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Quick Start Guide

for

RSU-352 Family

Product Variants

Model	Description
RSU-352	V2X Roadside Unit, 0A1
RSU-352ED	DSRC-V2X Roadside Unit, V2Xcast® - Europe ETSI ITS-G5 stack, 0A1
RSU-352UC	C-V2X Roadside Unit, V2Xcast® - US C-V2X stack, 0A1
RSU-352UD	DSRC-V2X Roadside Unit, V2Xcast® - US DSRC/WAVE stack, 0A1

Reviewers

Department	Name	Acceptance Date	Note
PD	Nidor Huang	2023/07/26	
RD	P.C Kang	2023/07/26	

Modification History

Revision	Date	Originator	Comment
0.1	2021/08/23	Nidor Huang	Creating document
0.2	2021/10/12	Nidor Huang	Adding product variants Adding product characteristics Adding dimensions and weight
0.3	2021/11/18	Nidor Huang	Updating temperature range Updating mechanical drawing
0.4	2022/04/15	Nidor Huang	Adding GNSS antenna detection mechanism Adding V2X antenna detection mechanism
0.5	2022/06/28	Nidor Huang	Adding GORE® Vent
0.6	2022/12/30	Nidor Huang	Updating product variants to 352 series Updating functional block diagram
0.7	2023/03/03	Nidor Huang	Updating Unex BSP interface settings Updating mounting bracket instructions
0.8	2023/03/24	Nidor Huang	Updating Unex logo Adding GNSS reset in Unex BSP interface settings

Revision	Date	Originator	Comment
			Adding installation precaution about surge protection
0.9	2023/07/10	Nidor Huang	Updating functional block diagram Removing EC series from product variants
1.0	2023/07/26	Nidor Huang	Adding screw anti-seize compound description

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1. Objective

The purpose of this document is to provide necessary information to help setup and installation of RSU-352 series products. To provide for safe installation and operation of the equipment, read the safety guidelines at the beginning of this manual and follow the procedures outlined in the following chapters before connecting power to RSU-352. Keep this operating manual handy and distribute to all users, technicians and maintenance personnel for reference.

2. Reference

- Unex RSU-352 datasheet
- 61-00021-00_RSU-352_0A1_Drawing
- 80-00032_EX-40_Drawing_B

3. Limited Warranty Policy

Unex Technology Corporation selling the product warrants that commencing from the date of shipment to customer and continuing for a period of twelve (12) months. This limited warranty extends only to the original customer of the product. Customer's sole and exclusive remedy and the entire liability of Unex under this limited warranty will be, at Unex's option, return for repair to Unex's repair center with freight and insurance prepaid or shipment of a replacement within the warranty period or a refund of the purchase price if the hardware is returned to Unex. Unex's obligations hereunder are conditioned upon the return of affected hardware in accordance with Unex's service center's then-current Return Material Authorization (RMA) procedures.

This warranty does not cover:

- Products found to be defective after the warranty period has expired.
- Products subjected to misuse or abuse, whether by accident or other causes. Such product conditions will be determined by Unex at its sole and unfettered discretion.
- Products damaged due to a natural disaster, including but not limited to lightning, flooding, earthquake, or fire.
- Software products.
- Products dismantled or opened by unauthorized persons. Please contact a representative of Unex if you need advanced technical support.

- Products with an altered and/or damaged serial number.
- Loss of data or software.
- Products that have been updated, reworked, or improperly tested by the Customer, or by a third party at the request of the Customer.
- Customized and original design manufacturer (ODM) products. The warranty terms for customized and ODM products should be defined in the contract that governs the project.

4. Safety Guidelines

- Keep working area clean and dry while assembling/installing
- When operating under extreme temperature conditions, environmental control measures (e.g., heating, cooling) should be considered.
- Always make sure the metal enclosure is connected to a well-grounded metal structure.
- Make sure every screw has been fastened, including the mounting bracket, pole clamps and earth wire.
- Make sure every accessory has been fastened, including the V2X antennas, GNSS antenna, PoE surge protector and cable gland.

5. Product Appearance

An RSU-352 series package contains the following items:

- RSU-352 x1
- V2X antenna x2
- GNSS antenna x1
- PoE surge protector x1
- Cable gland x1
- Mounting bracket set x1
- Earth wire (1 Meter) x1

The photos shown in this document may seem different from actual product. However, the differences do not affect actual functionalities.

Note ⚠	Some oily black residue may be found around screw heads. This black substance is an anti-seize compound, not dirt or contamination. This anti-seize compound is intentionally applied to improve corrosion resistance of our product. Any smudge caused by the anti-seize compound affects only cosmetics and is not considered as a defect.
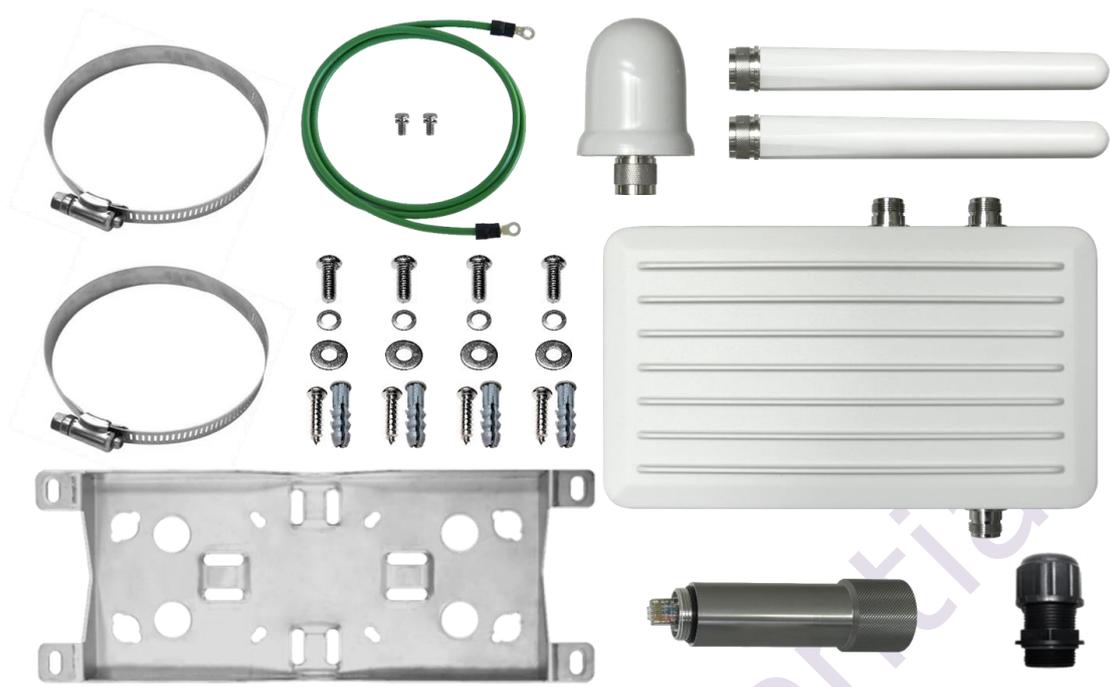
Figure 1: RSU-352 series package content
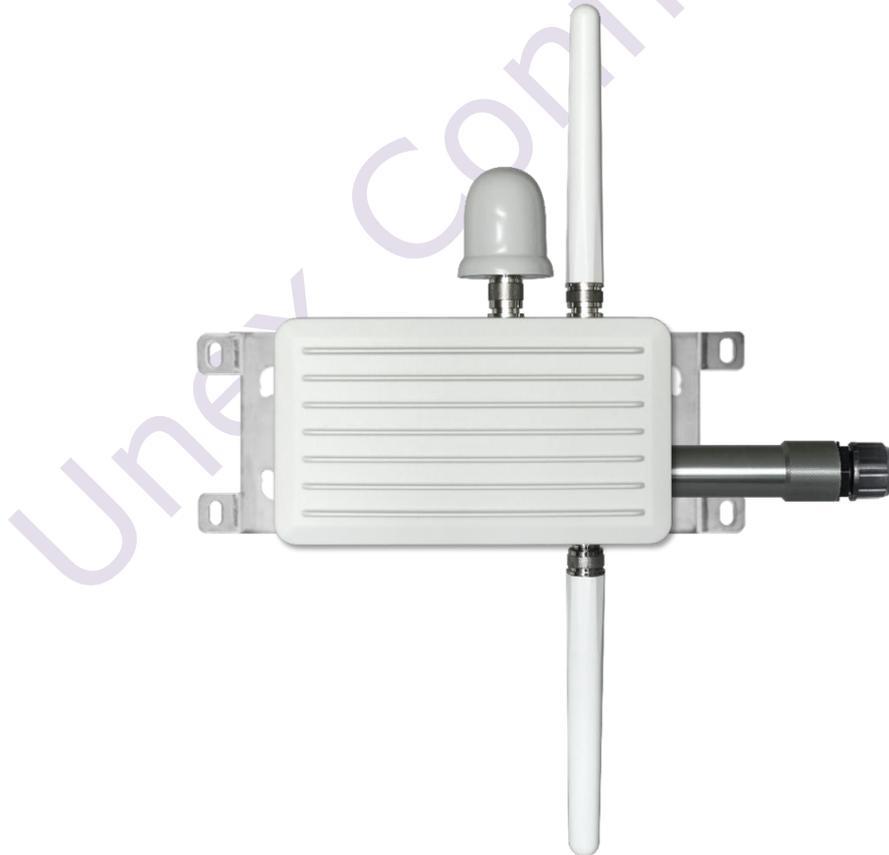
Figure 2: RSU-352 series complete assembly appearance

6. Functional Block Diagram
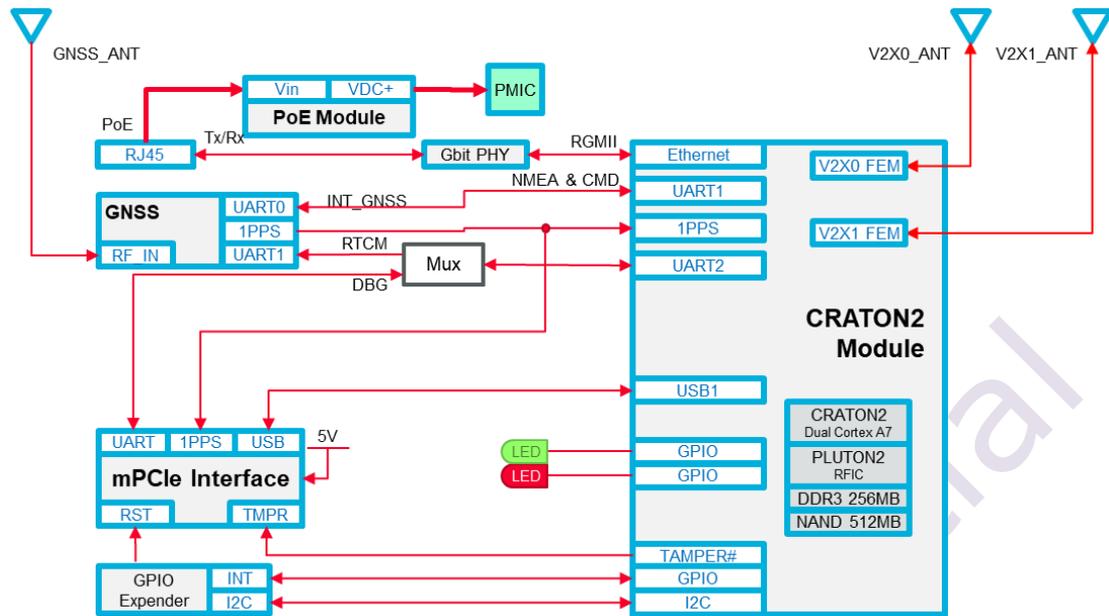

Figure 3: Functional block diagram

7. Electrical Characteristics

7.1. Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted).

Table 1. Absolute maximum ratings

Parameters	Conditions	Min.	Max.	Unit
Storage Temperature	-	-40	70	°C
Supply Voltage	PoE *1	-	60	V
V2X maximum input level	-	-	10	dBm
GNSS maximum input level	-	-	-10	dBm

Note:
*1: Powered by an 802.3af/at PSE

Note:
(1) Operation outside the Absolute Maximum Ratings may cause permanent device damage. Absolute Maximum Ratings do not imply functional operation of the device at these or any other conditions beyond those listed under Recommended Operating Conditions. If used outside the Recommended Operating Conditions but within the Absolute Maximum Ratings, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime.
(2) All voltages are with respect to network GND.

7.2. Recommended Operating Conditions

Over operating free-air temperature range (unless otherwise noted).

Table 2. Recommended operating conditions

Parameters	Conditions	Min.	Typ.	Max.	Unit
Ta (Ambient operating temperature)	Free-air temp.	-40	25	85 *1	°C
Supply voltage	PoE *2	36	48	57	V
V2X antenna gain	5850-5925MHz	-	-	7.6	dBi
V2X sensitivity	PER ≤ 10%	-92	-	-	dBm
	PER ≤ 10%, -40 - +85 °C	-82	-	-	dBm
V2X maximum input level	PER ≤ 10%	-	-	-30	dBm
V2X adjacent channel rejection	-	13	-	-	dB
V2X non-adjacent channel rejection	-	29	-	-	dB
V2X output power	Spectrum mask Class C	-	-	20	dBm
GNSS antenna gain	Antenna Gain	-	-	2.4 *3 2.85 *4	dBic
	LNA Gain *5	24	27	30	dB
GNSS sensitivity (C/N$_0$)	Acquisition	22	30	45	dB-Hz
GNSS antenna bias	I_{ANT} ≤ 20mA	3.0	-	3.3	V
GNSS antenna detection current	I_{ANT} *6	12	-	58	mA

Note:
 *1: Excluding V2X antennas. Ta of V2X antenna is -40 ~ +70°C
 *2: Powered by an 802.3af/at PSE
 *3: Measured at 1575MHz
 *4: Measured at 1602MHz
 *5: GNSS LNA bias = 3.0V
 *6: I_{ANT} under Min. = OPEN; I_{ANT} over Max. = SHORT; I_{ANT} between Min/Max. = NORMAL.

7.3. Power Consumption

RSU-352 is an 802.3af PD (powered device) and should be powered with an 802.3af/802.3at PoE PSE (power sourcing equipment).

Table 3: Power consumption

Condition			Power Consumption		
Temp.	Power Source	Voltage (V)	Low *1	Typical *2	High *3
25°C	802.3af PoE PSE	54.3	0.06A (3.26W)	0.06A (3.26W)	0.11A (5.97W)
85°C	802.3af PoE PSE	54.3	0.07A (3.80W)	0.07A (3.80W)	0.12A (6.52W)

Note:
*1: RX only
*2: TX @ 1% duty cycle (CH172, 20dBm, 6Mbps, 750B, 10Hz)
*3: TX @ 100% duty cycle (CH172, 20dBm)

8. I/O Interfaces

8.1. Status LED

Figure 4: Status LED

Table 4: LED function

LED Status	Description
Blinking Green	Start-up
Solid Green	Operational
Amber	FW upgrade
Red	Fault
Note: Please see TABLE 8: UNEX BSP INTERFACE SETTINGS for Status LED BSP settings. The definition of each status and its related behavior should be implemented by the user.	

8.2. PoE (Power-Over-Ethernet)


Figure 5: PoE port

RSU-352 has one Gigabit Ethernet port which supports 10/100/1000Mbps connection.

It is suggested to use an Ethernet cable compatible with Cat5e or above standard for best connection speed.

This Ethernet port also acts as a 12W PoE (802.3af) PD (powered device). It supports both mode A and mode B PSE (power sourcing equipment). Passive PoE is not supported.

8.3. 5.9GHz V2X
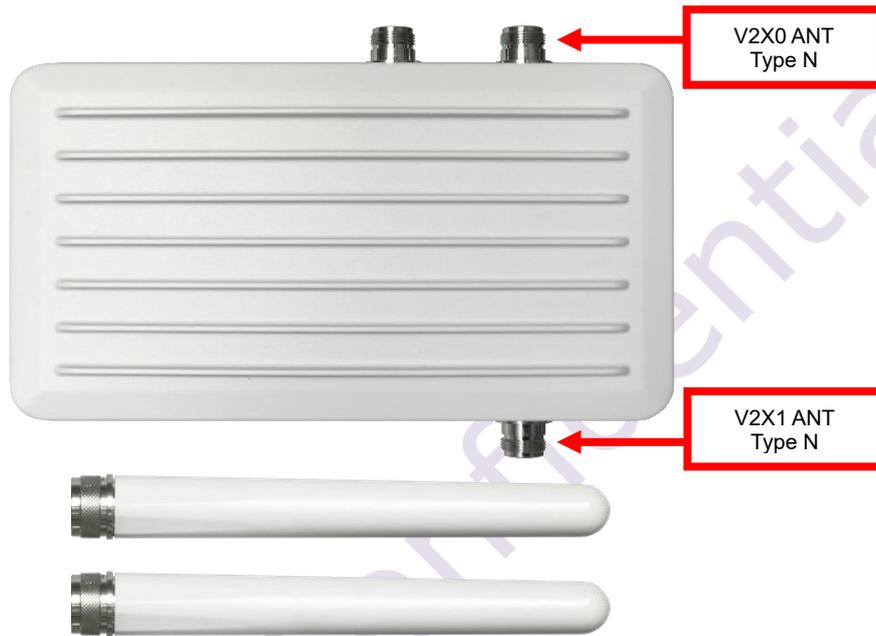

Figure 6: V2X antenna ports and V2X antennas EX-53

RSU-352 provides two 5.9GHz V2X antenna connectors. Receptacle connectors are Type-N. These V2X ports are surge protected (5KA min with 8/20 µs, 10KV min with 1.2/50 µs). A pair of Type-N V2X antennas (EX-53, 7.6dBi omni-directional) are also provided in RSU-352 package.

The V2X antenna ports has a built-in antenna detection function. This detection mechanism only works with the stock EX-53 antennas provided.

Table 5: V2X antenna status

Antenna Status	Value	Command
OPEN	616-1023	V2X0: cat /sys/bus/iio/devices/iio\:device0/in_voltage4_raw
NORMAL	410-615	V2X1: cat /sys/bus/iio/devices/iio\:device0/in_voltage5_raw
SHORT	0-409	

8.4. GNSS
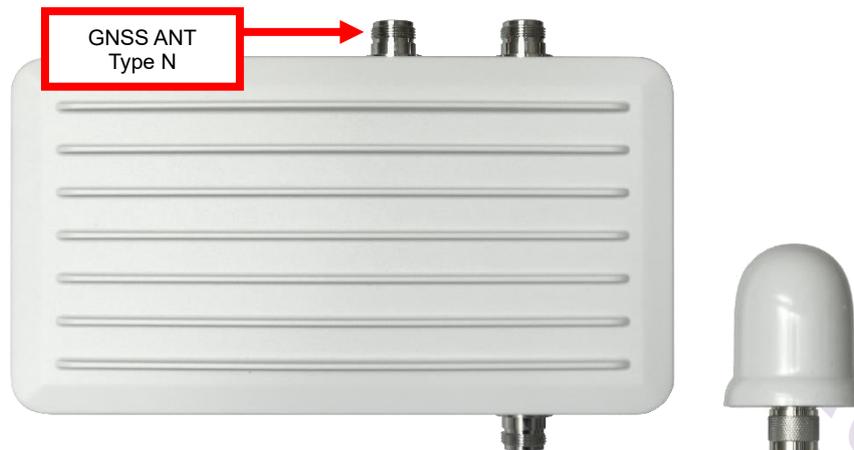
GNSS ANT Type N

Figure 7: GNSS antenna port and GNSS antenna

RSU-352 provides one GNSS antenna connector. This GNSS antenna port is Type-N. This GNSS port is surge protected (5KA min with 8/20 μs, 10KV min with 1.2/50 μs).

An active GNSS antenna (EX-33) is also provided in RSU-352 package.

For stable fix acquisition, at least 4 satellites with enough signal strength (C/N_0 value above 30 dB-Hz) are required. If the signal strength goes below 30 dB-Hz, the fix will become unstable.

8.4.1. GNSS Antenna Detection

The antenna detection mechanism is a 2-step process: First check the signal strength. If the signal strength drops to zero, then check the antenna status flag.

When all the C/N_0 values becomes null, it means that the GNSS antenna or its cable may either become detached or damaged. The GNSS antenna port has a built-in antenna detection function. The detection mechanism is based on the current consumption of an active antenna (I_{ANT}). If the active antenna consumes less current than 12 mA, then it is considered as the OPEN status; if the antenna consumes more than 58 mA, then it is considered as the SHORT status. Anything between 12-58 mA is considered as the NORMAL status.

The GNSS 3.3V antenna bias will be continuously supplied in OPEN/NORMAL status. Once the SHORT status is triggered, the SHORT flag will persist, and the 3.3V bias will be turned off until the reset of the GNSS module. After the reset of the GNSS module, the detection process will start all over again.

It is possible for a good active antenna to be reported OPEN because it consumes less current than 12 mA (e.g., the bundled EX-33 antenna consumes only 8 mA), or a good passive antenna to be considered SHORT because it is DC shorted (e.g., a slot antenna). However, as long as there are more than 4 satellites with enough signal strength (C/N_0 value above 30 dB-Hz), the GNSS is in good state.

The antenna status flag is reported in a proprietary NMEA message:

`$PSTMANTENNASTATUS,<status>*<checksum><cr><lf>`

where `<status>` can be:

- 0 - The antenna current is in the normal range (NORMAL)
- 1 - The antenna current is below the normal range (OPEN)
- 2 - The antenna current is above the normal range (SHORT)

Table 6: GNSS antenna status

Antenna Status	Current Consumption (mA)	3.3V bias	NMEA Sentence
OPEN	< 12	ON	$PSTMANTENNASTATUS,1*4C
NORMAL	between 12- 58	ON	$PSTMANTENNASTATUS,0*4D
SHORT	> 58	Turned OFF once triggered	$PSTMANTENNASTATUS,2*4F

9. Accessories

9.1. GORE® Vent

A GORE® Vent is pre-installed to continuously equalize the pressure inside the RSU enclosure with the atmosphere, while the PTFE membrane prevents the water and dust ingress at the same time. This vent manages common outdoor weather conditions such as precipitation or condensation, and as a result, it increases the service life of the RSU.
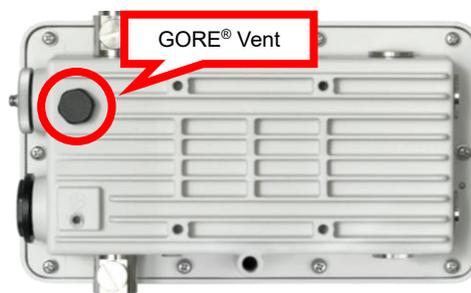
Figure 8. The GORE® Vent

9.2. Surge Protector

RSU-352 is powered by PoE. The PoE surge protector should be installed on the PoE port before connecting Ethernet cable. Please follow the instruction below for installation:

1   Extend the short RJ45 cable on the surge protector

2   Plug the short RJ45 cable into the PoE port on RSU-352

3   Screw the surge protector over the PoE port until fastened

Figure 9: PoE surge protector

9.3. Cable Gland

To ensure weather resistance, always connect the Ethernet cable with the cable gland on the cable outlet. Please follow the instruction below for installation:

1   Cable outer diameter: 4.5-6.5mm.

2   Insert RJ45 cable through sealing nut, clip, body and O-ring in a row. (See above drawing for parts direction)

3   Securely connect the RJ45 connector with the RJ45 port.

4   Fasten the body to the RJ45 port, with O-ring side facing the metal housing.

5   Sit the seals firmly into the body.

6   Push the clip and seals all the way down to the body.

7   Fasten sealing nut with the body.
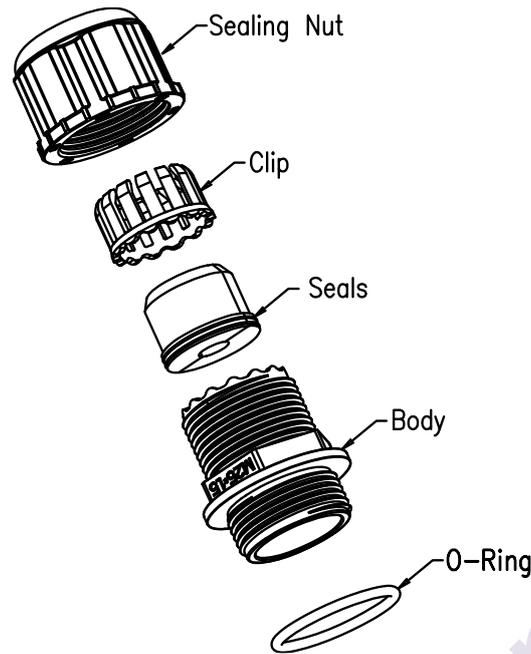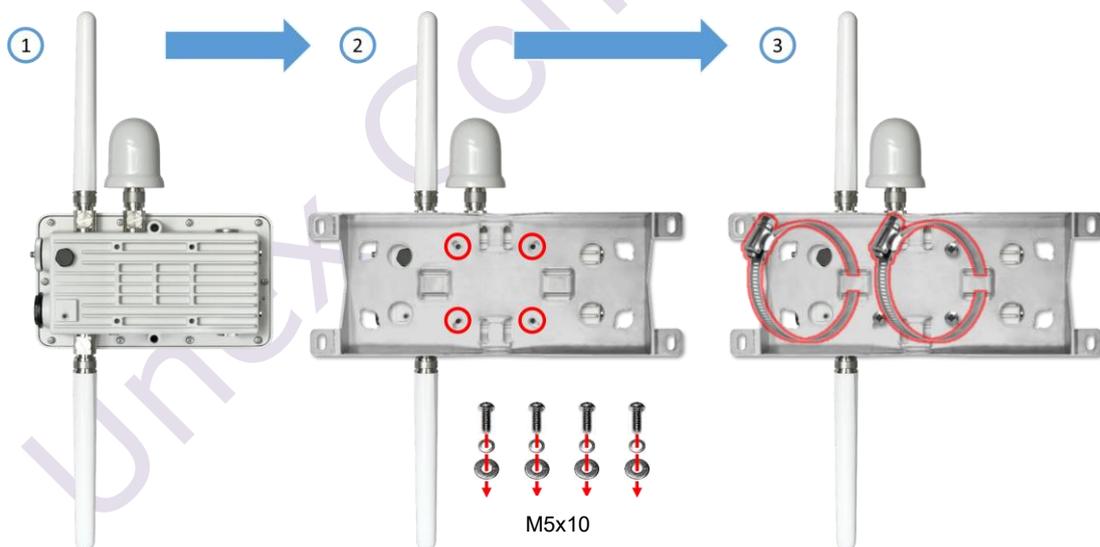
Figure 10: Cable gland drawing

9.4. Mounting Bracket

For best RF signal coverage, it is best to install RSU-352 on a horizontal mast/gantry and to keep it away from any large metal object nearby (FIGURE 13). However, RSU-352 can also be installed on a vertical post or on a wall if needed (FIGURE 14). The length of the earth wire is 1 meter long.
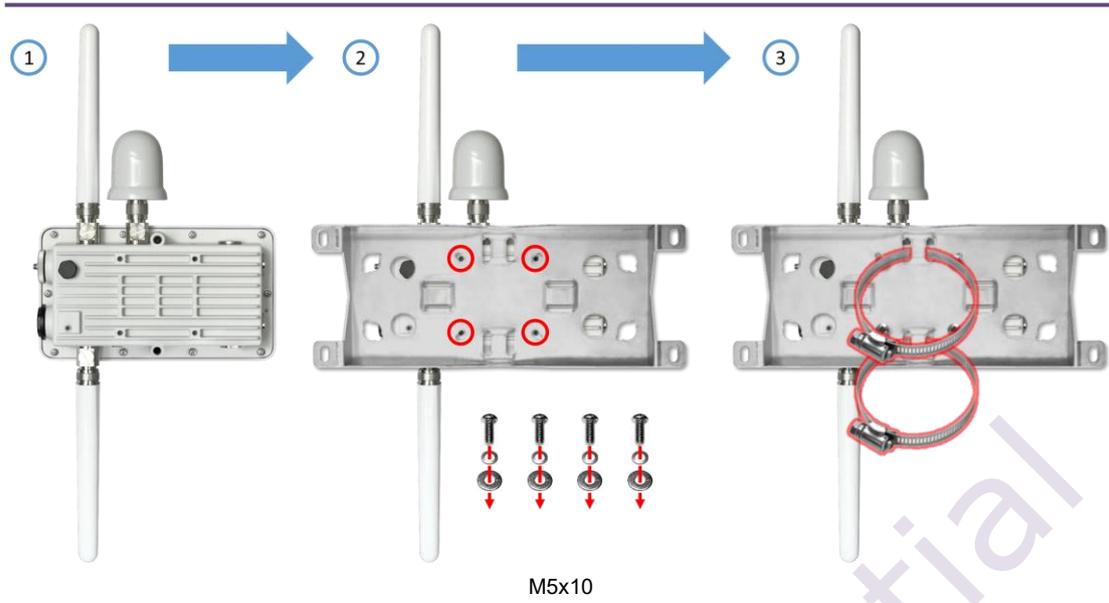
The diameter of the mast/post should be between 78-101mm. The total weight of RSU-352 (including antennas, PoE surge protector, mounting bracket, earth wire and cable gland) is about 2.7 kg. Before installation, always make sure the structural strength of the mast/post/wall can hold the extra weight of RSU-352.

Aluminum corrosion deposits may start to build on the mounting hole threads over time if an RSU-352 is installed by the seashore or in an environment where salt mist could become a problem. As a general rule of thumb, it is highly recommended to always apply a generous amount of waterproof/anti-seize lubricant (e.g., LOCTITE LB 8150) over the threads of the mounting screws and the earth wire screw before installing.

Caution ⚠	An RSU would be vulnerable to electric overstress if not installed properly. In order to avoid electric overstress related hardware failures, please make sure to follow the instructions below before installation: 1 **Surge Protector** 　1.1　Always install the surge protector on the PoE port. 2 **If Proper Earthing Available** 　2.1　Make sure the electric potential of the metal structure where the earth wire connects to equals to the actual earth potential before connecting the earth wire. 　2.2　The earth wire should be connected to a metal structure with less than 10 ohms of earthing resistance. 　2.3　Connect the earth wire (green jacket) between the RSU and the well-grounded metal structure (FIGURE 15). 3 **If Proper Earthing Not Available** 　3.1　If a properly earthed metal structure is not available, make sure that the RSU enclosure and the PSE earth wire are at the same electric potential. 　3.2　Connect the RSU and the PSE via a STP (shielded twisted pair) cable instead of an UTP (unshielded twisted pair) cable. 　3.3　Insulate the RSU and the mounting bracket from the metal structure. 　3.4　Remove the earth wire to achieve proper insulation.

M5x10

Figure 11: RSU-352 mounting bracket assembly (horizontal) steps

M5x10

Figure 12: RSU-352 mounting bracket assembly (vertical) steps
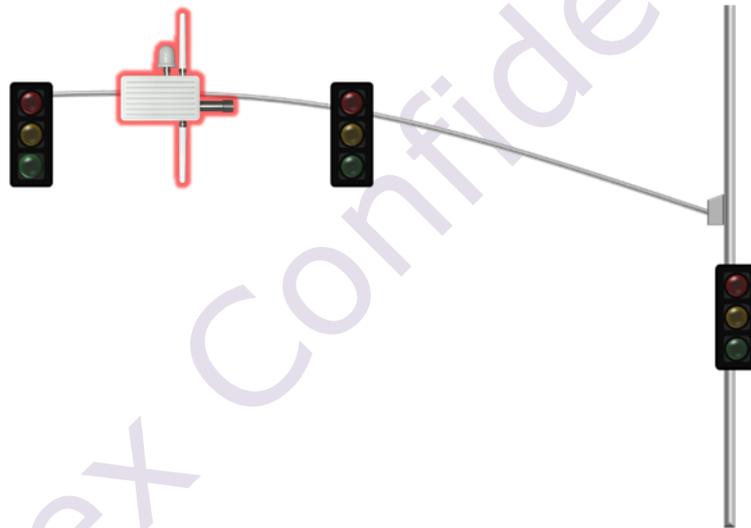
Figure 13: An example illustration of RSU-352 mounting on a horizontal mast/gantry

Figure 14: An example illustration of RSU-352 mounting on a vertical mast/post

Figure 15: Earth wire connection position (left), earth wire and earth wire screw (right)
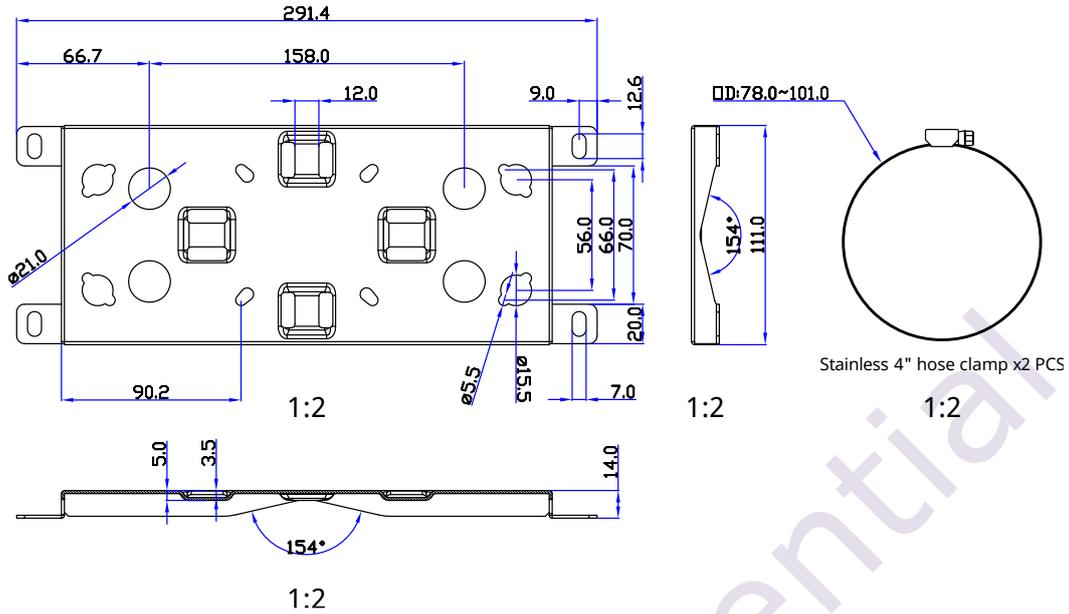
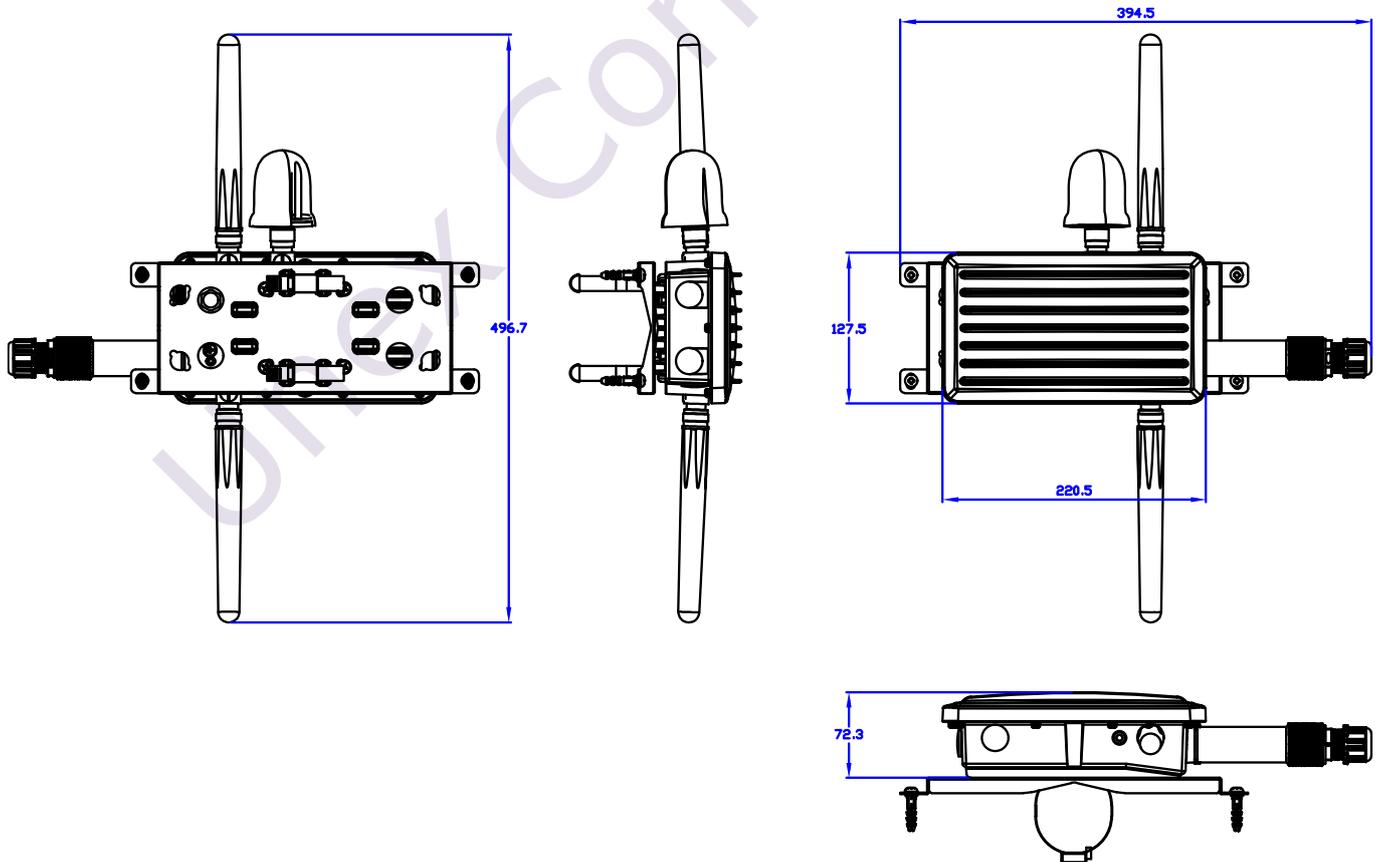# 10. Dimensions and Weight

Figure 16: Mounting bracket dimensions

Figure 17: Mechanical dimensions

Table 7: Dimensions and weight

Model	Length (mm) *1	Width (mm) *1	Height (mm) *1	Weight (kg) *2
RSU-352	220.5	127.5	72.3	2.7
Note: *1: Enclosure only without any accessory, antenna ports excluded. *2: With all accessories: V2X antennas, GNSS antenna, surge protector, mounting bracket, and earth wire.				

11. Software Settings

The following BSP settings are applicable for Unex software package only.

Table 8: Unex BSP interface settings

Function	Description
Ethernet	Default IP address 192.168.100.3
GNSS NMEA	UART1, 230400bps, 8N1, ttyAMA1
GNSS Reset	GPIO111, 0->1 = GNSS module reset (cold start, clear SRAM and RTC)
mPCIe Reset	GPIO 511, 0->1 = mPCIe module reset
STATUS LED Green	/sys/class/leds/status-green/brightness, 0=OFF, 1-255=ON
STATUS LED Red	/sys/class/leds/status-red/brightness, 0=OFF, 1-255=ON
V2X0 antenna detection	/sys/bus/iio/devices/iio\:device0/in_voltage4_raw
V2X1 antenna detection	/sys/bus/iio/devices/iio\:device0/in_voltage5_raw
MAC address	grep V2X_0 /etc/unex/device/device_info.txt
BSP/protocol version	/etc/unex/update.log