing unit (ECU). This option allows for combining the field of view of two ibeo LUX®, the data are merged in the ECU.

- ibeo LUX Power Fusion System
  To combine four (default) or up to six ibeo LUX® with the corresponding advantage of a very large field of view serves the ibeo LUX Power Fusion System.
  As in the ibeo LUX Fusion System, this also requires the processing unit of the ECU to combine the scan data.
  In addition, a LUX-Switch serves for connecting the ibeo LUX® .

3.1.1 System of standard individual components

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

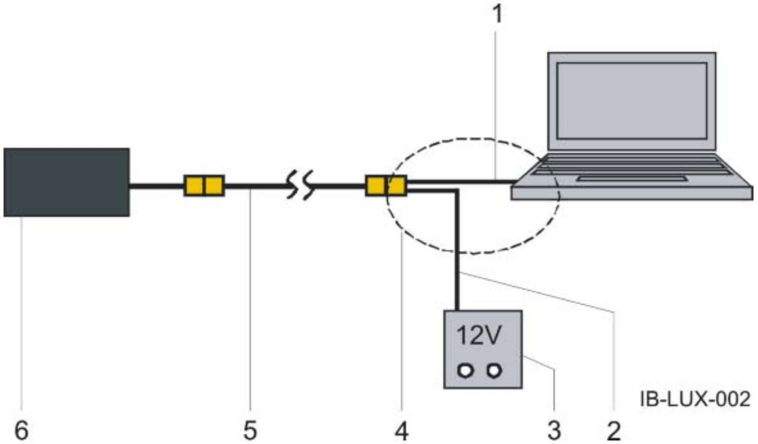

Figure 3-1: *System of standard individual components*

Description of items in figure 3-1:

1	Ethernet connection to network or PC	4	LUX standard connection cable
2	Supply line	5	LUX extension cable (option)
3	Power supply	6	ibeo LUX® incl. permanently installed connecting cable

3.1.2 ibeo LUX Single System

The ibeo LUX Single System with the LUX-Connector (3-3/10) is used if more than one interface is to be used, see chapter 3.2.2 LUX-Connector, page 3-46.

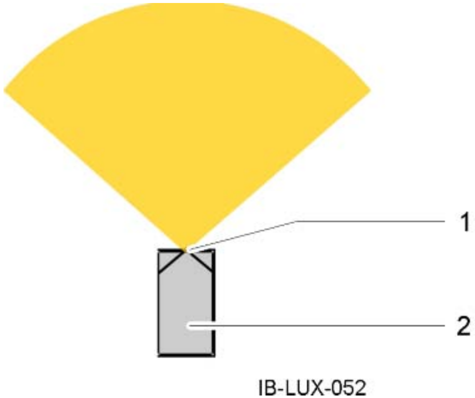

Figure 3-2: ibeo LUX® in the Single System

Figure 3-2 illustrates an example for using the ibeo LUX Single Systems with integrating the ibeo LUX® (3-2/1) in the front area of a vehicle (3-2/2).

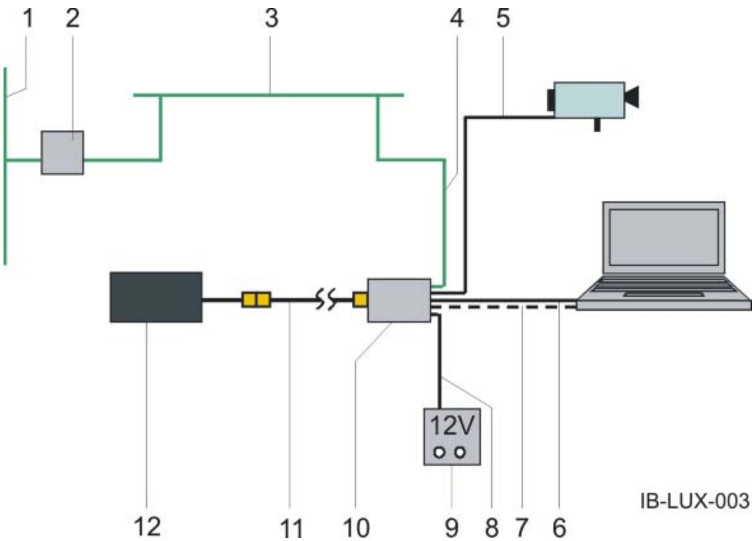

Figure 3-3: Principle of the ibeo LUX Single System

Description of items in figure 3-3:

1	CAN bus, vehicle	7	Interface RS232
2	CAN gateway	8	Supply line
3	CAN customer	9	Power supply
4	Connector cable for CAN	10	LUX-Connector
5	Sync line to or from external devices	11	LUX extension cable
6	Ethernet connector cable to network or PC	12	ibeo LUX® incl. permanently installed connecting cable

3.1.3 ibeo LUX Fusion System

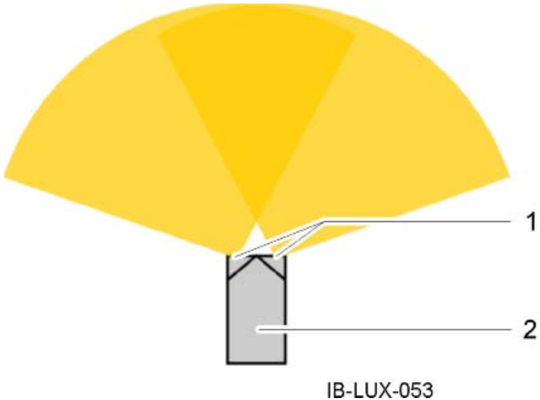

Figure 3-4: Two ibeo LUX® in the front area

The ibeo LUX Fusion System with its two ibeo LUX® (3-4/1) is often used to achieve an almost complete coverage of the area in front of the vehicle when integrating the ibeo LUX® into the vehicle front area (3-4/2).

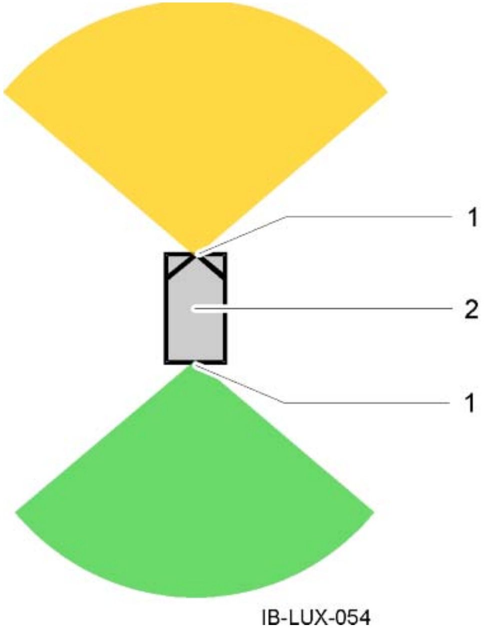

Figure 3-5: ibeo LUX® in the front and back area

With central placement at the front and the back of the vehicle (3-5/2), the two ibeo LUX® (3-5/1) cover the corresponding areas.

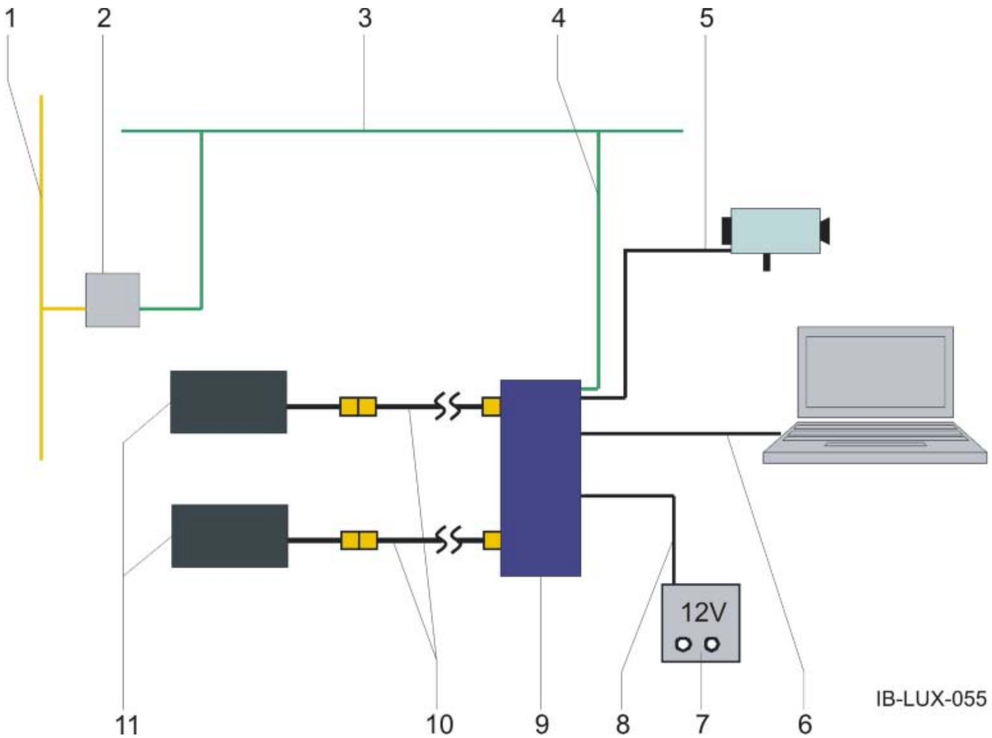

Figure 3-6: Principle of the ibeo LUX Fusion System

Description of items in figure 3-6:

1	CAN bus, vehicle	7	Power supply
2	CAN gateway	8	Supply line
3	CAN customer	9	ECU
4	Connector cable for CAN	10	LUX extension cable
5	Sync line to or from external devices	11	ibeo LUX® incl. permanently installed connecting cable
6	Ethernet connector cable to network or PC		

The ibeo LUX Fusion System employs two ibeo LUX® (3-6/12) in combination with a processing unit (ECU) (3-6/10).

This system allows for combining the field of view of two ibeo LUX®. The data are merged in the ECU.

3.1.4 ibeo LUX Power Fusion System

The ibeo LUX Power Fusion System with four ibeo LUX® (3-7/1) is often used to achieve very large fields of view. If places at the front and the back of the vehicle (3-7/2), the four ibeo LUX® cover the corresponding area.

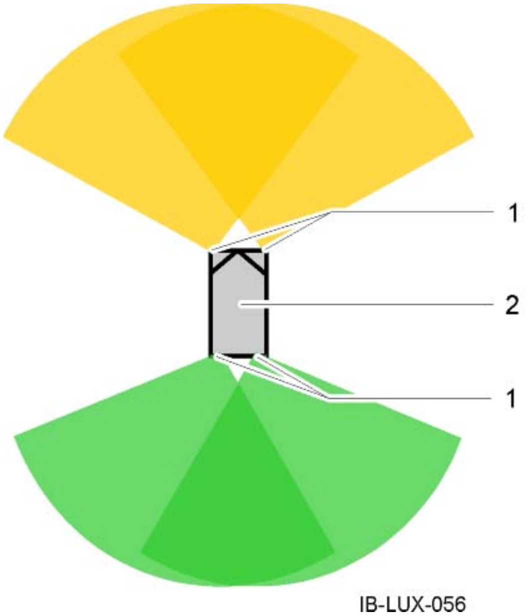

Figure 3-7: Two ibeo LUX® each in the front and back area

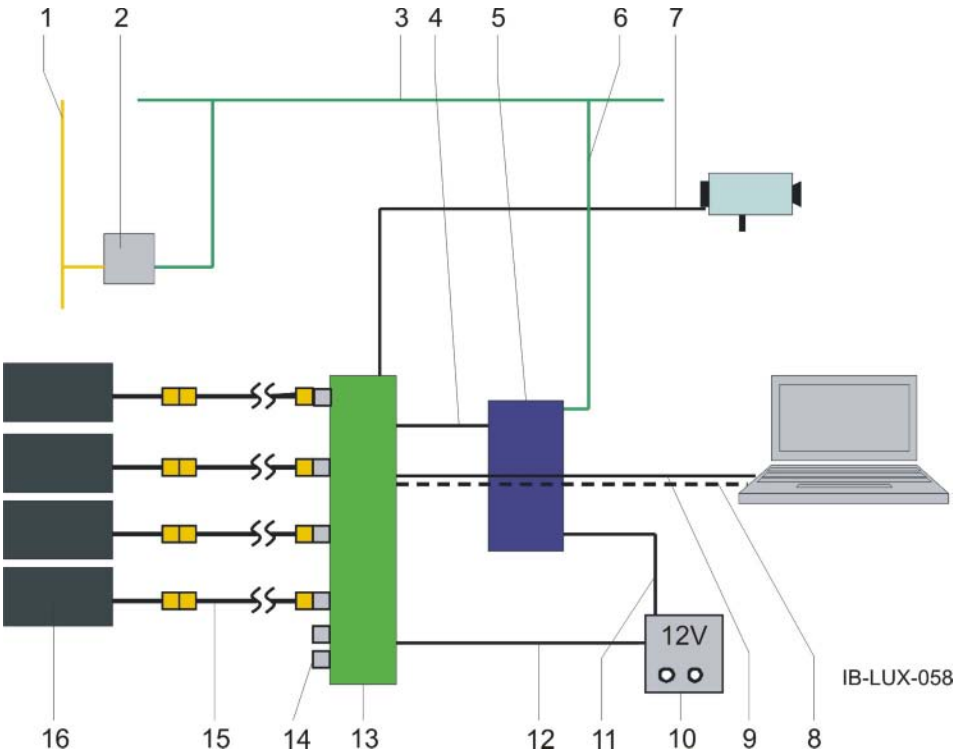

Figure 3-8: Principle of the ibeo LUX Power Fusion System

Description of items in figure 3-8:

1	CAN bus, vehicle	9	Ethernet connector cable to network or PC
2	CAN gateway	10	Power supply
3	CAN customer	11	Supply line
4	Ethernet connection from the LUX-Switch to the ECU	12	Supply line
5	ECU	13	LUX-Switch
6	Connector cable for CAN	14	Interface sensor
7	Sync line to or from external devices	15	LUX extension cable
8	Interface RS232	16	ibeo LUX® incl. permanently installed connecting cable

The ibeo LUX Power Fusion System operates four (default) or up to six ibeo LUX® (3-8/16) via the LUX-Switch (3-8/13) with one processing unit (ECU) (3-8/5).

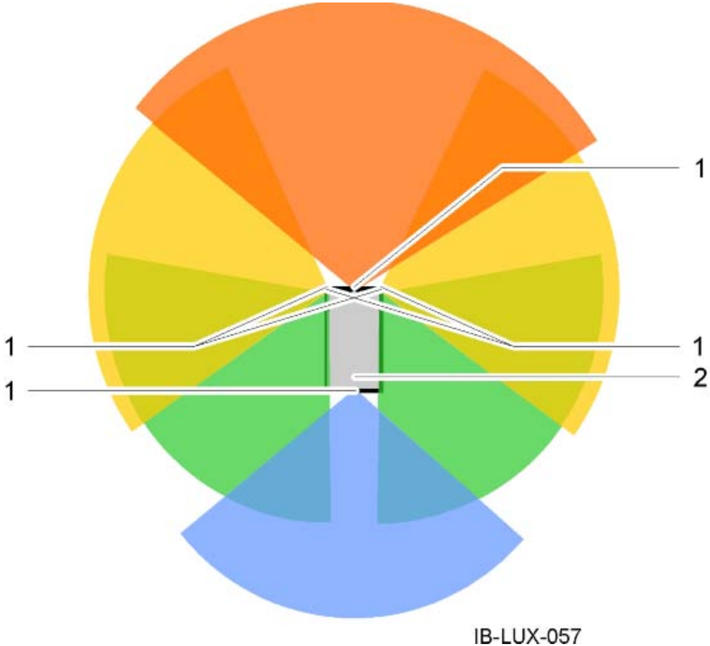

Figure 3-9: Six ibeo LUX® around the vehicle

The ibeo LUX Power Fusion System with six ibeo LUX® (3-9/1) is often used to achieve extensive all-around detection of the vehicle's surroundings.

To achieve all-round detection, the six ibeo LUX® can be mounted on the vehicle (3-9/2) as shown in figure 3-9.

3.2 Components

3.2.1 ibeo LUX®

3.2.1.1 Function

The function of the ibeo LUX® 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 LUX® over four levels and measure the distance and the direction (the angle in relation to the ibeo LUX®) 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 4-1.

The ibeo LUX® provides two different kinds of information:

- Scan data
  (for all scan frequencies)
- Object data
  (for the scan frequency of 12.5 Hz)

The scan data are the initial information, i. e. information in which area of the field of view of the ibeo LUX® 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 only provided via Ethernet because of their details representation and thus the very extensive amount of data.

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 can be sent via the interface CAN (3-1/7) and/or the interface Ethernet (3-1/6) and can be reused, if necessary, see chapter 3.3 Interfaces , page 3-76.

To transform scan data into object data, different processes are performed in the ibeo LUX®. For a detailed description see chapter 4 Scan and object data, page 4-1.

The ibeo LUX® is pre-configured by default, however, the customer can adjust some parameters, see chapter 8 Configuration, page 8-1.

3.2.1.2 Measuring process and measuring properties

The ibeo LUX® is a measuring instrument basing on Light Detection And Ranging (LIDAR) technology, i. e. the ibeo LUX® 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 interfaces Ethernet and/or CAN.

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 LUX®. The scan data of the ibeo LUX® consist of the distance, the angle and the echo pulse width.

The measurement properties base on

- time-of-flight measurement,
- multi-target capability,
- multi-layer technology,
- the working range and the relation of angle to range
- the angle resolution and the scan frequency.

3.2.1.2.1 Time-of-flight measurement

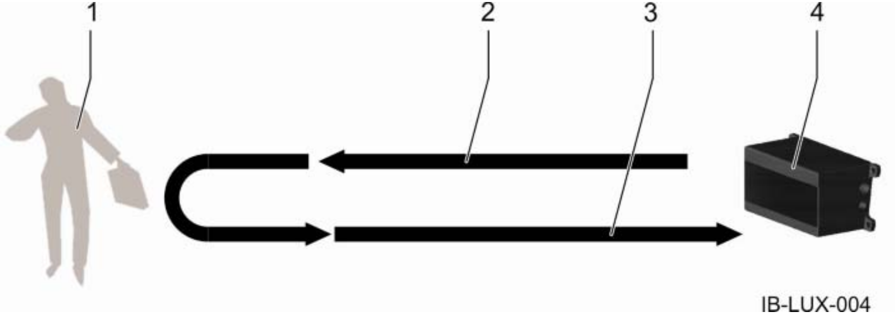

Figure 3-10: Principle of time-of-flight measurement

Description of items in figure 3-10:

1	Object	3	Laser pulse, reflected
2	Laser pulse, transmitted	4	ibeo LUX®

The laser pulses (3-10/4) transmitted by the ibeo LUX® (3-10/2) are reflected by the objects (3-10/1) in the surrounding area.

The ibeo LUX® gathers the reflection of the laser pulse (3-10/3), processes the information, and sends the data to the customer via Ethernet/CAN.

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 LUX®.

3.2.1.2.2 Multi-target capability

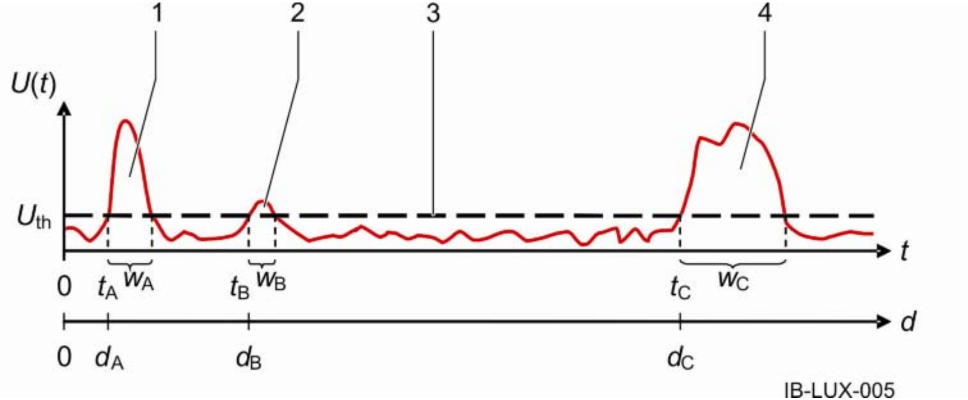

Figure 3-11: Multi-target capability

Description of items in figure 3-11:

1	Example: echo of a window pane	V(t)	Output voltage
2	Example: echo of a rain drop	t	Time
3	Threshold voltage	d	distance
4	Example: echo of an object	W	echo pulse width
		A	Window pane
		B	Rain drop
		C	Object
		U_{th}	Threshold voltage

The ibeo LUX® 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 LUX®, the received intensity is transformed into a voltage.

The example in figure 3-11 shows that a reflected echo of a window pane (3-11/1) yields a very high voltage over a short period of time.
The echo of a rain drop, however, yields a very low voltage (3-11/2) over a short period of time.
The echo of an object (3-11/4) 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 LUX® uses the two threshold passages to analyze the echo pulse widths $w_{A/B/C}$.

3.2.1.2.3 Multi-layer technology

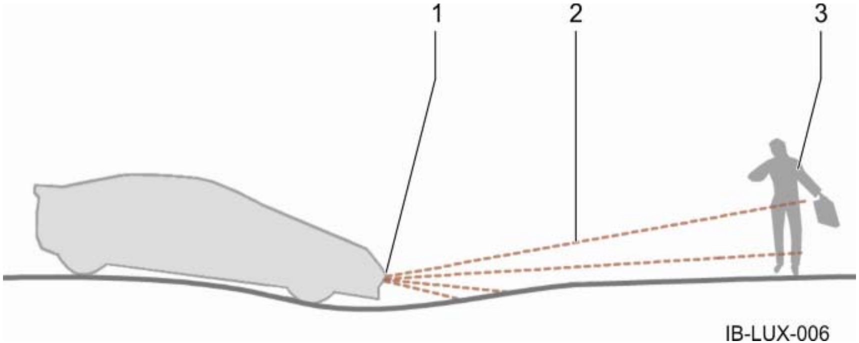

Figure 3-12: Principle of multi-layer technology

The multi-layer technology of the ibeo LUX® allows for pitch angle compensation by means of four scan levels (3-12/2) with different vertical angles of the vehicle.
The enables the ibeo LUX® (3-12/1) to detect the object (3-12/3) better, also if the vehicle is e. g. accelerating or braking.

Description of items in figure 3-12:

1	ibeo LUX®
2	Scan level
3	Object

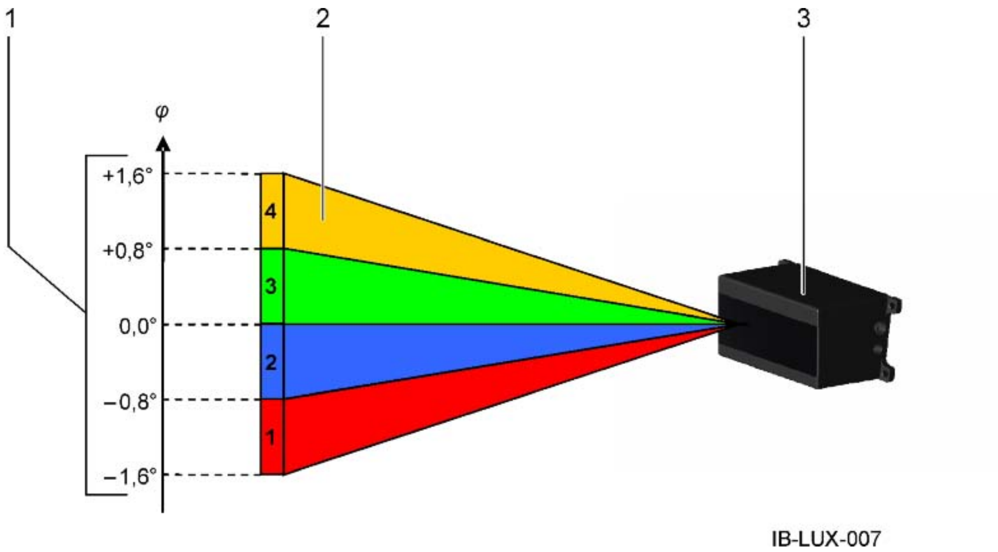

Figure 3-13: *Scan level*

Description of items in figure 3-13:

1	Vertical opening angle (φ)	3	ibeo LUX®
2	Scan level		

The photo diode receiver of the ibeo LUX® (3-13/3) consists of four independent receivers arranged in a line. These four receivers enable the multi-layer technology.
One receiver is assigned to each level, which divides the vertical opening angle (3-13/1) into four scan levels (3-13/2).

These four scan levels are scanned interlaced. This means that the combination of two levels is always scanned simultaneously (first e. g. the yellow and the green level, then the blue and the red level), see chapter 3.2.1.2.5 Angle resolution and scan frequency, page 3-34.

.

Level	Echo 1	Echo 2	Echo 3
yellow	Scan level 4	Scan level 4	Scan level 4
green	Scan level 3	Scan level 3	Scan level 3
blue	Scan level 2	Scan level 2	Scan level 2
red	Scan level 1	Scan level 1	Scan level 1

Table 3-1: Naming convention (colors see figure 3-13)

Color hues visualize the levels and color saturation of the echoes. Table 3-1 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 3-11

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).

3.2.1.2.4 Working range and relation of angle to range

Working range

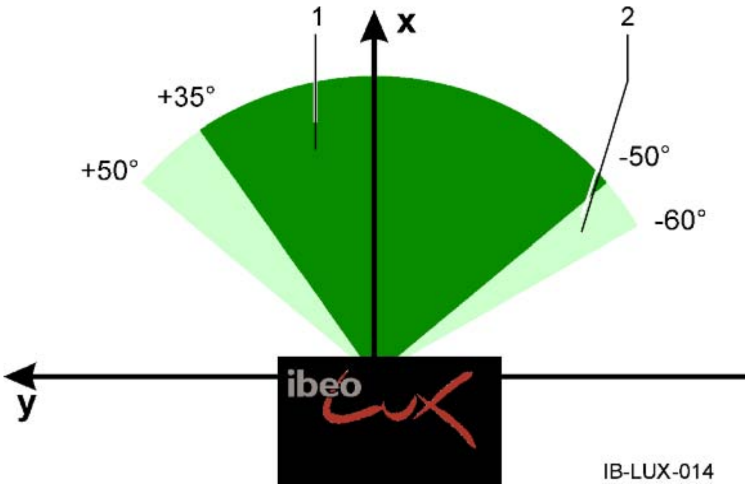

Figure 3-14: Working range

Description of items in figure 3-14:

1	central working range (green)
2	lateral working range (light green)

The ibeo LUX® is designed with a central working range of 85° for four scan levels (3-14/1).

The working range can be extended between +35° and +50° or -50° and -60° to 110°. The lateral working ranges (3-14/2) only provide two instead of four scan levels.

Relation of angle to range

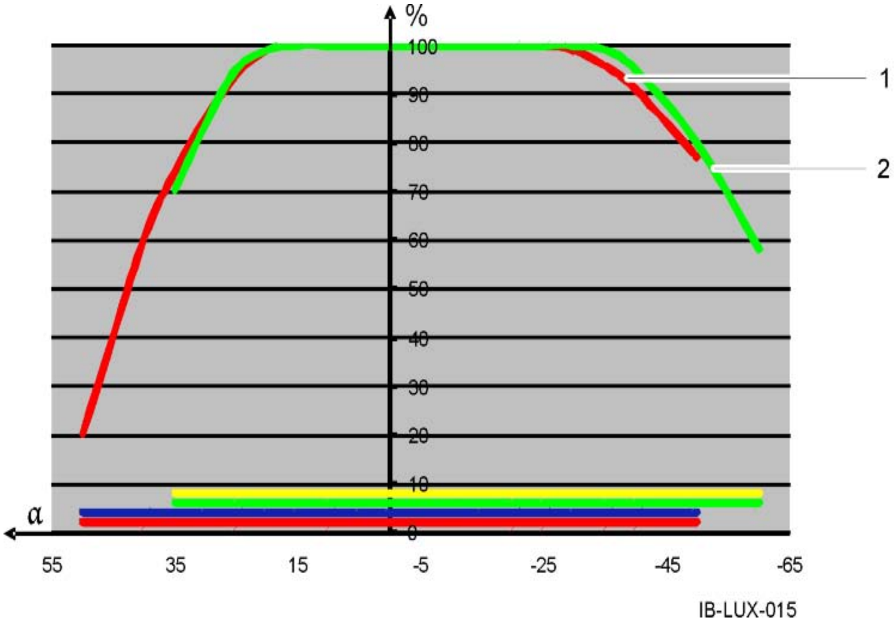

Figure 3-15: Relation of angle to range

Description of items in figure 3-15:

1	Upper levels (scan levels 1 and 2)	%	Range in %
2	Lower levels (scan levels 3 and 4)	α	Angle in °

Due to the optical design of the ibeo LUX®, the working range depends on the angle, see figure 3-15.

3.2.1.2.5 Angle resolution and scan frequency

The ibeo LUX® can be operated with three different scan frequencies (12.5 Hz, 25 Hz and 50 Hz), which allow for different settings of the angle resolution.
These parameters can be configured by the customer, see chapter 8 Configuration, page 8-1.

Angular resolution

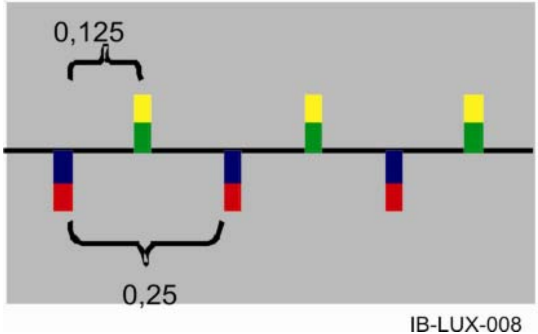

Figure 3-16: Angular resolution

Two scan levels (3-13/2) each are measured and analyzed simultaneously. If an angle resolution of 0.125° is specified for a certain range, then 0.125° is the distance between two scan levels (e. g. red-blue) and their partners (e. g. yellow-green). The angle for the next measurement on the same level is twice as high, in this example 0.25°.

With a scan frequency of 12.5 Hz the angle resolution can be selected constant or differing by sector.
The scan frequencies of 25 Hz and 50 Hz only allow for constant angle resolution.

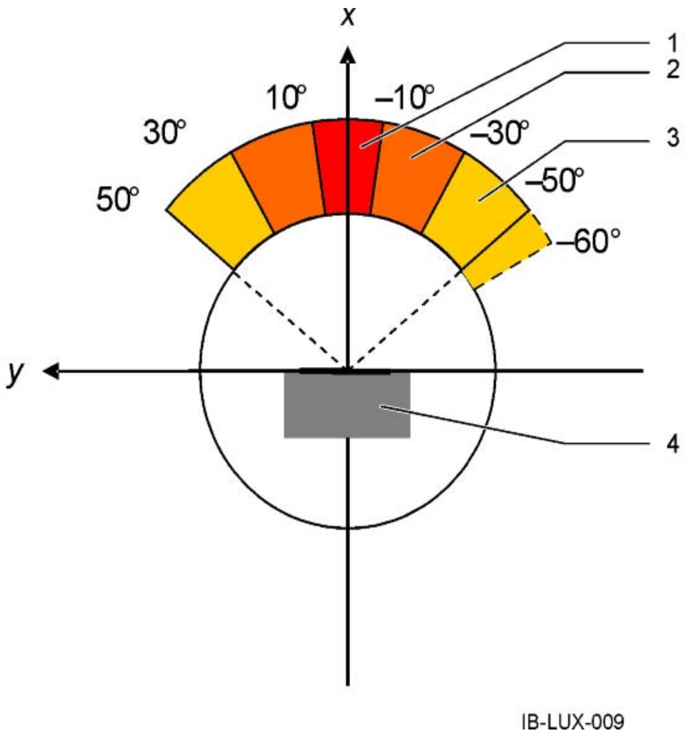

Figure 3-17: Angle resolution differing by sector

Description of items in figure 3-17:

1	central range	3	lateral range
2	medium range	4	ibeo LUX®

The angle resolution differing by sector depends on the requirements of use in the vehicle.

The focus of the angle resolution is in an area of ±10 ° (3-17/1) around the direction of travel, referred to as central area.
The direction of travel is defined as the x-axis of vehicles.
The central area is characterized by a high angular resolution in order to gain good measuring results, e.g. for ACC (Adaptive Cruise Control) even over larger distances with multiple measuring data per object.

A slightly lesser angle resolution is applied in the medium area (3-17/2) of ±(30° to 10°) around the x-axis.

The lateral area between +50° to +30° and -30° to -60° (3-17/3) for objects on the side has a smaller angle resolution because the objects in that area are less relevant.

Scan frequency 12.5 Hz

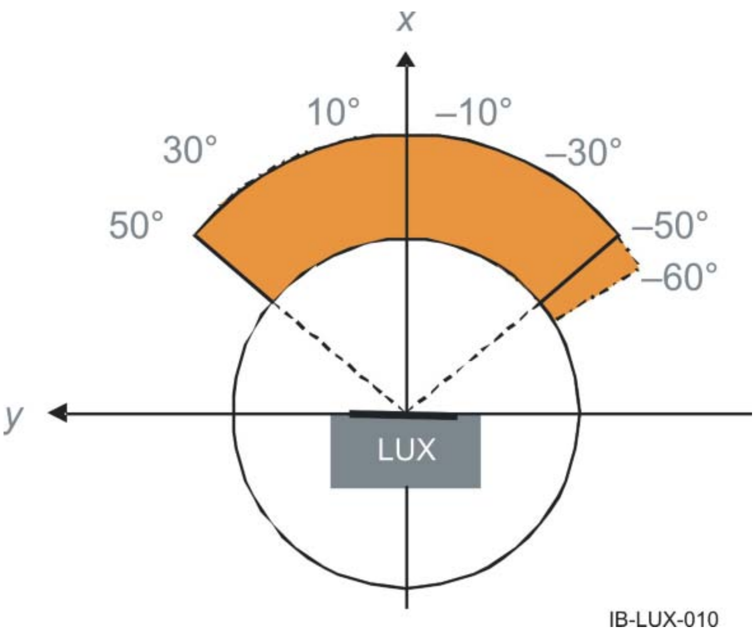

Figure 3-18: Scan frequency 12.5 Hz, constant angle resolution of 0.25°

At the scan frequency 12.5 Hz with constant angle resolution, the angle resolution is 0.25°, see figure 3-18.

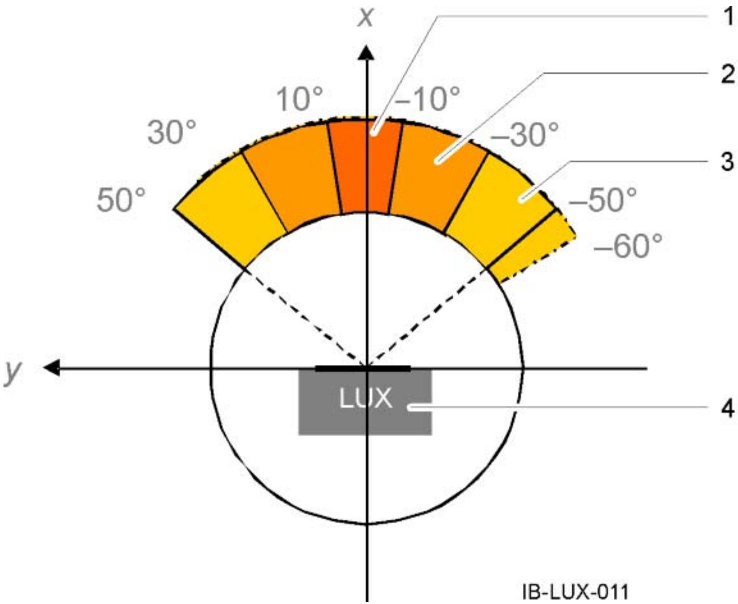

Figure 3-19: Scan frequency 12.5 Hz, angle resolution differing by sector

Description of items in figure 3-19:

1	Central area of the angular resolution 0.125°	3	Lateral area of the angular resolution 0.5°
2	Medium area of the angular resolution 0.25°	4	ibeo LUX®

With a scan frequency of 12.5 Hz and an angle resolution differing by sector, the range with the highest attention in 0° direction is at ±10° (3-19/1).

Scan frequency 25 Hz

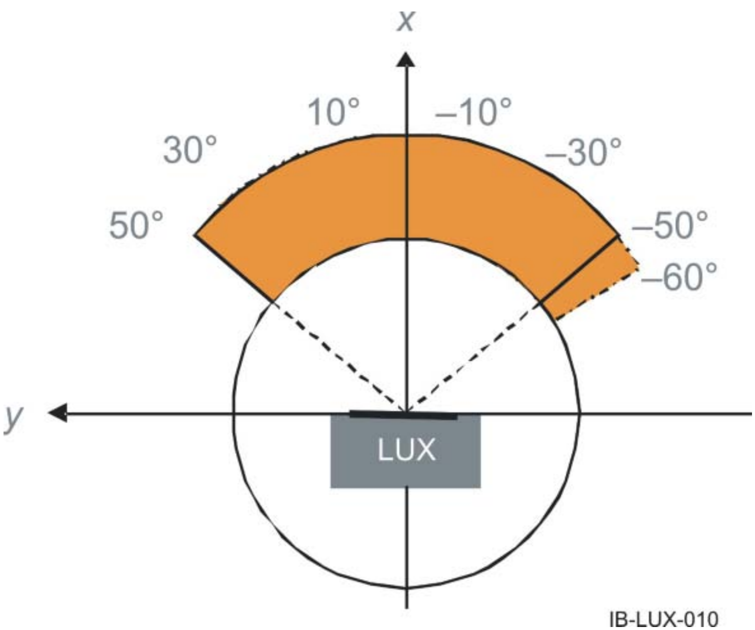

Figure 3-20: Scan frequency 25 Hz, constant angle resolution of 0.25°

At the scan frequency 25 Hz with constant angle resolution, the angle resolution is 0.25°, see figure 3-20. Here the ibeo LUX® only provides scan data.

Scan frequency 50 Hz

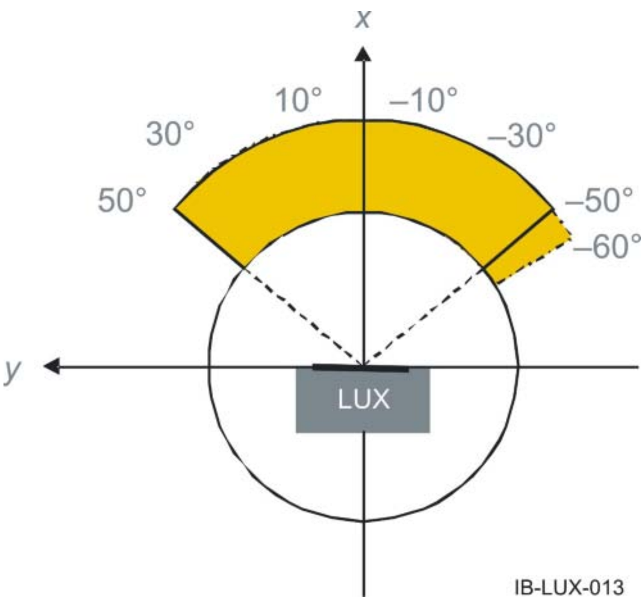

Figure 3-21: Scan frequency 50 Hz, constant angle resolution of 0.5°

At the scan frequency 50 Hz with constant angle resolution, the angle resolution is 0.5°, see figure 3-21. Here the ibeo LUX® only provides scan data.

3.2.1.3 Available data interfaces and data types

	CAUTION
	The bending radius of the connecting cable of the ibeo LUX® must be at least 6 cm. Else the connecting cable could be damaged.

At the connecting cable of the ibeo LUX®, the ibeo LUX® 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
  - Reception of commands

- CAN
  - Output of object data
  - Output of warnings and fault messages
  - Reception of information about the vehicle's movement
  - Reception of commands
- Sync
  - Sync IN: Synchronization of the ibeo LUX® to an external source
  - Sync OUT: Synchronization of an external device to the ibeo LUX® or another external source
- RS232 debug
  - This interface is not in use in normal operation. It can be used if faults occur and need to be debugged.
- Voltage
  - Voltage supply 9 … 27 Volt DC

3.2.2 LUX-Connector

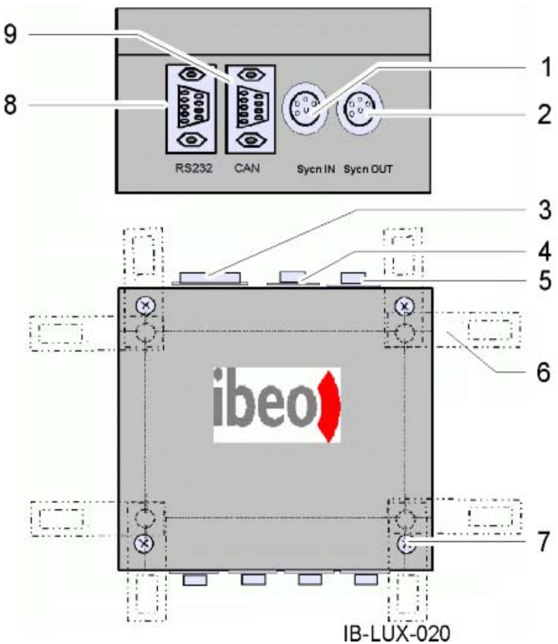

Figure 3-22: LUX-Connector (principle)

Description of items in figure 3-22:

1	Interface Sync IN	6	Holder
2	Interface Sync OUT	7	Screw for the lid
3	Interface sensor	8	Interface RS232
4	Interface voltage	9	Interface CAN
5	Interface Ethernet		

The LUX-Connector enables the user to connect different devices to the ibeo LUX®.

The LUX-Connector distributes the interfaces provided at the connecting cable of the ibeo LUX® to individual plugs and sockets.

3.2.2.1 Interface RS232

The interface RS232 (3-22/8) is not in use in normal operation. It can be used if faults occur and need to be debugged.

As an optional you can connect external devices (e. g. GPS) via this interface to the LUX-Connector.

If the interface must be used for service purposes, use a null modem cable to connect to your PC.

3.2.2.2 Interface Ethernet

The interface Ethernet (3-22/5) is available for the connection to a local network or a notebook, e.g. for service purposes.

Due to the high bandwidth, the Ethernet can transmit scan data as well as object data, see chapter 5 Visualization, page 5-1.

	NOTE
☞	*For information about the Ethernet Protocol Specification refer to the provided CD-ROM.*

The following data types in the Ibeo LUX format are provided by the LUX-Connector via the interface Ethernet:

- Output of scan data
- Output of object data
- Output of warnings and fault messages
- Reception of commands
- Communication with the ibeo LUX®

3.2.2.3 Interface voltage

The interface Voltage (3-22/4) is designed for the connector cable to the voltage supply of the LUX-Connector.

3.2.2.4 Interface sync

The interface Sync IN (3-22/1) provides the signals for synchronization of the ibeo LUX® to an external source.

The interface Sync OUT (3-22/2) provides data types for synchronization of an external device to the ibeo LUX® or other external sources.

	NOTE
☞	*For information about the interface Sync IN and the interface Sync OUT, refer to the specific document on the provided CD-ROM.*

3.2.2.5 Interface CAN

CAUTION

Never connect the CAN bus of a vehicle or a CAN bus of external devices directly to the LUX-Connector via the interface CAN.
This can cause malfunctions!

Ibeo strongly recommends using a CAN gateway, see chapter 3.2.10 CAN gateway, page 3-75.

The interface CAN (3-22/9) is used for data exchange between the LUX-Connector and the vehicle, usually over a CAN gateway. This includes:

- Output of object data
- Output of warnings and fault messages
- Reception of information about the vehicle's movement

3.2.2.6 Interface sensor

The LUX-Connector is equipped with a sensor interface (3-22/3). The connecting cable of the ibeo LUX® is plugged into this interface.

The voltage supply of the ibeo LUX® is also provided via the sensor interface.

3.2.3 ibeo API

	NOTE
☞	*In order to use the ibeo API you need experience in C++ programming.*

The ibeo API supports your usage of Ibeo sensors and systems.

It comprises several libraries which can be used under

- MS Visual Studio 2005 ®,
- MS Visual Studio 2008 ® and
- Linux gcc 4

.

The libraries are available as dynamic and static versions.

	NOTE
☞	*You find the libraries on the provided CD-ROM.*

Notes on usage

	NOTE
☞	*The provided CD-ROM contains the documentation of the ibeo API created with doxygen.* *This documentation contains sample codes for using the ibeo API.* *Details about the libraries can be found in the respective header files.*

In order to create your own application program with the ibeo API you need the required libraries (boost and asio, see documentation of the API) for your application development system.
Then use your application development system or your compiler to create a program that includes the ibeo API.
Please also refer to chapter 8 Configuration, page 8-1.

3.2.4 Electronic Control Unit (ECU)

	CAUTION
☝	The ECU is **not** waterproof. Please note the technical data of the ECU, see chapter 14 Technical data, page 14-1. If the requirements for operation are not met, the ECU cannot start correctly.

Figure 3-23: *Control unit*

Description of items in figure 3-23:

1	Interface voltage	6	Interface Sensor (LUX A)
2	Interface Ethernet	7	Interface Sensor (LUX B)
3	Interface RS232	8	Interface Sync OUT
4	Interface CAN	9	Interface Sync IN
5	Interface USB		

The electronic control unit (ECU) serves for processing the measured data of several ibeo LUX®.

The ibeo LUX® in the ibeo LUX Fusion System send their measured data via Ethernet to the ECU. There the data are merged, i. e. consolidated so that they match in regard to time and space.
Objects are built and issued basing on the merged scan data.

NOTE

The ECU can also provide object data if a scan frequency of the ibeo LUX® of more than 12.5 Hz is desired.

3.2.4.1 Interface RS232

The interface RS232 (3-23/3) is not in use in normal operation.

As an optional you can connect external devices (e. g. GPS) via this interface to the ECU.

3.2.4.2 Interface Ethernet

The interface Ethernet (3-23/2) is provided for the connection to a local network or a notebook.

Due to the high bandwidth, both scan data and object data can be transmitted via Ethernet, see chapter 5 Visualization, page 5-1.

	NOTE
☞	*For the Ethernet Protocol Specification refer to the provided CD-ROM.*

The following data in the API format can be transmitted or received via the interface Ethernet:

- Output of scan data
- Output of object data
- Output of warnings and fault messages
- Reception of commands
- Communication with the ibeo LUX®

3.2.4.3 Interface voltage

The interface Voltage (3-23/1) connects the cable to the voltage supply of the ECU.

3.2.4.4 Interface sync

The interface Sync IN (3-23/9) allows for synchronization of the ibeo LUX® to an external source.

The interface Sync OUT (3-23/8) allows for synchronization of an external device to the ibeo LUX® or another external source connected to the interface Sync IN.

The distribution of the synchronization signal runs from the interface Sync IN via the ibeo LUX® at the interface Sensor (LUX A) to the ibeo LUX® at the interface Sensor (LUX B) to the interface Sync OUT.

☞	**NOTE**
	For information about the interface Sync IN and the interface Sync OUT, refer to the specific document on the provided CD-ROM.

3.2.4.5 Interface CAN

CAUTION

Never connect the CAN bus of a vehicle or a CAN bus of external devices directly to the ECU via the interface CAN.
This can cause malfunctions!

Ibeo strongly recommends using a CAN gateway, see chapter 3.2.10 CAN gateway, page 3-75.

The interface CAN (3-23/4) is used for data exchange between the ECU and the vehicle, usually over a CAN gateway. This includes:

- Output of object data
- Output of warnings and fault messages
- Reception of information about the vehicle's movement

3.2.4.6 Interface USB

	CAUTION
☝	Do not connect any input devices (e. g. mouse, keyboard) via the interface USB to the ECU as this can cause unexpected behavior.

The interface USB (3-23/5) allows for the optional connection of

- a web cam
- external memory media
- a GPS
- or other devices to extend the system

to the ECU.

3.2.4.7 Interface sensor

The ECU is equipped with an interface Sensor (3-23/6). The connecting cable of the ibeo LUX® is plugged into this interface.

The voltage supply of the ibeo LUX® is also provided via the interface Sensor.

A second ibeo LUX® can be connected to the second interface Sensor (3-23/7).

3.2.5 LUX-Switch

CAUTION

In order to ensure proper function of the LUX-Switch, an ibeo LUX® must be connected to the interface Sensor LUX 1. The other ibeo LUX® can be distributed arbitrarily.

The LUX-Switch allows for connecting up to six ibeo LUX® via the interface Sensor (3-24/5) to the ECU and for connecting external devices to the ibeo LUX®.

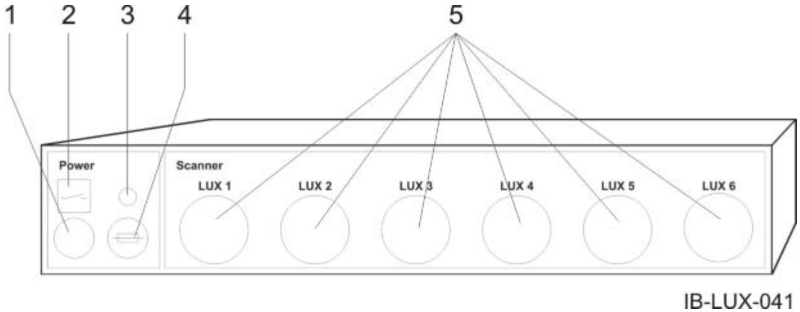

Figure 3-24: LUX-Switch, front side (schematic view)

Description of items in figure 3-24:

1	Interface voltage	4	Fuse
2	Main switch	5	Interface sensor
3	LED voltage		

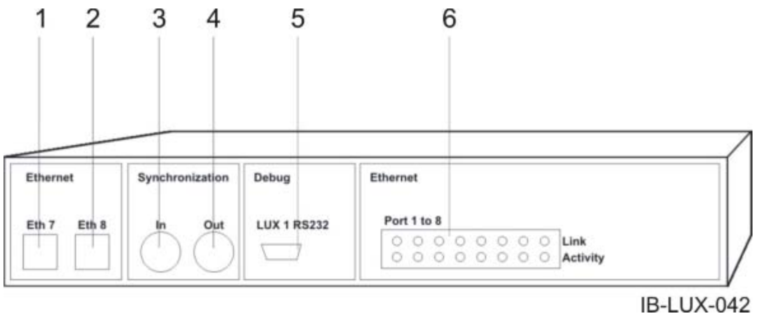

Figure 3-25: LUX-Switch, rear side (schematic view)

Description of items in figure 3-25:

1	Interface Ethernet	4	Interface Sync OUT
2	Interface Ethernet	5	Interface RS232
3	Interface Sync IN	6	Info field

Use the main switch (3-24/2) to switch off the LUX-Switch. An LED (3-24/3) indicates whether the LUX-Switch is switch on or off.

The LUX-Switch is protected by a fuse (3-24/4).

3.2.5.1 Interface RS232

The interface RS232 (3-25/5) is not in use in normal operation. It can be used if faults occur and need to be debugged.

The interface RS232 is connected to the RS232 debug interface of the ibeo LUX® at the interface Sensor (3-24/5) LUX 1.

3.2.5.2 Interface Ethernet

The first interface Ethernet (3-25/1) is provided for the connection to the ECU.

The second interface Ethernet (3-25/2) is provided for the connection to a local network or a notebook.

Due to the high bandwidth, the Ethernet can transmit scan data as well as object data, see chapter 5 Visualization, page 5-1.

	NOTE
☞	*For information about the Ethernet Protocol Specification refer to the provided CD-ROM.*

The following data in the API format can be transmitted or received via the interface Ethernet:

- Output of scan data
- Output of object data
- Output of warnings and fault messages
- Reception of commands
- Communication with the ibeo LUX®

3.2.5.3 Interface voltage

The interface Voltage (3-24/1) is provided for the connector cable to the voltage supply of the LUX-Switch.

3.2.5.4 Interface sync

The interface Sync IN (3-25/3) can serve for connecting an external source with which the ibeo LUX® at the interface Sensor LUX 1 shall be synchronized.

The interface Sync OUT (3-25/4) allows for connecting external sources. Those are then synchronized together with the ibeo LUX® at the interface Sensor LUX 2 … 6 with the ibeo LUX® at the interface Sensor LUX 1.

	NOTE
☞	*For information about the interface Sync IN and the interface Sync OUT, refer to the specific document on the provided CD-ROM.*

3.2.5.5 Interface sensor

The LUX-Switch is equipped with the interface Sensor (3-24/5) LUX 1 … 6. The respective connecting cable of the ibeo LUX® is plugged into this interface.

The voltage supply of the ibeo LUX® is also provided via the interface Sensor.

3.2.5.6 Info field

Data transmission of the individual Ethernet ports are indicated via an info field (3-25/6) with LEDs.
Ports 1 … 6 are connected to the interface Sensor LUX 1 … 6. Ports 7 … 8 are connected to the interface Ethernet Eth 7 … 8.

3.2.6 LUX standard connector cable

	CAUTION
	The bending radius of the LUX standard connector cable must be at least 6 cm. Else the LUX standard connector cable can be damaged.


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Figure 3-26: LUX standard connector cable

The LUX standard connector cable distributes some of the interfaces provided at the connecting cable of the ibeo LUX® at the interface to the interface Voltage and the interface Ethernet.

3.2.7 LUX extension cable

	CAUTION
	The bending radius of the LUX extension cable must be at least 6 cm. Else the LUX extension cable can be damaged. When using the Sync function, bear in mind that for cables lengths of more than 10 m transmission of the Sync signal can be a problem. When in doubt, install a repeater between the LUX extension cables. For further information refer to the provided CD-ROM.

The LUX extension cable serves for bridging larger distances between the ibeo LUX® and the LUX standard connector cable or the LUX-Connector or the ECU or the LUX-Switch.

3.2.8 Ethernet connector cable

	NOTE
☞	*If you are using a hub or a switch in your system that does not provide automatic connection detection and if problems with the Ethernet connections arise, try using an Ethernet connector cable of the type Patch instead of type Crossover.*

Included in the scope of delivery are one or two Ethernet connector cables of the corresponding type which are designed for the vast majority of applications.

Ethernet connector cable are available in two types:

- Crossover
- Patch

Ethernet connector cable of the type Patch are used to connect computers or other devices with a switch or a hub.

Ethernet connector cable of the type Crossover are used to establish a direct connection between two computers or devices.

However, most all current computers / notebooks / switches are equipped with an automatic switchover system that renders this distinction of the two types unnecessary.

The ibeo LUX® is not equipped with this automatic switchover system, but it is sufficient if one of the devices in question has this function.

The ibeo LUX®, the ECU and the LUX-Switch use a data rate of 100 MBit/s. The Ethernet connector cables used must match category 5 or better.

3.2.9 CAN connector cable

The CAN connector cable is a CAN bus connector cable with a terminator at both ends.

3.2.10 CAN gateway

	CAUTION
	Do not connect the CAN bus of the ibeo LUX® or the ECU directly to a CAN bus of a vehicle or to a CAN bus of an external device. This can cause malfunctions!

The CAN gateway serves for separating the CAN bus of the vehicle from the Ibeo CAN bus if the ibeo LUX® is used in a vehicle.
This is required for the following reasons:

- The CAN messages can cause negative impact on the control units in the vehicle.
- Negative impact on the safety-related control units communicating in a vehicle can occur.
  These control units are e. g. responsible for activation of the airbags or they can initiate full braking.

	NOTE
	For the technical data on the CAN gateway refer to the technical information provided with the CAN gateway.

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 LUX®, the ECU and the LUX-Switch use Ethernet interfaces with 100 MBit/s. Therefore the cables used must meet the requirements of category 5 or better, see chapter 3.2.8 Ethernet connector cable, page 3-73.

Other components like the LUX-Connector or the LUX standard connector cable are designed accordingly.

Depending on the system configuration, the interface Ethernet provides different data types:

- Scan data (see chapter 4 Scan and object data, page 4-1)
  - ibeo LUX®: data type 0x2202
  - ECU/ibeo API: data type 0x2203
- Object data (see chapter 4 Scan and object data, page 4-1)
  - ibeo LUX®: data type 0x2221
  - ECU/ibeo API: data type 0x2223
- Warnings and fault messages
  - ibeo LUX®: data type 0x2030
  - ECU/ibeo API: data types 0x6400, 0x6410, 0x6420, 0x6430
- Commands and responses
  - Data types 0x2010 and 0x2020

☞	**NOTE**
	For a description of the mentioned data types refer to the provided CD-ROM. *Please also refer to chapter 4 Scan and object data, page 4-1. That chapter describes the differences between the data types and their basing coordinate systems.*

3.3.2 Interface CAN

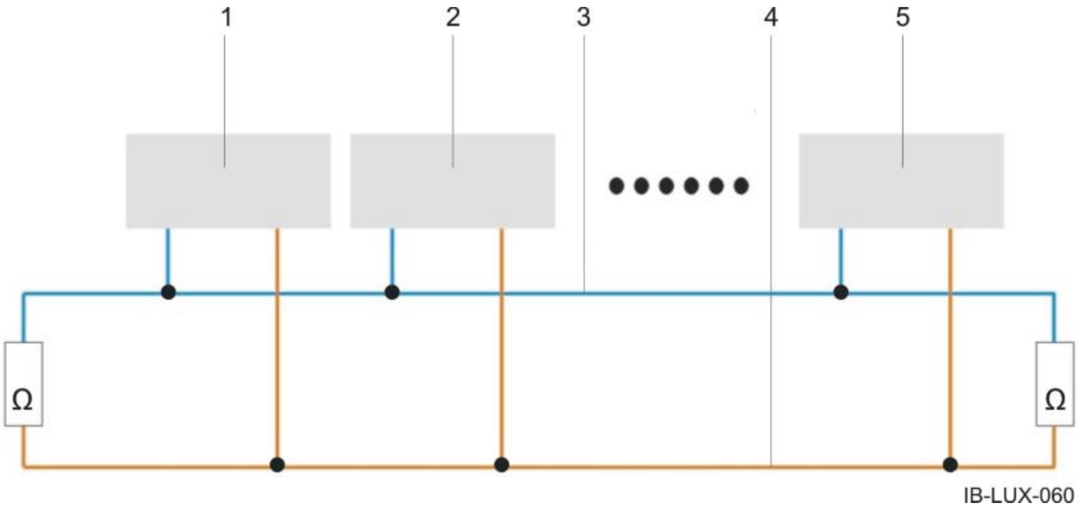


Figure 3-27: CAN bus

Description of items in figure 3-27:

1	1. Device with interface CAN	4	CAN low
2	2. Device with interface CAN	5	downstream device with interface CAN
3	CAN high	Ω	Resistor 120 Ω

	NOTE
☞	*Make sure to design and to terminate the CAN bus correctly.*

The ibeo LUX® and the ECU use CAN interfaces with 500 kBit/s.

CAN participants try to establish a connection to the CAN bus over branch lines which should be as short as possible, see figure 3-27.

For CAN communication with Ibeo systems remember the following:

- Several CAN identifiers (ID) are used.

- The parametric CAN base ID (factory default: 0x500) determines the first message identifier used.
- For the transmission of object data and commands, warnings and other data types, a block of 16 IDs each is used and/or reserved. I.e. the CAN base ID 0x500 uses the entire range of 0x500 to 0x50F (including).
- The range preset via the configured CAN base ID may not contain any ID already used by another device (ibeo LUX®, ECU or other bus participant).

The interface CAN provides the following data types:

- Object data (see chapter 4 Scan and object data, page 4-1 and chapter 8 Configuration, page 8-1)
- Warnings and fault messages
- Commands and responses

	NOTE
☞	*For details about the messages and the transmission protocol refer to the special document in the provided CD-ROM.*

3.3.3 Interface RS232

The ibeo LUX® and the ECU are both equipped with an interface RS232, using a baud rate of 57600 as per factory default.

These interfaces are not in use in normal operation.

With the ibeo LUX®, the interface RS232 can be used for service purposes, if required.

With the ECU, this interface can be used to connect optional external devices (e. g. GPS).

3.3.4 Interface sync

Several ibeo LUX® can be synchronized with each other and with external devices (e. g. camera). That means, each ibeo LUX® scans a certain angle position at a certain point of time (synchronization signal). This angle position can be configured for every ibeo LUX®, see chapter 8 Configuration, page 8-1.

It is also possible to synchronize external devices via an Ibeo system.

The ibeo LUX® detect a valid synchronization signal automatically once it is applied. In every case, a signal is issued or transmitted. It is even possible to use the synchronization input and output simultaneously.

3.3.5 Interface voltage

The interface Voltage serves for supplying the individual components of the system and the ibeo LUX® with voltage, see chapter 14 Technical data, page 14-1.

3.3.6 Interface sensor

The connecting cable of the ibeo LUX® is connected to the interface Sensor.

3.3.7 Interface USB

For the interface USB see chapter 3.2.4 , page 3-54.

4. Scan and object data

DANGER

Never use the data from the ibeo LUX® if the ibeo LUX® has not been adjusted or has been adjusted and configured incorrectly, see chapter 10 Adjustment, page 10-1.
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.

The scanning of the surroundings of the scan in the working range of the ibeo LUX® 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 LUX®. 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 LUX® generates a two-dimensional profile of the surroundings, with additional height information (three-dimensional information) resulting from the multi-layer technology, see figure 3-13.
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.

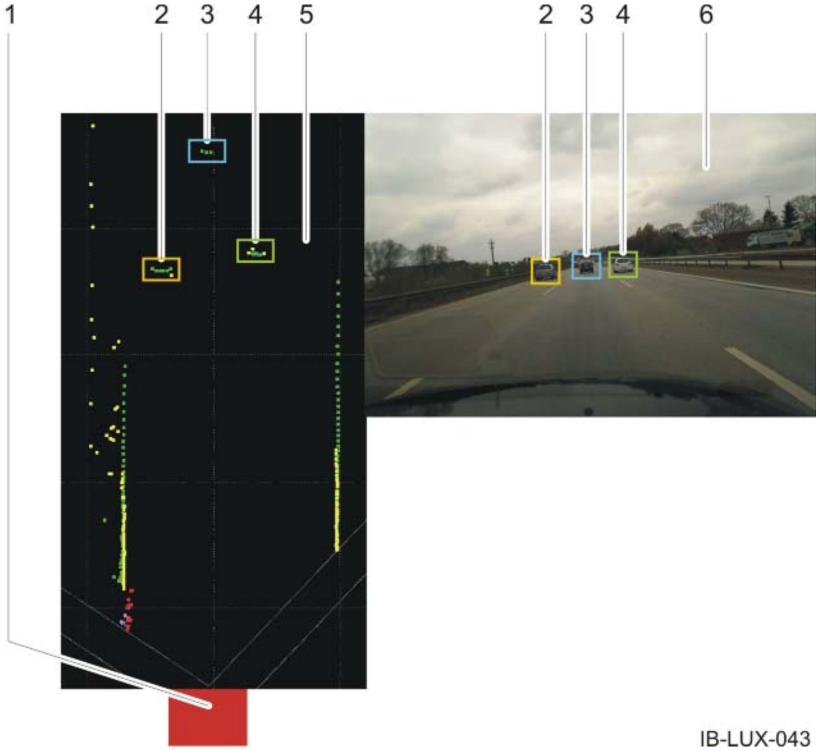


Figure 4-1: *Scan data and video image*

Description of items in figure 4-1:

1	ibeo LUX®	4	Vehicle on the right lane
2	Vehicle on the left lane	5	Scan data image
3	Vehicle on one's own lane	6	Video image

Figure 4-1 shows a picture with excerpts from scan data (4-1/5) taken while driving on the highway. The scan points are displayed as colored dots.
In the video image (4-1/6), which shall only serve for illustration, and in the scan data image, three vehicles (4-1/2, 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, see chapter 3.2.1.2.3 Multi-layer technology, page 3-26.
No processing has occurred yet.

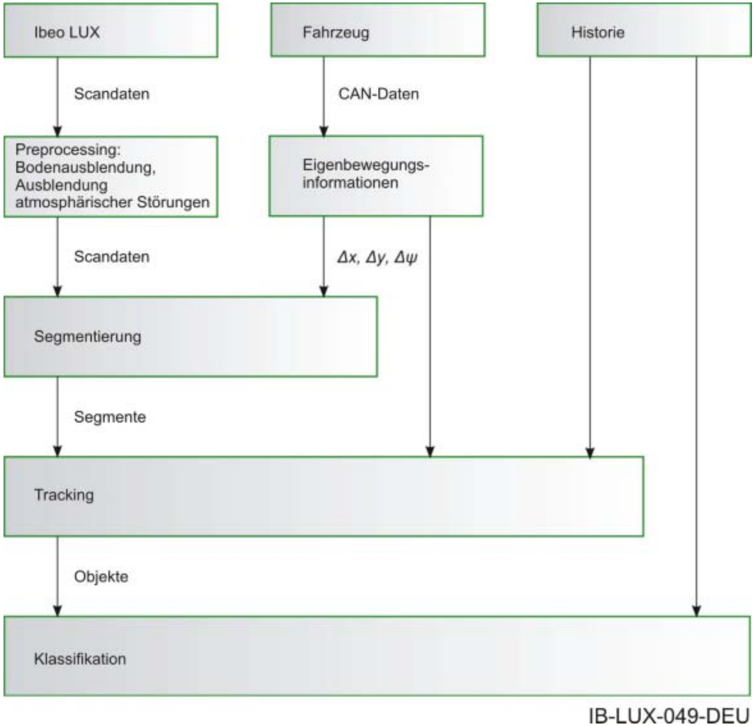


Figure 4-2: Scheme

The scheme 4-2 gives an overview of the steps from scan data processing all the way to classified objects.

4.1 Step 1, analysis of the scan data

First the scan data are analyzed. This analysis is called preprocessing.
Measured data of the ground or of atmospheric disturbances (e. g. rain) are marked. They are not used for segmentation, but remain available for other analysis steps.

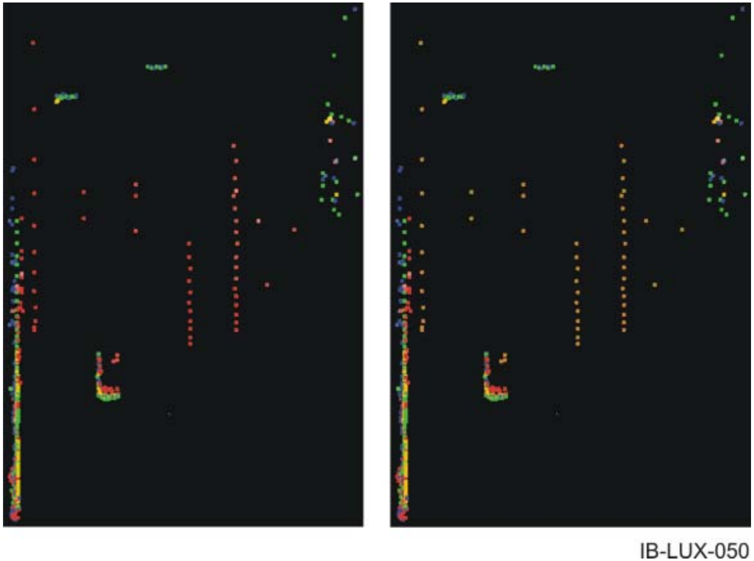


Figure 4-3: Scan data excerpt

Figure 4-3 shows an excerpt of scan data of a highway cruise.

In the left picture, the scan points are marked in the color of their scan level.
In the right picture, all valid points out of which objects will be built in the following processing steps are shown in red. Irrelevant points, such as measurements on the ground, are shown in brown.

Scan data are exclusively transmitted via Ethernet as data types

- 0x2202 from the ibeo LUX® and
- 0x2203 from the ECU/ibeo API

(see also the description of the Ethernet protocols to the provided CD-ROM).

Observe the following differences:

- Scan data of the ibeo LUX® are issued as polar coordinates in the sensor coordinate system. They contain the complete mounting position of the ibeo LUX®.
- Scan data of an ECU/ibeo API are issued as Cartesian coordinates in the reference or vehicle coordinate system.

	NOTE
☞	*The algorithms about scan data processing assume that the ibeo LUX® is aligned in parallel to a level surface. This is the basis for e. g. masking the ground.*

	NOTE
☞	

	Scan data are transmitted to the sensor coordinate system by the ibeo LUX®. They also contain information about the configured mounting position of the ibeo LUX®, which are available for all subsequent processing steps. *ibeo API, ECU or visualization transform the scan data from the sensor coordinate system into the vehicle's coordinate system. But this only considers the rotation around the yaw angle and the translations ∆x, ∆y and ∆z. Roll angle and pitch angle are not taken into consideration.*

4.2 Step 2, segmenting the scan data

Now the scan data are segmented. This generates segments as groups of associate scan points. The segmentation depends on the vehicle's own movement.

	NOTE
☞	*Segmentation and object formation are only available if the pitch angle and the roll angle are preset to 0° in the configuration.*

4.3 Step 3, object formation

During tracking, objects are built from the segments. In the process, the vehicle's own movement and the objects of the last scan (history) are also used.

Objects have the following main properties:

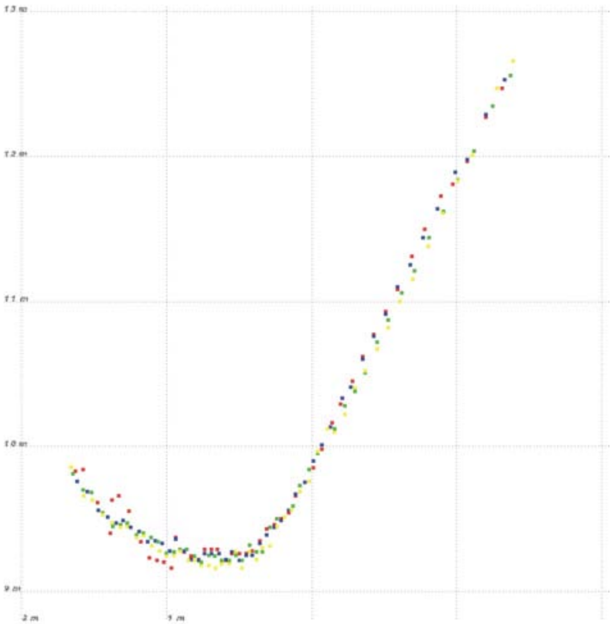
- position
- size
- outline
- speed

Different representations are available for an object:

- Object box – object position, orientation and size from the tracking
- Bounding box – object position and size basing on the scan data
- Object outline – the contour of the object as facing the ibeo LUX® as a polygon, basing on scan data

Figure 4-4: Reference image

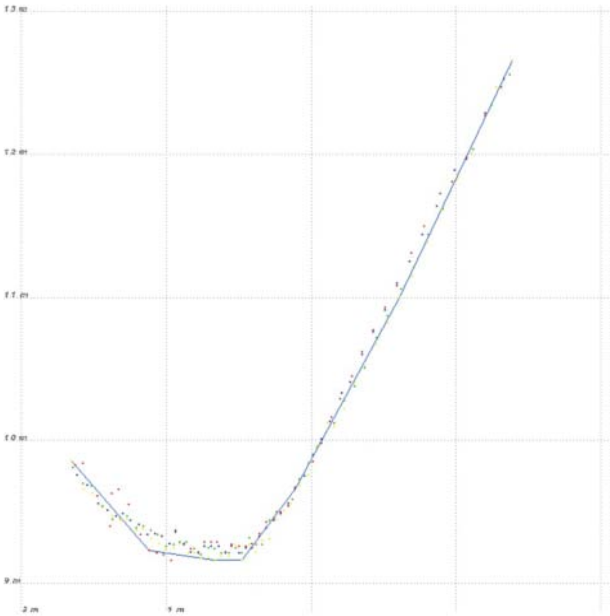
The reference image in figure 4-4 shows a moment in which a vehicle (4-4/1) passes an experimental vehicle (4-4/2) with integrated ibeo LUX® at an angle. The experimental vehicle with the ibeo LUX® is stationary.



IB-LUX-045

Figure 4-5: Scan data

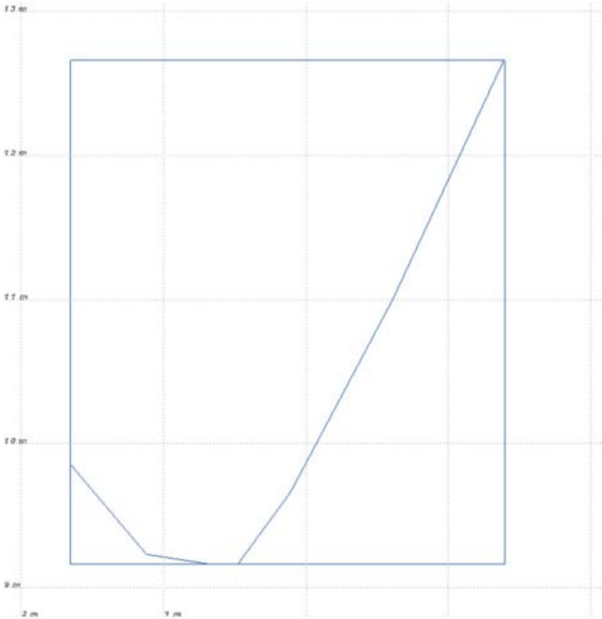
An excerpt of the scan data of the ibeo LUX® at this point of time is shown in figure 4-5. Only scan points of the passing vehicle are shown.



IB-LUX-046

Figure 4-6: Object outline

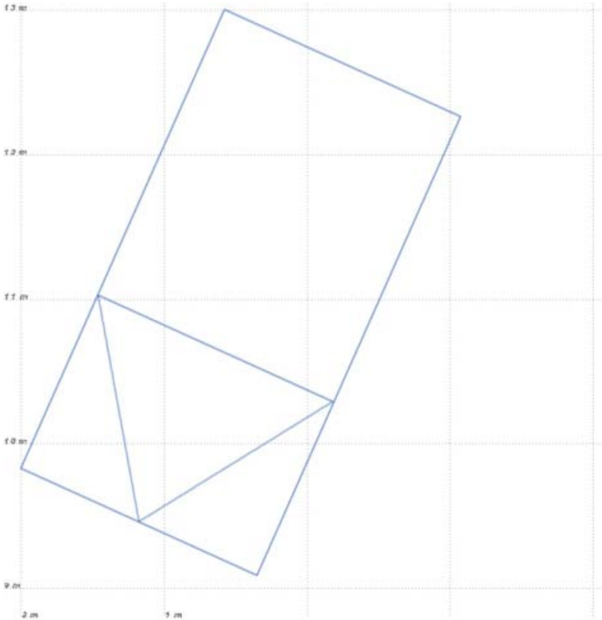
The blue line in figure 4-6 shows the outline of the object as generated from the scan points.



IB-LUX-047

Figure 4-7: Bounding box" of the object

The rectangle around the outline in figure 4-7 represents the bounding box of the object.



IB-LUX-048

Figure 4-8: *Object box*

Finally, the object box in figure 4-8 shows the filtered object information as determined during the tracking. With the speed of the vehicle, the orientation of the object box and thus the direction of movement is displayed. Length and width of the object also derive from the object racking. They must not match the current measured values exactly as they are filtered values.

Objects are generated from segments and tracked on a time-base. In doing so, object speeds and other object properties are determined.

The speed is issued both relative and absolute (if the vehicle's movement is available via a CAN bus):

- Absolute speed is the speed of a vehicle on the street or viewed from a stationary observer.
- Relative speed is the speed of a vehicle relative to an observer. While approaching a stationary target with a constant speed v, the corresponding object has the relative speed -v.
- Relative and absolute speed are identical as long as the own vehicle does not move.

Object speeds have an amount and an orientation, they can be divided into the x and y coordinates.

4.4 Step 4, classification

In the last processing step, the classification, the following classes are assigned to the objects, on the basis of properties and history:

- car
- cycle (motorcycle, bicycle)
- truck
- pedestrian (available in the 4. quarter of 2008)
- unknown, large
- unknown, small

5. **Visualization**

5.1 ibeoLaserView

ibeoLaserView (ILV) is the graphical user interface (GUI) for the visualization of the data of the ibeo LUX® or an ECU.

There are three operating states

- Waiting mode
- Operating mode measuring operation
- Playback mode

5.2 Main screen

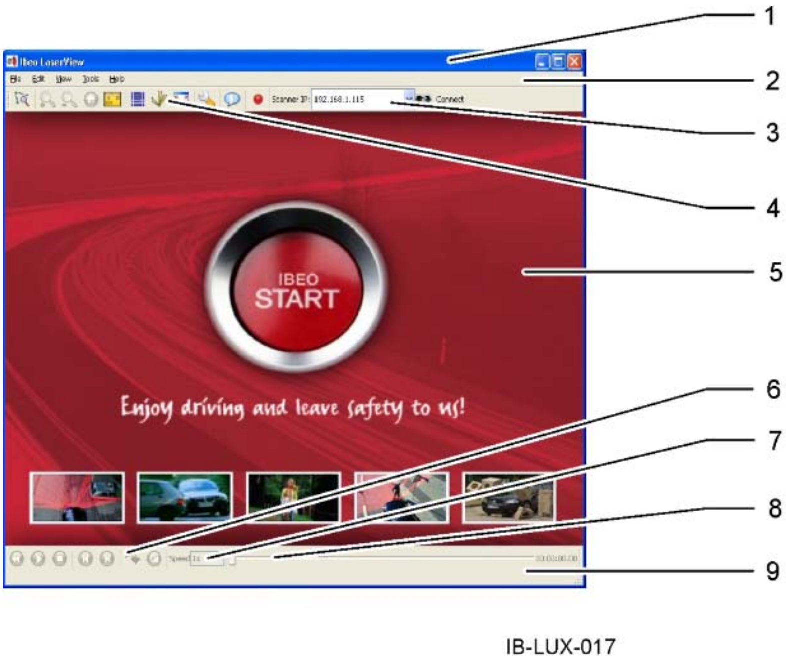


Figure 5-1: Main screen with start screen

Description of items in figure 5-1:

1	Title bar	6	Player bar
2	Menu bar	7	Playback speed
3	Input field for IP-address	8	Time bar
4	Tool bar	9	Status bar
5	Display area		

After starting ibeoLaserView, the start screen appears in the main screen.

ibeoLaserView is in waiting mode and not connected to a device.

Depending on the operating state, the individual areas of the main screen are active or inactive.

In the operating state "playback mode", the areas "player line", "playback speed" and "time bar" are active, see chapter 5.7 Playback mode, page 5-27.

5.2.1 Title bar

The title bar (5-1/1) displays the name of the software program, and the path and name of the open file if a stored file is played.

Additionally, it displays the system buttons minimize, resize and exit.

5.2.2 Menu bar

The menu bar (5-1/2) contains the following menu selections

- File
- Edit
- View
- Help

5.2.2.1 Menu option File

IB-LUX-021

Figure 5-2: Menu option File

File-Open

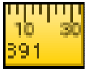
Press File and Open to open an existing *.idc-file with recorded scan or object data.

5.2.2.2 Menu option Edit

Figure 5-3: Menu option Edit

Edit-Ruler

Press Edit and Ruler to activate the ruler, see also

button  in chapter 5.2.3 Tool bar, page 5-12.

Edit-Preferences

Press Edit and Preferences to show the settings, see also

button  in chapter 5.2.3 Tool bar, page 5-12 and see chapter 5.8 Preferences, page 5-32.

Edit- Device Configuration

Press Edit and Device Configuration to display the device settings and change them, if required, see chapter 5.10 Device settings, page 5-38.

5.2.2.3 Menu option View

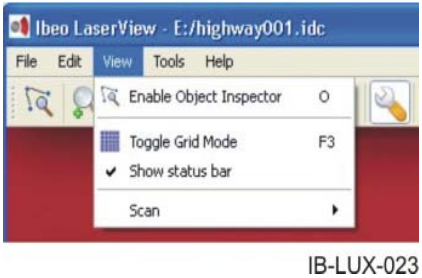


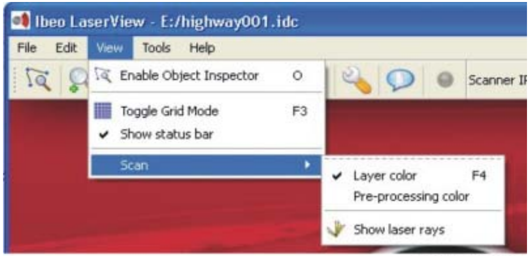
Figure 5-4: Menu option View

View-Show status bar

Press View and Show status bar to activate or deactivate the status bar.

If the status bar is active, a check mark appears in front of the option Show status bar, see figure 5-4.

View-Scan



IB-LUX-024

Figure 5-5: View-Scan

Press View and Scan to set the display of the scan points.

There are three categories in the option Scan

- Layer color
- Preprocessing color
- Show laser rays

View-Scan-Layer color

Press View, Scan, and Layer color to display the different colors per scan level (layer), see chapter 3.2.1.2.3 Multi-layer technology, page 3-26.

View-Scan-Pre-processing color

Press View, Scan, and Pre-processing color to display the different colors according to the scan point mark (rain, ground, etc.) from preprocessing, see chapter 4 Scan and object data, page 4-1.

View-Scan-Show laser rays

Press View, Scan and Show laser rays to display the visualization of the laser rays to the scan points, see also button  in chapter 5.2.3 Tool bar, page 5-12.

5.2.3 Tool bar

The tool bar (5-1/4) displays the buttons to control the visualization or the connected device.

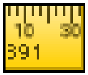
	NOTE
☞	*Even though the individual windows do not have a Close system, every window opened by pressing a button in the tool bar can be closed but pressing that button again.*

Object-Inspector
Press this button to activate or deactivate the object inspector.
The object inspector allows for the display of individual object properties.
Upon activation a window appears that lists the properties of a selected object, see chapter 5.2.3.1 Object Inspector, page 5-19.

Zoom in
Press this button to increase the size of the data display for a more detailed view of the scan and object data.

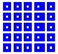
Zoom out
Press this button to decrease the size of the data display.

Refocus
Press this button to set the initial point of the coordinate system to the center of the lower border of the data display.



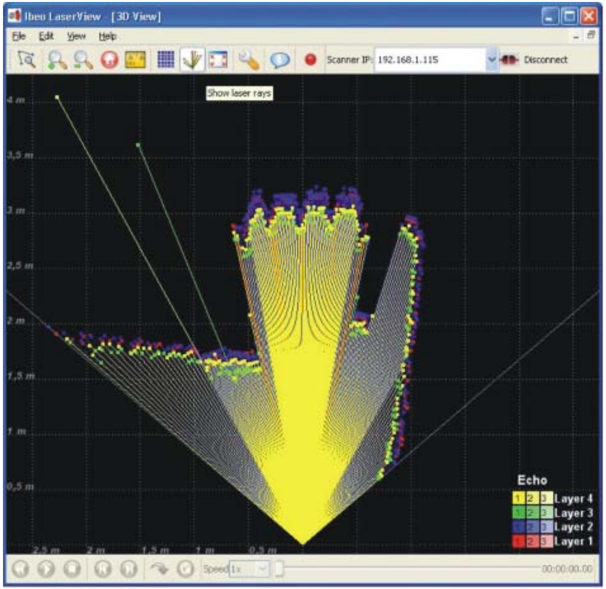
Ruler
Press this button to activate the ruler in the operating modes measuring operation or playback mode.

If the ruler is active, real distances can be measured in the data display,
see chapter 5.2.3.2 Ruler, page 5-20.



Toggle Grid Mode
Press this button to toggle between different grid settings (Cartesian → Cartesian with ruler → radial → radial with ruler).

Show Laser Rays
Press this button to display the visualization of the laser rays to the scan points.



IB-LUX-025

This option connects the scan points with their initial coordinates by lines ("laser rays") to illustrate the measuring principle of the ibeo LUX®.

Fullscreen Mode
Press this button to change the data display screen to the fullscreen mode.

NOTE

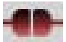
Press the key F11 to switch back to window mode.

Preferences
Press this button to activate a dialog window for the settings and the display of the data in ibeoLaserView, see chapter 5.8 Preferences, page 5-32.

Trace log
Press this button to activate a dialog window with information on warnings and fault messages of the connected devices, see chapter 5.2.3.3 Trace log, page 5-21.

Record
Press this button to save scan and object data in an *.idc-file, see chapter 5.2.3.4 Record, page 5-22.

Connect
Press this button to connect ibeoLaserView to a device with the IP-address set, see chapter 5.3 Input field, page 5-23.

Once the connection to the device is established, the button  and the display "Disconnect" appear next to the input field.

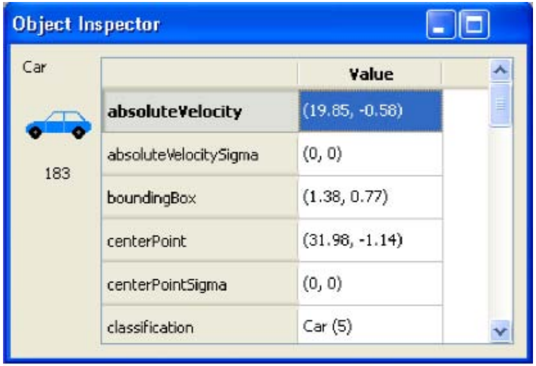
NOTE

Remember that with the ibeo LUX® only one Ethernet connection per device can be up at the same time.
ibeoLaserView accepts and establishes a second connection, but the first connection is then automatically closed.

Disconnect
Press this button to disconnect the ibeoLaserView from the device.

If the connection to the device is interrupted, the button  and the display "Connect" appear next to the input field.

5.2.3.1 Object Inspector



IB-LUX-026

Figure 5-6: Object Inspector

The object inspector allows for the display of individual object properties.
Upon activation a window appears that lists the properties of a selected object.

To select an object to be displayed, one of the options in the dialog window Preferences-Objects must be selected first, see chapter 5.8 Preferences, page 5-32.
Then click with the left mouse button onto the desired object the properties of which shall be shown in the window.

5.2.3.2 Ruler

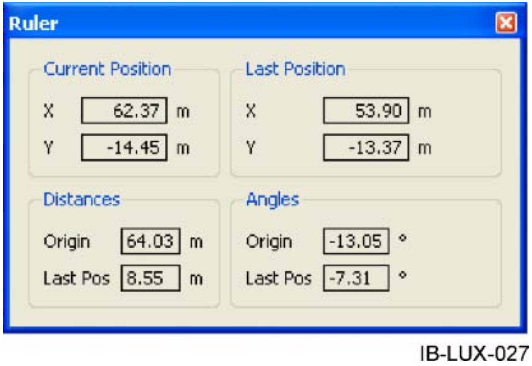


Figure 5-7: Ruler

If the ruler is active in the operating mode measuring operation, real distances can be measured.

Use the left mouse button to mark the start point and end point of a distance in the display area.

A dialog window appears which displays the corresponding information like length, angle, etc. of this distance, see figure 5-7.

5.2.3.3 Trace log

IB-LUX-066

Figure 5-8: Example of a trace log

The dialog window Trace log informs about warnings and faults of the connected devices.

A message consists of the level (e. g. Note, Warning, Error), the source (LUX or another device, ibeo API) and the message text.

The most recent message is additionally displayed in the status bar, see chapter 5.4 Status bar, page 5-23.

5.2.3.4 Record

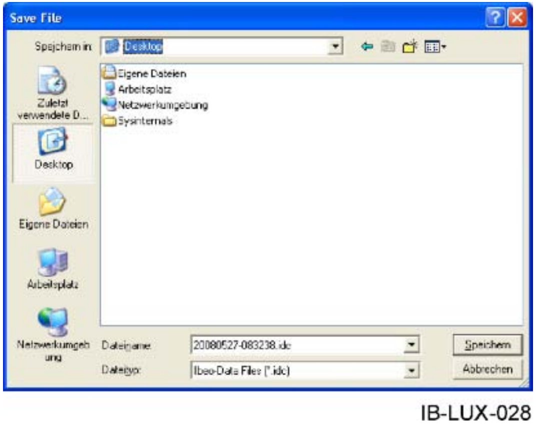


Figure 5-9: Record

Scan and object data can be saved in an *.idc-file.

To do so, a dialog window appears to select the path and the file name.
After confirmation, recording starts.

ibeoLaserView can play these data in playback mode, see chapter 5.7 Playback mode, page 5-27.

5.3 Input field

In the input field "Scanner IP:" enter the IP-address of the device that ibeoLaserView shall connect to, in order to receive data and to display them in the display area.

5.4 Status bar

Figure 5-10: Message in the status bar

The most recent message of the warnings and fault messages from the connected devices in displayed in the status bar (5-10/1).

The status bar can be activated or deactivated in the menu "View" → "Show status bar", see chapter 5.2.2.3 Menu option View, page 5-9.

The dialog window Trace log informs about warnings and faults of the connected devices, see chapter 5.2.3.3 Trace log, page 5-21.

5.5 Waiting mode

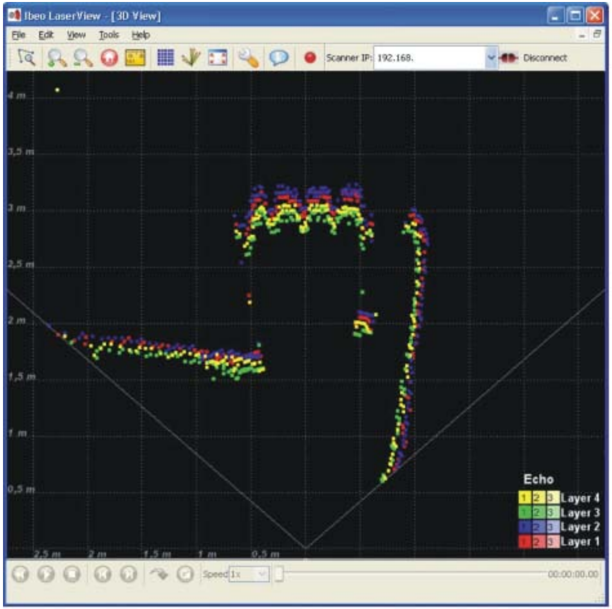
IB-LUX-029

Figure 5-11: Main screen with start screen

After starting ibeoLaserView, the start screen appears in the main screen.

ibeoLaserView is in waiting mode and not connected to a device.

5.6 Operating mode measuring operation



IB-LUX-030

Figure 5-12: Main screen in the operating mode measuring operation

In the operating mode measuring operation, ibeoLaserView is connected to a suitable device (e. g. ibeo LUX® or ECU) via Ethernet.
In this mode, real-time scan data and object data are displayed in the display area.

The individual scan levels (layer) and echoes are displayed in different colors. The levels differ by different colors, the individual echoes by different color saturation,
see chapter 3.2.1.2.3 Multi-layer technology, page 3-26.

☞	**NOTE**
	If no scan data or object data are displayed, check the ibeoLaserView settings in the dialog window Preferences-General, see chapter 5.8 Preferences, page 5-32.

5.7 Playback mode

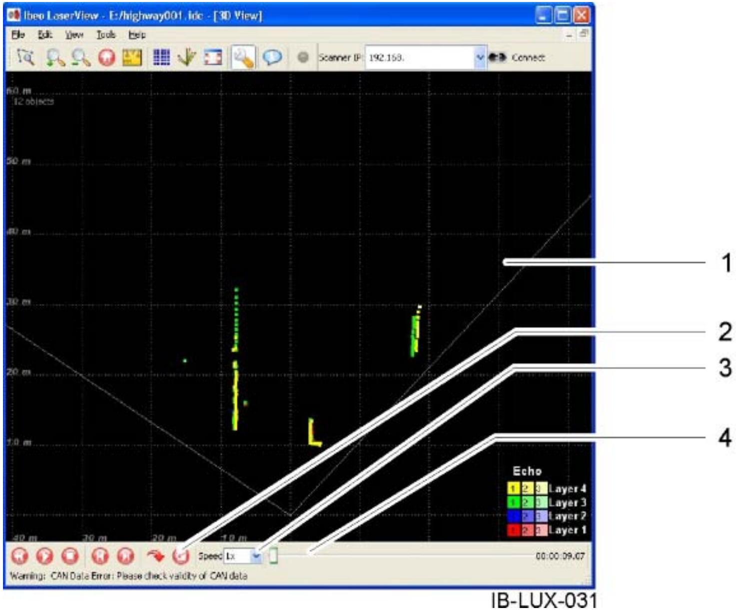


Figure 5-13: Main screen in playback mode

Description of items in figure 5-13:

1	Display area	3	Playback speed
2	Player bar	4	Time bar

In playback mode, recorded data can be played.

In the menu File → Open you can open the recorded data, see chapter 5.2.2.1 Menu option File, page 5-6.

In playback mode, the player bar (5-13/2) is active and allows for controlling the playing process.

5.7.1 Player bar

The player bar contains the buttons for displaying the scan and object data.

With the following buttons you can display or record the scan and object data:

Start
Press this button to play the data from the start.

Play
Press this button to play the data.

Stop
Press this button to stop the playback.

Step Back
Press this button to rewind the playback stepwise by one scan.

Step Forward
Press this button to move forward within the playback by one scan.

Toggle Reverse
Press this button to rewind the playback.

Toggle Forward
Press this button to fast forward the playback.

Loop
Press this button to repeat playback automatically.

5.7.2 Playback speed

The playback speed(5-13/3) indicates the playback speed for the display of the scan and object data.

5.7.3 Time bar

The time bar (5-13/4) displays the current file position and the current time stamp.

5.8 Preferences

Different preferences can control the dialog of ibeoLaserView in regard to the display of scan and object data. This is done in the dialog window Preferences.

The dialog window Preferences consists of three tabs

- General
- Scans
- Objects

5.8.1 Preferences-General

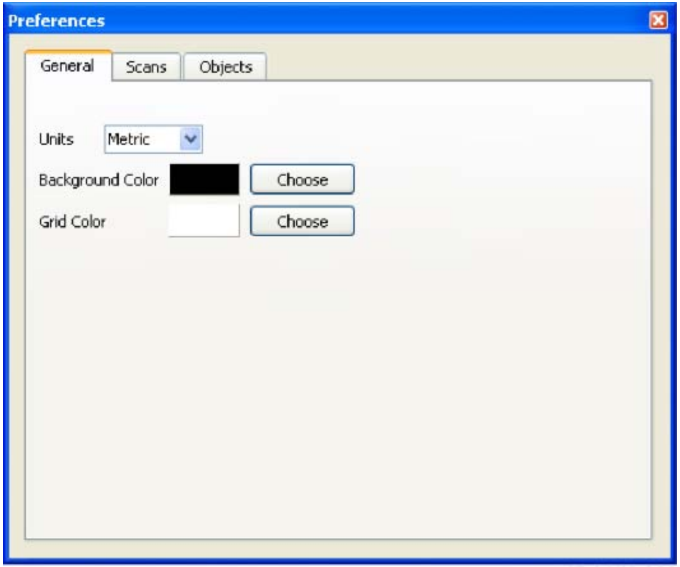


Figure 5-14: Dialog window Preferences-General

In the dialog window Preferences-General you can set the general display.

5.8.2 Preferences-Scans

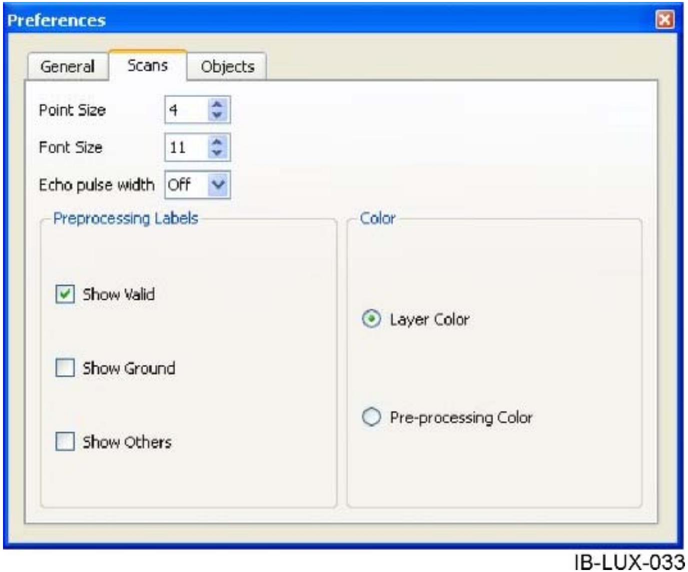


Figure 5-15: Dialog window Preferences-Scans

In the dialog window Preferences-Scans you can set the type of the display in the way you want the scan points to appear in the display area.

In the section "Preprocessing Labels" you can define which scan points to display as long as the received scan points are marked with the corresponding labels (Show Valid, Show Ground and Show Others).

5.8.3 Preferences-Objects

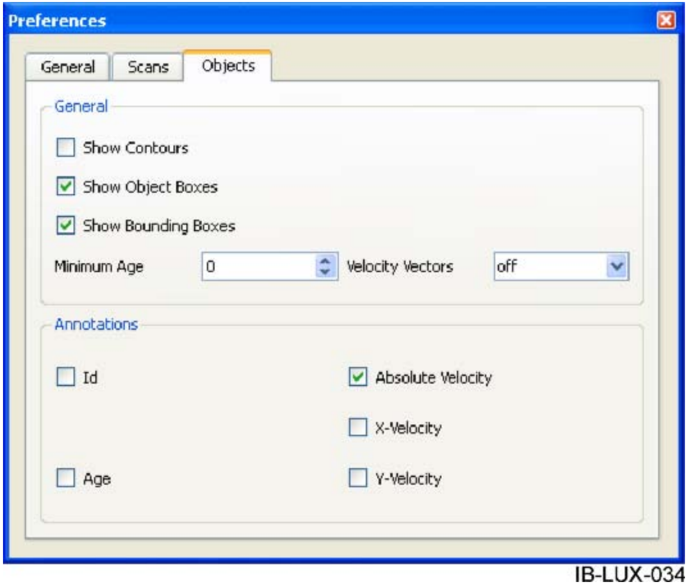
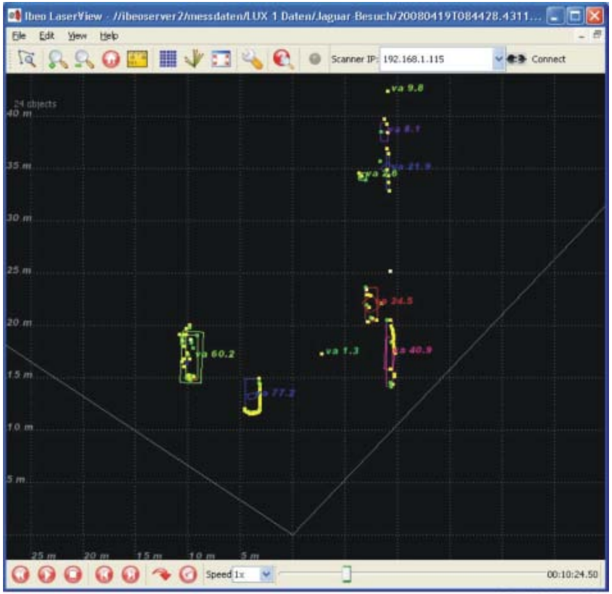


Figure 5-16: Dialog window Preferences-Objects

In the dialog window Preferences-Objects you can set the object information (see chapter 4.3 Step 3, object formation, page 4-11) that appear in the main screen.

5.9 Scan data display with objects



IB-LUX-035

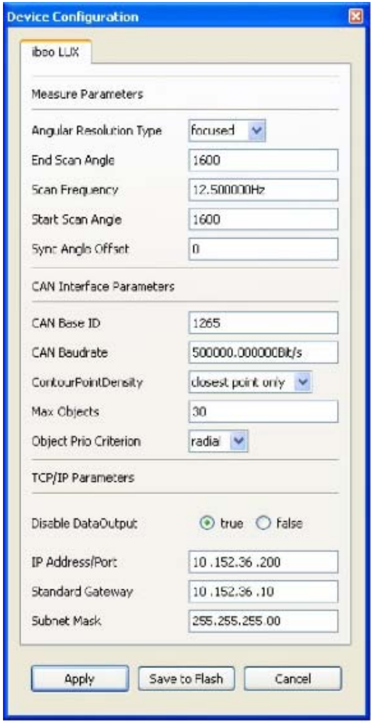
Figure 5-17: Scan data display with objects

Figure 5-17 shows a recorded traffic situation with object boxes and speed display, see dialog window Preferences-Objects in chapter 5.8 Preferences, page 5-32.

5.10 Device settings

The device settings serve for configuring connected devices.

In the menu bar, press Edit and Device Configuration to display the device settings and to change them, if required.



IB-LUX-059

Figure 5-18: Dialog window Device Configuration

When the dialog window Device Configuration is opened, current settings of the connected device are read and displayed.

If those settings can be modified, you can adjust them here and either use them temporarily in the device ("Apply") or store them permanently in the device ("Save to Flash").

With a few exceptions, the new settings are valid immediately.
The exceptions include parameters that are required for initialization of the device.
These values (e. g. IP-address, Subnet Mask, …) are permanently stored in the device and become effective after rebooting the device.

CAUTION

Do not enter parameters that prevent rebooting the device or for example prevent correct initialization of the interfaces.
Setting an IP-address that is not accessible, for example, renders it impossible to access the device via Ethernet after rebooting.

For a detailed description of the parameters refer to chapter 8 Configuration, page 8-1.

5.11 Update Firmware

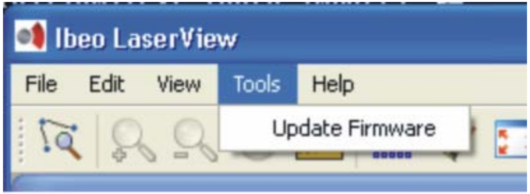
CAUTION

During the update process, the voltage supply to the ibeo LUX® my not be interrupted.
If the process is not completed corrected, you must send in the ibeo LUX®.

NOTE

The firmware is permanently stored in the device's memory. The old firmware in the device in then irrevocably overwritten.

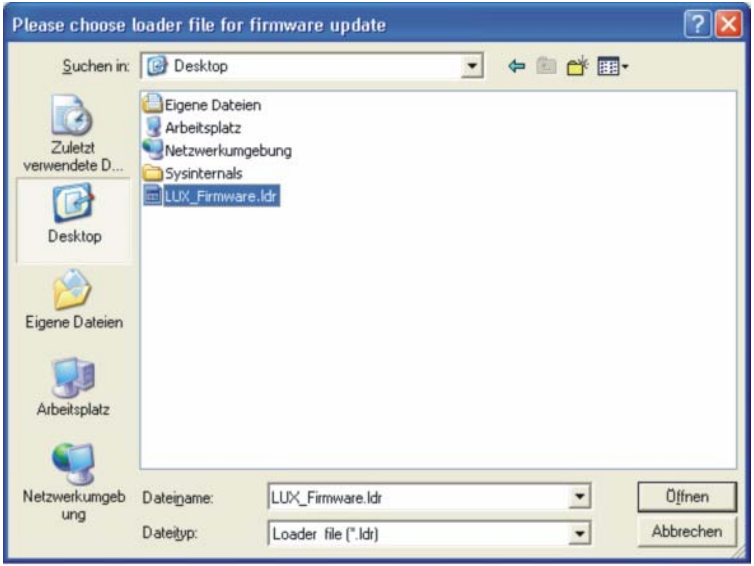
If a connection with an ibeo LUX® is established, the menu option Tools → Update Firmware is available.
This can be used to update the firmware of the device:



IB-LUX-068

Figure 5-19: Update Firmware

Press Tools and Update Firmware.



IB-LUX-067

Figure 5-20: Dialog window to select the Loader file

The dialog window to select the Loader file (*.ldr), which contains the software, appears.

Select and confirm the file. The firmware is then transmitted to the device.

7. Packaging, storage, and transport

6.1 Packaging

	NOTE
☞	*Improper disposal of the packaging materials burdens the environment.* *Dispose of the materials separately according to national and local regulations.*

6.1.1 ibeo LUX Single System and individual components

The ibeo LUX Single System as well as common combinations of individual components are packed in one packaging unit.
This packaging unit consists of

- an outer cardboard box,
- an inner cardboard box with the accessories,
- possibly filler material for safer transport e. g. in the inner box for the accessories, and
- a membrane pack to secure the ibeo LUX® between two film layers.

Accessories include the following components which can vary according to system:

- LUX standard connector cable
- LUX extension cable
- LUX-Connector
- Ethernet connector cable
- Connector cable for CAN
- CAN gateway
- Operating Manual
- CD-ROM

6.1.2 ibeo LUX Fusion System and ibeo LUX Power Fusion System

The ibeo LUX Fusion System and the ibeo LUX Power Fusion System are packed in a packaging unit each. The packaging unit consists of

- an outer cardboard box,
- an inner cardboard box with the accessories,
- possibly filler material for safer transport e. g. in the inner box for the accessories,
- an inner cardboard box for the LUX-Switch (only for ibeo LUX Power Fusion System),
- a membrane pack to secure the ECU between two film layers, and
- several membrane packs to secure each ibeo LUX® between two film layers.

Accessories include the following components which can vary according to system:

- LUX standard connection cable
- LUX extension cable
- LUX-Connector
- Ethernet connector cable
- Connector cable for CAN
- CAN gateway
- Operating Manual
- CD-ROM

6.2 Storage

Store the ibeo LUX® dust-free, dry and protected from direct sunlight. Cover the ibeo LUX® carefully.

In case of longer storage, arrange a contract of exactly defined storage conditions.

Do not remove or damage the packaging of the ibeo LUX® during storage.

Make sure that the shipping locks are not removed. The shipping locks may only be removed by trained staff prior to mounting.

Avoid larger thermal fluctuation and condensation.

Storage temperature	min. -40°C max. +95°C
Relative humidity	max. 93% for 21 days

NOTE

for the storage of the components see chapter 14 Technical data, page 14-1.

6.3 Transport

Please note the instructions on the packing list!

Make sure that the surfaces and seals are not deformed or damaged during transport.

Make sure that the shipping locks are not removed. The shipping locks may only be removed by trained staff prior to mounting.

Check the delivery for completeness and transport damages. Refer to chapter 14.10 , page 14.10 and the bill of delivery for the scope of delivery.

Check the ibeo LUX® upon reception on site for outer damages. In case of damages, immediately notify

ibeo Automobile Sensor GmbH

Merkurring 20

D - 22143 Hamburg

Phone: +49 - (0) 40 298 676 - 0

Fax: +49 - (0) 40 298 676 - 10

E-mail: info@ibeo-as.com

8. Mounting and installation

DANGER

Opening the ibeo LUX® is strictly forbidden.

Some parts inside the ibeo LUX® are under high voltage.

DANGER

Opening the ibeo LUX® 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.

CAUTION

Never operate the ibeo LUX®, the ECU and the LUX-Switch beyond the prescribed voltage range, see chapter 14 Technical data, page 14-1!

Ensure the correct voltage polarity in order to avoid damages to the devices!

7.1 Mounting

CAUTION

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

CAUTION

Opening the ECU and/or the LUX-Switch is prohibited.

NOTE

When using two or more ibeo LUX®, insufficient synchronization can cause malfunctions.

For information about synchronization refer to the separate document on the provided CD-ROM.

7.1.1 ibeo LUX®

1	Vehicle
2	Hexagon socket screw
3	ibeo LUX®

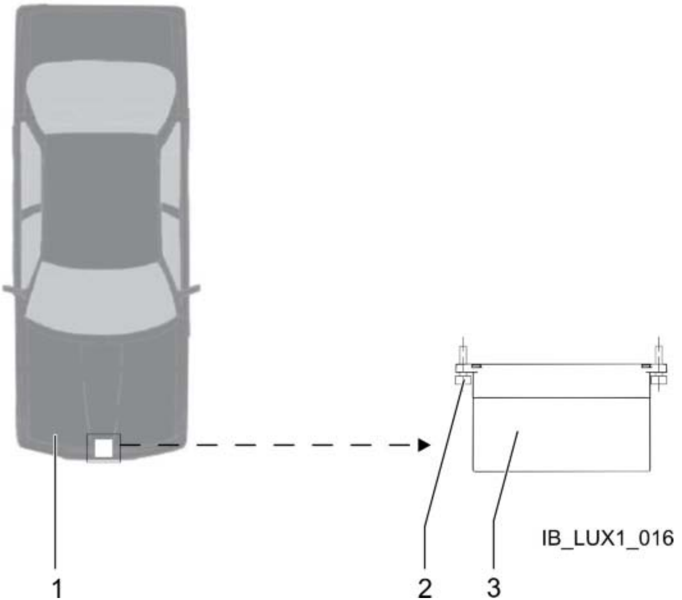


Figure 7-1: Standard installation ibeo LUX®

Description of items in figure 7-1:

By default, the ibeo LUX® (7-1/3) is attached to the front area of the vehicle (7-1/1).

☞	**NOTE**
	For information about other mounting options please contact Ibeo.

Mount the ibeo LUX®:

• at a height h_0 of 25 to 70 cm , measured from the ground, with the label pointing upwards,

☞	**NOTE**
	In case of a low mounting position, the tail of a high vehicle (e.g. truck) cannot be detected safely, as the ibeo LUX® might only measure the axles. *In such a case, the lower scan levels hit the ground early (according to the mounting angle). Thus, only three or two levels are available.*

	NOTE
☞	*Mounting must allow for later adjustment of the ibeo LUX® in order to set the pitch angle in such a way that the optical axis (0° orientation, see figure 10-3) of the ibeo LUX® is parallel to the ground.* *It must be possible to mount or adjust the yaw angle to the desired orientation (0°, see figure 10-4).* *For details about adjustment refer to chapter 10 Adjustment, page 10-1.*

- with a free field of vision for the working range,
- possibly behind a pane (glass or acrylic glass) which is transparent for infrared light (905 nm),

	NOTE
☞	*For further information about suitable material, contact ibeo.*

Proceed as follows to mount the ibeo LUX®:

1. Attach the sensor carrier at the vehicle.

☞	**NOTE**
	The sensor carrier is not part of the scope of delivery of the ibeo LUX®. *A sensor carrier facilitates adjustment.* *ibeo can provide help for designing a sensor carrier.*

2. Attach the ibeo LUX® with four hexagon socket screws DIN 912 M 6x16, 8.8, A2 (7-1/2) at the sensor carrier.
3. Adjust the ibeo LUX® vertically and horizontally, see chapter 10 Adjustment, page 10-1.

☞	**NOTE**
	You can also attach the ibeo LUX® at the vehicle without a sensor carrier. *Then adjust the ibeo LUX® vertically and horizontally.*

7.1.2 System components

	CAUTION
	Mount the respective system components (LUX-Connector, ECU, LUX-Switch) firmly at the vehicle and protect them from impact/shock and strong vibrations to prevent damages or loosening of the plug connections. Mount the system components at dry spots to prevent damages due to water contact or moisture. Mount the LUX-Switch at a dry and dust-protected spot to prevent damages. Make sure that the cooling ribs of the ECU are not covered after mounting to ensure sufficient cooling.

The system components can be mounted in any position.

Mount the system components as follows:

1. Build a holder for the system components according to the positions of the mounting points as shown in the technical drawing, see chapter 15.7 Dimension sheet, page 15-15.
2. Attach the system components at the respective holders.

☞	**NOTE**
	In order to attach the holder (3-22/6) at the LUX-Connector, you must remove the lid of the LUX-Connector. *To do so, loosen and remove the screws (3-22/7) of the lid of the LUX-Connector.* *As soon as you have attached the holder at the LUX-Connector, screw in the screws of the lid again, and tighten them.* *The screw for attaching the holder at the LUX-Connector may have a maximum diameter of 6 mm and a head height of 10 mm.*

3. Attach the system components at the vehicle in their respective mounting position, using suitable mounting material.

7.2 Installation

	CAUTION
	Please note that all connections are only waterproof if a matching waterproof plug or a matching waterproof cap is mounted! Do not lay the cables over sharp edges and make sure that the cables do not scour on sharp edges. If necessary, use an edge protection. The bending radius of the connecting cable of the ibeo LUX®, of the LUX extension cable and the LUX standard connector cable must be at least 6 cm. Else the cables could be damaged. Opening the ECU and/or the LUX-Switch is prohibited. The ECU is not polarity proof.

	NOTE
	When using two or more ibeo LUX®, insufficient synchronization can cause malfunctions. *For information about synchronization refer to the separate document on the provided CD-ROM.*

7.2.1 System of standard individual components

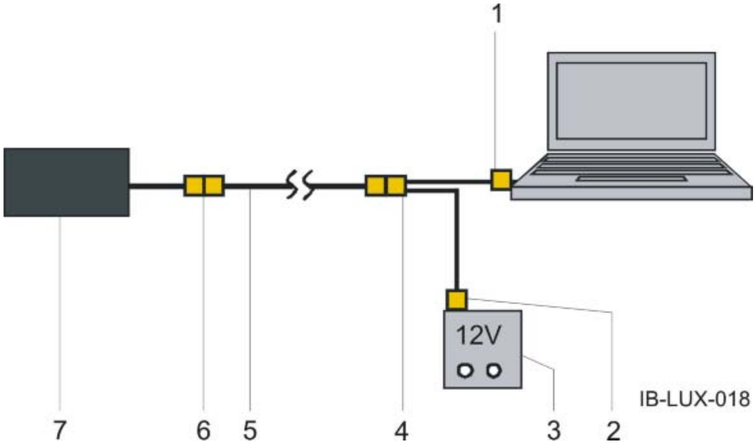


Figure7-2: System of standard individual components

Description of items in figure 7-2:

1	Interface Ethernet	5	LUX extension cable (option)
2	Interface voltage	6	Interface sensor
3	Power supply	7	ibeo LUX® incl. permanently installed connecting cable
4	LUX standard connection cable		

7.2.1.1 Interface sensor

Connect the ibeo LUX® (7-2/7) with the connecting cable via the interface Sensor (7-2/6) with the LUX standard connector cable (7-2/4).
If required, install a LUX extension cable (7-2/5) between the connecting cable and the LUX standard connector cable.

7.2.1.2 Interface Voltage

Connect the LUX standard connector cable via the interface Voltage (7-2/2) with the voltage supply (7-2/3), see chapter 3.2.4.3, Interface Voltage, page 3-58.

For information about the requirements of the voltage supply refer to chapter 14 Technical data, page 14-1.

7.2.1.3 Interface Ethernet

Connect the LUX-Standard connector cable lo a local network or a notebook via the interface Ethernet (7-2/1), see chapter 3.2.4.2 Interface Ethernet, page 3-57.

7.2.2 ibeo LUX Single System

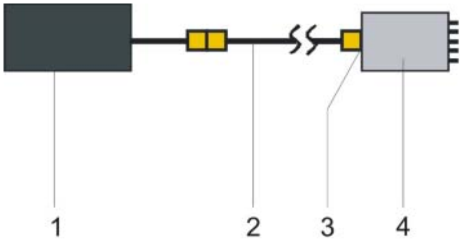


Figure 7-3: Installation ibeo LUX® with LUX-Connector

Description of items in figure 7-3:

1	ibeo LUX® incl. permanently installed connecting cable	3	Interface sensor
2	LUX extension cable	4	LUX-Connector

7.2.2.1 Interface sensor

Connect the ibeo LUX® (7-3/1) with the connecting cable via the interface Sensor (7-3/3) with the LUX-Connector (7-3/4).

If required, install a LUX extension cable (7-3/2) between the connecting cable and the interface Sensor.

7.2.2.2 Interface CAN

	CAUTION
	Never connect the CAN bus of a vehicle or a CAN bus of external devices directly to the LUX-Connector via the interface CAN. This can cause malfunctions! Ibeo strongly recommends using a CAN gateway, see chapter 3.2.10 CAN gateway, page 3-75.

Connect the LUX-Connector with a connector cable via the interface CAN (3-22/9) and a CAN gateway to the CAN bus of the vehicle.

7.2.2.3 Interface Voltage

Connect the LUX-Connector with a connector cable via the interface Voltage (3-22/4) with the voltage supply, see chapter 3.2.4.3, Interface Voltage, page 3-58.

For information about the requirements of the voltage supply refer to chapter 14 Technical data, page 14-1.

7.2.2.4 Interface Ethernet

Connect the LUX-Connector to a local network or a notebook via a connector cable and the interface Ethernet (3-22/5), see chapter 3.2.4.2 Interface Ethernet, page 3-57.

7.2.3 ibeo LUX Fusion System

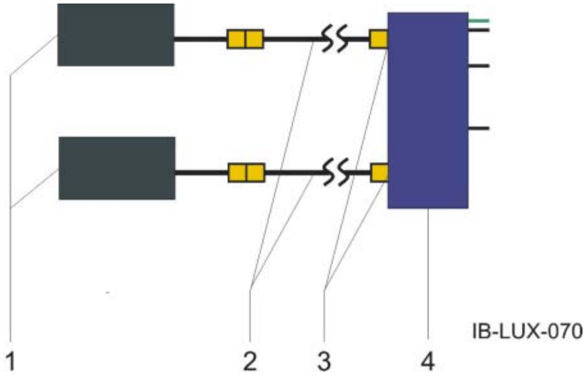


Figure 7-4: Installation of the ibeo LUX Fusion System

Description of items in figure 7-4:

1	ibeo LUX® incl. permanently installed connecting cable	3	Interface sensor
2	LUX extension cable	4	ECU

7.2.3.1 Interface sensor

Connect the respective ibeo LUX® (7-4/1) with the connecting cable via the interface Sensor (7-4/3) to the ECU (7-4/4).

If required, install a LUX extension cable (7-4/2) between the connecting cable and the interface Sensor.

7.2.3.2 Interface CAN

	CAUTION
	Never connect the CAN bus of a vehicle or a CAN bus of external devices directly to the ECU via the interface CAN. This can cause malfunctions! Ibeo strongly recommends using a CAN gateway, see chapter 3.2.10 CAN gateway, page 3-75.

Connect the ECU to the vehicle CAN via a connector cable, the interface CAN (3-23/6) and a CAN gateway, see chapter 3.2.4.5 Interface CAN, page 3-60.

7.2.3.3 Interface voltage

	NOTE
☞	*Please note that with the ibeo LUX Fusion System the ECU also provides connected ibeo LUX® with voltage which causes a higher power consumption at this voltage connection.*

Connect the ECU to the power supply via a connector cable and the interface voltage (3-23/3), see chapter 3.2.4.3 Interface voltage, page 3-58.

The ECU is connected directly to the power supply of the vehicle.

7.2.3.4 Interface Ethernet

Connect the ECU to a local network or a notebook via a connector cable and the interface Ethernet (3-23/4), see chapter 3.2.4.2 Interface Ethernet, page 3-57.

7.2.4 ibeo LUX Power Fusion System

	CAUTION
	Only connect external devices to the LUX-Switch while they are switched off.

	NOTE
	The ibeo LUX Power Fusion System uses the interface Sync IN and the interface Sync OUT of the LUX-Switch, not the interfaces of the ECU.

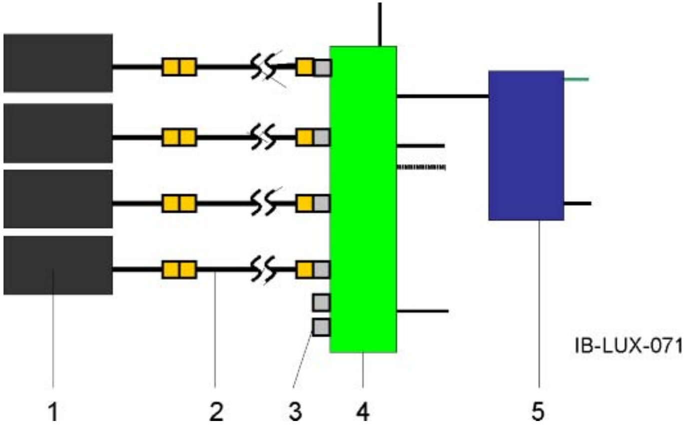


Figure 7-5: Installation of the ibeo LUX Power Fusion System

Description of items in figure 7-5:

1	ibeo LUX® incl. permanently installed connecting cable	4	LUX-Switch
2	LUX extension cable	5	ECU
3	Interface sensor		

7.2.4.1 Interface sensor

	CAUTION
	In order to ensure proper function of the LUX-Switch, an ibeo LUX® must be connected to the interface Sensor LUX 1. The other ibeo LUX® can be distributed arbitrarily.

Connect the respective ibeo LUX® (7-5/1) with the connecting cable via the interface Sensor (7-5/3) to the LUX-Switch (7-5/4).

If required, install a LUX extension cable (7-5/2) between the connecting cable and the interface Sensor.

7.2.4.2 Interface CAN

	CAUTION
	Never connect the CAN bus of a vehicle or a CAN bus of external devices directly to the ECU via the interface CAN. This can cause malfunctions! Ibeo strongly recommends using a CAN gateway, see chapter 3.2.10 CAN gateway, page 3-75.

Connect the ECU (7-5/1) with the connector cable via the interface CAN (3-23/6) and a CAN gateway to the vehicle CAN, see chapter 3.2.4.5 Interface CAN, page 3-60.

7.2.4.3 Interface voltage

NOTE

Please note that with the ibeo LUX Power Fusion System the LUX-Switch also provides connected ibeo LUX® with voltage which causes a higher power consumption at this voltage connection.

Connect the ECU with a connector cable via the interface Voltage (3-23/3) to the voltage supply.

Connect the LUX-Switch with a connector cable via the interface Voltage (3-24/1) to the voltage supply.

7.2.4.4 Interface Ethernet

Connect the ECU with a connector cable via the interface Ethernet (3-25/1) to the LUX-Switch.

Connect the LUX-Switch with a connector cable via the interface Ethernet (3-25/2) to a local network or a notebook.

7.2.5 Pin assignments of the interfaces

The following section describes the individual interfaces of the components LUX-Switch, LUX-Connector, ECU and the LUX standard connector cable. For more detailed information about the pin types refer to chapter 14.6 Plug types at the LUX-Connector, page14-11ff.

7.2.5.1 Pin assignment of the interface CAN

CAUTION

If the connected ibeo LUX® is the last device at the CAN bus, a terminator must be placed between pin 1 and 8.

Pin	Description
1	CAN L out
2	CAN L in
3	Signal ground
7	CAN H in
8	CAN H out

Table 7-1: Pin assignment of the interface CAN

7.2.5.2 Pin assignment of the interface RS232

Pin	Description
2	RS232 debug in
3	RS232 debug out
5	Signal ground

Table 7-2: Pin assignment of the interface RS232

7.2.5.3 Pin assignment of the interface Voltage

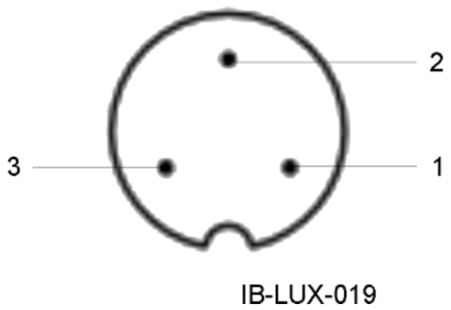


Figure 7-6: Pin assignment of the interface Voltage

Pin	Description
1	Voltage supply DC 12 V
2	Voltage supply ground
3	not assigned

Table 7-3: Pin assignment of the interface voltage

7.2.5.4 Pin assignment of the interface SYNC IN

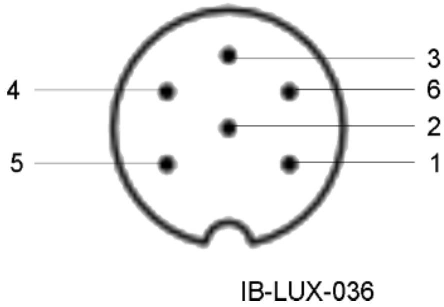


Figure 7-7: Pin assignment interface Sync IN

Pin	Description
2	Synchronization signal in
5	Signal ground

Table 7-4: Pin assignment of the interface Sync IN

7.2.5.5 Pin assignment of the interface Sync OUT

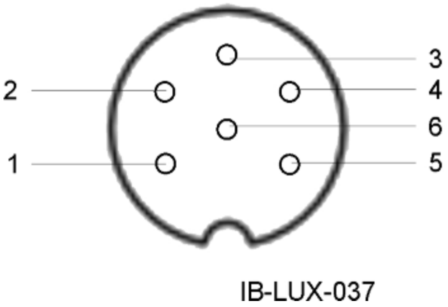


Figure 7-8: Pin assignment of the interface Sync OUT

Pin	Description
3	Synchronization signal out
5	Signal ground

Table 7-5: Pin assignment of the interface Sync OUT

7.2.5.6 Pin assignment of the interface Ethernet at the LUX standard connector cable

Pin	Description
1	Ethernet Rx+
2	Ethernet Rx-
3	Ethernet Tx+
4	Ethernet Nu1+**
5	Ethernet Nu1-**
6	Ethernet Tx-
7	Ethernet Nu2+**
8	Ethernet Nu2-**

** No function, optional termination possible.

Table 7-6: Pin assignment of the interface Ethernet

This pin assignment was selected to enable a direct connection to a network participant.

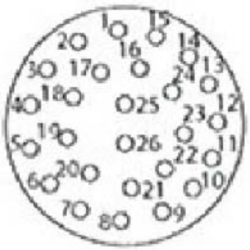
7.2.5.7 Pin assignment of the interface Ethernet at the LUX-Connector, LUX-Switch and at the ECU

Pin	Description
1	Ethernet Tx+
2	Ethernet Tx-
3	Ethernet Rx+
4	Ethernet Nu1+**
5	Ethernet Nu1-**
6	Ethernet Rx-
7	Ethernet Nu2+**
8	Ethernet Nu2-**

** No function, optional termination possible.

Table 7-7: Pin assignment of the interface Ethernet

7.2.5.8 Pin assignment of the interface Sensor



IB-LUX-038

Figure 7-9: Pin assignment of the interface Sensor

Pin	Description
1	Synchronization signal in
2	Synchronization signal out
3	Synchronization signal/RS232 ground*
4	RS232 debug out
5	RS232 debug in
6	CAN L in/out
7	CAN L out/in
8	CAN H in/out
9	CAN H out/in
10	Voltage supply DC 12 /24V
11	Voltage supply ground*
12	Voltage supply ground*
13	Cable shield
14	Cable shield

15	Cable shield
16	Cable shield
17	Not connected
18	Ethernet Tx-
19	Ethernet Tx+
20	Ethernet Rx-
21	Ethernet Rx+
22	Ethernet Nu1-**
23	Ethernet Nu1+**
24	Ethernet Nu2-**
25	Ethernet Nu2+**
26	-

* Voltage supply and signal ground are connected internally.

** No function, optional termination possible.

Table 7-8: Pin assignment of the interface Sensor

9. Configuration

	DANGER
	Changes to the configuration can impair the safety of the system, because they impact the object tracking (number of objects, quality of the objects, etc.). After every configuration change, you must perform a safety check. If necessary, contact the ibeo service team. Ibeo does not assume any liability if a system is operated with incorrect configuration..

Ibeo delivers the systems preconfigured so that usually a first usage is possible without changing the settings.

For the extended usage of the systems it is required to configure the systems according to the requirements and the application range.

In this chapter you find the configuration of the components:

- ibeo LUX®
- ECU

Not all components listed are necessarily part of your system, see chapter 3 Product overview, page 3-1.

NOTE
Details about the available system parameters and the different ways to read out and modify the parameters can be found on the provided CD-ROM.

8.1 ibeo LUX®

The central components of all systems build one or more ibeo LUX®.
These sensors offer different setup options.

With the help of the data visualization ILV, the corresponding parameters can be viewed, modified and stored or applied temporarily or permanently in the ibeo LUX®, see chapter 5 Visualization, page 5-1.

If parameters are only set temporarily, the ibeo LUX® uses the old, permanently set parameters at the next start (if the voltage supply has been interrupted or if the ibeo LUX® has been interrupted by a reset command).

8.1.1 Parameters of the interfaces

The interfaces provide specific and general configuration options.

- Network
  - IP address
    Here you can modify the preset IP address and adjust it to your needs.
  - Subnet mask
    Please make sure that the selected subnet mask matches your network or the IP range used by you.
- CAN
  - Transmission rate
    A transmission rate of 500 kBit/s is typical. The transmission rate can be adjusted to your CAN bus.

☞	NOTE
	Please note that lower data rates also mean that less objects can be transmitted.

  - Base identifier
    The base identifier determines the ID range used by the ibeo LUX®. From this base value on, a range of 16 IDs is used or reserved as working range.

- Maximum object number

  The data rate of the CAN bus, the bus load if already present and the selected density of contour points (see section "general", page 8-7) limit the maximum possible number of objects transmitted per scan.
  A limit value defines this maximum number of transmitted objects as a parameter. Currently, the closer objects are transmitted in such a case.

- ibeo LUX®

  The ibeo LUX® expects information about the vehicle's movement in a specified format, see the description of the CAN data log on the provided CD-ROM
  These data are required for tracking.
  If no information about the movement is available, warnings or fault messages are issued and no absolute object speed is available.
  In addition, the quality of these object data is not at its optimum if the ibeo LUX® moves e. g. with a vehicle without information about the vehicle's movement.

• General

- Selection which data to transmit.
- Minimum age of the transmitted objects (in scans).
- Maximum prediction age (number of pure predictions without measurement; in scans) of the transmitted objects.
  If this value is larger than 0, objects without current measurement values are also issued.
- Contour point density
  Here you can select to show the densest object point or a low / high contour point density, see the section "maximum object number", page 8-6.

8.1.2 Parameters of the measuring process

By modifying the following parameters you can influence the measuring properties of the ibeo LUX®.

- Start angle of the scan range
  The start angle of the scan range must always be larger than the end angle of the sensor coordinate system. The maximum value is +50°.
- End angle of the scan range
  The end angle of the scan range must always be smaller than the start angle of the sensor coordinate system. The minimum value is -60°.
- Scan frequency
  Scan frequencies of 12.5 Hz, 25 Hz and 50 Hz are possible, however, the available angle resolutions depend on the scan frequency, see chapter 3.2.1.2.5 Angle resolution and scan frequency, page 3-34.
- Angle resolution
  With a scan frequency of 12.5 Hz, the angle resolution can be set to be optimized towards the front. Else the angle resolution is constant, see chapter 3.2.1.2.5 Angle resolution and scan frequency, page 3-34.

8.1.3 Parameters of the mounting position and the carrier vehicle

☞	**NOTE**
	For details about the coordinate systems and the selection of the mounting position refer to chapter 10 Adjustment, page 10-1.

- Mounting position of the ibeo LUX® referring to the center of the back axle of the carrier vehicle
- Vehicle dimensions
- Transmission of steering wheel angle into wheel angle

8.2 System with ECU

	DANGER
	Only modify the system as described in this OM.

If an ECU is part of the systems (e. g. for the ibeo LUX Fusion System), then the ECU contains a central configuration file.
The parameters set in there are transmitted to the ibeo LUX® in the system and used by it.
The configuration stored within the individual ibeo LUX® remains unchanged.

Upon delivery, the ECU is preconfigured to have the system with all ibeo LUX® functional and ready to use.
However, some parameters (e. g. the mounting position) must still be adjusted.

The configuration files on the ECU cannot be modified with ILV to date.

8.2.1 Operating system and data structure

The ECU uses Linus, adapted by Ibeo, as operating system.
For the interaction with the system or to process configuration files or application updates, you can connect to the ECU via FTP and Telnet.

The access data are:

- User name: root
- Password: ibeo

In order to use Telnet to work on the ECU you must be experienced with the work with Linux as well as the editors vi or nano. The data structure on the ECU is as follows:

- The directories (incl. the subdirectories)
  /var/etc,
  /var/bin,
  contain configuration files, scripts and applications that the user can modify.

DANGER

All changes in these directories permanently impact the system behavior.

Perform modifications only in these two directories.

8.2.2 Modifying configuration files

The ECU contains the following configuration files that can be adjusted, if required:

- /var/etc/ifup
  Configuration of the network interface, see chapter 8.2.3 Configuration of the network interface, page 8-13
- /var/etc/appbase2.conf
  Configuration of the application AppBase2, see chapter 8.2.4 Configuration of the Ibeo application AppBase2, page 8-13

DANGER
Do not modify other configuration files.

You can modify configuration files via Telnet and with vi or nano.
Alternatively you can also download them via FTP and then modify them on another computer.
Please note that you may not change the Linux/UNIX format (line ends, encoding).

The Windows editor notepad is not suitable, use other editors e. g. notepad++ or UltraEdit.

8.2.3 Configuration of the network interface

The file /var/etc/ifup contains:

```
#!/bin/sh
/sbin/ifconfig eth1 up
/sbin/ifconfig eth1 10.152.36.100 netmask 255.0.0.0
```

If required, you can modify the IP address of the ECU (default 10.152.36.100) and the subnet mask (default 255.0.0.0). Modify only these values in the file.

8.2.4 Configuration of the Ibeo application AppBase2

The file /var/etc/appbase2.conf contains several configuration blocks, depending on the system used. Firstly, it must contain blocks that describe the system components and interfaces with a block each.

In order to make the software AppBase2 accept the configuration, consider the following:

- The individual sections begin with the keyword 'BEGIN' and end with 'END'.
- After the keyword 'BEGIN' follows a type, possibly a specific name e. g. 'BEGIN IbeoLUX "myLUX1"'. The specific name may only be used once. If you want to add another ibeo LUX®, it can be referred to as follows 'BEGIN IbeoLUX "myLUX2".
- Interfaces (e. g. interface CAN) must be declared prior to their first use. Every interface may only be declared once.
- All devices (e. g. of the ibeo LUX®) need a unique device ID, which can be assigned arbitrarily between 1 and 254.
- Start comments with a semicolon.

8.2.4.1 System

```
;#########################################################################
; System Config
;#########################################################################

BEGIN System
      ; --- Interface(s) ---
      BEGIN CAN "myCAN"
            Device = /dev/pcan0
            BaudRate = 500 kBaud
      END

      ; --- Sensors ---
```

```
    BEGIN IbeoLUX "Lux1"
        DeviceID = 1
        IPAddress = 10.152.36.206
        OffsetX = 0.0 m
        OffsetY = 0.0 m
        OffsetZ = 0.0 m
        SyncAngle = 0 deg
        YawAngle = 0 deg
        PitchAngle = 0 deg
        RollAngle = 0 deg
        ScanStartAngle = 50 deg
        ScanEndAngle = -50 deg
        ScanFrequency = 12.5 Hz
    END

END ; System
```

In this example, the interface CAN of the system is configured first.
It is followed by a configuration block for one ibeo LUX®. According to the number of ibeo LUX® used, there are several of these blocks.

8.2.4.2 CAN Data parser

The following block describes the configuration for the vehicle CAN data parser. It describes the messages and data containing the information about movement of the vehicle itself.

```
;##########################################################################
; CAN Parser Config
;##########################################################################

BEGIN CanParserCollection

      BEGIN CanParser "VEH_CrossAcceleration"
            ; Required
            Identifier = 0x301
            Picture = "-------- xxxxxxxx -------- -------- -------- --------
                              -------- --------"
            ; Optional
            ErrorValue = 0x80
            Factor = 0.1 ; conversion from 0.1 m/s^2 to m/s^2
            UseLittleEndian = false
            TwosComplement = true
      END
```

```
BEGIN CanParser "VEH_Velocity"
      ; Required
      Identifier = 0x301
      Picture = "-------- -------- xxxxxxxx xxxxxxxx -------- --------
                 -------- --------"
      ; Optional
      ErrorValue = 0x8000
      Factor = 0.02777778 ; conversion from 0.1 km/h to m/s
      UseLittleEndian = false
      TwosComplement = true
END

BEGIN CanParser "VEH_SteeringWheelAngle"
      ; Required
      Identifier = 0x301
      Picture = "-------- -------- -------- -------- xxxxxxxx xxxxxxxx
                 -------- --------"
      ; Optional
```

```
        ErrorValue = 0x8000
        Factor = 0.001745329; conversion from deg to rad
        UseLittleEndian = false
        TwosComplement = true
    END

    BEGIN CanParser "VEH_YawRate"
        ; Required
        Identifier = 0x301
        Picture = "-------- -------- -------- -------- -------- --------
                       xxxxxxxx xxxxxxxx"
        ; Optional
        ErrorValue = 0x8000
        Factor = 0.0001745329; conversion from 0.01 deg/s to rad/s
        UseLittleEndian = false
        TwosComplement = true
    END
END ; CanParser
```

The data on vehicle movement are required for tracking.
If no information about the movement is available, warnings or fault messages are issued and no absolute object speed is available.
In addition, the quality of these object data is not at its optimum if the ibeo LUX® moves e. g. with a vehicle without information about the vehicle's movement.

8.2.4.3 Object data output

Some settings are available for the output of object data. Some of them are of general value, some only refer to CAN (can be seen from the name of the parameter).

```
;##########################################################################
; Object Output Config
;##########################################################################

BEGIN ObjectOutput
      MinimumObjectAge = 0
      MaximumPredictionAge = 0
      ContourPointDensity = 1 ; 0 = closest point, 1 = low, 2 = high
      MaxObjectsViaCAN = 20
      ObjectPriorizationViaCAN = 0
      AbsoluteVelocitiesViaCAN = true ; false = relative velocities
      ObjectBoxesViaCAN = true ; false = bounding boxes
END ; ObjectOutput
```

8.2.5 Data connections ECU/sensors via network

It can possible to use ILV to establish a connection both to the ECU and to the individual ibeo LUX®.

However, to date you can only establish one connection at to each ibeo LUX® at a time.

On system start, the ECU connects to all configured ibeo LUX®.

Establishing a direct connection to an ibeo LUX® with ILV interrupts the present connection ibeo LUX®-ECU and causes the application on the ECU to stop.
Hence, if a direct connection to an ibeo LUX® is required, e. g. to modify the configuration or to check the sensor data, the ECU must be rebooted.

10. Commissioning

	CAUTION
	Commissioning and decommissioning of the ibeo LUX® may only be performed by trained staff. Make sure to observe all national and local safety requirements. Never operate the ibeo LUX®, the ECU and the LUX-Switch beyond the prescribed voltage range, see chapter 14 Technical data, page 14-1! Ensure the correct voltage polarity in order to avoid damages to the devices!
	NOTE
	This chapter describes issues that are only valid for the Windows operating system. Act accordingly for other operating system.

9.1 First steps

To ensure safety during commissioning, check the following. Every requirement must be fulfilled.

1. Check that all screw connections are tight.
2. Check if all cables are installed correctly and completely, see chapter 7.2 Installation, page 7-10.
3. Check if any cable runs around sharp edges or can scour sharp edges in case of movements. If that is the case, change the cable layout or use an edge protection around the sharp edges.
4. Check if the supply voltage is applied.

9.2 Commissioning

9.2.1 Quick start incl. basic configuration for an ibeo LUX Single System

1. Connect the ibeo LUX® with the LUX standard connector cable or the LUX-Connector.
2. Connect the LUX standard connector cable or the LUX-Connector to the voltage supply.
3. Connect the LUX standard connector cable or the LUX-Connector with the Ethernet.
4. Switch on the voltage supply.
5. Start the computer.
6. Prepare the network interface of the computer.
   - The default IP address of the ibeo LUX® can be found on the sticker of the ibeo LUX®
     (e. g. 10.152.36.134, subnet mask 255.0.0.0)

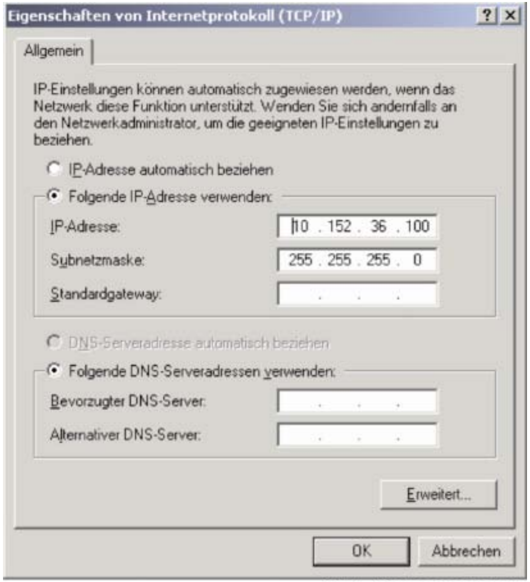
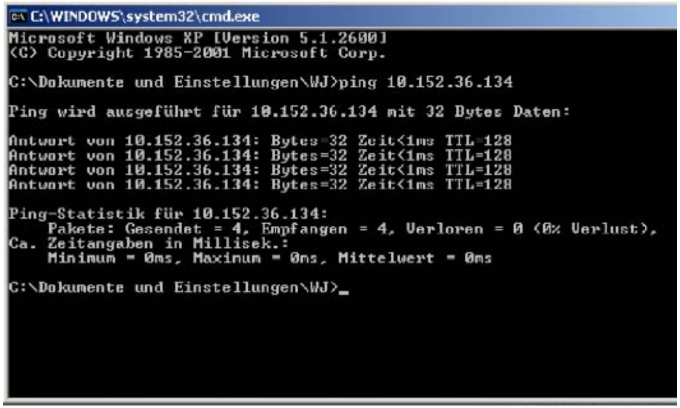


Figure 9-1: Properties

7. Configure the network of the computer in such a way that the ibeo LUX® can be reached. Figure 9-1 shows a dialog window to setup the network settings for a Windows operating system. If necessary, contact your system administrator.
    - Subnet mask 255.255.255.0
    - IP address range 10.152.36.1 … 10.152.36.254
    - IP addresses may only be assigned to one device within a network
    - Gateway, DNS etc. may not be modified



IB-LUX-040-DEU

Figure 9-2: Optional test for the ibeo LUX® or an ECU

8. Test the configuration or check all issues again. To do so, access the prompt of the system under cmd.exe.

- Enter "ping <ibeo-LUX-IP-Address>" at the prompt: e. g. "ping 10.152.36.134".
- If the ibeo LUX® answers, the configuration was successful.
- If the ibeo LUX® does not answer, repeat the procedure starting with step 6.

9.2.2 Starting the operating mode "measuring process"

	NOTE
	For further information about the operating mode "measuring process" refer to chapter 5.6 Operating mode measuring operation, page 5-25.

1. Start the program ILV.
2. Enter the IP address of the ibeo LUX® into the input field "Scanner IP:".
3. Press the button .
4. The ibeo LUX® starts the operating mode "measuring process" with the default settings.
5. The scan data or the object data appear in the display area.
6. In order to finish the measurement, press the button  or the system button "Exit".

9.3 Decommissioning

CAUTION

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

Always dispose of unusable or irreparable devices according to the local waste regulations (e.g. European Waste Code 16 02 14).

Only trained staff may separate materials!

Prior to supplying the devices to environment-friendly recycling processes, you must separate the different materials of the ibeo LUX®. Separate the housing from the remaining components.

We will gladly assist you in the disposal of these devices. Contact us.

Dispose of the individual materials according the applicable recycling processes, see chapter 14.9 Materials, page 14-14.

11. Adjustment

DANGER

Never use the data from the ibeo LUX® if the ibeo LUX® is not or incorrectly adjusted.
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.

CAUTION

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

CAUTION

Never operate the ibeo LUX®, the ECU and the LUX-Switch beyond the prescribed voltage range, see chapter 14 Technical data, page 14-1!

Ensure the correct voltage polarity in order to avoid damages to the devices!

In order to ensure proper function of the system, the ibeo LUX® must be configured and adjusted after mounting.

If more than one ibeo LUX® is integrated into the vehicle, perform steps 1 to 4 of the following chapters 10.2 to 10.5 for each ibeo LUX® .
If an ibeo LUX® is not adjusted, it must be either switched off or its scan range must be covered.

10.1 Coordinate system

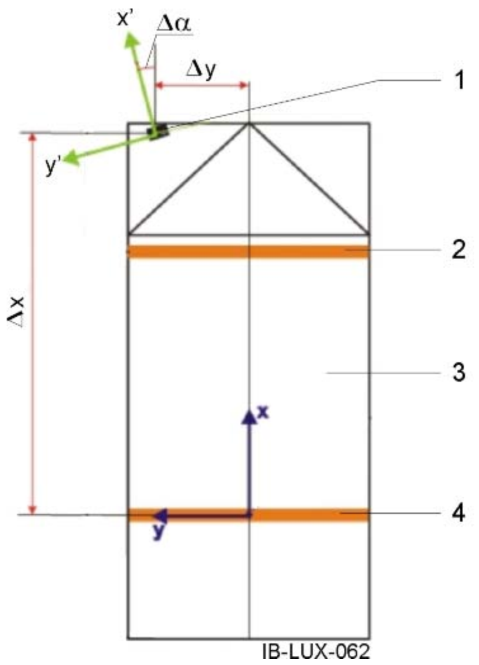


Figure 10-1: Coordinate system, view from above

Description of items in figure 10-1:

1	ibeo LUX®	$\Delta\alpha$	Yaw angle
2	Front axle	Δx	Offset to the vehicle's coordinate system on the x-axis
3	Vehicle	Δy	Offset to the vehicle's coordinate system on the y-axis
4	Rear axle	x	x-axis of the vehicle's coordinate system
		y	y-axis of the vehicle's coordinate system
		x'	x-axis of the sensor's coordinate system
		y'	y-axis of the sensor's coordinate system

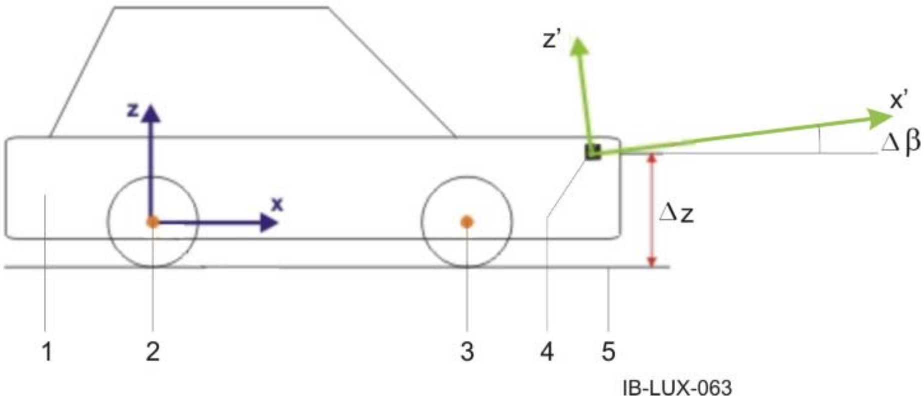


Figure 10-2: Coordinate system, side view

Description of items in figure 10-2:

1	Vehicle	Δz	Offset to the underground of the z-axis
2	Rear axle	Δß	Pitch angle
3	Front axle	z	z-axis of the vehicle's coordinate system
4	ibeo LUX®	z'	z-axis of the sensor's coordinate system
5	Level surface		

To calculate the movement of the vehicle, the ibeo LUX® (10-1/1) requires the exact mounting position on the vehicle (10-1/3), because the object data must be transformed into the vehicle's coordinate system.
To do so, the values Δx (10-1/Δx), Δy (10-1/Δy), Δz (10-2/Δz), the yaw angle (10-1/Δα), the roll angle and the pitch angle (10-2/Δß) in the ibeo LUX® must be set (configured) or the ibeo LUX® must be adjusted accordingly.
The origin of the vehicle's coordinate system is always the center of the rear axle (10-1/4).

10.2 Step 1, mounting position ibeo LUX®

Use a suitable measuring instrument to determine the exact mounting position of the ibeo LUX® referring to the vehicle's coordinate system or accept the mounting data from the technical drawing or CAD data.

Configure the mounting position Δx, Δy, Δz of the ibeo LUX® using the ILV program.

10.3 Step 2, adjusting the pitch angle

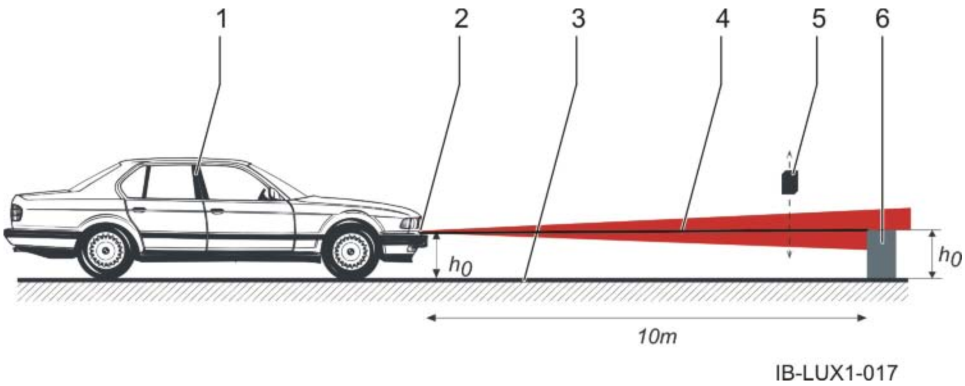


Figure 10-3: Pitch angle

Description of items in figure 10-3:

1	Vehicle	5	Laser detector
2	ibeo LUX®	6	Reference target
3	Level surface	h_0	Height
4	Optical axis		

Adjust the ibeo LUX® (10-3/2) vertically (static pitch angle of the ibeo LUX®) by aligning the optical axis (10-3/4) of the ibeo LUX® parallel to a surface ground assumed as even (10-3/3).

Proceed as follows for adjustment:

1. Park the vehicle (10-3/1) on a level surface and make sure that the surface is level up to 10 m in front of the vehicle.
2. Load the vehicle as under normal conditions, e.g. with one driver and one passenger.

☞	**NOTE**
	If the vehicle is equipped with an automatic chassis adjustment, it must be activated. This requires the engine to be running.

3. Activate the ibeo LUX®. It must measure actively.
4. Measure the height h_0 between the ground and the center of the ibeo LUX®.
5. Perform the adjustment either with a laser detector or with the help of ILV and a reference target.

10.3.1 Adjustment with the help of a laser detector

1. Place the laser detector (10-3/5) in a distance of 10 m in front of the ibeo LUX® in 0° direction (sensor coordinate system).
2. Adjust the ibeo LUX® so that the height of the beam center is identical with the height h_0 directly at the ibeo LUX®.
3. Repeat this process starting with step 2 for at least one other direction (e.g. 30°) in order to correct a possible roll angle/bank angle of the ibeo LUX®. After this correction, the scan level should be parallel to the ground and the mirror center should be inside the scan level.

10.3.2 Adjustment using ILV and a reference target

1. Build a simple reference target (10-3/6) with the height h_0, e. g. a wooden block or wooden plank with a foot to make it stand upright on its own.
2. Place the reference target in a distance of 10 m in front of the ibeo LUX® in 0° direction (sensor coordinate system).
3. Adjust the ibeo LUX® so that the height of the beam center is identical with the height h_0 directly at the ibeo LUX®.
4. Adjust the ibeo LUX® so that the only the lower two scan levels (predefined colors: red and blue) hit the reference target in the ILV while the upper two scan levels (green and yellow) hit the background or show no measurement at all, see figure 3-13.
5. Repeat this process starting with step 2 for at least one other direction (e.g. 30°) in order to correct a possible roll angle/bank angle of the ibeo LUX®. After this correction, the scan level should be parallel to the ground and the mirror center should be inside the scan level.

10.4 Step 3, adjusting the yaw angle

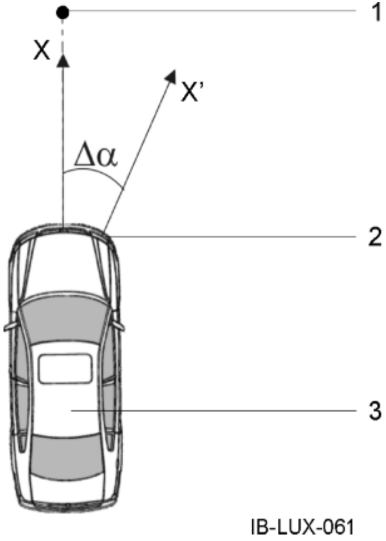


Figure 10-4: Yaw angle

Description of items in figure 10-4:

1	Reference target	x	x-axis of the vehicle's coordinate system
2	ibeo LUX®	x'	x-axis of the sensor's coordinate system
3	Vehicle	$\Delta\alpha$	Yaw angle

Adjust the ibeo LUX® (10-4/2) horizontally (static yaw angle of the ibeo LUX®) by adjusting the 0° alignment of the ibeo LUX® into the desired direction (default mounting 0° direction in the vehicle's coordinate system).

Proceed as follows for adjustment:

1. Park the vehicle (10-4/3) on a level surface and make sure that the surface is level up to 10 m in front of the vehicle.
2. Place a reference target (10-4/1) (ideally a target with a height of approx. 1 m and a diameter of 15 … 20 cm) in a distance of 10 m centrally in front of the vehicle or the x-axis of the vehicle's coordinate system (10-4/x).

3. Switch on the ibeo LUX® and start ILV.

4. Use the ILV to measure the yaw angle (10-4/$\Delta\alpha$) of the ibeo LUX®.
   Please note that ILV considers all set offsets (apart from roll and pitch angle) and that the data are displayed in the vehicle's coordinate system.
   If the ibeo LUX® is mounted with a yaw angle of -25°, as shown in figure 10-4, the target is displayed in the ILV under the angle 25°.
   Check the yaw angle adjustment of the ibeo LUX® and adjust them to your requirements until the angle is correctly shown in the ILV.

5. Configure the mounting position yaw angle of the ibeo LUX® in the ILV program.

	NOTE
	So far, no angle offset has been set in the ibeo LUX®. The measured data are not yet displayed in a turned way, but may be shifted due to the offset values (step 1). Hence, measured data from the 0° direction of the sensor coordinate system are displayed in 0° direction of the ILV.

10.5 Step 4, test

Check if the reference target is transformed correctly, i. e. if 0° in the vehicle's coordinate system are displayed as 0° in the ILV.

If the reference target is transformed correctly, the adjustment of the ibeo LUX® is complete.

If the reference target is not displayed correctly, repeat the steps starting with chapter 10.4 Step 3, adjusting the yaw angle, page 10-12.

If all steps have been performed correctly, the pitch angle and the roll angle both have the value 0°.

10.6 ibeo LUX Fusion System and ibeo LUX Power Fusion System

If you have an ibeo LUX Fusion System or an ibeo LUX Power Fusion System in which the individual scan ranges overlap (see figures 3-4, 3-5, 3-7 and 3-9), put up a reference target in the overlapping areas.

Check if the reference target matches in the scan data of the involved ibeo LUX® with ILV.
If mismatches occur, check and correct the offset values Δx, Δy, Δz and the adjustment or the configuration of the respective yaw angle.

12. Operation

DANGER

Never use the data from the ibeo LUX® if the ibeo LUX® has not been adjusted or has been adjusted incorrectly, see chapter 10 Adjustment, page 10-1.
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.

CAUTION

Never operate the ibeo LUX®, the ECU and the LUX-Switch beyond the prescribed voltage range, see chapter 14 Technical data, page 14-1!

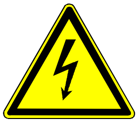
Ensure the correct voltage polarity in order to avoid damages to the devices!

Check the correct adjustment regularly, see chapter 10 Adjustment, page 10-1.

NOTE

During operation, the requirements for the ambient conditions must be met, see chapter 14 Technical data, page 14-1.

13. Cleaning and maintenance

	**DANGER** Opening the ibeo LUX® is strictly forbidden. Some parts inside the ibeo LUX® are under high voltage.
	**DANGER** Opening the ibeo LUX® 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.
	**NOTE** *Send the ibeo LUX® immediately to Ibeo for repair if you notice damages to the plastic panel of the ibeo LUX®.*

12.1 Cleaning

The ibeo LUX® is waterproof.

Use a soft cloth with water and a non-aggressive, nonabrasive cleaning agent for cleaning.

If mounted, the ibeo LUX® can also be cleaned with a high pressure cleaner as long as the maximum values regarding pressure, duration and distance of the high pressure cleaner to the ibeo LUX® comply with DIN 40050.
Else water can permeate the seals or damage parts of the ibeo LUX® housing.

12.2 Maintenance

The ibeo LUX® is maintenance-free, you do not need to service any inner parts.

12.3 Customer service

In case of malfunctions / failure please contact you local customer service representative, your vendor or the Ibeo customer service.

ibeo Automobile Sensor GmbH

Merkurring 20

D - 22143 Hamburg

Phone: +49 - (0) 40 298 676 - 0

Fax: +49 - (0) 40 298 676 - 10

E-mail: info@ibeo-as.com

14. Warnings and fault messages

For a complete list of warnings and fault messages, refer to the provided CD-ROM.

If a fault occurs at the ibeo LUX®, warnings and fault messages are issued via CAN and Ethernet.

The user can extract the warnings and fault messages from the data stream of the CAN or the Ethernet.

NOTE

If you use ibeoLaserView (ILV) for the visualization of the scan / object data, the faults are displayed in that system, see chapter 5.2.3.3 Trace log, page 5-21.

The warnings and fault messages contain Bit fields, each Bit represents one warning or one fault. Available are a maximum of twice 16 Bit each for warnings and faults.

NOTE

For a description of the log of warnings and fault messages refer to the provided CD-ROM.

13.1 Warnings

13.1.1 Bit field warning_1

Bit	Description	Comment
15	reserved	
14	reserved	
13	reserved	
12	reserved	
11	reserved	
10	reserved	
9	reserved	
8	reserved	
7	synchronization error	check synchronization frequency and scan frequency
6	reserved	
5	internal warning	

4	temperature too high	warning of excess temperature
3	temperature too low	warning of insufficient temperature
2	internal warning	
1	internal warning	
0	internal communication error	

13.1.2 Bit field warning_2

Bit	Description	Comment
15	reserved	
14	reserved	
13	reserved	
12	reserved	
11	reserved	
10	reserved	
9	no objects due to mounting position	correct mounting position according to the OM
8	no or incorrect CAN vehicle data	check CAN vehicle data
7	segment overflow	contact support
6	memory access failed	restart ibeo LUX®, contact support
5	command error	check command
4	Ethernet data error	check Ethernet data

3	incorrect scan data	contact support
2	CAN data error	check CAN data
1	Ethernet communication fault	check Ethernet connection
0	CAN communication fault	check CAN bus and CAN connection

13.2 Fault messages

13.2.1 Bit field error_1

Bit	Description	Comment
15	reserved	
14	reserved	
13	internal error	contact support
12	motor fault	contact support
11	motor fault	contact support
10	motor fault	contact support
9 … 8	Bit 9: internal temperature too high Bit 8: internal temperature too low Bit 8 and 9: temperature sensor defect	provide cooling provide heating contact support
7	reserved	

6	reserved	
5	reserved	
4	reserved	
3	scanner buffer overflow	decrease scan resolution / frequency / range contact support
2	scanner buffer transmitted incompletely	decrease scan resolution / frequency / range contact support
1	motor fault	contact support
0	internal error	contact support

13.2.2 Bit field error_2

Bit	Description	Comment
15	reserved	
14	reserved	
13	reserved	
12	reserved	
11	reserved	
10	reserved	
9	reserved	
8	reserved	
7	time-out tracking	contact support
6	time-out data processing	decrease scan resolution / frequency / range
5	incorrect parameter	load correct configuration values
4	incorrect configuration values	load correct configuration values
3	internal error	contact support

2	incorrect scan data	contact support
1	internal communication error	contact support
0	no scan data received	contact support

15. Technical data

14.1 ibeo LUX®

14.1.1 Identification

Type	Laserscanner
Designation	ibeo LUX®
Laser class	1
Protection type (mounted)	IP6K9K (DIN EN 40050-9)
Operating temperature	-40 °C ... +85 °C
Dimensions (H x W x D)	max. 85 x 152 x 93 mm
Weight	approx. 900 g
Weight incl. connecting cables	approx. 1100 g

14.1.2 Electric data

Supply voltage	12 V, 24 V nominal	
Operating voltage	9 V ... 27 V	
Overvoltage protection	2 h at 30 V, 2 min at 36 V	
Polarity proof	up to 36 V	permanently
Starting current	2 A for < 0.1 s	
Operating current	< 0.6 A	at 12 V, medium output load
	< 0.8 A	at 12 V, max. output load
Power consumption	< 7 W, medium output load	
	< 10 W, max. output load	

14.1.3 Miscellaneous

Working range	horizontal 85° (extended 110°)
Opening angle	vertical 3.2°
Detection range	from 0 m on
Measurement range	0.3 m … 200.0 m in 0° direction
Range to target	
with 10% remission	50 m
Distance resolution	0.04 m
Repeat accuracy (1 σ)	0.1 m
Scan levels	4 parallel

Echoes per shot and measurement level	3
Scan frequency	12.5 Hz/25 Hz/50 Hz
Sender	pulsed laser diode
Wavelength	895 nm ... 915 nm
Horizontal divergence of the collimated beam	0.08°
Pulse duration	approx. 4.5 ns
Startup time	< 15 s (ibeo LUX Single System)
Data interfaces	CAN, Ethernet 100 MBit/s

14.2 ECU

14.2.1 Identification

Protection type	IP54 (DIN EN 60529)
Operating temperature	-20°C ... +60 C
Storage temperature	±0°C ... +70 C
Relative humidity	10% … 90%, non-condensing
Dimensions (H x W x D)	250 x 160 x 112 mm
Weight	approx. 4.7 kg

14.2.2 Electric data

Supply voltage	12 V
Operating voltage	9 V ... 18 V
Overvoltage protection	no
Starting current	short-term up to 4 A for approx. 25 s (booting)
Operating current	< 1.2 A at 12 V, medium output load < 1.7 A at 12 V, max. output load
Power consumption	< 14 W, medium output load < 20 W, max. output load

14.3 LUX-Connector

Temperature range	-20 °C ... +70 °C
Dimensions (H x W x D)	approx. 125 x 124 x 81 mm

14.4 LUX-Switch

Temperature range	-20 °C ... +70 °C
Dimensions (H x W x D)	approx. 210 x 440 x 66 mm
Fuse	10 A

14.5 CAN gateway

☞	**NOTE**
	For the technical data on the CAN gateway refer to the technical information provided with the CAN gateway.

14.6 Plug types at the LUX-Connector

14.6.1 Interface Sync IN

6-pin DIN plug (DIN 45322)

14.6.2 Interface Sync OUT

6-pole DIN socket

14.6.3 Interface Ethernet

RJ45 socket

14.6.4 Interface RS232

9-pin D-Sub plug

14.6.5 Interface CAN

9-pin D-Sub plug

14.6.6 Interface sensor

26-pole Ibeo socket

14.6.7 Interface voltage

3-pin DIN plug (DIN 41524)

14.7 Plug types at the ECU

14.7.1 Interface Sync IN

6-pin DIN plug (DIN 45322)

14.7.2 Interface Sync OUT

6-pole DIN socket

14.7.3 Interface Ethernet

RJ45 socket

14.7.4 Interface RS232

9-pin D-Sub plug

14.7.5 Interface CAN

9-pin D-Sub plug

14.7.6 Interface USB

USB socket

14.7.7 Interface sensor

26-pole Ibeo socket

14.7.8 Interface voltage

3-pin DIN plug (DIN 41524)

14.8 Plug types at the LUX-Switch

14.8.1 Interface Sync IN

6-pin DIN plug (DIN 45322)

14.8.2 Interface Sync OUT

6-pole DIN socket

14.8.3 Interface Ethernet

RJ45 socket

14.8.4 Interface RS232

9-pin D-Sub plug

14.8.5 Interface Sensor

26-pole Ibeo socket

14.8.6 Interface voltage

3-pin DIN plug (DIN 41524)

14.9 Materials

Housing ibeo LUX®	Aluminum and plastic pane
Housing ECU	Aluminum and steel
Housing LUX-Connector	Aluminum
Housing LUX-Switch	Aluminum

14.10 Scope of delivery

14.10.1 System of standard individual components

System of standard individual components as described in chapter 3.1.1 System of standard individual components,
page 3-5.

Standard individual components	
	1 x ibeo LUX®
	1 x LUX standard connector cable
	1 x LUX extension cable 8 m

14.10.2 ibeo LUX Single System

ibeo LUX Single System	1 x ibeo LUX®
	1 x LUX Connector
	1 x ibeo API
	1 x LUX extension cable 8 m
	1 x CAN gateway
	1 x CAN connector cable
	1 x Ethernet connector cable

14.10.3 ibeo LUX Fusion System

ibeo LUX Fusion System
2 x ibeo LUX®
1 x ECU
1 x ibeo API
2 x LUX extension cable 8 m
1 x CAN gateway
1 x CAN connector cable
1 x Ethernet connector cable

14.10.4 ibeo LUX Power Fusion System

ibeo LUX Power Fusion System
4 x ibeo LUX®
1 x LUX-Switch
1 x ECU
1 x ibeo API
4 x LUX extension cable 8 m
1 x CAN gateway
1 x CAN connector cable
2 x Ethernet connector cable

14.11 Accessories

Ibeo offers the following products which you can order as accessories:

- LV Extended
- Adapter and plug for the interfaces
- ibeo LUX®
- LUX standard connection cable
- LUX-Connector
- LUX-Switch
- ECU
- ibeo API
- LUX extension cable 2 m
- LUX extension cable 8 m
- CAN gateway
- Connector cable for CAN
- Ethernet connector cable

17. Annex

15.1 Manufacturer's declaration

according to EC Machine Directive 98/37/EC

The manufacturer	Ibeo Automobile Sensor GmbH Merkurring 20 D - 22143 Hamburg
hereby declares that for the	Laserscanner ibeo LUX® Version 1.0

commissioning is prohibited until determined that the vehicle into which this unit is to be mounted fulfills the requirements of the machine directive.

Applied standards and technical specifications:

- DIN 40050-9:1993-05 Road vehicles; degrees of protection (IP-code); protection against foreign objects; water and contact; electrical equipment
- IEC 60825-1: 1994 + A1:2002 + A2:2001 Safety of laser products - Part 1: Equipment classification, requirements and user's guide

Hamburg, 8. August 2008 --

Managing Director Dr. Ulrich S. Lages

15.2 Change service

Index	Date	Name	Description of changes

15.3 Abbreviations

ACC	Adaptive Cruise Control
CAN	Controller Area Network
ECU	Electronic Control Unit = processing unit for segmentation, classification and tracking
GND	ground = uncharged conducting body
GPS	Global Positioning System
ILV	Software program IbeoLaserView
LASER	Light Amplification by Stimulated Emission of Radiation
LIDAR	Light Detection And Ranging = method to measure distances basing on Laser technology
TOF	Time of Flight = method to measure the distance of objects to the sensor's origin

15.4 Glossary

User interface	Windows oriented input interface in the PC software "CLV-Setup" for operation and configuration.
Big / Little Endian	In a computer, the memory is divided into small units called byte. If a number value higher than the memory capacity must be stored in memory, the value must be distributed onto several bytes. There are some options to arrange the individual bytes of such a number value in the memory. The two most important ones are called Big Endian (big end first) and Little Endian (little end first).
CAN bus	asynchronous, serial bus system; often used in vehicles
Crossover cable	Crossed wired are called crossover cables, they are used to connect two participants directly.
Divergence	Drifting of two objects or processes, starting with one origin, hence the opposite of convergence. For a laser this means that the beam opens out.
D-Sub	Type of plug system for data connections.
Echo (pulse)	A pulse reflecting from an object or a person in the surroundings of a vehicle, which is detected and thus allows for conclusions regarding distance and reflectivity of the object.
Ethernet	Cable-bound data network technology for local data networks. It allows for data exchange in form of a data frame between all connected devices.

Interfaces	The interfaces are the part of a systems that serve for communication. Information is exchanged as physical values (e. g. voltage, current) or logical values (data).
Gateway	A Gateway allows the communication of networks which base on entirely different protocols.
Yaw angle	If the ibeo LUX® is rotated around the z-axis of the coordinate system, this angle is called yaw angle.
Hub	A hub is a network component to connect several computers or devices with network access in a local are network (LAN), see also switch.
Classification	Assignment of an object to an object class (pedestrian, car,..)
Collimated beam	Parallel direction of the laser beam
Laser pulse	Pulsed laser beam
Laser detector	The laser detector has a diode which is sensitive to the wave range of the laser and issues optical and/or acoustic signals if a laser beam is detected.
Pitch angle	If the ibeo LUX® rotates around the y-axis of the coordinate system, this angle is calked pitch angle.
Object	Element in the surroundings of a vehicle to which certain properties can be assigned, e.g. size, position, speed, type
Patch cable	Connector cable in networks are called patch cables. These 1:1-cables connect network participants via switches or hubs.

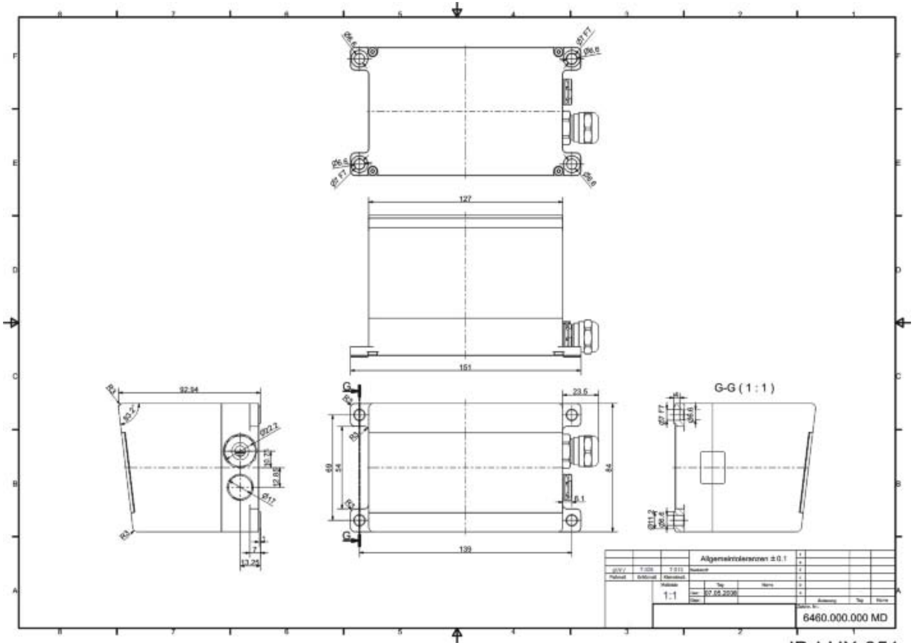
Remission	Reemission of incoming visible light and other electromagnetic waves as lights (passive light source) or wave radiation
Roll angle	If the ibeo LUX® rotates around the x-axis, the angle is called roll angle. The roll angle is also called bank angle as the ibeo LUX® banks to the side.
Scan	Generated distance profile of all measurement levels for one pass of the entire defined working range of the sensor.
Scan data	Information about reflected echoes, consisting of compensated radial distance data, pulse widths and angular information.
Segmentation	Generation of groups of scan data belonging together
Switch	A switch is a network component to connect several computers or devices with network access in a local are network (LAN), see also switch.
Tracking	Tracking (moving) objects

15.5 List of tables

15.6 List of figures

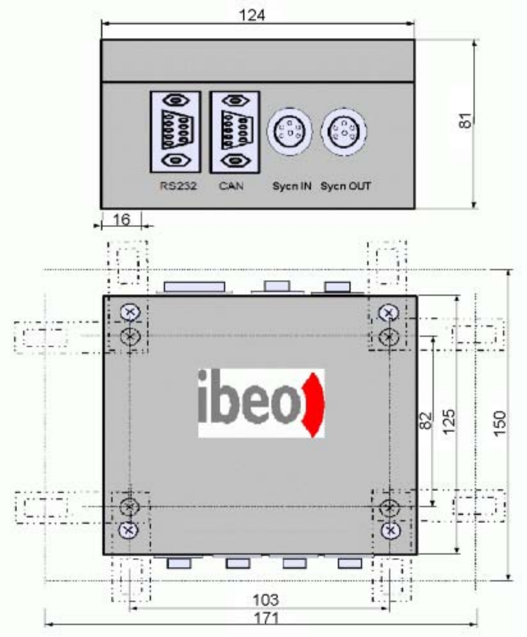
15.7 Dimension sheet

15.7.1 ibeo LUX®



IB-LUX-051

15.7.2 LUX-Connector



IB-LUX-072

15.7.3 ECU

	NOTE
☞	*The dimension sheet of the ECU can be found on the provided CD-ROM or you can order the dimension sheet of the ECU directly from Ibeo.*

15.7.4 LUX-Switch

	NOTE
☞	*The dimension sheet of the LUX-Switch can be found on the provided CD-ROM or you can order the dimension sheet of the LUX-Switch directly from Ibeo.*

15.8 Index

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