RSU2X
Installation Manual

Version 1.1 - Released

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Preface

Notes on safety and environmental protection

Safety notice

The devices/systems are only to be employed for their intended use in accordance with the product documentation; the warning labels and product documentation are to be adhered to. The installation and initial startup of the devices may only be performed by authorized professional personnel.

If not sufficiently trained personnel are working on the devices, substantial bodily damage and property damage can come as a consequence. The devices/systems are to be tested regularly by authorized professional personnel. The test intervals and the checks to be performed can be found in the specifications of the product standards. If there are no product standards with information about regular checks for the devices, then the tests are to be performed in accordance with the standards VDE 0100-600, VDE 0105-100 and BGV A3.

Occupational safety, environmental protection

All legal regulations regarding occupational safety and environmental protection are to be complied with during the course of production. We design our products (parts, devices, systems) in such a way that these present no health hazards to the user or hazards the environment according to the current state of information if properly and predictably used.

Recycling, disposal

The information above makes it possible to assess to a large extent the possible potential for hazards to people and the environment, even at the end of the product's life cycle. The regulations for recycling and disposal procedures must be observed here.

All information has been given to the best of our knowledge and belief. It is in accordance with the current state of the art. The information does not constitute a guarantee in the legal sense of a warranty.

Batteries need to be handles correctly in order to mitigate the risk of toxic emissions or explosions.

1. Introduction

This document describes the assembly and installation of the Road Side Unit RSU2X.

The RSU2X typically comprises an IP67 housing and connectors to which three antennas can be attached. The unit is typically operated without the external antennas using the internal antennas only but can be remotely cabled considering cable loss and protection devices.

Figure 1: RSU2X

1.1. Important Information

Throughout the document there may be sections that require particular attention. These are marked and have meaning as exampled below:

> ⚠️
>
> *A warning/condition that contains important information that MUST be read and understood. It may often contain health or safety information.*

2. Assembly of Units

The closed RSU2X typically comes together with a mounting bracket, 4 screws and the following items:
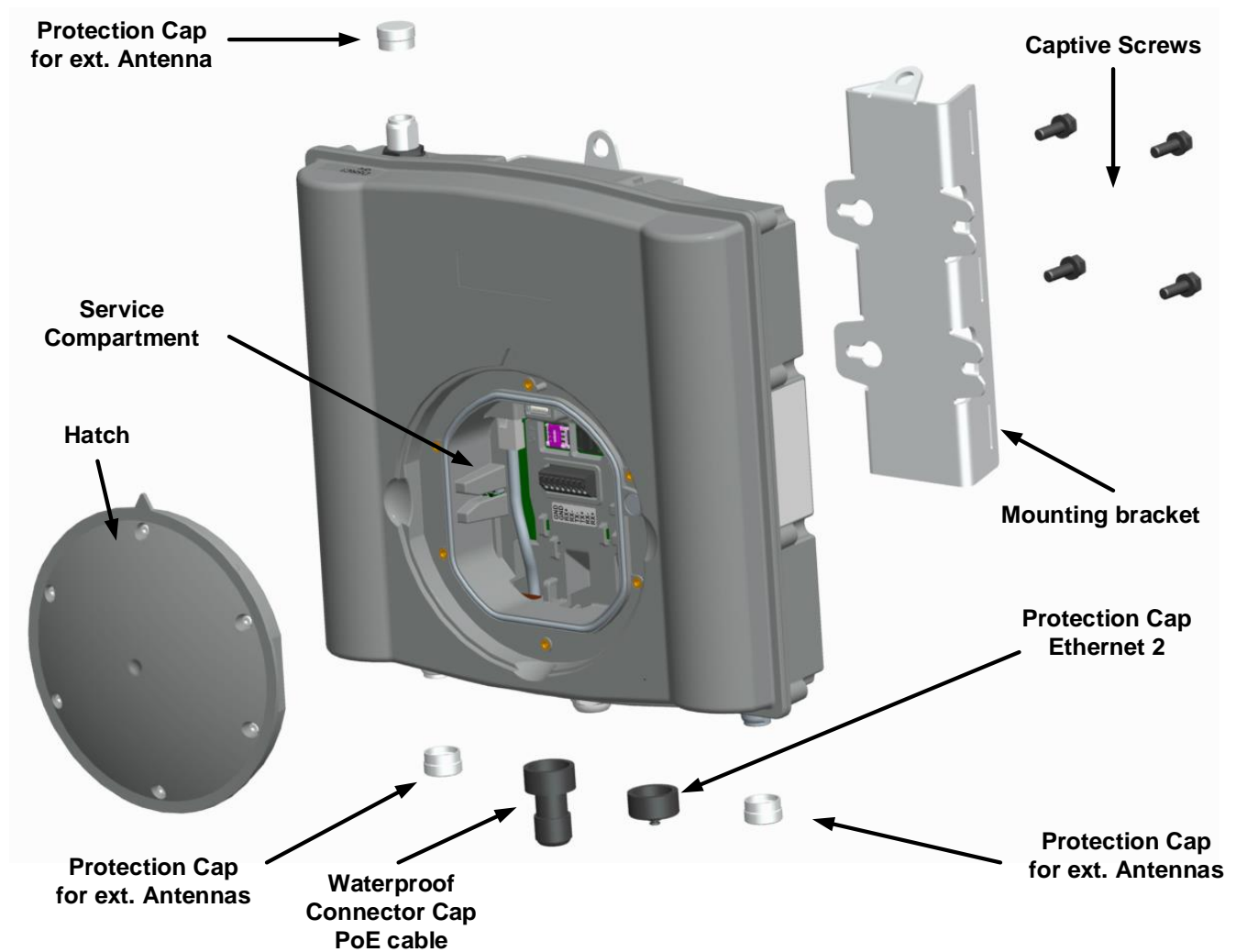

Protection Cap for ext. Antenna

Captive Screws

Service Compartment

Hatch

Mounting bracket

Protection Cap Ethernet 2

Protection Cap for ext. Antennas

Waterproof Connector Cap PoE cable

Protection Cap for ext. Antennas

Figure 2: RSU2X Delivery Units

1	RSU2X with closed service hatch, external connectors and fixing plate
1	RJ45 plug for Ethernet cable and waterproof cable gland (V24707-Z102-A1)
2	protection caps for RJ45 connectors
3	protection caps for external antenna connectors
1	RSU2X mounting bracket with 4 captive screws

Assembly of the units typically proceeds in the following order:

1. Only if needed prepare the configuration inside the RSU2X service compartment behind the hatch (e.g. to install SIM card)

2. Preassemble the 4 screws in the right position on the rear side of the RSU2X housing for use with the bracket

3. Attach the external antennas if it is intended to use them.

4. Install the mounting bracket on the mast

5. Attach the RSU2X to the mounting bracket

6. Attach required cables (if required)

For further information please read the following chapters.

⚠
If the use of external antennas is configured it is important that all antennas are connected before power is applied to the unit.

⚠
The worst case of all transmitters operational in this unit results in a MPE of ≤ 1.0 mW/cm^2 for 50 cm separation. Please ensure that installers and technicians maintain their distance from powered and operational units and take this into consideration when locating the unit to avoid public exposure.

⚠
Except the service hatch, in any case the RSU2X shall not be opened by unauthorized persons.

2.1. External Connectors and Interfaces accessible from Outside

- RJ45 cable connector with PoE+ functionality (ETH0)

- RJ45 cable connector (ETH1)

- external antenna connectors for V2X (DSRC1-1, DSRC1-2 and DSRC2/C-V2X on the top of the RSU2X)

- status indicator LEDs (Power, Status)

- cable gland with blind plug (RS485)

Figure 3: RSU2X external connectors accessible from outside

3. RSU2X Site Installation

3.1. Choosing the right Location and Orientation

This section discusses the factors that should be considered in the positioning and orientation of the RSU2X in typical use cases with regard to target coverage area, local topography and nearby structures.
This section does not cover all possible situations. The Customer and Installers must discuss and agree to these local installations to ensure performance of the system.

As a first step, depending on the overall requirements and the situation at the location where the RSU2X shall be installed, the right mounting position of the RSU2X needs to be chosen carefully to achieve the optimum V2X range and functionality (e.g., GNSS, WiFi/BT) of the RSU2X.

⚠️

DO NOT Install RSU against/near flat metallic surfaces unless separated by more than 2 meters!

For maximum V2X range normally a central position in the height of 3 to 10 m on an intersection considering line of sight to the planned V2X covered area is the best choice.

Usually, the RSU2X can be used with internal antennas only. In special cases e.g., large mast diameter or if remote antenna setup required external antennas should be considered.

RSUs must be separated from another at least 1 m horizontally when co-located. Vertical offset is required to be the same.

The RSU should not be placed in a location where a member of public may be able to easily touch the device with outstretched arm.

The poles for vertical mounting of the RSU2X shall be between 60 mm and 160 mm diameter. Any larger diameter and the use of the supplied bracket is not recommended due to placement of the antenna too close to the pole which degrades antenna performance and line of sight. Please see also chapter 3.3.2
If mounting on vertical poles larger than this with adapter plates/brackets (not supplied) then care must be taken to ensure that the pole is more than 300 mm away from the antenna to minimize impedance and other effects.

The poles for horizontal mounting of the RSU2X shall be between 60 mm and 120 mm diameter. Please see chapter 3.3.2 for choosing the right position in relation to the internal antennas and for recommendations for horizontal masts with a larger diameter.

RSU2X vertical alignment: Ideally the RSU should be vertical ± 5 degrees at most. Non vertical installation may be required to obtain maximum range in some circumstances where the road is non horizontal.

When installing the RSU against flat surfaces ensure that the surface does not have internal metallic structures within the limits laid out above. If the building is inhabited ensure minimum separation for human safety. See MPE limits for the country/region in which this device is installed for appropriate limits/requirements. The RSU under worst case conditions provides MPE of ≤ 1.0 mW/cm2 for 50 cm separation.

For details regarding the mounting position of the RSU2X and using of external antennas see 3.3.2

3.2. RSU2X Preparation for Installation

Before the RSU2X is mounted on a pole it should be prepared for installation. If it is intended to use the RSU2X with internal antennas, with an Ethernet connection with PoE+ and no planned adaptions inside the service compartment only step 2) of the list below is needed.

The preparation steps are depending on the intended use of the RSU2X:

1. If any of the connectors or switches, SIM or SD card holders in the service compartment need to be used, the related tasks shall be performed as far as possible before mounting the RSU2X to the pole. This applies especially for the SIM and SD cards and the use of the RS485 interface.

2. Preassemble the 4 screws in the right position on the rear side of the RSU2X housing if the bracket is used.

3. Assemble the external antennas if it is intended to use them.

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> *Except the service hatch, in any case the RSU2X shall not be opened by unauthorized persons.*

3.2.1. Preparation of the Functions inside the service compartment

External Connectors and Interfaces accessible inside the Service Compartment:

•   RS485 cable connector

•   SIM card holder and SIM card

•   slot for an optional SD-card

•   service USB connector

•   reset button
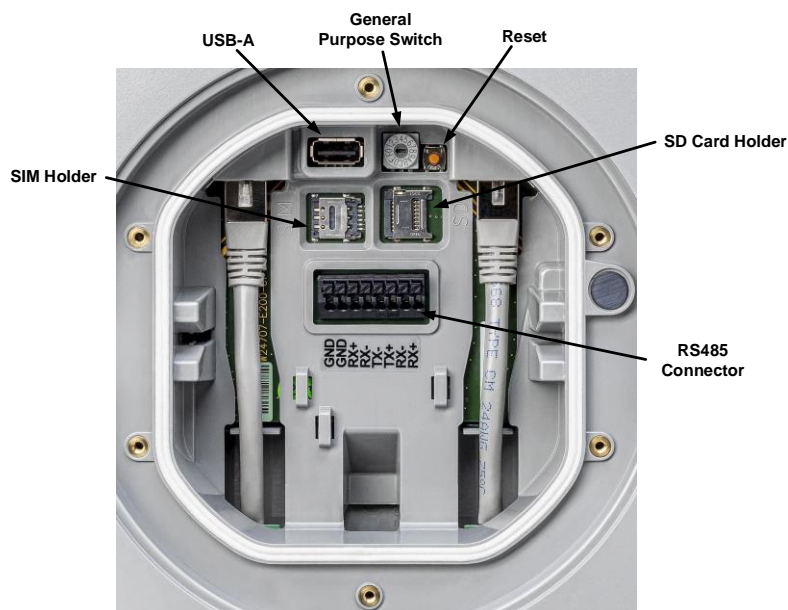
•   general-purpose rotary switch

Figure 4: RSU2X external connectors accessible inside the service compartment

To open the hatch for the RSU2X service compartment 6 screws need to be unscrewed with a screwdriver T10 and the hatch then needs to be opened carefully.

The position of the different functions in the service compartment behind the RSU2X hatch are shown in Figure 4

> ⚠
>
> *As long the hatch is opened be careful to prevent items to fall into the RSU2X housing, don't damage the sealing gasket and the air vent in the service compartment as well as the sealing fin of the hatch, and make sure that no water gets into the opened service compartment. When the hatch is closed again the guiding rips on the left and the right side on the backside of the hatch shall match the corresponding guiding in the RSU2X service compartment.*

In best case the service hatch is closed or stays closed before the RSU2X is mounted to the pole. If it needs to be opened, make sure when closing that the screws are tightened with the required maximum torque of 0,35 Nm (see also 4.2.4). This is essential to make sure that the hatch will prevent water ingress. The use of a higher torque can damage the RSU2X housing.

3.3. RSU2X Mounting

The RSU2X is intended to be mounted at a pole using the RSU2X mounting bracket with banding systems.
A grounding cable is not necessary.

> ⚠
>
> *During installation of the RSU2X the mounting bracket and the RSU2X itself shall be secured from falling by using a safety rope fixed to the holes in the RSU2X fixing plate and the mounting bracket.*
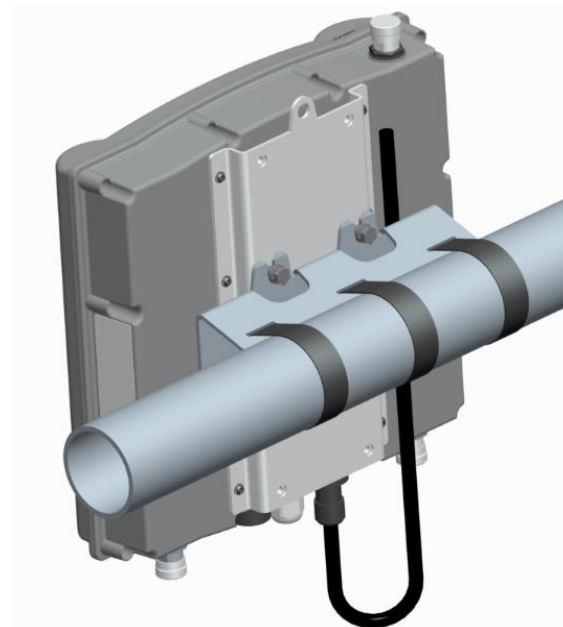

Figure 5: RSU2X mounted at horizontal pole in central position

3.3.1. RSU2X Mounting Bracket

The RSU2X is mounted on vertical or horizontal poles using the RSU2X mounting bracket together with appropriately rated banding systems. As soon the mounting bracket is installed the RSU2X can be fixed to the bracket with 4 screws applying a maximum recommended torque of 9 Nm.

> ⚠️
>
> *With horizontal poles the position of the mounting bracket on the RSU2X fixing plate needs to be chosen carefully. In any case the influence on the V2X and other internal antennas needs to be considered.*

The recommended mounting variants depending on the diameter of the pole are described in chapter 3.3.2
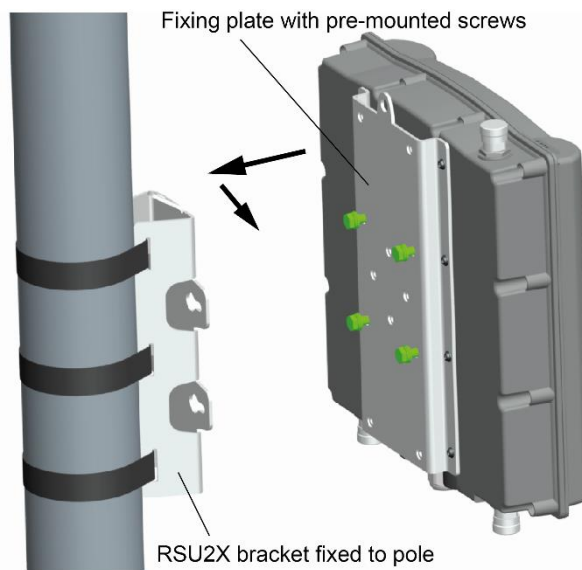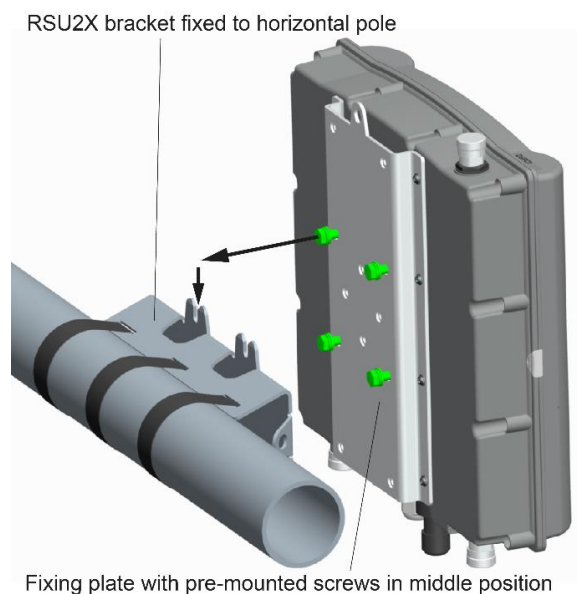

Figure 6: RSU2X bracket on vertical Pole

Figure 7: RSU2X bracket on horizontal Pole in center position

There are 3 sets of slots on the mounting bracket intended for use with banding systems. Maximum band size is a single 19 mm wide by 0.75 mm thick band. A double wrap is possible with 12.7 mm wide by 0.75 mm thick bands. The slots are spaced at 77 mm to across the wider sides of the bracket.

Tensioning on these bands is up to the installer to determine based upon the rated wind loading at 240 km/h (67 m/s). The enclosure and mounting bracket have been tested in both horizontal and vertical mounting bracket orientations with the following forces applied as a static wind test.
The Static Wind Loading test had 436 N applied to the front face. The side faces had 99 N applied. Forces were not applied to the top and bottom faces as the unit is intended to be mounted in the vertical orientation and wind loading tests only consider horizontal wind forces. In this configuration with 3 bands strapping used the system passed all tests.

⚠️

If the RSU2X mounting bracket is used with horizontal poles, the open residuals at the bracket for the screws shall show upwards to prevent the RSU2X from falling while fixing of the screws.

3.3.2. Choosing the right Mounting Position

As soon the location of the RSU2X is defined and it is decided whether the RSU2X is mounted on a vertical or a horizontal pole, the position of the RSU2X in relation to the pole needs to be optimized. For this there are 12 screw nuts on the back side of the RSU2X. If the RSU2X bracket is used 8 of these screw nuts correspond with this bracket, where only 4 of them are needed for the different mounting positions.
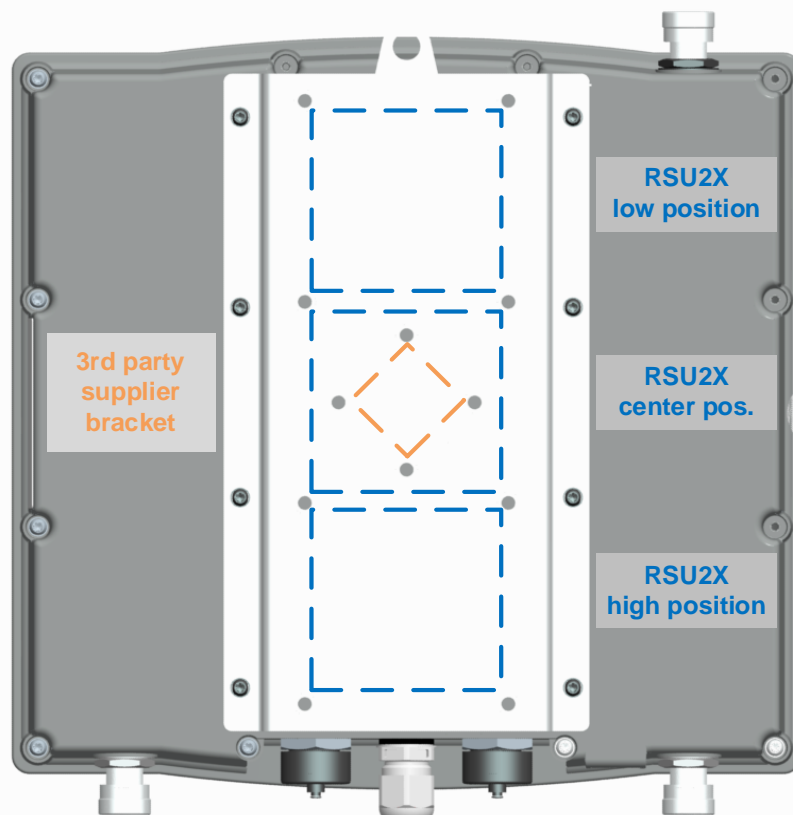

Figure 8: RSU2X Mounting using 4 Screws

3.3.2.1.   Vertical poles:

For vertical poles only the central position of the bracket is recommended.

Figure 9: RSU2X mounted at vertical pole with cables to external antennas

The poles for vertical mounting of the RSU2X shall be between 90 mm and 160 mm diameter. Any larger diameter and the use of the supplied bracket is not recommended due to placement of the antenna too close to the pole which degrades antenna performance and line of sight.

3.3.2.2. Horizontal poles:

Especially with horizontal poles the influence on the internal antennas needs to be considered. If a degradation of the antenna performance and line of sight is not tolerable the horizontal pole may not be placed close to the internal antennas.

For details regarding the internal antennas see chapter 4.1.1

With the mounting bracket the RSU2X can be installed in 3 positions, (low, center, high) related to the horizontal pole.
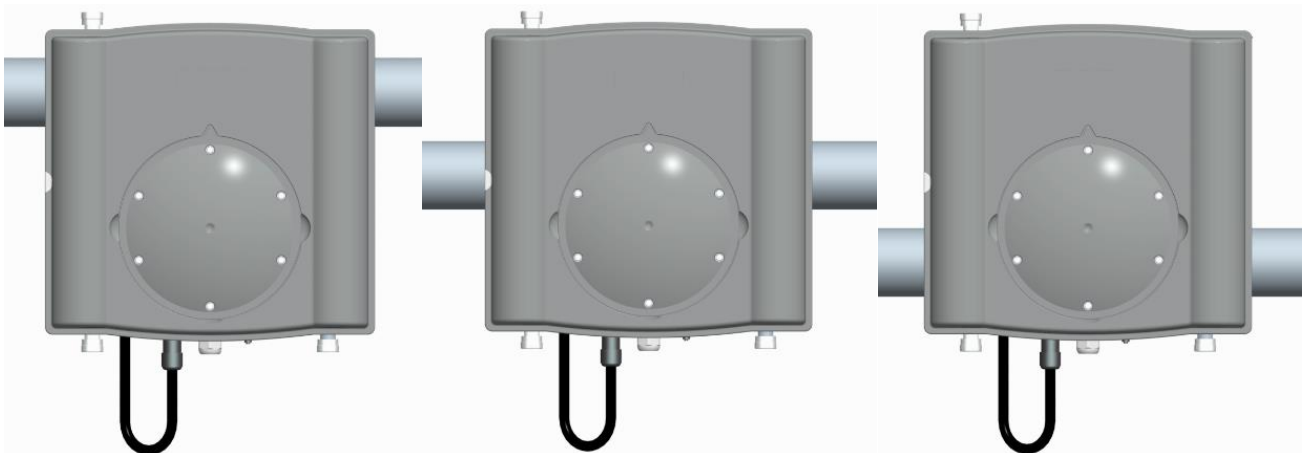

Figure 10: RSU2X mounted at horizontal pole in low, center and high position

The following mounting positions are suggested depending on the operating mode for standard masts with up to 120 mm:

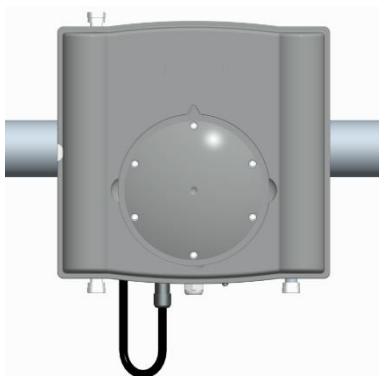• 802.11p dual channels and Dual mode 802.11p/C-V2X: Center position

Figure 11: RSU2X mounted at horizontal pole in center position

• C-V2X only: Low position

Figure 12: RSU2X mounted at horizontal pole in low position

For horizontal masts with larger diameter than 120mm the following mounting options are recommended:

• Usage of a vertical mast extension (example)

Figure 13: RSU2X mounted at vertical mast extension (example)

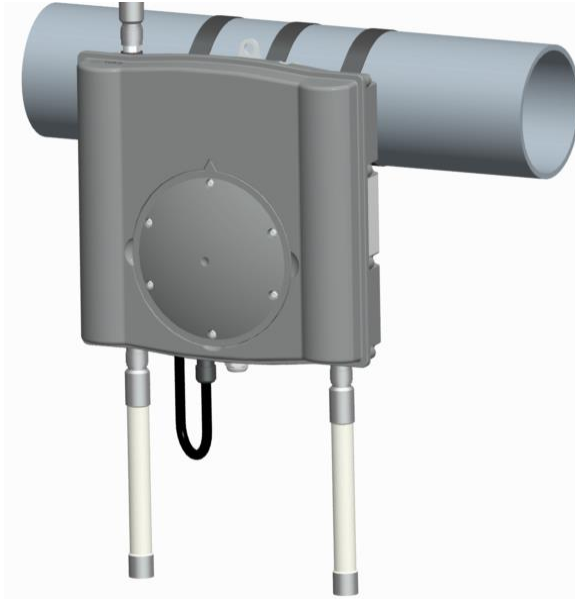- Use of external antennas for both DSCR and C-V2X

Figure. 14: RSU2X mounted at horizontal pole in low position with three external antennas

⚠️

Do not configure for external antennas without ensuring they are fitted!

3.3.3. RSU2X with 3rd Party Supplier Bracket

The RSU2X can be installed using a separate 3rd party supplier bracket together with the 4 screw nuts in the center of the fixing plate on the backside of the RSU2X. For details see chapter 3.3.2

The 3rd party supplier bracket can be fixed to the RSU2X using 4 captive screws M6 applying a maximum recommended torque of 9 Nm.

⚠️

The length of the 4 screws needs to be chosen depending on dimensions of the 3rd party supplier bracket. The fixed screw shall not contact the plastic rear housing below the RSU2X fixing plate.

3.4. RSU2X Connecting

3.4.1. Connecting the PoE Interface

> ⚠️
>
> *The Installer is responsible for the selection and installation of all associated equipment and cabling. They must adhere to all electrical and safety codes as required in the country/region of the installation.*
> *The Installer MUST be an appropriately skilled electrician (according to EN 50110 in Europe and local legal requirements elsewhere)!*

The Installer shall ensure the following:

1. PoE+ supply equipment must be 802.3at Type2 equipment capable of supplying 30 W at PSE (25.5 W at PE). The recommended device is: RSU PoE+ Injector (V24707-Z103-A6)
2. The PSE equipment is built and approved to the appropriate electrical safety standards of the country or region into which it will be installed. In Europe this requires a valid EU declaration of Conformity.
3. The CAT6 or CAT5e shielded cable run between RSU and the switch/destination must be less than 100 m and optimally as short as practical.
4. The RSU accepts Mode A or B PoE wiring for the ETH0 port in the PSE supply configuration.
5. No earthing cable connecting is required
6. To connect the Ethernet cable to the PoE+ connector use an RJ45 connector on the cable and the waterproof cable gland.

The Ethernet cable must first be threaded through the individual parts of the waterproof cable gland (sealing nut, seal, screw nut and housing). Then a suitable RJ45 connector can be connected to the corresponding strands of the cable. After removing the waterproof cover of the RJ45 socket of the RSU2X, the RJ45 connector can be plugged in. First make sure that the front gasket of the cable connector is in the correct position. Then the correctly aligned housing is fixed to the RJ45 socket with the screw nut and the rear seal is fixed with the sealing screw.
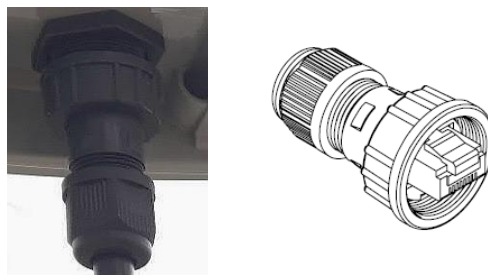The RSU2X cable gland and connector has the internal part number V24707-Z102-A1.

Figure 15: Ethernet cable with RSU2X cable gland

> ⚠️
>
> *The used cables shall be min. Cat5e with a diameter of 6 to 9 mm.*

3.4.2. Connecting the Ethernet 2 Interface

To connect an Ethernet cable to the Ethernet 1 (ETH1) interface follow the same steps regarding the use of the waterproof cable gland described in 3.4.1 above.
The RSU2X cable gland and connector has the internal part number V24707-Z102-A1.

3.4.3. Connecting external Antennas

Per default the RSU2X comes without external antennas supplied. If external antennas are needed the following V2X antennas shall be used:

Port	Model	Manufacturer	Yunex Part Number
DSRC1-1, DSRC1-2 DSRC2/C-V2X	5.9G external glass fiber tube antenna (ZG-0I-596005-NM)	Top-Link	V24707-Z100-A1

Tab. 1: External Antennas

For detailed specifications of the antenna please consult the antenna data sheets. All antenna ports are N type Female 50Ω on the RSU2X enclosure. For the N-type connector of the specified external antenna the manufacturer recommends a max. torque of 0,8 Nm.

The nominal design of the N type connectors and the antenna do not normally require sealing other than that inherent in the design. Nevertheless, an additional sealing is recommended.

> ⚠️
>
> *Do not configure for external antennas without ensuring they are fitted!*

3.4.4. Connecting the RS485 Interface

The RSU2X RS485 connector is in the service compartment behind the hatch. It can be used in 2 wire or 4 wire mode. For electrical details see the RSU2X datasheet.
The RSU2X RS485 connector, located in the service compartment behind the hatch, is an 8-circuit terminal block with push-in contacts. See Figure 3 1

It has the following signal assignment:

Signal	Pin	Description
RX+	1	A/RX+
RX-	2	B/RX-
TX+	3	Y/TX+
TX-	4	Z/TX-
RX-	5	Internally connected to Pin 2
RX+	6	Internally connected to Pin 1
GND	7	GND isolated
GND	8	GND isolated

Tab. 2: Pin assignment RS485

The RS485/RS422 interface can be used in 2 wire or 4 wire mode. If it is used in 2 wire mode additional cable bridges between RX+ and TX+ and between RX- and TX- are needed.
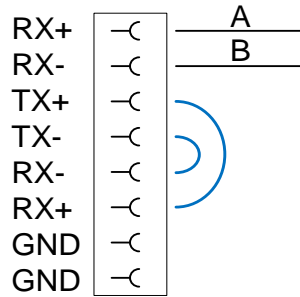
RS485 2 wire mode:

Figure 16: RS485 in 2 wire mode
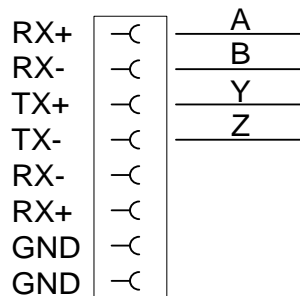
RS485/RS422 4-wire mode:

Figure 17: RS485/RS422 in 4 wire mode

To connect a cable to the RS485 connector of the RSU2X, the RSU2X hatch needs to be opened first. It is essential that no force is exerted to the RS485 connector terminal block by the cable, otherwise the terminal block could be broken. Therefore, the cable needs to be carefully inserted through the cable gland into the service compartment and then it must be fixed to the RSU2X housing using a cable strap together with the lug inside the service compartment to prevent the cable of slipping out again. The cable gland shall also be fixed before the single signal wires are connected to the terminal block. The cable compression nut should be tightened to max. 1.5 Nm.

Figure 18: RSU2X with RS485 cable (4 wire mode)

4. Additional Information

4.1. RSU2X Antennas

4.1.1. Internal Antennas

The RSU2X is equipped with internal antennas for all radio frequency interfaces, therefore it is typically operated without external antennas. The RSU2X includes four internal V2X antennas along the left and the right edge of the RSU2X housing. Additionally, internal antennas for Wi-Fi and Bluetooth and two 4G antennas are also placed inside the RSU2X housing. The internal GNSS antenna is mounted facing to the top of the RSU inside the housing.

For optimum V2X range it is necessary to consider the influence of metallic poles on the antenna patterns of the internal antennas and line of sight when choosing the mounting position. For details regarding the RSU2X installation see chapter 3.3.2

Figure 19: Location of internal Antennas in the RSU2X

4.1.2. External Antennas

If there is the need to use separate external V2X antennas, three antenna connectors are provided, accessible from outside of the RSU2X housing. Two external antennas will be sufficient under standard conditions.

For antenna type see chapter 3.4.3

4.2. Mechanical Data

4.2.1. RSU2X Outer Dimensions

Width		about 290 mm
Height	including connectors	about 300 mm
Thickness	without bracket	about 100 mm
	with bracket	about 140 mm

Tab. 3: Outer Dimensions

4.2.2. RSU2X Mounting Bracket Dimensions

Width		about 95 mm
Height		about 200 mm
Standoff		about 40 mm
Opening width		about 35 mm

Tab. 4: Mounting Bracket Dimensions

4.2.3. Weight (approx.)

Weight	RSU2X without bracket	about 2500 g
	RSU2X with bracket	about 3000 g

Tab. 5: Weight

4.2.4. Maximum recommended Torques

RSU2X service hatch	6 captive screws M3, T10	0,35 Nm
RSU2X mounting bracket	4 captive screws M6 x 20mm, SW10 (AF10)	9 Nm
3rd party supplier bracket	4 captive screws M6 Note: The fixed screw shall not contact the plastic rear housing below the fixing plate	9 Nm
Ethernet connector		max. 0,46 Nm
RS485 cable compr. nut		max. 1.5 Nm
N-jack connectors	Ext. antennas	max. 0,8 Nm

Tab. 6: Maximum recommended Torques

4.3. Electrical Data

4.3.1. Power Supply Voltage

For power supply a PoE+ 802.3at PoE+ injector is needed.
The recommended device is: RSU PoE+ Injector (V24707-Z103-A6)

In general, the PoE+ injector shall fulfill IEC 62368-1 or IEC 60950-1 with 48V and not exceeding 100W.

4.3.2. Power Consumption

The power consumption is measured at an ambient temperature of 25°C and depends highly on the activity of the RSU2X.

RSU2X active	at 25°C	12W typ.	20W max.
RSU2X shutdown	at 25°C	1,1W typ.	

Tab. 7: Power Consumption

4.3.3. Electrical Parameters RS485 Signals

RS485A, RS485B	Driver Output/Receiver Input Voltage to GND2 (GND on RS485 Connector)	−9 V to +14 V
	IEC 61000-4-2 Air Discharge ±15 kV	±15kV
	ESD IEC 61400-4-2 contact discharge	±12kV
	IEC 61000-4-2 ESD Across Isolation Barrier (A, B, Y, Z to RSU main GND)	±8kV

Tab. 8: Electrical Parameters RS485 Signals

4.4. Operating Conditions

4.4.1. Operating Temperatures

The RSU2X operating and storage temperature range:

RSU2X operation	full functionality	-40°C… +85°C
RSU2X storage		-40°C… +85°C

Tab. 9: Operating and Storage Temperatures

Note that the operating temperature range of the SIM card can differ from the operating temperature range of the RSU2X.

4.5. RSU2X Labeling

Each RSU2X has a unique serial number printed on a label which is located on the right side of the housing. It details the manufacturing related identifiers as well as the unique device number. The RSU2X serial number is visible in printed form and can also be read electronically by a barcode reader.
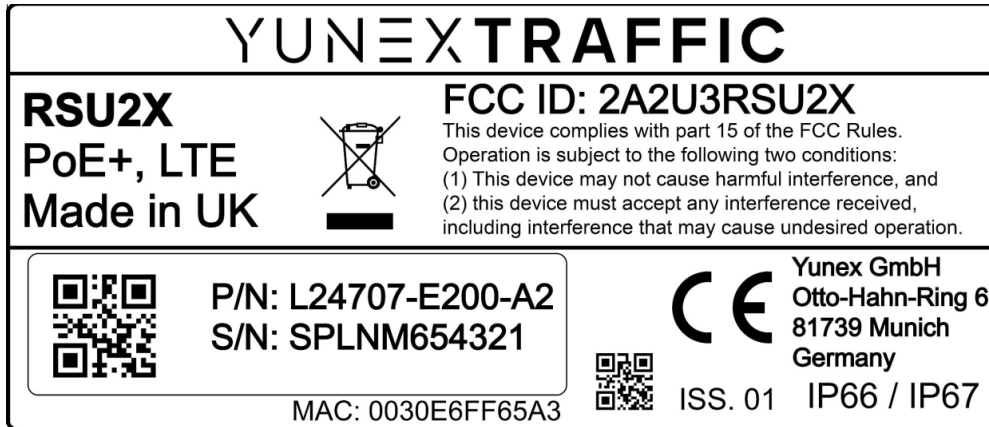

Figure 20: RSU2X Label (Example)

Part number: L24707-E200-A2
Serial number (example):   SPLNM654321

5. Legal Requirements

The RSU2X satisfies European guideline 2014/53/EU (RED) and 2011/65/EU (RoHS). -- "CE" mark

6. List of abbreviations

C2X	**car to everything**
C-V2X	cellular V2X 3GPP standard
DSRC	dedicated short range communication, in this context: V2X version ITS-G5 or 802.11p
GNSS	global navigation satellite system
GPS	global positioning system
LTE	long term evolution, 3rd generation telephone and mobile broadband standard, also called 4G technology
PoE	Power over Ethernet
RF-technology	in this context the International Telecommunication Unions (ITU) radio band symbols of the UHF - Ultra High Frequency and SHF - Super High Frequency) is simplified to radio frequency (RF)-technologies
RSU	Road Side Unit
SW	software
V2X	Vehicle to Everything

7. List of figures

8. List of tables

9. Version history

Date	Revision
05.15.2022	Version 1.1 - Valid

10. Annex A - RSU2X Mounting Bracket

11.   Annex B - RSU2X V2X Antenna Pattern

11.1.   Antenna pattern For RSU mounted without pole

EIRP(dBm) XY-Cut, without mast

EIRP(dBm) XZ-Cut, without mast
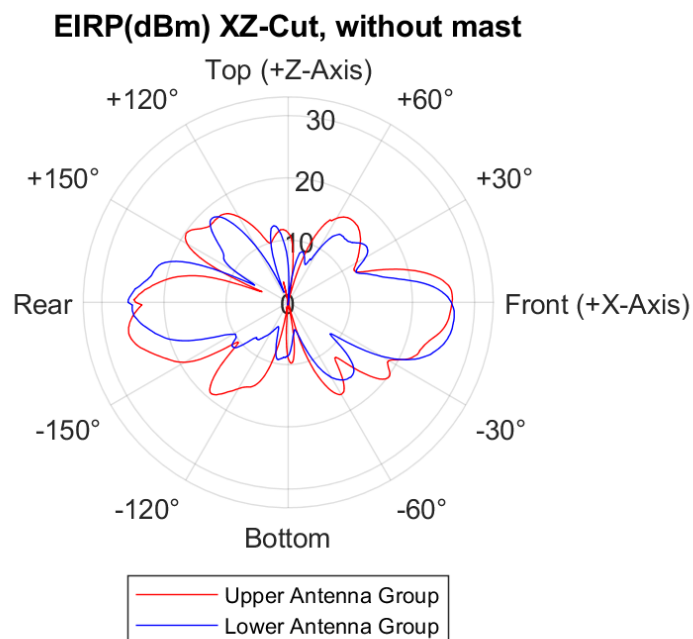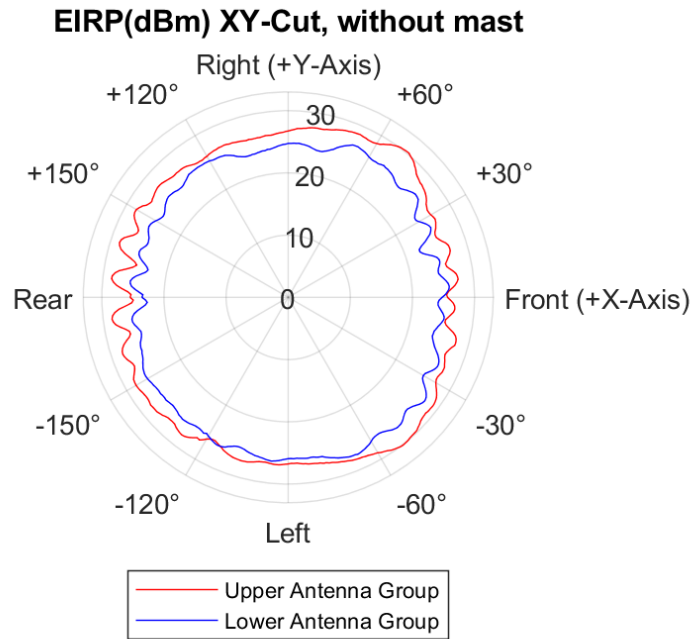
11.2.   Antenna Pattern for RSU mounted on horizontal Pole in Center Position

EIRP(dBm) XY-Cut, with mast

EIRP(dBm) XZ-Cut, with mast
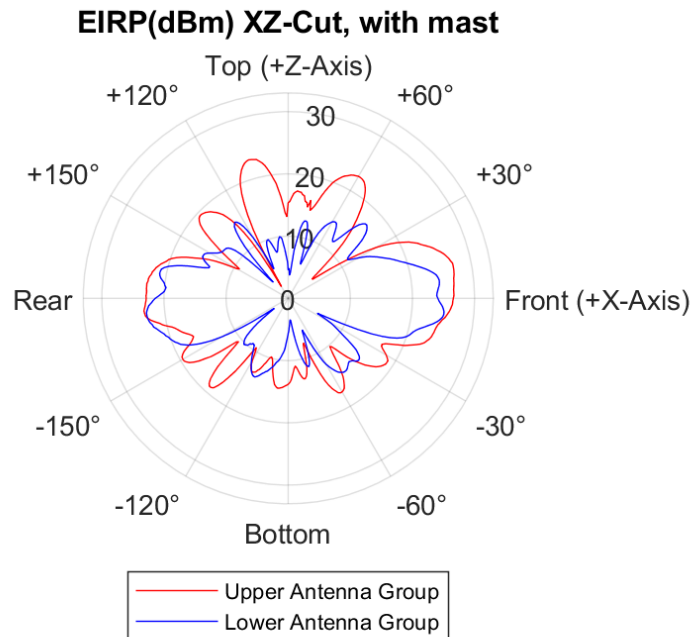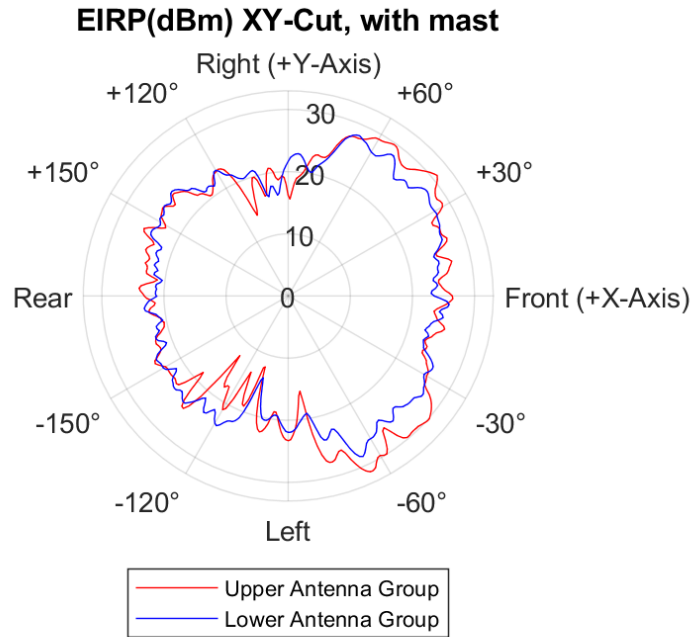
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