KY-LOC 1D.03.01 User Manual

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1	24.11.2020	1.0	All	First Version
2	21.03.2023	2.0	4.2, 12	Clarified use of falling protection, adjust technical data

Reference Documents

Siglum	Doc Number	Title
RD-1	KY.DOC.0215	Datasheet

*Appropriate version to be obtained from supplier

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List of Abbreviations

Acronym	Definition
AC	Alternating Current
CE	European Conformity Marking
DC	Direct Current
DE	Germany
ETH	Ethernet
ETSI	European Telecommunications Standards Institute
EU	European Union
FCC	Federal Communications Commission
FW	Firmware
GND	Ground
HVIN	Hardware Version Identification Number
IC	Identification number
ID	Identification
IEC	IEC System of Conformity Assessment Schemes for Electrotechnical Equipment and Components
IEEE	Institute of Electrical and Electronics Engineers
ISED	Innovation, Science and Economic Development
ISM	Industrial Scientific Medical Frequency Band
LAN	Local Area Network
LED	Light Emitting Diode
LOS	Line of Sight
MAC	Medium Access Control
N.A.	Not applicable
PMN	Product Marketing Name
PoE	Power over Ethernet
QA	Quality Assurance
RAL	RAL Colour Code
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RF	Radio Frequency
RX	Receive
SN	Serial Number
SNR	Signal to Nose Ratio
SW	Software
TX	Transmit
UDP	User Datagram Protocol
VAC	Voltage AC
VDC	Voltage DC
WEEE	Waste Electrical and Electronic Equipment Directive

Table 1: List of Abbreviations and Terms

1 General Information

The purpose of this user manual is to provide the required information to install, configure and operate the measurement system.
The user manual provides information to the following aspects:

- System description including the principles of system operation
- Description of the individual system parts/segments
- Mechanical installation
- Configuration of the measurement system
- Product performance and limitations
- Maintenance, repair, and troubleshooting

Please read this user manual carefully before powering up and start working with the measurement system.

2 Warnings and Notices

2.1 General Notes

This manual is subject to change.

Before installing and starting up a device, please observe the safety instructions listed in the following sections. This will help you use the device in the appropriate way and avoid making serious errors that may impair your health and damage the devices. We, therefore, recommend that you keep this manual near the devices.

Please observe the relevant user documentation when installing and operating the system. This product has been tested and found to comply with the product safety requirements according to Chapter 2.3.

KYMATI GmbH is not liable for any damages caused by unauthorised modifications of the devices.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

The devices satisfy the requirements of the EU regulation Electromagnetic Compatibility, Low Voltage Directive, RoHS as well as, REACH and RED Directives. The devices for ETSI member states carry the CE mark of conformity
(CE = Communauté Européenne = European Union).

All devices comply with the limits for a Class B digital device, pursuant to Part 15 of the Federal Communications Commission (FCC) rules.

Further to the above mentioned, be advised that all pictures are for information only and information provided in this document are subject to change without notice and do not represent a commitment on the part of KYMATI GmbH.

2.2 Signal words and their meaning

DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury
Info: not used in this manual

WARNING indicates a hazardous situation which, if not avoided, may result in death or serious injury.

CAUTION indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.

NOTICE indicates a very important message.

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2.3 Declaration of Conformity

Declaration of Conformity

1. Product model:

KY-LOC 1D.03.01

2. Name and address of the manufacturer or his authorised representative:

Kymati GmbH
Am Hochacker 5
85630 Grasbrunn
Germany

3. This declaration of conformity is issued under the sole responsibility of the manufacturer.

4. Object of the declaration:

Equipment: Radar Sensor
Brand name: KY-LOC
Model/type: KY-LOC 1D.03.01

5. The object of the declaration described above is in conformity with the following standards:

- (RoHS) Directive 2011/65/EU
- (WEEE Directive) Directive 2012/19/EU
- EN 305 550 V2.1.0
- EN 301 489-3 V2.11
- EN 62311:2008
- EN 62368-1:2014

6. Signed for and on behalf of Kymati GmbH:

Grasbrunn, December 09, 2022

_____
Michael von Voithenberg / QA

_____
Martin Glänzer / Chief Technical Officer

Figure 1: Declaration of Conformity

2.4 Compliance Statement USA

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:
(1) This device may not cause interference.
(2) This device must accept any interference, including interference that may cause undesired operation of the device.

2.5 Compliance Statement Canada

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:
(1) This device may not cause interference
(2) This device must accept any interference, including interference that may cause undesired operation of the device.

Cet appareil contient des émetteurs / récepteurs exemptés de licence conformes aux RSS (RSS) d'Innovation, Sciences et Développement économique Canada. Le fonctionnement est soumis aux deux conditions suivantes:
(1) Cet appareil ne doit pas causer d'interférences
(2) Cet appareil doit accepter toutes les interférences, y compris celles susceptibles de provoquer un fonctionnement indésirable de l'appareil.

2.6 Compliance Statement Brazil

Resolução 680: Este equipamento não tem direito à proteção contra interferência prejudicial e não pode causar interferência em sistemas devidamente autorizados.

CISPR22: Este produto não é apropriado para uso em ambientes domésticos, pois poderá causar interferências eletromagnéticas que obrigam o usuário a tomar medidas necessárias para minimizar estas interferências.

2.7 Health and Safety Liability Statement

The ultimate responsibility for health and safety in connection with the installation and operation of the measurement system lies with the customer. The units comply with the relevant regulations as stated in section 2.3. The operators of the product should ensure that the health and safety regulations of the relevant country and site operations are met, and health and safety instructions are followed.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

In order to comply with FCC and ISED RF Exposure requirements, this device must be installed such that a minimum separation distance of 20cm is maintained between the device and all persons during normal operation.

2.8 Copyright

This manual and all included documents are subject to copyright by KYMATI GmbH. All rights reserved.

It is not allowed to duplicate and/or transfer them (or parts of it) to a third party, to pass them on or to make use of their content. To do so, the explicit permission of KYMATI GmbH is required. Infringements may be punished and will lead to compensation. Information and figures in this document are subject to change without notice.

2.9 End of Life WEEE Statement

WEEE Disposal Instructions

In accordance with the European Union WEEE directive 2002/96/EC, KYMATI will arrange for the collection and treatment of Waste Electrical and Electronic Equipment (WEEE) put on the EU market after 13 August 2005 at no expense to the customer.

Equipment falling into this scope are marked with the KYMATI company label and name and with the "crossed-out wheelie bin" label. This label on the product or its packaging indicates that this product must not be disposed of with household waste. Instead, it is the user's responsibility to return it to KYMATI GmbH for proper disposal following current national regulatory requirements.

Figure 2: Crossed-Out Wheelie Bin

WEEE collection by KYMATI GmbH

The process for collection of WEEE from a European location may be subject to change between the time when a customer purchases our product, and years later when they ultimately decide to dispose of it. The current process will be available from the KYMATI GmbH on written request.

Please take note that the KYMATI GmbH Company will refuse collection of WEEE, which has been used in a particularly hazardous environment, such as nuclear or subsequently been contaminated or polluted with hazardous substances such as propulsion fluids, oil, etc.

KYMATI GmbH company products are provided through business-to-business activities only. Those consumers who have obtained KYMATI GmbH products through other sources should return those products to their vendor.

👆 **KYMATI's WEEE registration number is "KYMATI GmbH DE 16389341"**

Information for WEEE disposal by user

This equipment does not require any special dismantling instructions, hence there is nothing listed in this manual. The equipment also does not contain any dangerous substances and preparations.

3 System Description

3.1 System Overview

The measurement system consists of two units that conduct a range measurement between each other. The two units are using the time of flight of the Radar signals to measure a precise distance between each other. The units can be configured to receive the distance values on one unit or on both units. The units must be configured as Master and Slave devices.The information of the distance measurement is available on either device.

Both units need to be powered with either DC power supply or PoE (802.3af). The unit, where the range measurement is requested, needs to be connected via the Ethernet interface. Figure 1 shows the complete system including mounting bracket for mounting on any suitable structure.

For FCC and CA, the system is for fixed operation only. This includes installation in fixed equipment, even if the sensor itself moves within the equipment.

3.2 Range Measurement & Range Computation

To perform a range measurement between two devices, they need to be synchronised. Therefore, the Master device sends out a synchronization signal and the Slave synchronizes onto that signal. When the devices are synchronized, they start automatically with the range measurement and stay synchronized. Additionally, the front LEDs are used to show whether the devices are synchronizing or synchronized, for more information please refer to chapter 4. If the devices lose their wireless connection to each other (e.g. object in between) for a long time, they will automatically re-synchronize.

3.3 Intended Use

A system comprising of two radars provide accurate range information between them. All system components shall only be used for the above operation and every other use is unintended. The manufacturer will not be responsible for damages caused through incorrect usage.

Incorrect usage may be, but is not limited to:

- Any other use except of the intended application.
- Noncompliance of the provided connectors.
- Operation outside of defined environment conditions.
- Disassembling of any of its components.
- Usage of components and spare parts, which are not in the manufacturer's scope of delivery or are not authorized by the manufacturer.

WARNING **The system is not certified for safety critical applications. The product therefore does not satisfy any safety class requirements and must only be used as assisting system in safety-critical applications, such as anti-collision.**

4 Device Description

The following chapter describes the sensor mechanics as well as the electrical interfaces in detail.

4.1 Mechanical Data

Colour

The unit is powder coated in colour RAL 5001 – The painting is non-conductive.

Dimensions

The following figures specify the outside dimensions as well as the mechanical and electrical connection points.
All dimensions in mm.

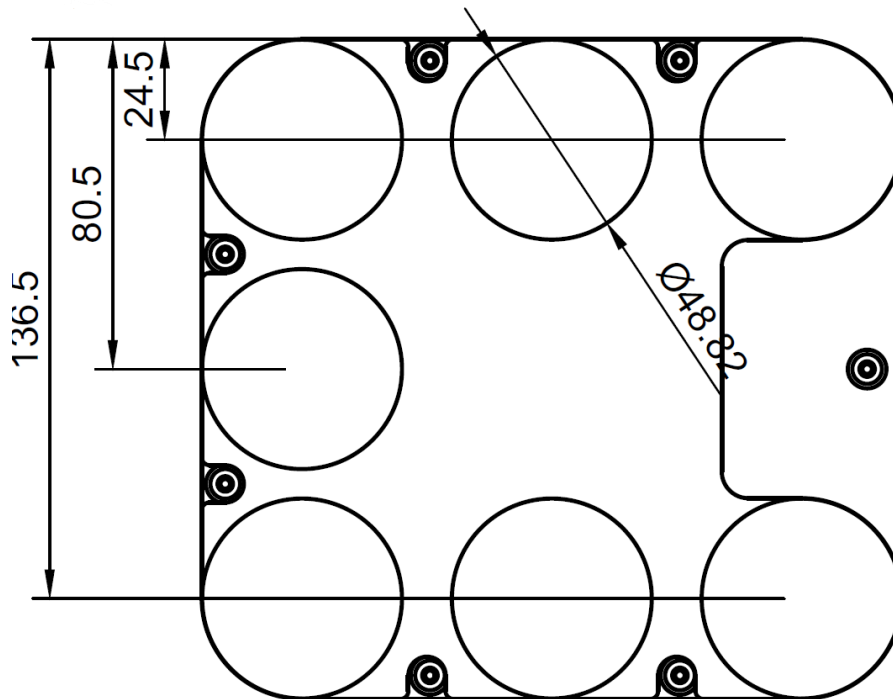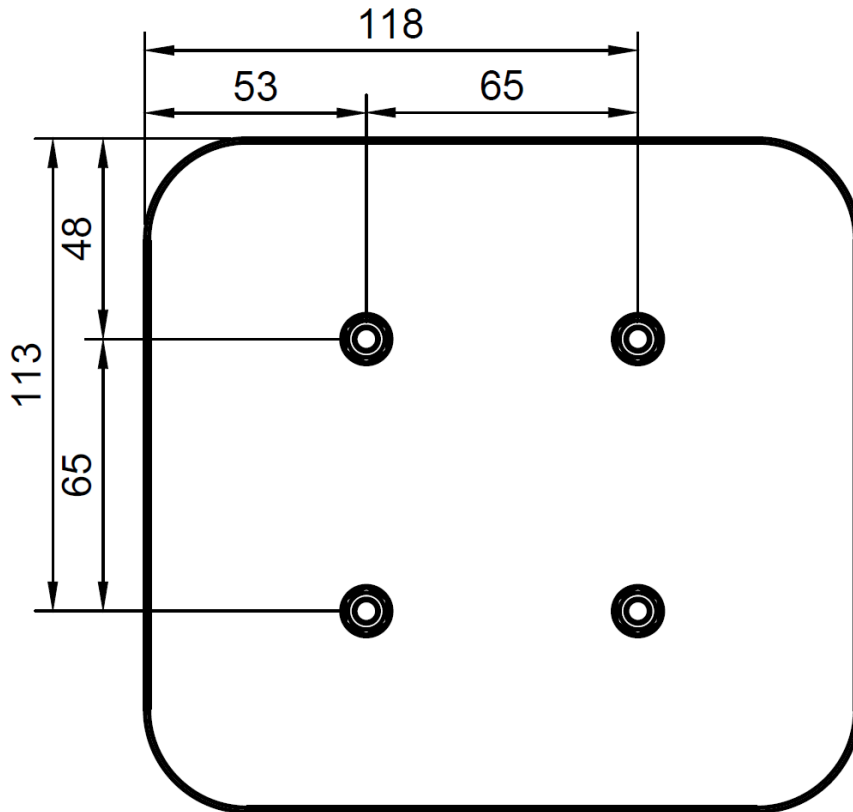**Figure 3: Mechanical Drawing (Front View)**

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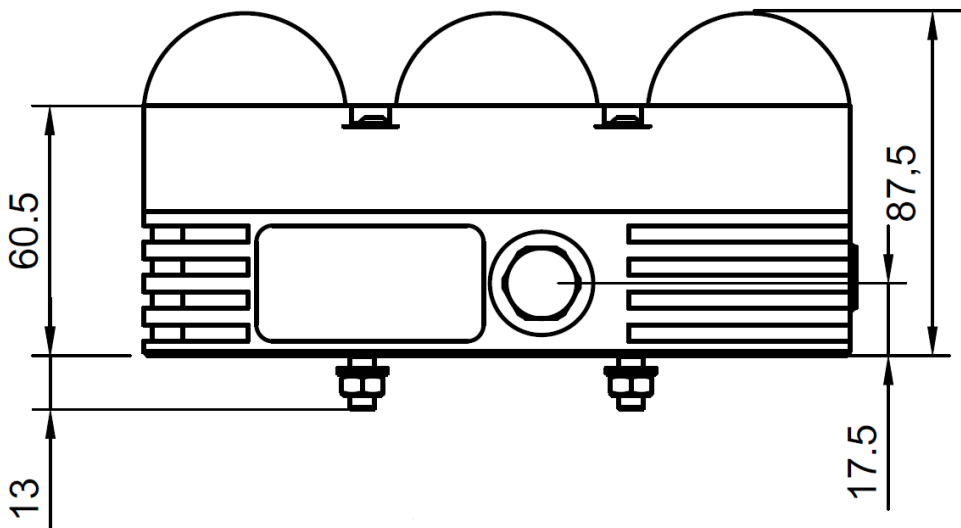**Figure 4: Mechanical Drawing (Back View)**

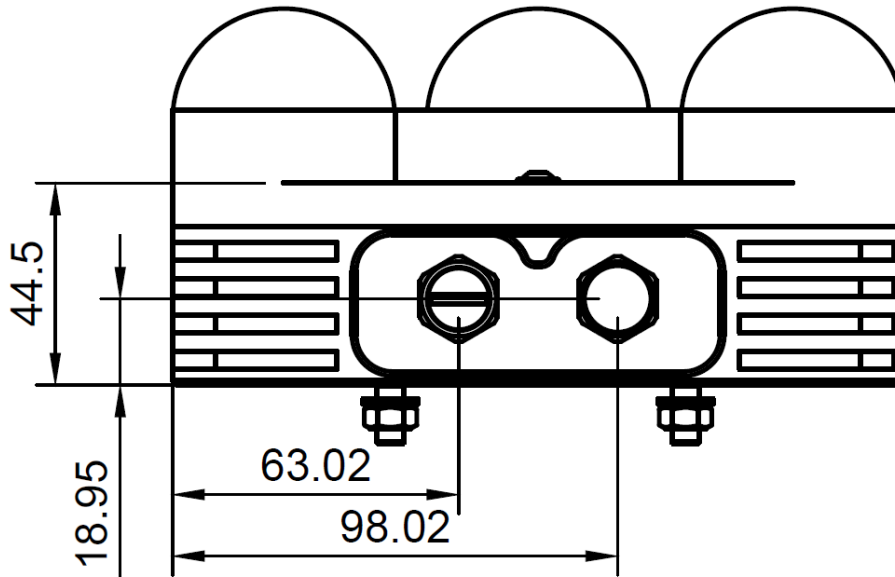**Figure 5: Mechanical Drawing (Left Side View)**

Figure 6: Mechanical Drawing (Bottom View)

4.2 Mounting

The product has 4 x M6x13 bolts (at the rear) for mounting purpose. Use only stainless steel M6 DIN 985 nuts plus 6,4 mm washer according to:

- 1.4301 / AISI 304 / V2A (X5CrNi18/10) or
- 1.4571 / AISI 316 / V4A (X6CrNiMoTi17-12-2)

to mount the bracket.

 For safety reasons only self-securing stainless-steel nuts with a strength value of 12.9 shall be used.

The device can be mounted in any position, but the two devices need to have the same orientation facing each other. It is recommended to install the device with the original KYMATI bracket (KY-XTRA M.01.01 – more information can be found under www.kymati.com).

 If there is rain or similar situations where water can fill the hole of the pressure valve it is not allowed to mount the device with the pressure valve (see chapter 4.3) on the top side.

The device shall be mounted tightly so that it cannot be moved unintentionally.

 A falling protection must be used for the device to avoid any accidents or damages. A falling protection as shown below is available KY-XTRA.M.03.01. It is recommended to use one of the 4xM6 bolts on the back of the device.
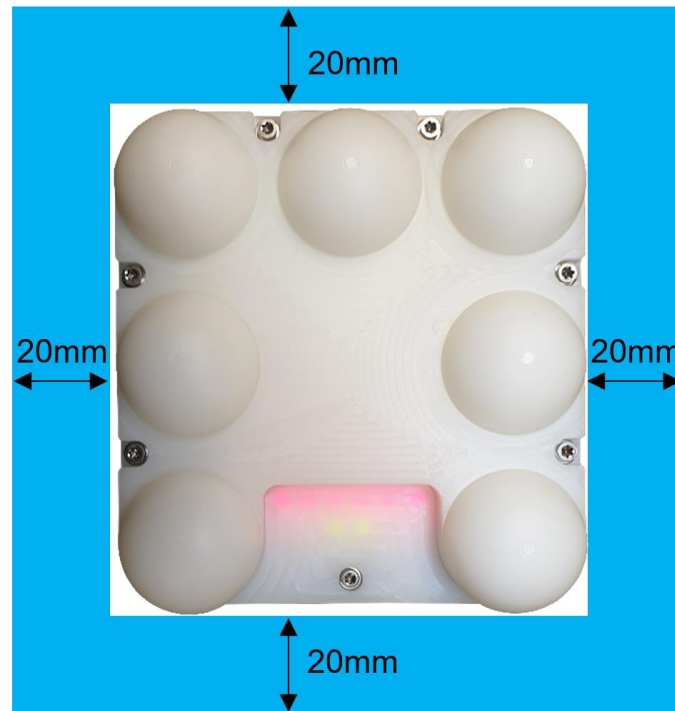
Figure 7: Recommended mounting

Figure 8: Falling Protection KY-XTRA.M.03.01

4.3 Interfaces

A brief description of the interfaces is given below.
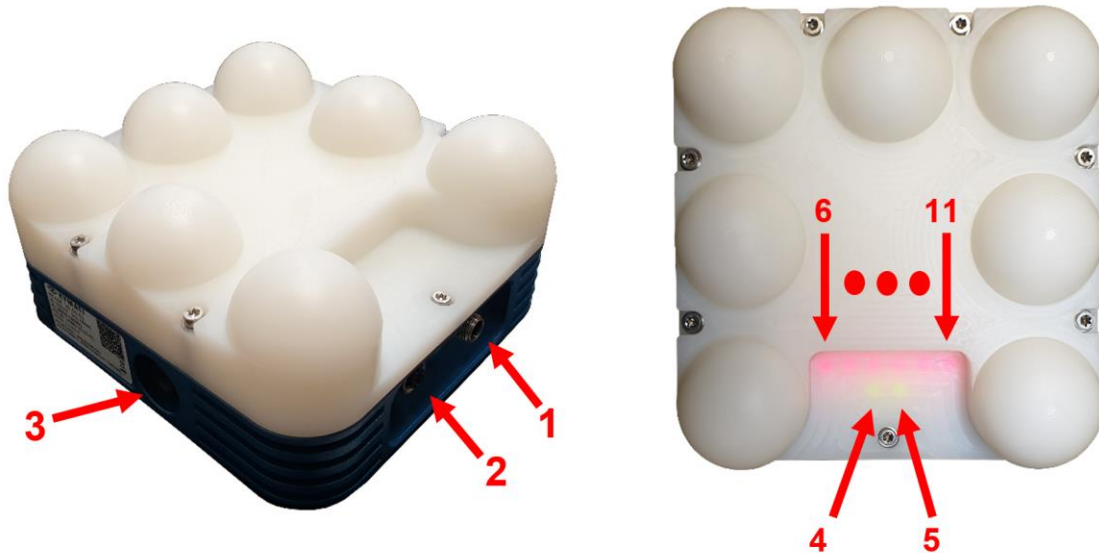
Figure 9: Physical Interfaces

(1)   Plug for DC – IN (X1)
Power connector (X1) to power the device

(2)   Ethernet (X2)
Ethernet connector (X2) to communicate with the device and to power the device via PoE (802.3af).

(3)   Pressure Valve
The pressure valve ensures that temperature changes do not cause any water ingression into the housing as well as prevents overpressure in case of heat.

(4)   Power LED

(5)   Status LED

(6)-(11) Information LEDs

All LEDs are described in chapter 4.6

⚠ WARNING   **Use connector covers if connectors are not used. The specified IP rating is only given with connectors or covers mounted.**

4.4 Power Supply

The sensor shall be powered with either a DC power supply via the X1 connector or via X2 connector (PoE - 802.3af) or plugging both is also allowed.

⚠ WARNING	**The power supply for the sensor must comply with the ES1 limits and the voltage range stated in the datasheet.**
⚠ WARNING	**The sensor is protected with a reverse polarity circuit to avoid damages. In case there is a wrong polarity the power LED will not illuminate, and the user must remove the power immediately.**

4.5 Connectors

The sensor has 2 x M12 connectors located on the bottom side of the device. To avoid faulty connection the connectors are coded differently and on top are female and male respectively.
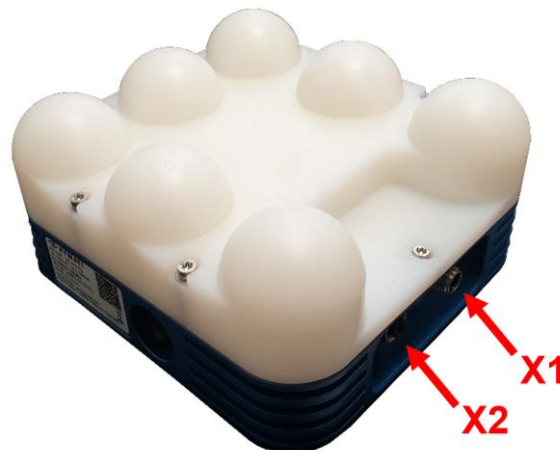

Figure 10: Bottom side X1 (DC connector) & X2 (Ethernet / PoE connector)

X1: DC connector (Male M12):
Connector type: M12 according to IEC 61076-2 -101, 102 & 109, 5 pin, male, A-coding, material: Zinc Die Cast (default) or 1404 Steel (possible on customer request)
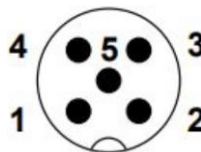

Figure 11: Connector X1 pin diagram (front view of male connector with pin numbers)

X1 Connector	Function
Pin 1	N.A.
Pin 2	N.A.
Pin 3	DC In (9 - 36V DC)
Pin 4	GND
Pin 5	N.A.

Table 2: Pin Definition X1 (DC connector)

The IP rating of the unit is only ensured if a connector cap (default) or a connector is mounted correctly.

X2: Ethernet connector (Female M12):
Connector type: M12 according to IEC 61076-2 -101, 102 & 109, 8 pin, female, X-coding, material: Zinc Die Cast (default) or 1404 Steel (on customer request) Further details on the Ethernet interface are mentioned in chapter 0.
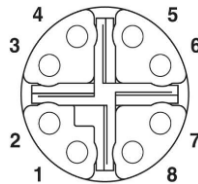
Figure 12: Connector X2 pin diagram (front view of male connector with pin numbers)

X2 Connector	Function
Pin 1	TX+
Pin 2	TX-
Pin 3	RX+
Pin 4	RX-
Pin 5	DC-
Pin 6	DC-
Pin 7	DC+
Pin 8	DC+

Table 3: Pin Definition X2 (Ethernet Connector)

The IP rating of the unit is only ensured if a connector cap (default) or a connector is mounted correctly.

4.6 Indicators

For the detailed description of the following LEDs and the corresponding blinking patterns, please refer to the Troubleshooting section of this manual (chapter 11).

Power LED (4)
If power is connected to the device this LED will illuminate. If this LED does not illuminate check the power connection (see Section 4.4)

Status LED (5)
        The status LED indicates whether the hardware has been properly initialized.

Information LEDs - left (6) to right (11):
        These LEDs are used to indicate the current state of the device.

4.7   Warranty Seal & Product Label

👆   **Each unit is labelled with a warranty seal. If the seal is damaged or broken the warranty is void.**
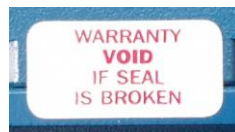
Figure 13: Warranty Seal

The Product label is permanently attached to the left side of the device and shows besides the Product Marketing Name (PMN), the product ID, the serial number (S/N), the Industry Canada Identification Number (IC), the FCC ID , the Hardware Version Identification Number (HVIN) as well as the company address. In addition to that the QR code includes Product Marketing Name (PMN), the product ID, the serial number (S/N), the MAC Address of the device, and the production date.

5 System Installation

5.1 Wiring Diagram

To power the device, there are three options:
1) An external DC power supply via the connector X1 can be used
2) A PoE (802.3af) can be provided via X2
3) or both interfaces can be used to power the device to have a redundant power supply.

For data communication there is an Ethernet interface on connector X2 (see Figure 10).

If other interfaces/protocols like Profinet, Profibus, Ethernet/IP, Modbus, digital I/Os or similar are needed, an accessory from the KY-XTRA B family is necessary (for more details please visit www.kymati.com).

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Option 1:

Data Output: Master Side only
Power: DC
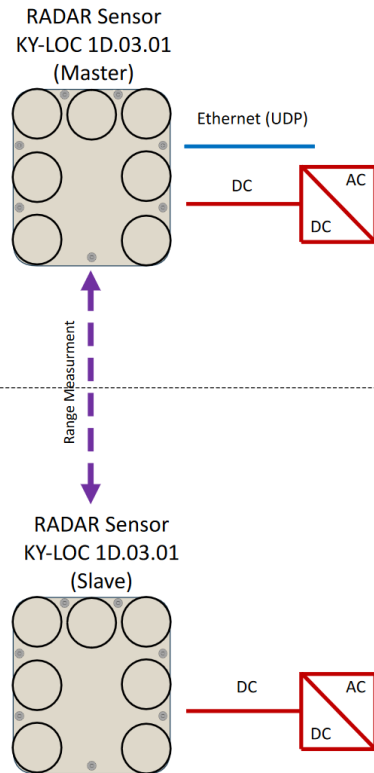
Option 2:

Data Output: Master Side only
Power: PoE
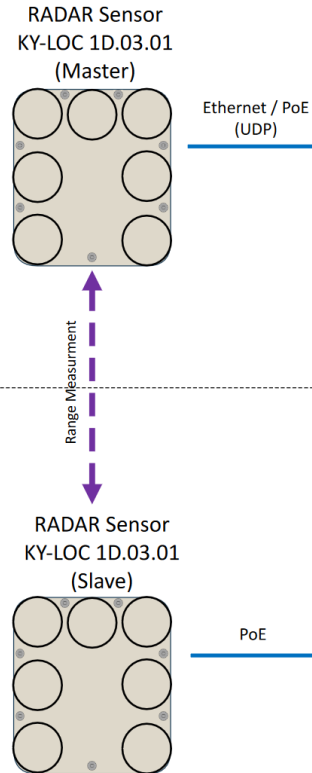
Option 3:

Data Output: Master + Slave Side
Power: DC
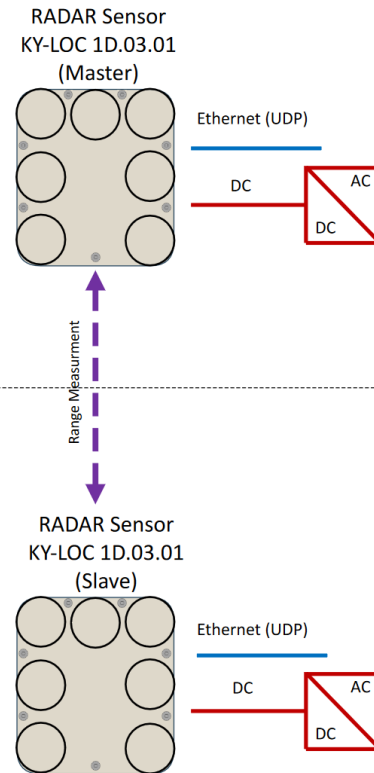
Option 4:

Data Output: Master + Slave Side
Power: PoE
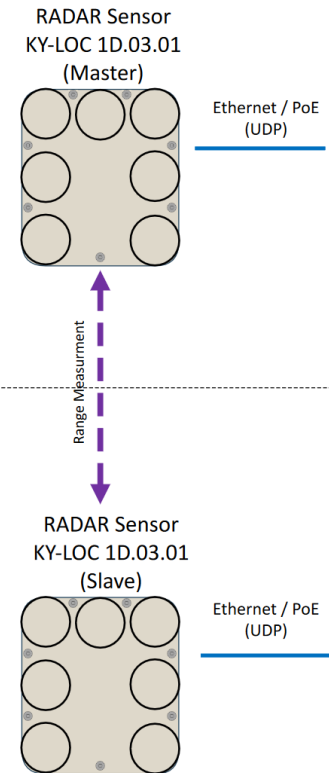
Figure 14: Sensor Wiring Options

5.2 Installation and Setup

WARNING	**All installation, repair and servicing work must be carried out by qualified and trained technicians!**

The power supply source must be chosen in accordance with the power supply requirements.

6 Setting Up the Devices and System Operation

This chapter describes how to operate the sensor. The following steps must be taken to have a basic measurement running:

1. Device installation

   (see chapter 6.1)

2. Power up the devices

   (see chapter 6.2)

3. Configure the devices

   (see chapter 6.3)

4. Do the first measurement run

   (see chapter 6.5)

After this procedure, the system is correctly installed and will start automatically measuring if both sensors are powered and synchronized.

6.1 Installation of the Sensor

For a proper operation, the following parts must be considered:
- The devices must face each other and aligned better than 2.5°.
- A minimum distance of 2 m between the two units must be maintained to guarantee the specified accuracy.
- The orientation of the two devices must be the same.
- The vertical and horizontal offset must be smaller than 0.3 m.
- One sensor must be configured as master and one sensor as slave using the Kymati Commander as described in Chapter 9.
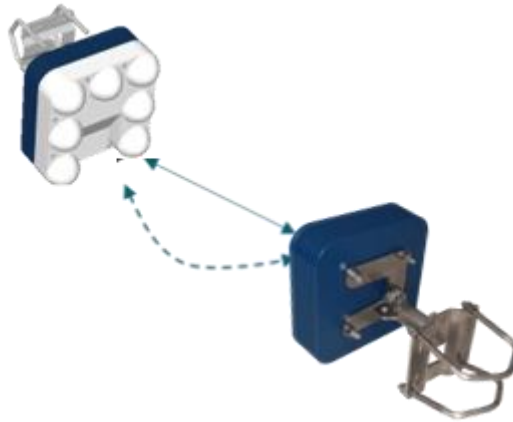
Figure 15: Typical Set-up

After mounting the device, the cable(s) must be connected. It is preferable to use the master device on the moving side and the slave on the fixed/stationary side. Plug in minimum the power to both devices and at least communication to one of the devices where the distance measurements are needed.

> **Do not use unintended force to mount the connectors. If the connector does not fit, check the coding/index notch of the connector.**

> **Open connector sockets need to be protected with a cap. Only with sealed connectors, the device has its stated IP rating.**

6.2 Powering Up

> **First connect all cables to the devices and then power up them.**

After the installation of the devices the power can be turned on. Therefore, a proper power supply as described in chapter 4.4 must be used.

After power up, the power LED shall illuminate constantly, stating that the device is properly powered. In case of wrong polarity, the device has a polarity protection, hence if the power LED is not illuminating, the power must be removed immediately.

6.3 Initial Configuration

The devices must be configured during initial setup and the parameters must be configured through the commissioning tool provided by KYMATI. To configure the device the Ethernet interface shall be used. How to connect to the device is described above.

> **It is only possible to configure the devices via the Ethernet Interface. The devices may be connected separately. This can be done before installation.**

6.4 Connect to the System

After the sensors are powered, they will start automatically. The master will start sending out a signal and the slave tries to synchronize to that signal. This can take up to 20 seconds. If the devices are synchronized, they start measuring the distance and the LEDs will stop blinking and illuminate constantly. For short distances, it may take several cycles, i.e some seconds additionally, until the right power level between the sensors is achieved and the sensors provide a stable measurement. For more than 15 m this is not the case.

6.5 First Run

Before using the system operationally, a reference measurement should be recorded. Therefore, the system should be running from the minimal distance to the maximum possible distance and the range and SNR values should be recorded during this movement. Afterwards the Zero Point should be set. Therefore, the device carrying the moving sensor should drive to the position were the zero of the measurement should be. At this position, the zero offset on the Kymati Commander may be written and applied on the configuration. Additionally, the user may reset the sensor and reconnect throught the Kymati Commander to make sure that the zero offset is set properly.

6.6 Turning off the System

To turn off the sensor, simply switch off the power supply. The status LED and power LED will turn off. After unintended power cycle, the system will be automatically restarted.

6.7 Anti-Collison

The system has built in an Anti-Collision feature that can raise up to 4 different alarms when a configurable distance is reached. How to configure the device is described in chapter 9
The Anti-Collision feature has two modes which are described below. Each mode can be configured for a single crane scenario or a double crane scenario:

Fixed Warning Zones:

There is a possibility to select fixed warning zones. This means if the system is measuring a distance that is smaller than the defined warning zone, an alarm is generated. Fixed warning zones can be used for single and double crane applications.

Dynamic Warning Zones:

The idea for the dynamic warning zone is, that a crane may need a relatively large warning zone if it is traveling at full speed but needs to go close to a dangerous area. This is archived by increasing the warning zone with the speed of the crane. So, if the crane is traveling at full speed the warning zone is automatically increased depending on the speed of the crane, this allows to drive close to a dangerous area. The so-called breathing (dynamic increase / decrease) of the warning zone can be specified by the deceleration or by the maximum speed and maximum braking distance. Dynamic warning zones can be used for single and double crane applications.

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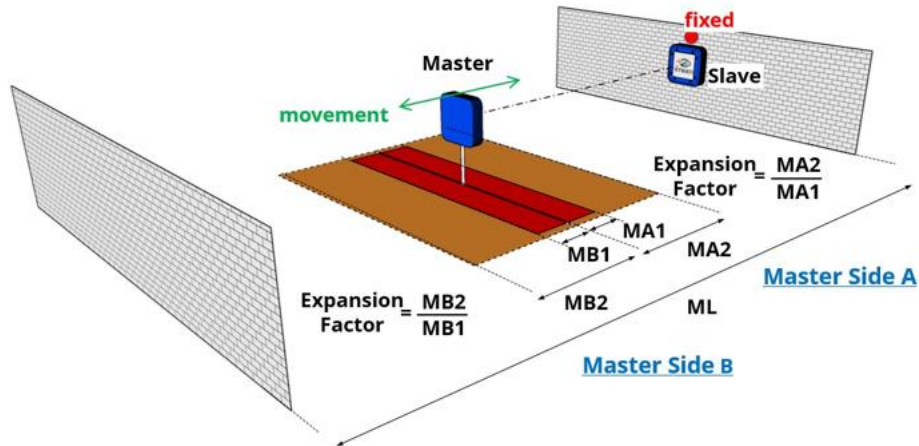**WAVES ARE OUR VISION**

Single Crane:

Figure 16: Single Crane Mode

In single crane mode the Master sensor is mounted on a crane and the Slave sensor is mounted on the wall. There are two warning zones (MA1 and MA2) on the 'Master sensor Side A'. This is the zone in the direction of the Slave sensor. You can define two warning zones there. Additionally, two warning zones (MB1 and MB2) on the 'Master Side B' can be defined at the opposite side of the sensor. If one of the measured distances is smaller than the associated warning zone, an alarm is raised. For Master Side B there is a configuration of the maximum length (ML) needed to generate the warning. These defined maximum length minus the measured value is used for the Side B warnings.
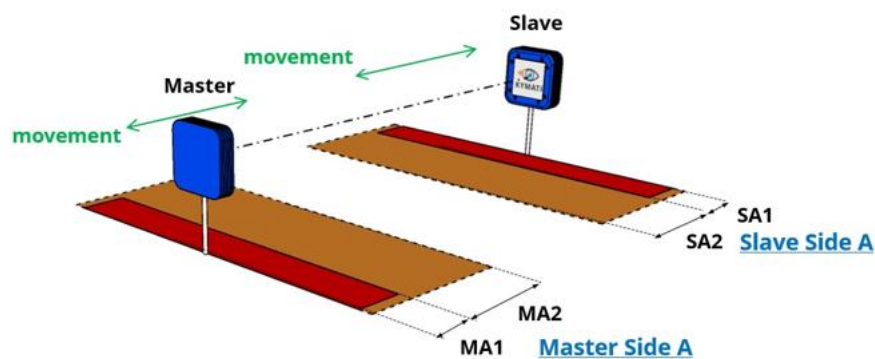
Double Crane:

Figure 17: Double crane Mode

In a scenario with two cranes operating side by side there is the possibility to specify two warning zones for the 'Master Side A' and two for the 'Slave Side A'. Side A is the direction to the other radar.

7 Operational Limitations

7.1 Fresnel Zone Clearance

To prevent performance degradation, the Fresnel zone clearance (at least of 1st order) between two sensors should be respected. The following notation is used hereafter:
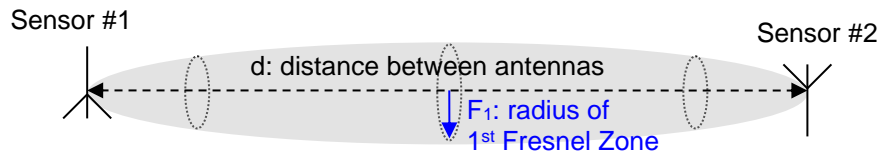

Figure 18: First Fresnel Zone

The Fresnel Zone is the grey area shown in Figure 18. It is mainly depending on the system frequency and the distance between the two sensors.
The maximum radius of the first Fresnel zone can be computed with the following formula, where it has already been predefined that the device operates at f = 61 GHz:

$$F_{1,max} = \frac{1}{2}\sqrt{\lambda D} = \frac{1}{2}\sqrt{\frac{c_{air}}{f}D} = \sqrt{\frac{c_{air}}{4f}}\sqrt{D} = 0.035\sqrt{D}$$

$F_{1,\,max}$ (max. radius of the Fresnel Zone) is in units of meters, as well as the antenna distance d.

Distance [m]	Max Radius of Frenzel Zone [m]
50	0.25
100	0.35
300	0.61
500	0.78

Table 4: Maximum radius of Fresnel zone at different distances.

This also implies that the two sensors must be mounted in such a way that there is still some spacing to neighbouring objects, to respect the Fresnel zone clearance.

Objects obstructing the Fresnel Zone can cause signal degradation depending on the amount of the obstruction. E.g. it shall be avoided to place any objects in the field of view of the sensor or mount the sensor in locations close to obstacles, which might affect the overall range performance and/or the measurement quality.

7.2 Line of Sight Clearance

The most important technical aspect for the system is to have a continuous Line of Sight (LOS) condition between the master device and the slave device at any time. A proper Line of Sight analysis during the first time shall be made taking also possible temporary objects into account.

If objects are in the line of sight, it may be that the device measures a wrong distance or even loose the contact and therefore also the synchronization totally. In the case of a total loss, the synchronisation like the one at start-up will take place when the object is no longer in the line of sight, which might affect the overall range performance and/or the measurement quality.

7.3   Simultaneous Operation

Adjacent measurement systems must use a different channel configuration avoiding interference between the different ranging systems. It is in the responsibility of the system operator to ensure that either adjacent systems make use of different channel configurations or, when re-using the same channel configuration for different measurement systems, an adequate spatial separation is kept between different measurement systems. Currently the system supports up to 32 channels and in the future, this might increase based on the customer needs (software upgrade).
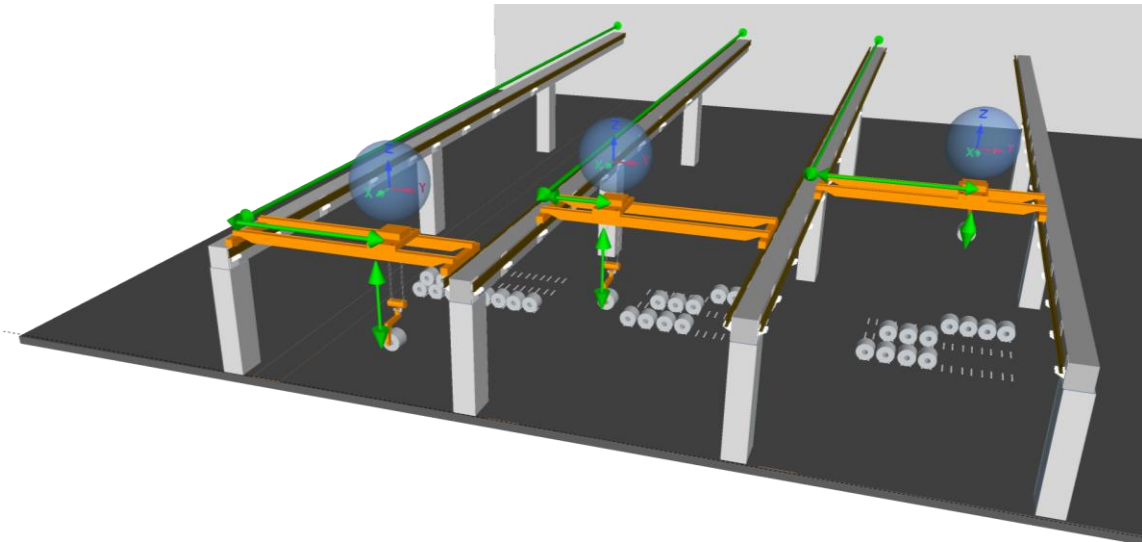

Figure 19: Typical installation of multiple devices operating at the same area.

8 Establishing a UDP Connection

For configuring the radar devices, a UDP connection must be established with the local host. The Kymati Commander application only supports Microsoft Windows XP or higher. Additionally, one port (27513) on the firewall must be allowed to pass through the UDP packets. A description is provided below:

8.1 Ethernet settings

The local machine and the radar units shall be in the same network. The default IP address of the radar units is 192.168.75.100. The destination IP address is 192.168.75.1 and the subnet mask is 255.255.255.0. Therefore, for the first-time usage the IP address of the local machine must be in that network. If the IP settings will be changed after uploading a configuration, then the IP settings on the local machine shall be also changed. The following figure shows the network settings on Microsoft Windows.
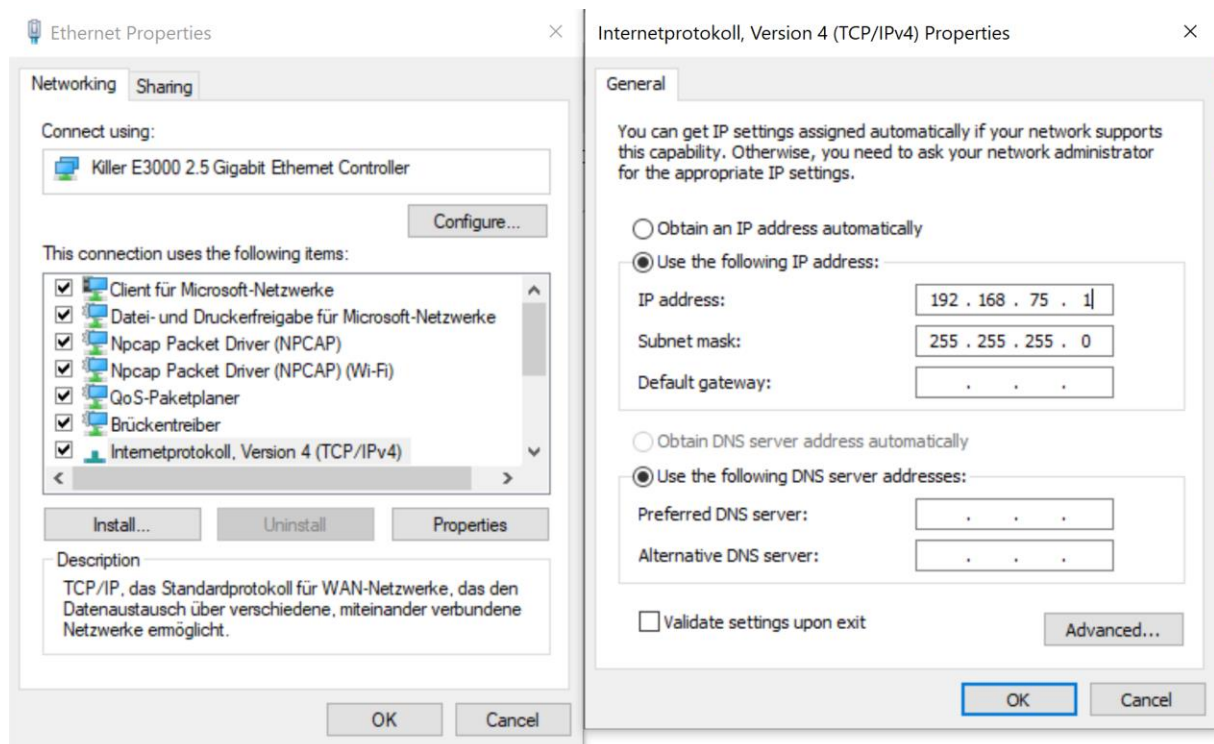

Figure 20: Setting up the Network Settings on the local machine

The ping command on a windows terminal is used to check the radar sensors, if they are present on the network configured above. The ping command can be executed following the steps:
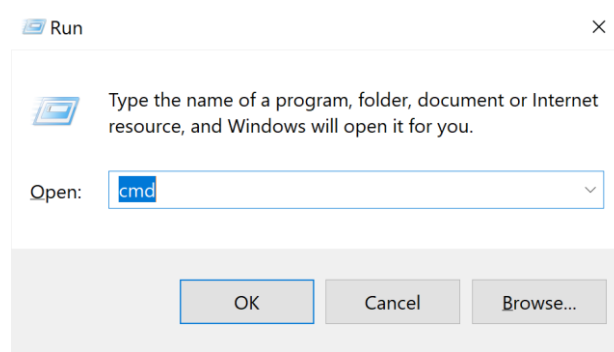- Press the **start** button on windows
- Choose or type Run

Figure 21: Run application on windows

- On the Run Window type '**cmd'**
- On the terminal opened please type the following command:
  ping RADAR_IP_ADDRESS
  where the RADAR_IP_ADDRESS is the IP address of the radar unit, so for example is 192.168.75.100 (this is the default IP address of every sensor)

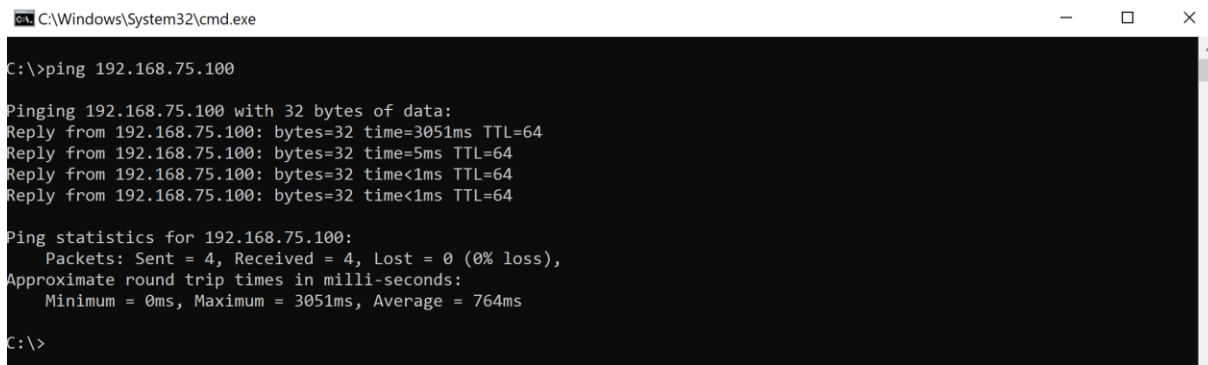The following figure shows the ping command on a command prompt window.

Figure 22: Ping command on a windows command prompt terminal

In case the ping command doesn't work, that means:
- The radar is not properly connected. Check the cables and if power is present on the radar by checking the LEDs in front of the unit as described on Chapter 4.6.

8.2 Firewall settings on Windows environment

In order to receive data from the radar devices the firewall settings on the local machine have to be disabled or specific ports shall be opened. In order to open specific ports on the firewall, a command prompt with administrator rights is necessary. Two ports are necessary to be allowed. In order to disable the firewall settings, follow the steps below:
- Press the **start** button on windows
- Choose or type Run
- On the Run Window press **cmd**
- Type "cmd" into the box and then press Ctrl+Shift+Enter to run the command as an administrator.
- Then type in the command prompt:

netsh advfirewall firewall add rule name="KY Port 27513" dir=in action=allow protocol=UDP localport=27513

- The response shall be "ok."

9 Device Setup using the KYMATI User Interface

In the following paragraphs the Kymati User Interface the so called "KYMATI Commander", will be described. It can be used to configure the device and display the measurement values.

9.1 Start Window

Once started the "KYMATI COMMANDER" a pop-up window will appear asking for permission to run properly the program. The user shall allow the access to the program as special firewall settings will be placed on the host computer. More specifically, the UDP port 27513 shall be enabled in order to be able to flash the firmware and communicate with the sensors.
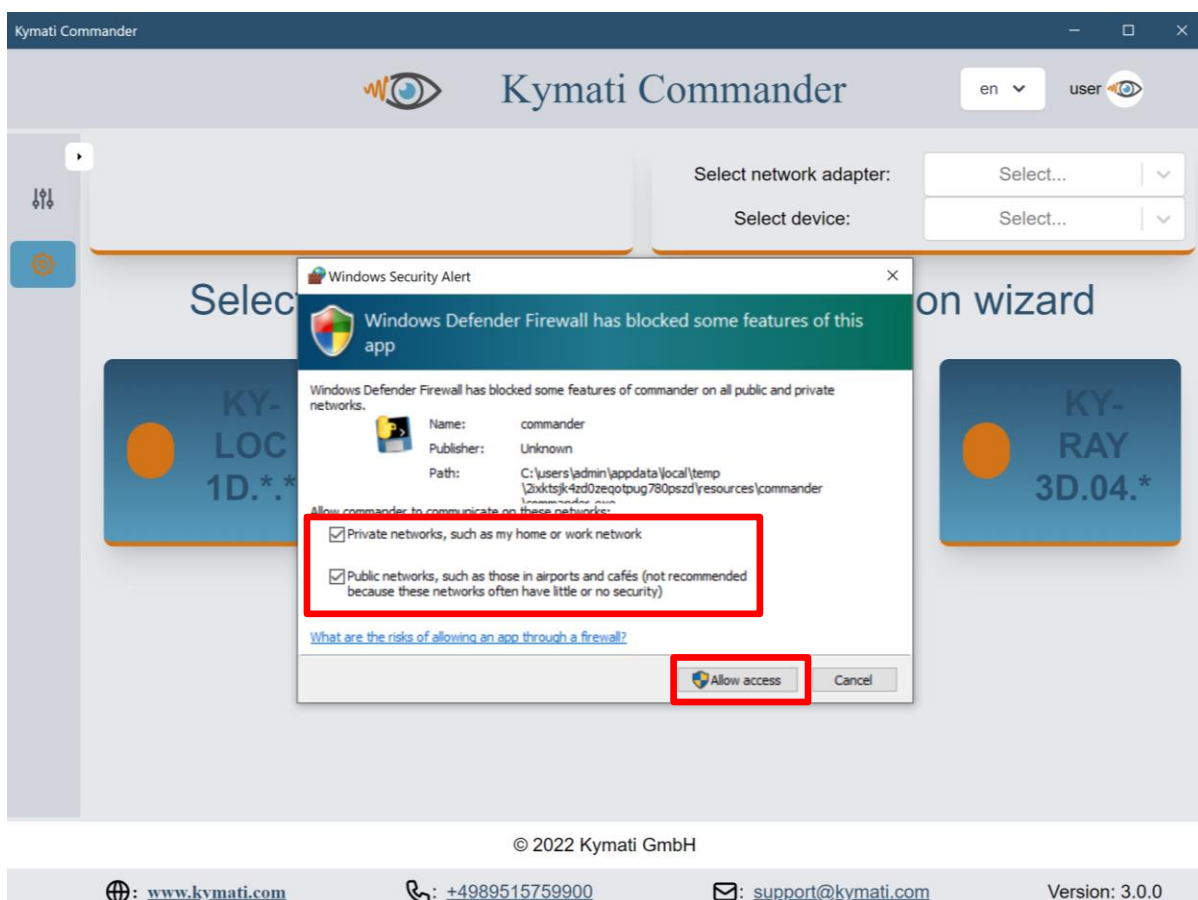
Figure 23: Start window on the Kymati Commander

After accepting the windows firewall settings, the user shall either choose to work without a sensor or with a sensor. If working without a sensor a radar family need to be selected. If working with a sensor first select an appropriate network adapter (default IP settings for the host are 192.168.75.1) and next select the device (default IP settings for the radar are 192.168.75.100) on the dropdown menu. The software will also provide the device name afterwards.
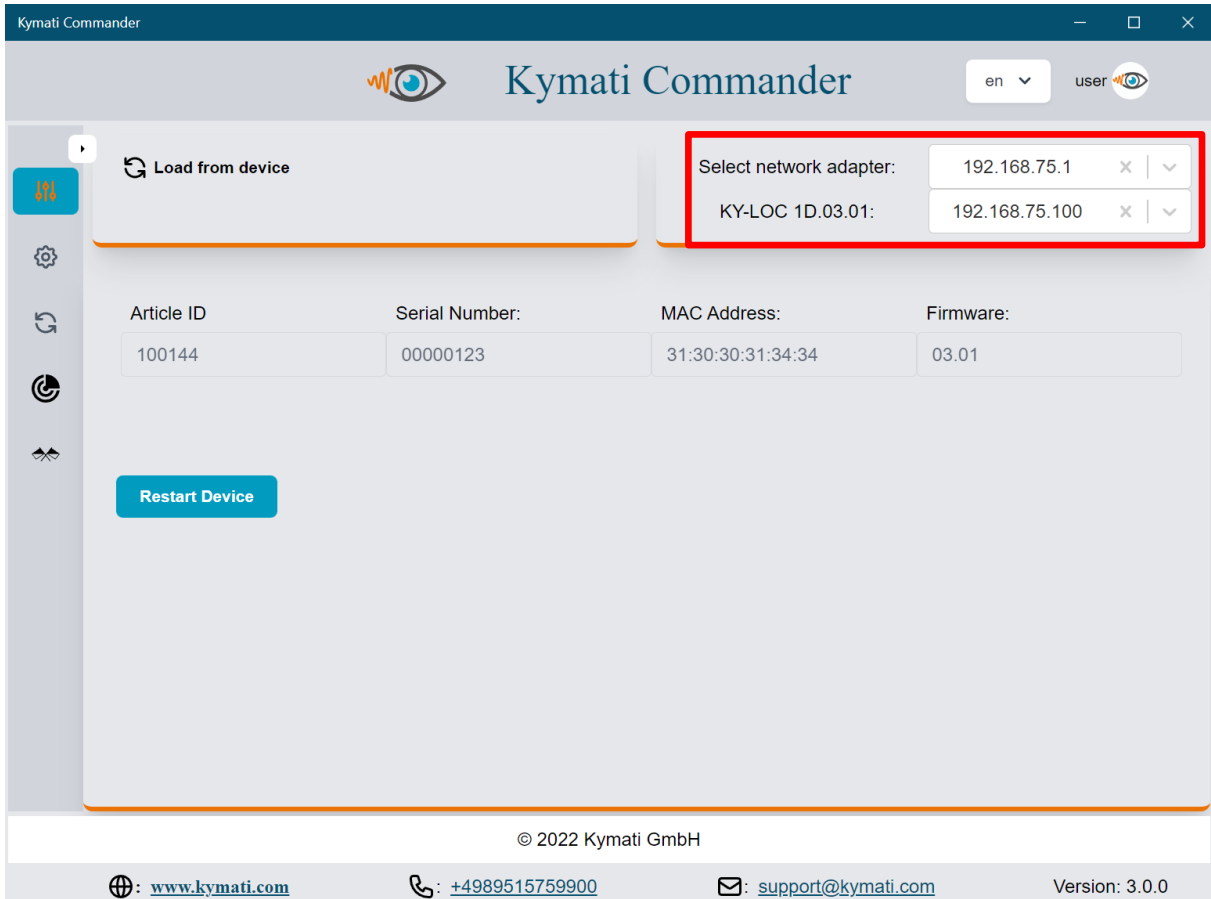

Figure 24: Select a network adapter and device

The Kymati Commander consits of two different users, (user and kymati) and four or five, if anticollision is enabled, main tabs. The "user" user will be addressed here and the four main tabs will be shown in detail. The "kymati" user is only used for development purposes.
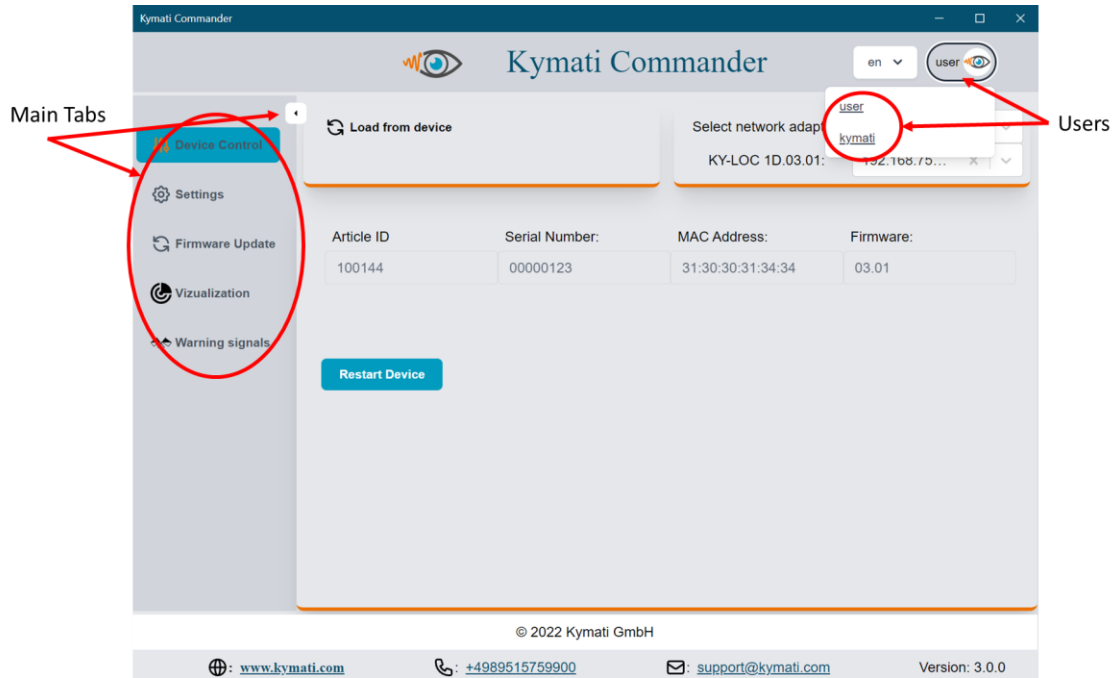

Figure 25: Kymati Commander

9.2   Device information tab

The user here may see some of the basic information of the sensor like the serial number, the article ID, the MAC address and the current firmware version of the application software running on the radar sensor. Additionally, once the user is connected to a radar sensor, it is possible to perform a reset of the device.

Figure 26: Device information tab

9.3 Settings Tab

The settings tab consists of multiple tabs where the user can modify the parameters of the radar.

- Sensor Settings: Configure the sensor settings, like
  - Frequency channel: If multiple systems are operating in the same region every system need to select a different channel. The two devices that are working together (Master and Slave) need to be on the same channel. With that, it is possible to operate multiple systems in close proximity without disturbance. Valid values are 0 to 31.
  - Operation mode: A system consist always of a Master and a Slave. Under Operation mode the role can be selected
  - User data enable: There is the possibility to transmit user data. To do so, this point must be selected. If no user data is transmitted deselect this button. Enabling the user data, will decrease the update rate of the measurements.
  - Zero offset [m]: The user is allowed to set a zero offset. This option is helpful if the operator would like to set a zero-point other than the zero distance between the two radar devices. The user can only change the zero offset independently on every device.

If the zero offset is different between the two radar the distance output will be different.

User data setting must be the same at both units. If User data is enabled on one device and disabled at the other device, there will be *no* distance measurement possible.

Figure 27: Settings tab – Sensor settings

- Anticollision Settings: A feature that can be utilized by the user is the anticollision feature where the sensors react to warning distances that falls within specified warning zones by sending out a signal that can be used, for example, to stop the vehicle and avoid collision or turn on an alarm. For a more detailed description please have a look at Chapter 6.7 There are three options for the anticollision feature:
  - No anticollision (no selection)
  - Fixed warning zones: 2 distance-based zones identified by the user to indicate operational limits in the environment
  - Dynamic warning zones based on current speed: the warning zones are calculated and placed based on the vehicle's current speed
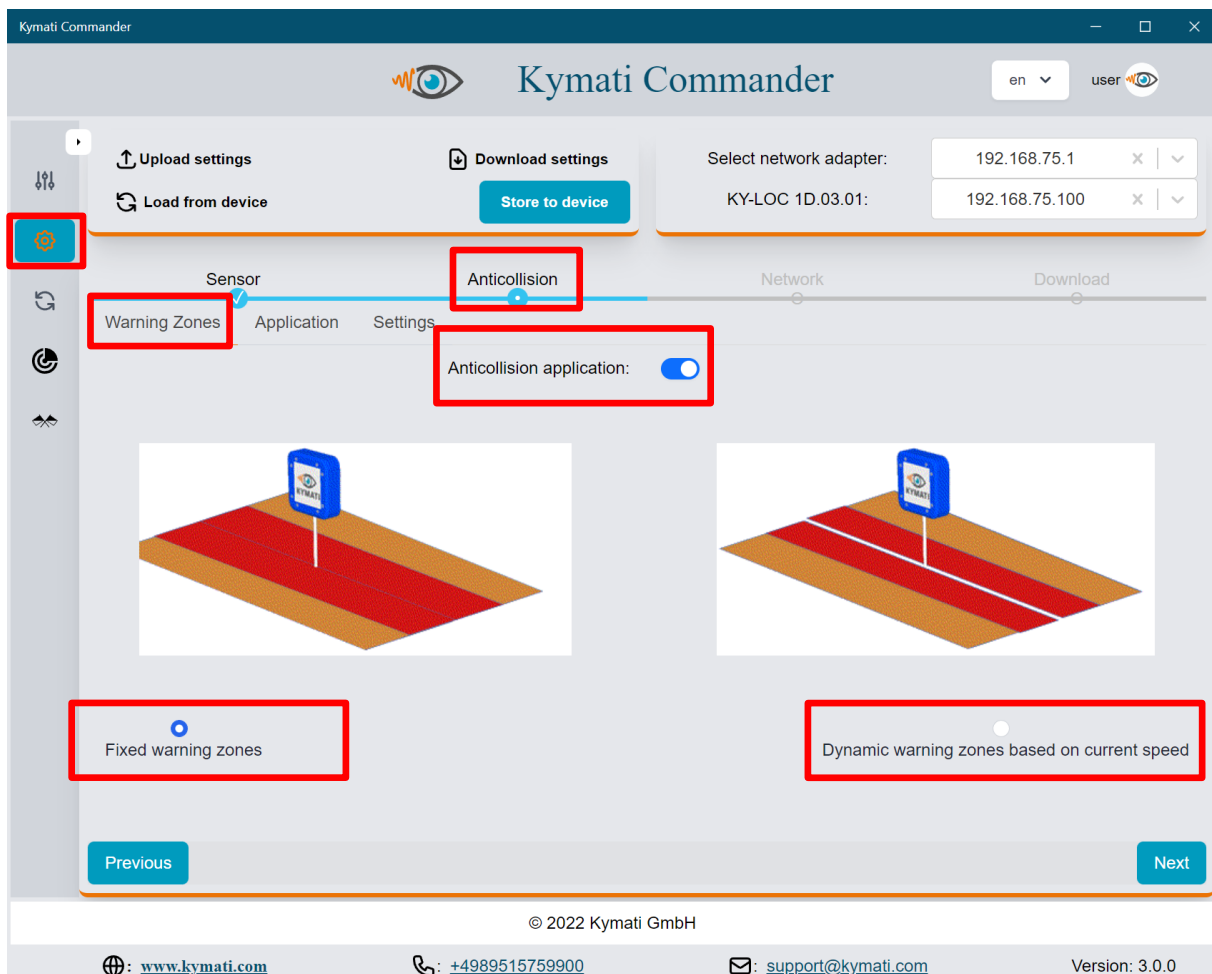

Figure 28: Anticollision tab – Selecting between fixed and dynamic zones

In addition, there exist two different applications for the user to choose based on the sensors' setup in the environment, the **Single Crane** and the **Double Crane**.
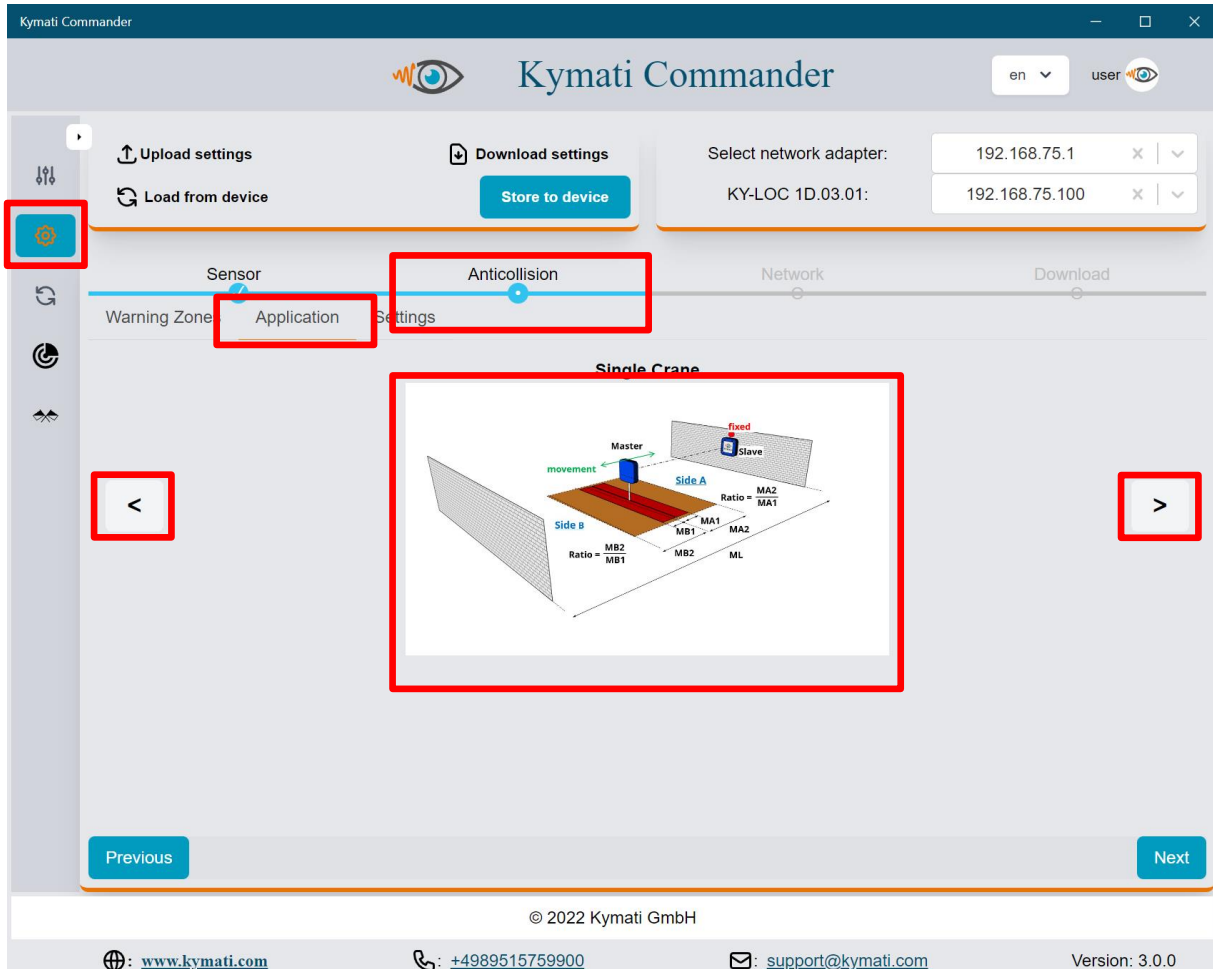

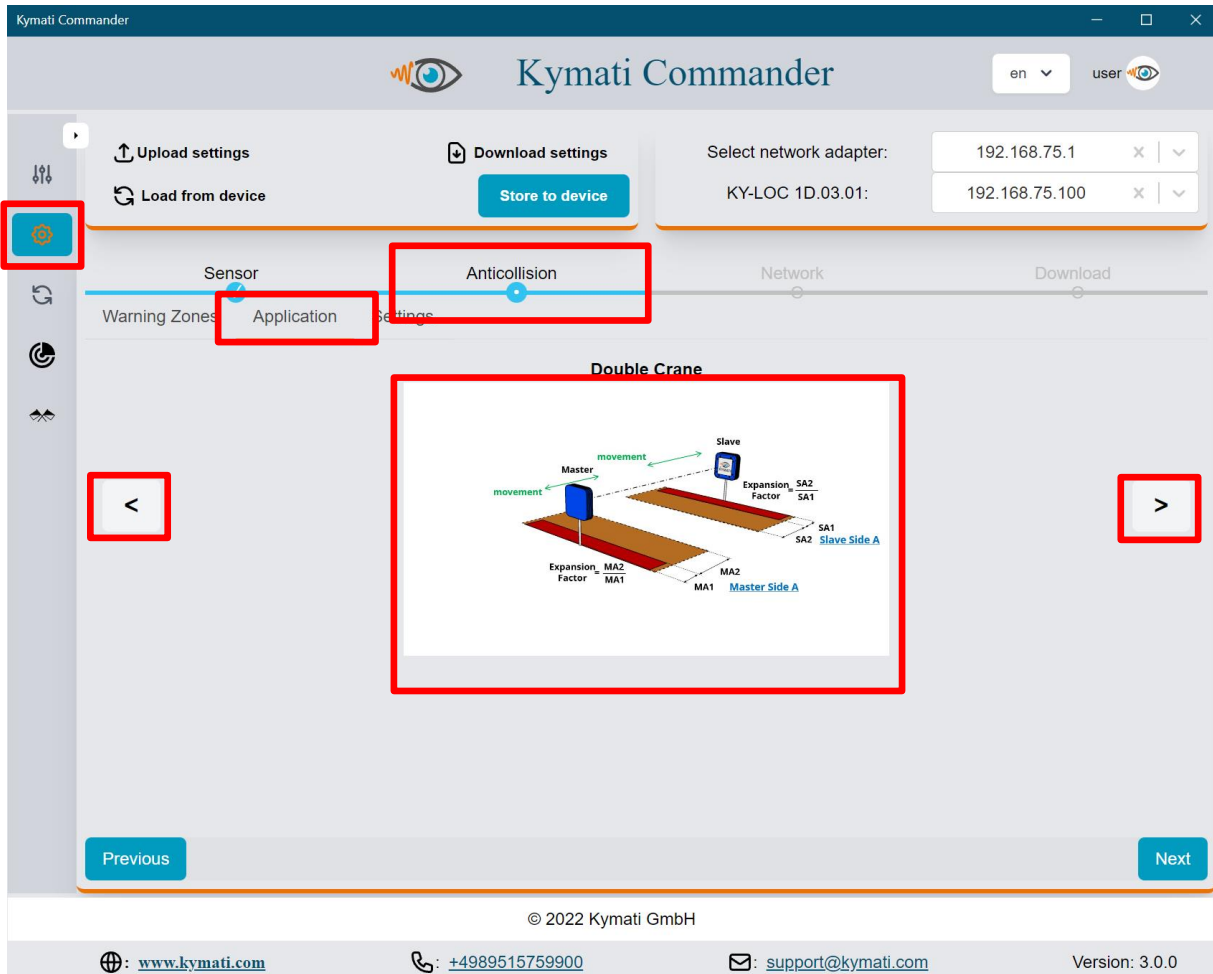**Figure 29: Anticollision tab – Single crane mode**

Figure 30: Anticollision tab – Double crane mode

After choosing the anticollision mode and application type, the user should input a collection of values to successfully setup the anticollision feature. These values are chosen based on the user's preference and few values are based on the vehicle on which the sensor(s) is mounted. These are all the values that are required from the user to input:

- Fixed Warning Zones (Single Crane mode):
    - MA1/MA2 [m]: two different warning zones for side A of Master sensor
    - MB1/MB2 [m]: two different warning zones for side B of Master sensor
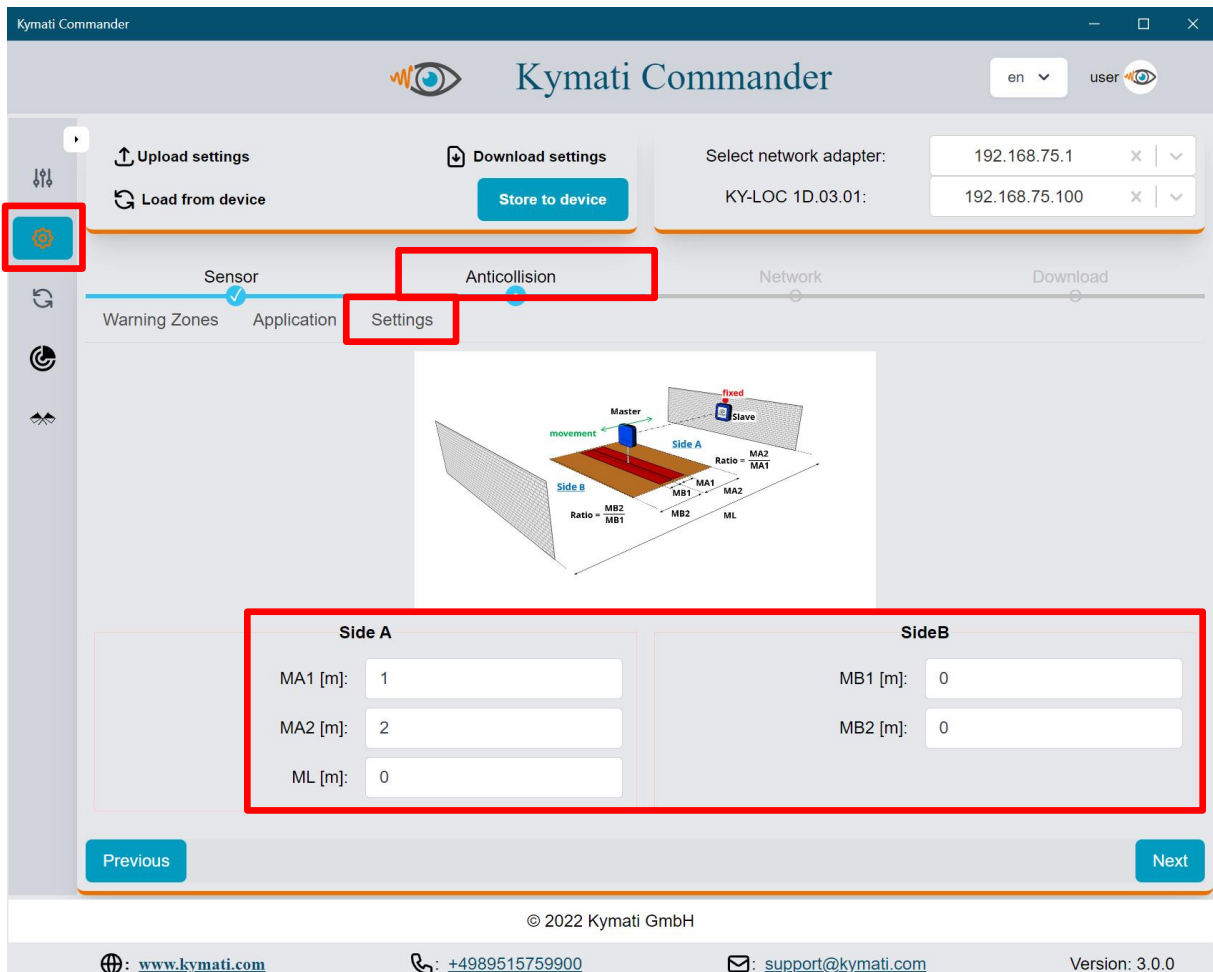   - ML [m]: total distance of the operational area of the sensors.

Figure 31: Anticollision tab – Fixed zone and single crane mode

- Fixed Warning Zones (Double Crane mode):
  - MA1/MA2 [m]: two different warning zones for side A of Master sensor
    -Or-
  - SA1/SA2 [m]: two different warning zones for side A of Slave sensor

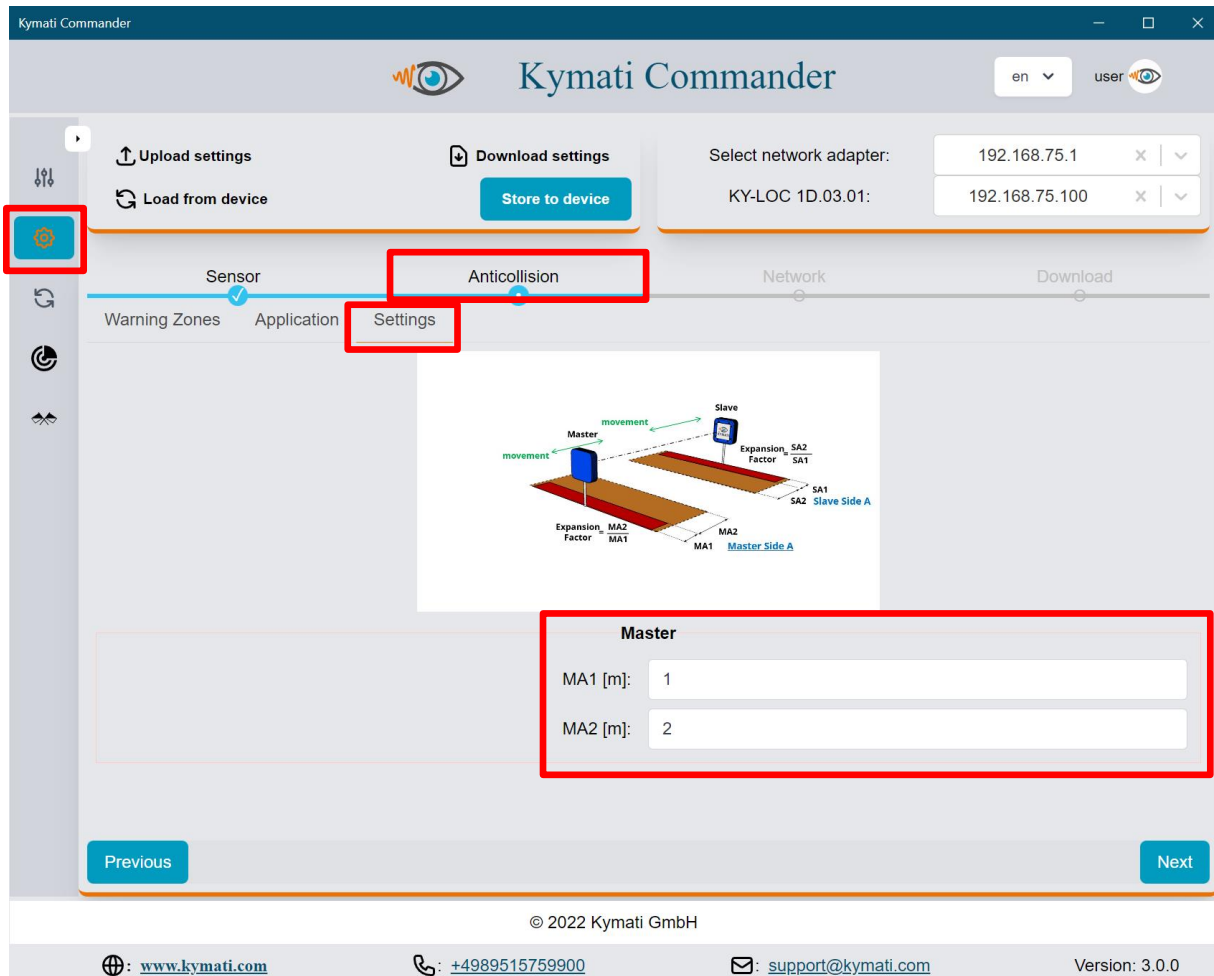 Depending on the operation mode defined at the settings tab.

Figure 32: Anticollision tab – Fixed zone and double crane mode

For the dynamic mode, these are the inputs that the user is required to input:

- Dynamic Warning Zones (Single crane mode):
  - min MA1/min MA2 [m]: two different minimum warning zones (regardless on current speed) for side A of Master sensor
  - min MB1/min MB2 [m]: two different minimum warning zones (regardless on current speed) for side B of Master sensor
  - ML [m]: distance between the minimum and maximum operational boundaries in environment
  - Expansion Factor (shown as ratio on the figure below): the factor which the dynamic warning zone depending of the current speed will different between MA1 and MA2
  - Max Speed [m/s]: maximum speed of the vehicle on which the sensor(s) is mounted
  - Max Brake Dist. [m]: maximum braking distance the machine
  - Deceleration [m/s^2]: deceleration of the vehicle on which the sensor(s) is mounted

    User may choose between max braking distance and deceleration. The sensor is responsible for doing the calculations for the dynamic zone.
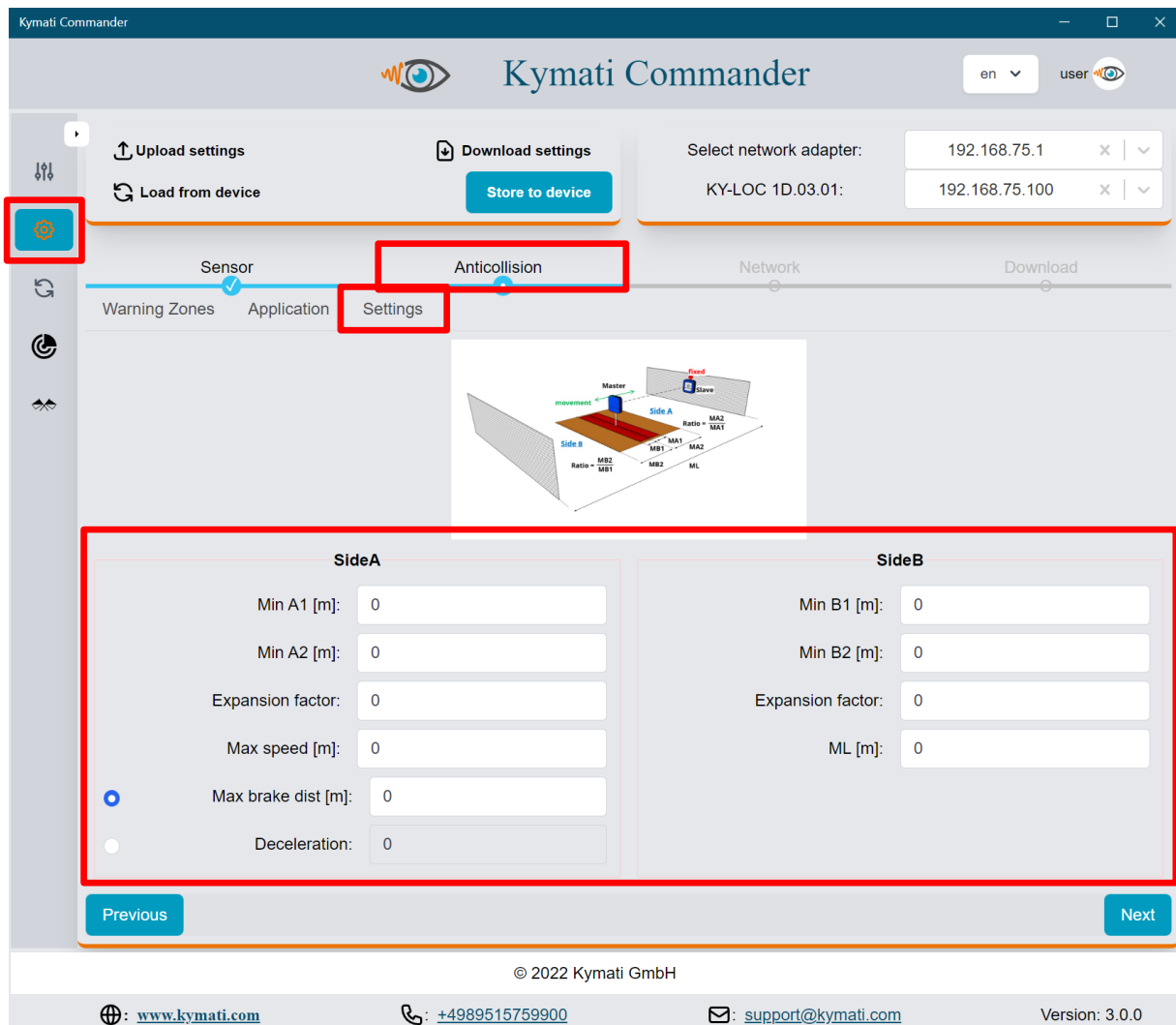

Figure 33: Anticollision tab – Dynamic zone and single crane mode

- **Dynamic Warning Zones (Double crane mode) at the master:**
  - min MA1/min MA2 [m]: two different minimum warning zones (regardless on current speed) for side A of Master sensor
  - min MB1/min MB2 [m]: two different minimum warning zones (regardless on current speed) for side B of Master sensor
  - Expansion Factor (shown as ratio on the figure below): the factor which the dynamic warning zone depending of the current speed will different between MA1 and MA2

-or at the slave-
  - min SA1/min SA2 [m]: two different minimum warning zones (regardless on current speed) for side A of Slave sensor
  - min SB1/min SB2 [m]: two different minimum warning zones (regardless on current speed) for side B of Slave sensor
  - Expansion Factor (shown as ratio on the figure below): the factor which the dynamic warning zone depending of the current speed will different between SA1 and SA2

-and-
  - Max Speed [m/s]: maximum speed of the vehicle on which the sensor(s) is mounted
  - Max Brake Dist. [m]: maximum braking distance as provided by the vehicle manufacturer
  - Deceleration [m/s^2]: deceleration of the vehicle on which the sensor(s) is mounted

User may choose between max braking distance and deceleration. The sensor is responsible for doing the calculations for the dynamic zone. Additionally, depending on the operation mode defined at the settings tab the master or the slave will be used to modify the right anticollision settings.

Figure 34: Anticollision tab – Dynamic zone and double crane mode

On the network tab the user may modify all ethernet related settings. For this example, the user data are enabled on the sensor tab, therefore, the user data network settings are shown. The following figures show the parameters that the user may modify.

IP Settings:

- IP source: The IP address of the sensor itself.
- Destination: The IP address of the host computer for visualization and commissioning purposes.
- Subnet Mask: The general subnet mask of the network to be connected.
- Default gateway: The default gateway address of the network.
- Port number: The default port number is 27513. Please change this port number only if you are sure of what you are doing, as you may not be able to receive data from the sensor anymore.
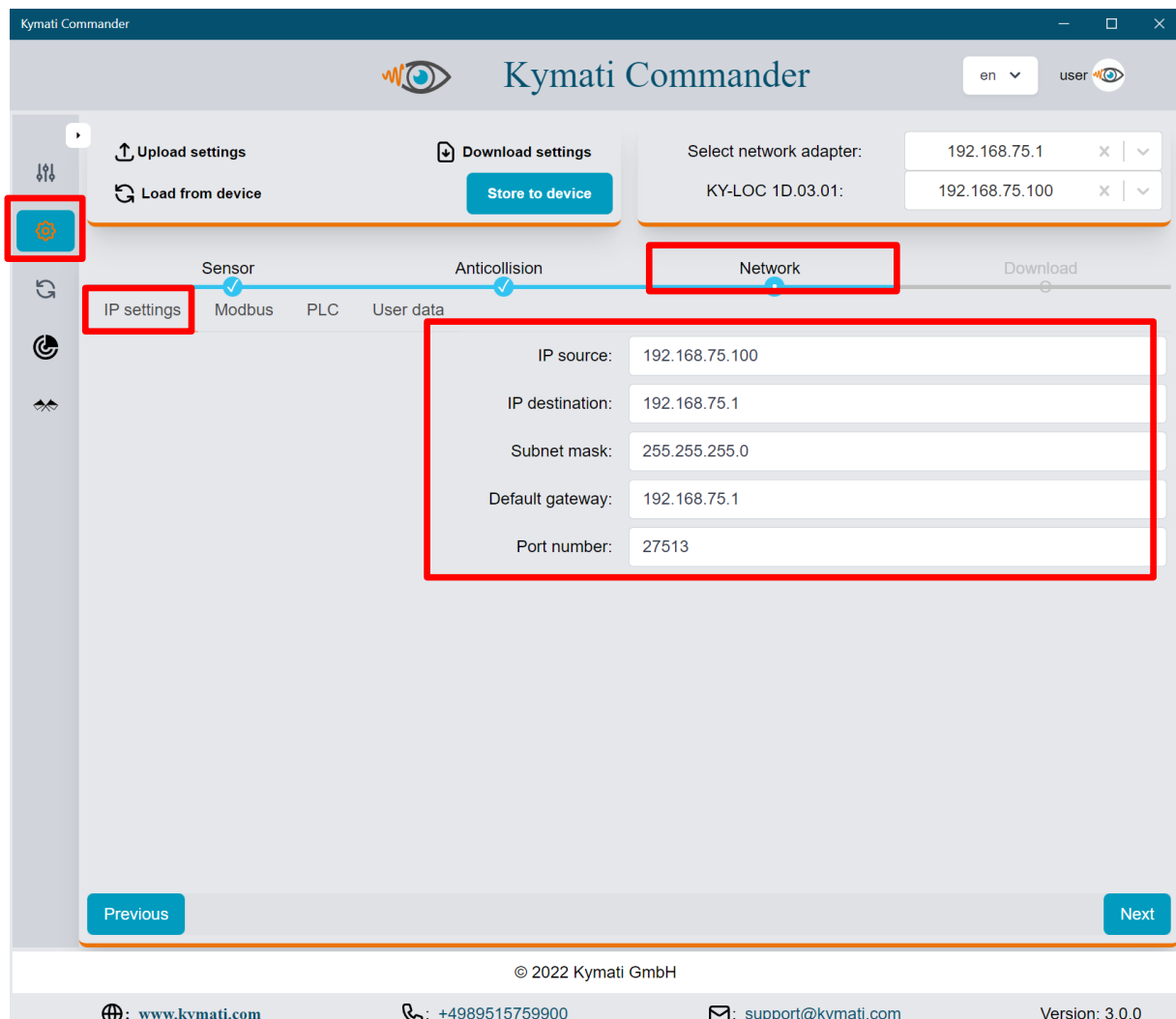
Figure 35: Network tab – IP settings

Modbus:

The Modbus is correlated to the anticollision tab, as explained before. The system is designed to send Modbus TCP messages based on the "Function Code 15 - Write Multiple Coils" and the register address 8256 (0x2040).

☞ **As Modbus TCP device, it is recommended to use KY-XTRA B.10.01 (Siemens Logo PLC providing 4 dry contacts) only.**

The following parameters shall be configured:

- Target IP address: The destination Modbus Server IP address.
- Target port: The destination Modbus Server port.
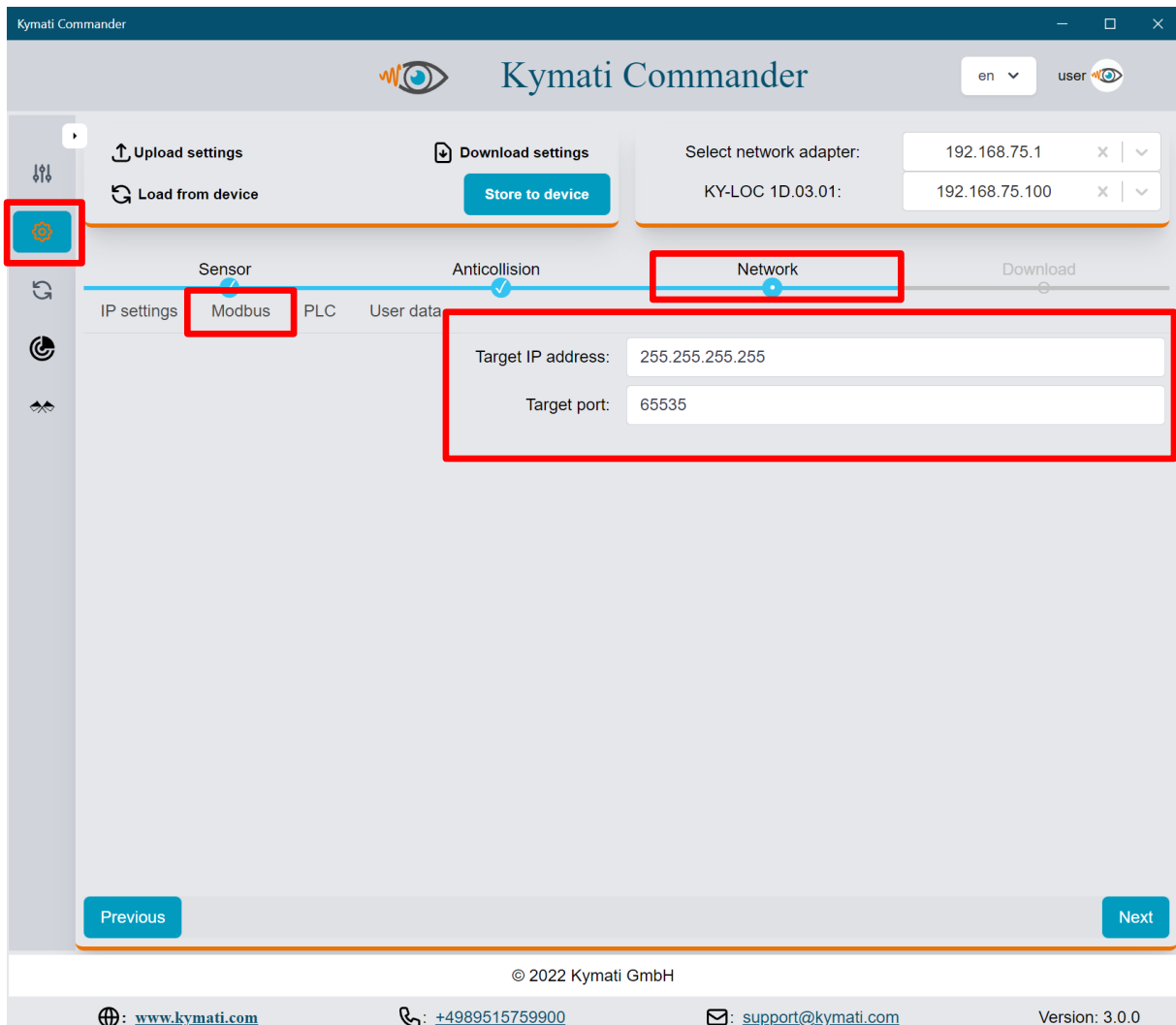
Figure 36: Network tab – Modbus settings

PLC:

On the PLC tab the user may choose to modify:

- The destination IP address, i.e. the ip address of the PLC
- The port address. Please note that if port 0 is used then no data will be sent.
- The cyclic time of the PLC, usually 100ms. If a 0 is applied then it follows the maximum update rate of the sensor.

Every 'cycle time' period, KY-LOC.1D sends one 64byte UDP data frame to 'ip:port' from 'source port 2000'. IP address of '0.0.0.0' means that output is deactivated.
PLC/customer protocol facts at a glance:

- UDP
- 64 bytes frame length
- Data fields are 'network byte order'
- For details, please refer to the 'interface control document'

Figure 37: Network tab – PLC settings

User Data (only available if user data is enabled on the settings tab):
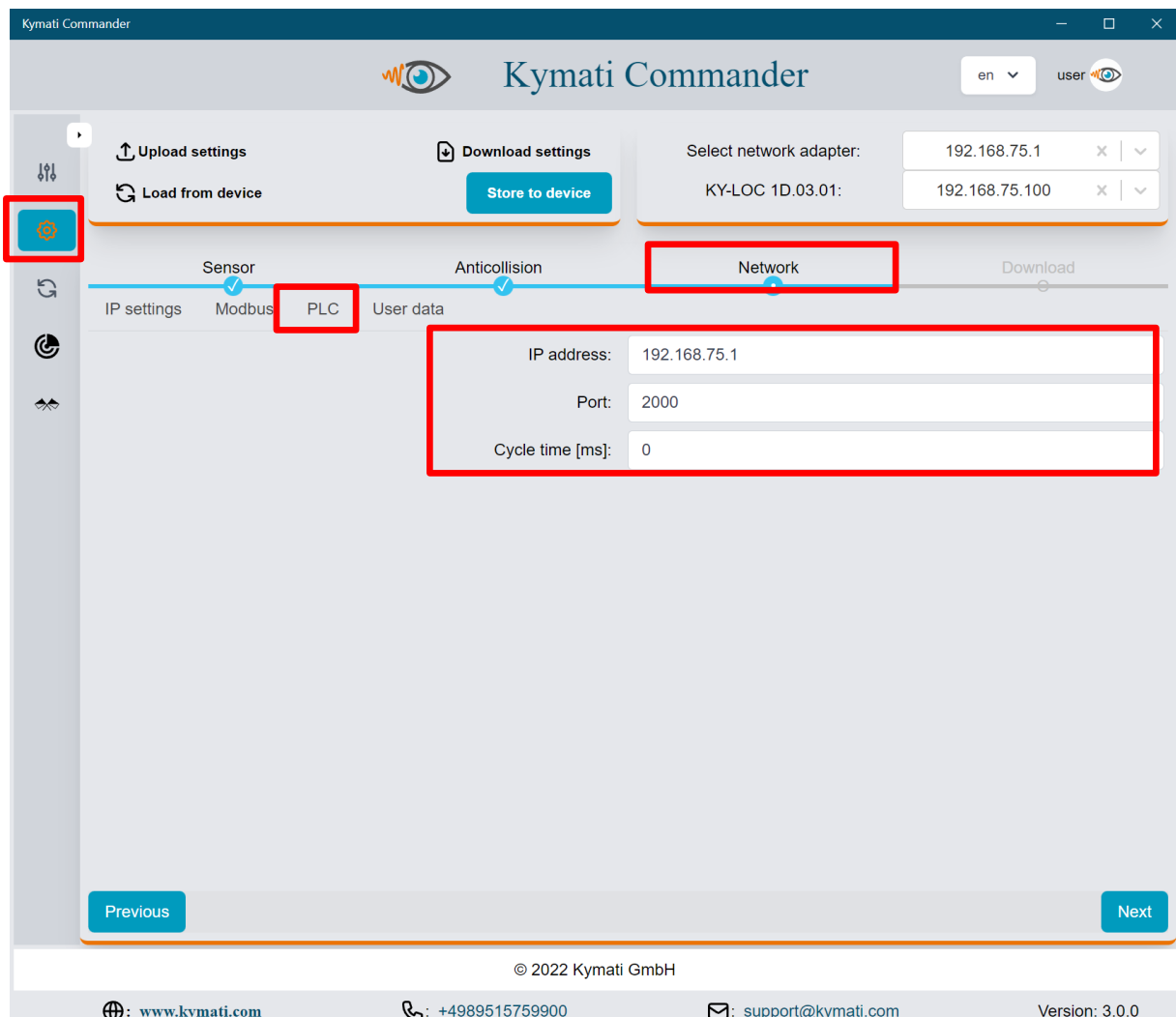
The device offers two dedicated bidirectional channels through the radar link: A Modbus Channel (1) for "Function Code 15 - Write Multiple Coils" Messages and a Generic Channel for UDP Datagrams (2).

The Modbus Channel works in the following way:

1. A Modbus client can connect to the device (e.g. master) on port 2001 to initiate a Write Multiple Coils command with support for up to 24 Relays.

2. This message will then relayed to the other paired device (e.g. the slave) through the RADAR link.

3. The paired device (e.g the slave) will then connect to a remote Modbus Server and initiate a WriteCoils command there.

- This remote Modbus server can be configured by the user in the GUI through the "Target output IP" and "Target output port" settings. (As shown on the following figure)

The Generic Channel works in a similar way.

1. An application sends a UDP datagram to the RADAR sensor on port 2002.
2. This message will then be relayed to the other paired device (e.g. the slave) through the RADAR link.
3. The paired device (e.g the slave) will then send the datagram from step 1 to a remote UDP datagram endpoint.

   This special endpoint can be configured by the user in the GUI through the PLC settings using the IP address and the plc port +2.

The payload per cycle on the radar datalink is 4 bytes with 4 bytes overhead and only one channel is in transit all the time. Hence, Modbus and Generic data will be sent in every other cycle.
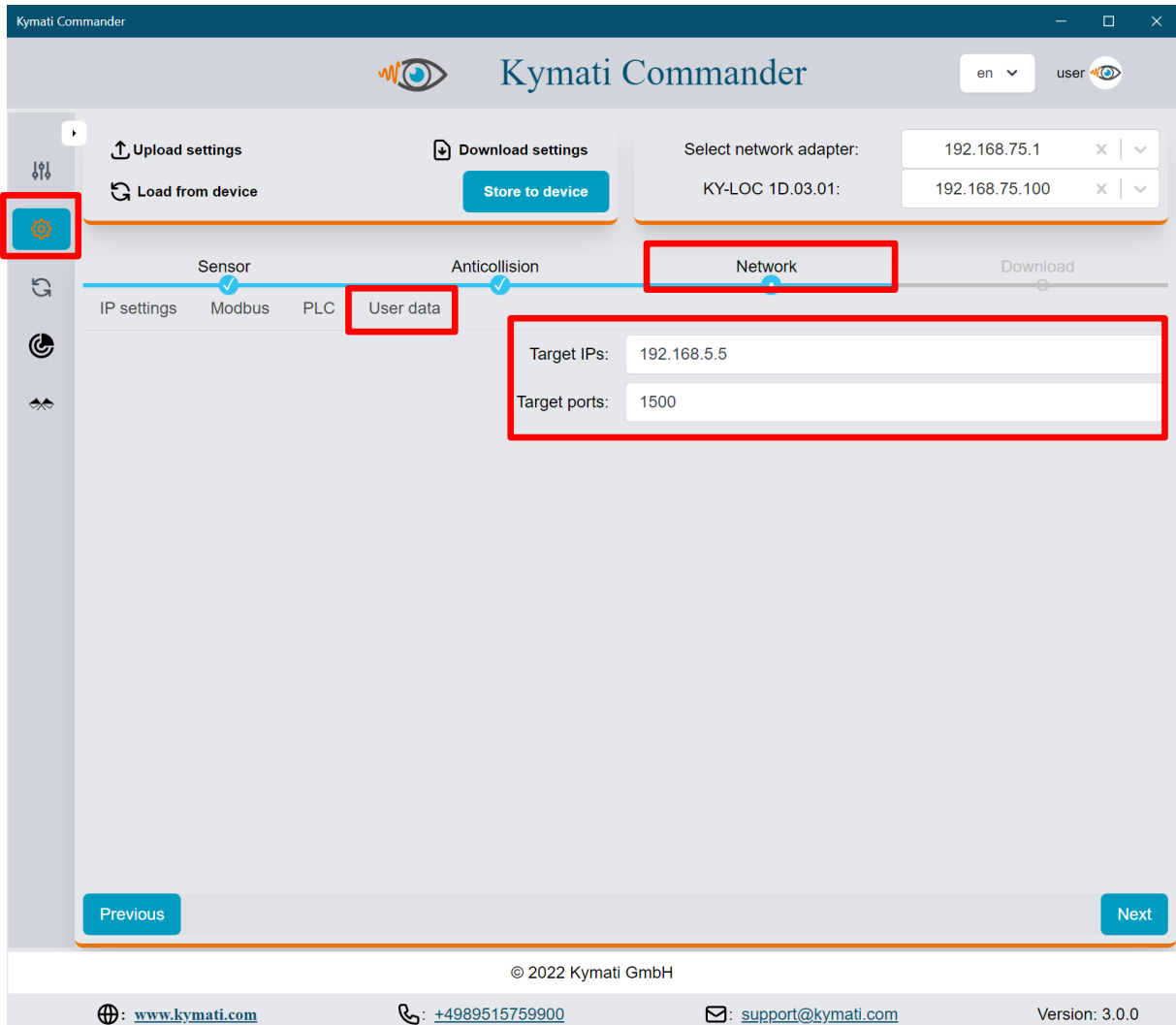
Figure 38: Network tab – User data settings

If there is at least one change on the settings tab then a button on the top is appearing as "**Store to device**". This can be used at any time to upload the new configuration to the device. Additionally, the user may also press the "**Download setting**" and choose a folder in the local computer to save two TOML files. One will contain the master and the other the slave configuration. On the same area, the user may use a TOML file to directly upload it to the sensor using the "**upload settings**". The "**download settings**" is used to request from the sensor the current configuration and store it on a TOML file. Finally, the "**load from device**" button is used only to fetch data from the sensor to the Kymati Commander.
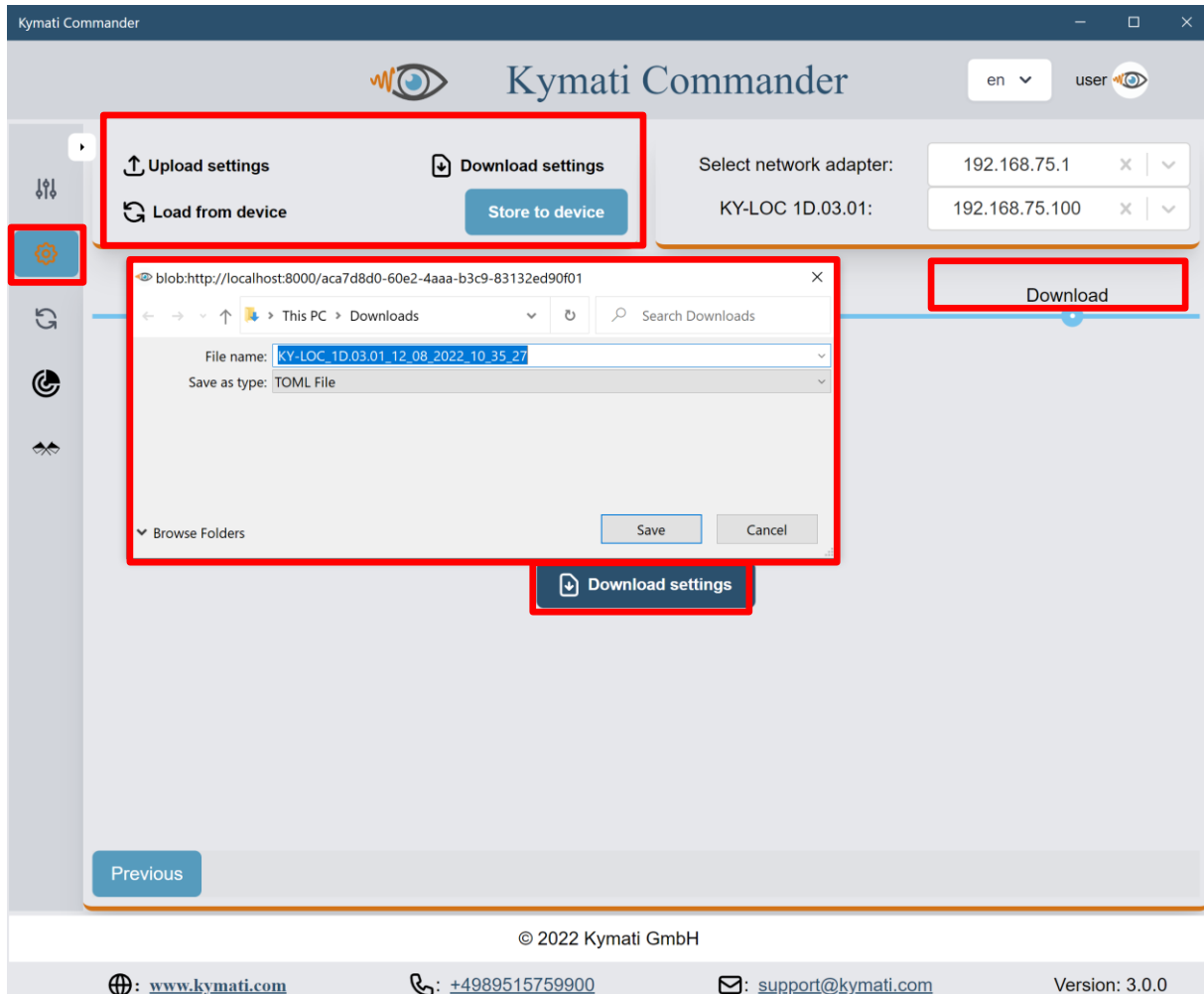
Figure 39: Download tab

9.4 Firmware update tab

The user may use the zip files provided by KYMATI GmbH to upload the sensors to the latest firmware. After pressing the upload button, the user will choose through a windows explorer tab the zip file to be updated to the sensor.

For a successful Radar firmware update, IP address of the PC must match IP address of the 'Default Destination IP address' setting!
In this manual, PC IP address is '192.168.75.1' and Destination IP address setting is '192.168.75.1'.

Figure 40: Firmware update tab

9.5 Visualization tab

The user may use this tab to visualize the incoming data from the radar sensor. The buttons on the graphs are illustrated on the following figure. Make sure if you zoom in or accidentally change something on the graph, always use the home button to reset the graph and get back to the auto-scaled figured.

Figure 41: Visualization tab

9.6 Warnings Signals tab

If, and only if the anticollision is enabled, then the warning signals tab is appearing. On that tab the user may see the status of the Side A and Side B of the warning signals.
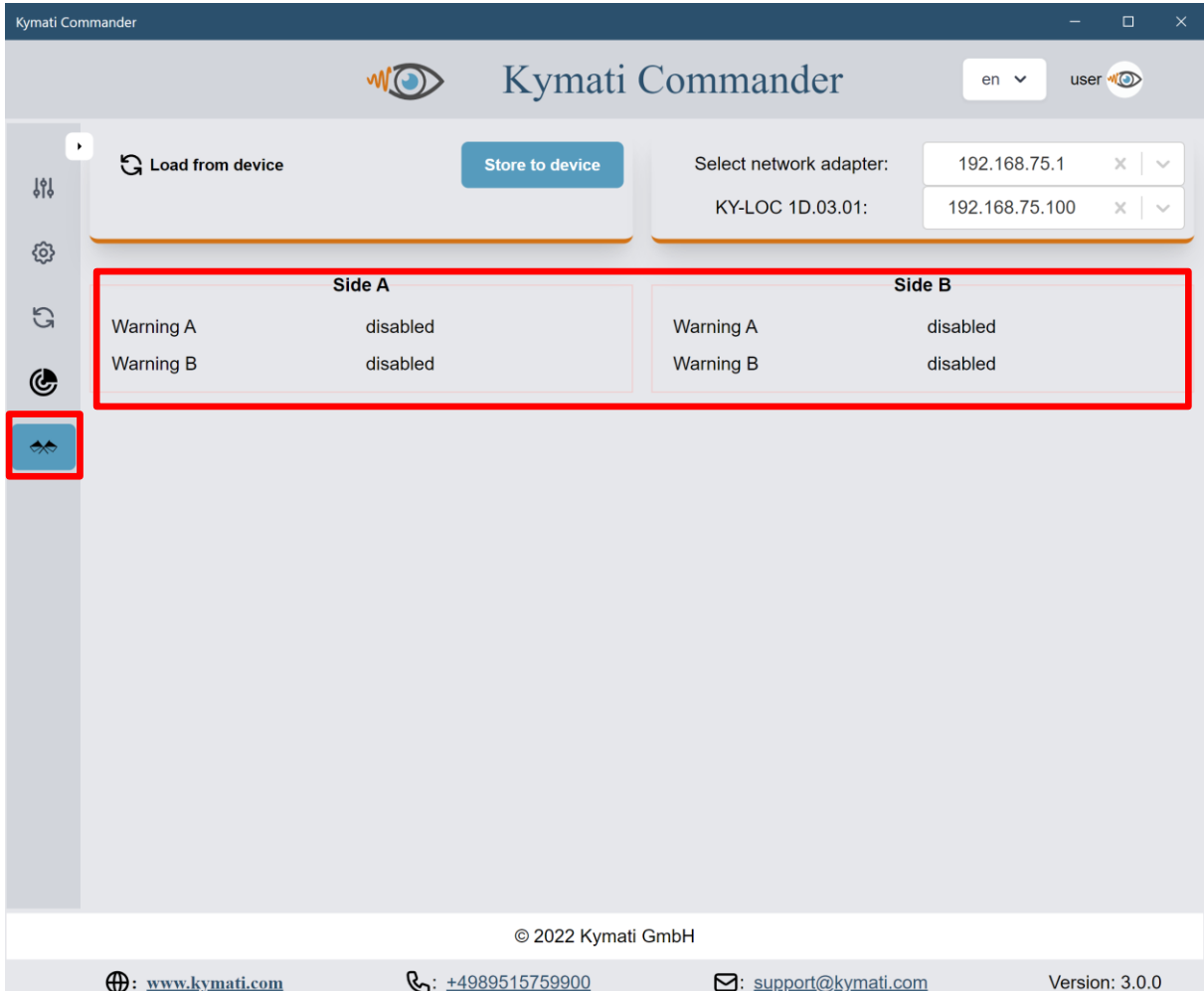
Figure 42: (Optional) Warning Signals tab

10 Maintenance and Repair

☝ **Do not open the units. In case it is opened, the warranty has expired.**

All Units are maintenance free. In case of any problem with one or more devices, check first chapter 11. If the problem remains the unit might be damaged. Under any circumstances the units shall not be opened, and repair must not be attempted by the customer.

10.1 Replacement of Equipment

The following points must be considered if a device needs to be replaced:
- The device should be mounted in the same place as the old ones to achieve the same results
- The new device should be configured with the same settings as the old device. This can be done by uploading the configuration file of the old device. User should ensure that these files are accessible in case of a replacement. Please refer to chapter 6 for more information
- The steps described in chapter 6 should be performed especially the zero calibration is necessary to get the same results out of the device as before

10.2 Cleaning and Painting

External pollution can be removed with a rag and water. Do not use detergents, solvents, or other chemicals. Painting especially of the front cover is not allowed.

10.3 Connectors

The electrical connectors are limited to 100 mating cycles.

11 Troubleshooting

Please contact the KYMATI Service Team if you cannot fix your problem with the given instructions.

11.1 Diagnostic Information and LED Status
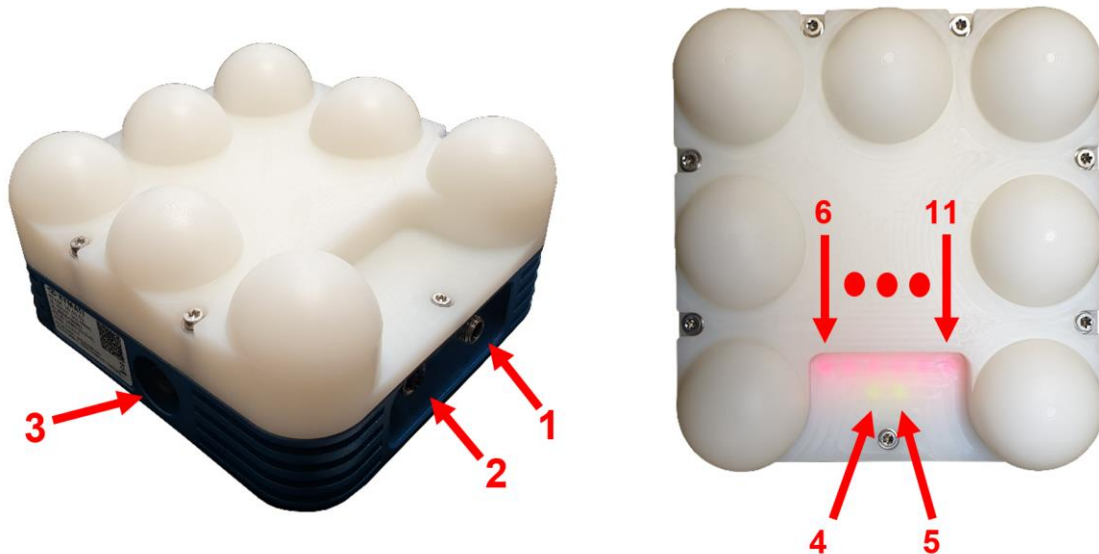
Figure 43: Physical Interfaces

Power LED (4)
If power is connected to the device this LED will illuminate. If this LED does not illuminate check the power connection (see Section 5.2)

Status LED (5)
The status LED indicates the following operation modes:

Mode	Description
Off	Device failure during hardware initialization.
On	System ready

Upper (6), left (7), bottom (8), right (9) LEDs
These LEDs indicates the following operation modes:

Mode	Description
Off	Device start-up failed.
Only Information LEDs 6 and 11 are blinking	Device is in Bootloader Mode

Information LEDs (6-11) are blinking and not rotating	Device is in Bootloader Mode but will switch to normal mode soon
Information LEDs (6-11) are blinking and moving from left to right and from right to left	Trying to synchronize
Constant Illumination of all Information LEDs	Radar provides range measurements, i.e. radars are synchronized

11.2   Plug does not fit

Only use connectors specified by KYMATI.

Do not wear gloves when applying the connectors. Take care of the index position and do not apply unnecessary force.

Problem: One of the plugs does not fit into the connector.

Solution:
- Make sure, that you have the correct connector and that you attach it at the correct plug.
- Make sure, that no pins are bent.
- The plugs only fit at one position. The plugs have an index notch that indicates the correct position. The connector must be carefully rotated, until it suits. Afterwards it can be fastened with the screw cap.

12 Technical Data

12.1 KY-LOC 1D.03.01

Parameter	Value / Description
Range[1]	3m ≤ x ≤ 500 m
Antenna opening angle	horizontal ± 2.5°, vertical ± 2.5°
Repeat accuracy of measurement	typ. ± 3 mm
Absolute distance accuracy	typ. ± 5 mm
Update rate	up to 20/50 Hz (double/single sided measurement)
Data transfer parallel to measurement	up to 1 kbit/s
Weight	2010 g (without support bracket)
Dimensions (LxWxD)	171 x 161 x 97mm
Power supply	12 … 24 V DC (typ.) 9 ... 36 V DC (abs. max.) or PoE
Power consumption	3.5 W typ. / 5 W (max.)
Frequency band	60 GHz band
Interfaces	Ethernet (100Base-Tx) - M12, 8 Pin, X-coded
Ingression Protection (DIN EN 60529)	IP66, IP66K and IP68 24h diving at 1m (with connected plugs or caps)
Operating temperature (DIN EN 600068-2-1 & DIN EN 600068-2-2)	-30 ... +75 °C / -22 ... 167 °F
EMC Compliance EN 305 550 v2.1.0	The equipment is classified as Short-Range Devices (SRD); Radio equipment to be used in the 40 GHz to 246 GHz frequency range
EMC Compliance EN 301 498-3 V2.11	The equipment fulfils the Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements
Radio emissions EN 62311:2008	Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz - 300 GHz)
Product Safety EN 62368-1:2014	Audio/video, information and communication technology equipment – Part 1: Safety requirements

[1] Max. range depending on radio regulations applicable

Table 5: Technical Data KY-LOC 1D.03.01

12.2 KY-XTRA B.10.01

The KY-XTRA B.10.01 Switching Device is currently based on a Siemens LOGO! PLC.
It receives ModBus TCP coil messages from the sensor.
KY-XTRA B.10.01 comes with pre-programmed application and with default ip address 192.168.75.9:

Figure 44: KY-XTRA B.10.01 application settings

Available Application Settings:
- Invert On/Off:
  - Off: Contact closed if inside area → Example: Switch warning lights
  - On: Open contact if inside area → NO (normally open contact) behaviour
- Timeout On/Off
  - Off: Keep last known coil message state
  - On: Toggle contact if no ModBus TCP coil message for Timeout-Time period
- Timeout Time:
  - Range from 1 second to 59 minutes 59 seconds

Of course, KY-XTRA B.10.01 must be in the same ethernet network segment as the sensor device and 'Switching device' ip:port must be properly set at the KY-LOC device. IP settings of the KY-XTRA B.10.01 can be set via the LOGO! display after 'stopping' the application.

Technical data LOGO! 24 RCE (6ED1052-1HB08-0BA1) - Excerpt:

Parameter	Value / Description
Mounting:	DIN RAIL (35mm) or Wall mount
Dimension (WxHxD):	90 x 71.5 (4TE) x 60 [mm]
Weight:	Approx. 240g
Ambient temperature range (non-condensing)	-20 … +55 °C
Power Supply Range:	20.4 .. 26.4 VAC, nominal 24VAC
	20.4 .. 28.8 VDC, nominal 24VDC
Power consumption @ 24VDC:	25mA .. 185mA

WAVES ARE OUR VISION

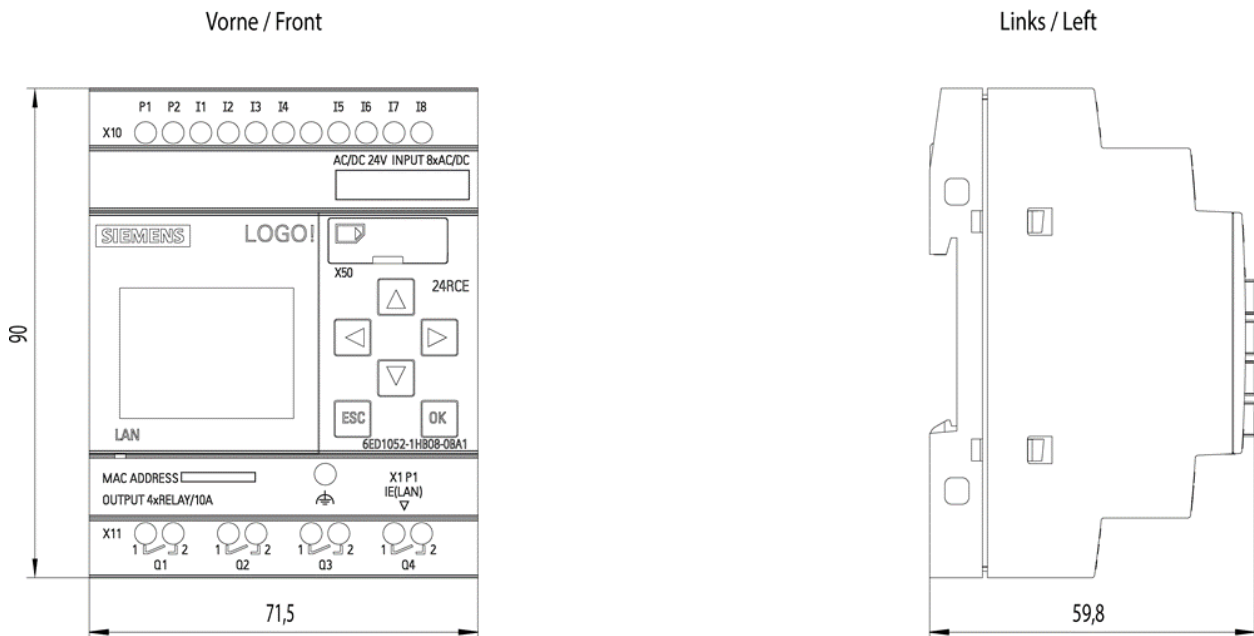| Digital Outputs:	4 x Relay
Short-circuit protection:	No; external fuse necessary
Relay Rated Voltage:	240VAC/VDC
Surge Current:	30A max.
Max Current (Resistive load):	10A
Max Current (Inductive load):	3A
Relay lifetime (dependant on load type & current):	0.1 .. 1 million switching cycles typ.
Ingress Protection:	IP20

Table 6: Technical Data KY-XTRA B.10.01

Figure 45: KY-XTRA B.10.01 dimensions

13 Related Products

Article Number	Description	Order Number
KY-XTRA B.10.01	Switching Relay device	100112
KY-XTRA M.01.01	Adjustable Mounting Bracket	100034
KY-XTRA M.03.01	Falling Protection	100102
KY-XTRA E.01.01	Connector for ethernet interface / PoE	100036
KY-XTRA E.02.01	Connector for power	100037
KY-XTRA E.03.01	Ethernet / PoE Cable 5m -> RJ45	100069
KY-XTRA E.05.01	Power Cable 5m -> open End	100070

Table 7: Related Articles / Accessories

14 Contact and Responsible Party

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