



Product Technical Specification

OW50M-Rac

OneWeb 9.3 dB/K Maritime User Terminal

Document Revision History

| Version | Date        | Author    | Reason for Change |
|---------|-------------|-----------|-------------------|
| 1.0     | 23 May 2023 | Harry Lee | Official release  |
| 1.1     | 2 June 2023 | Harry Lee | Corrected Typos   |
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Approvals

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# 1. Introduction

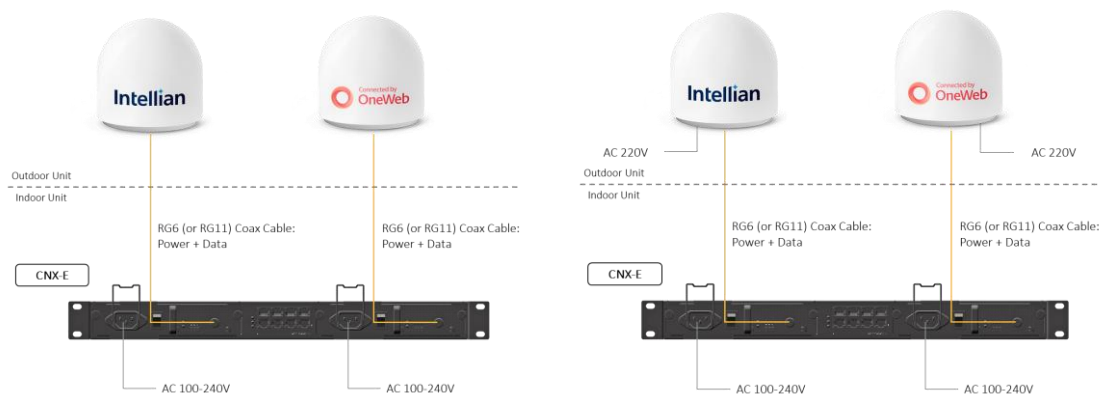
## 1.1 Purpose of the Document

This document describes the overall system design and architecture as well as the technical and the functional requirements of the Intellian Ku-band OW50M-Rac Maritime User Terminal (UT).

## 1.2 Overview of the OW50M-Rac

Dual antennas for satellite handover and an indoor unit are consisting as shown in Figure 1. It possesses all the capabilities of the Maritime UT (OW50M-Rac) and enhances it with hardware and software features specifically designed for Basic maritime environment. Additionally, The UT is simple to install, commission, and operate with automated setup functions. Once completed, users can expect a reliable, high-quality, high-speed, low-latency service with minimal intervention.

The OW50M is designed specifically for maritime operation such ship motion response and provides satellite blockage mitigation in various maritime condition.



**Figure 1 Example configuration of the 50M/50M w/ heater**

# 2. Product Application

The UT has been designed to operate on Maritime condition.

- Merchant shipping fleets
- Passenger industry (cruise vessels and ferries)
  - Mainstream & Mega cruise ship
  - Ocean & Luxury cruise ship and other types of cruise
- Ferries, Superyachts, Small Leisure boats, Commercial fishing
- Offshore platforms and support vessels

## 3. Key Features

### 3.1 Mechanical

- Independently controlled, mechanically steered parabolic reflector antennas
- Simple industrial design suitable for professional installation on a pole or platform
- 3-axis device for motion detection accuracy and fast measurement
- Single RG6 up to 30m (RG11 up to 100m) between below deck unit (CNX-E) and each above deck unit (antenna).
- Environmentally-sealed for global deployment in outdoor applications
- Embedded Radar rejection filter for interference prevention
- Factory pre-assembled heating module (optional)

### 3.2 Electrical

- One CNX required from common parts of OW50M-Rac system.
- Wideband Global Navigation Satellite Systems (GNSS) antenna for improved location precision and expanded field of view (FOV)
- 100-240VAC input for CNX-E
- +56V DC and MoCA Data from the CNX to the Antenna Subsystem
- Meets EN60945 EMC/EMI requirement

### 3.3 Radio Frequency (RF) Performance

- Minimum 9.3 dB/K antenna gain-to-noise-temperature (G/T) performance
- Full duplex operation
- Full frequency operation on OneWeb constellation
  - 10.7 – 12.7 GHz Receive (Forward Link)
  - 14.0 – 14.5 GHz Transmit (Return Link)
- Network throughput performance
- Transmit(Tx)/Receive(Rx) RF characterized to optimize return link capacity and service
- Orthomode Transducer (OMT) with radar filter to minimize interference from other onboard maritime RF equipment

### 3.4 Functional

- Auto set-up with self-acquiring and connection to customer network
- Satellite blockage mitigation
- Enhanced stabilization for maritime circumstance
- LEO beam and constellation tracking based on Program and Signal tracking
- Dual dome, supports tracking and IP switching in OneWeb's LEO network
- A single IP address is allocated to common user device behind CNX when UTs are paired. Use of same IP enables seamless session mobility across UTs
- Local management interface available to the end user for onsite remote-monitoring, diagnostics, and trouble-shooting

- Automatic provisioning for default services with Web-based user interface to configure advanced services
- Fault detection and recovery (Please refer to trouble shooting guide)

## 4. System Design

The OW50M-Rac consists of the outdoor antenna subsystem (Dome) and the indoor Customer Network Exchange (CNX). The antenna subsystem is comprised 53 cm parabolic reflector antenna, mounted on 3-axis stabilized pedestals, enclosed within environmentally sealed domes.

The antenna subsystem contains several core modules, are covered in greater detail in the following sections. Figure 2 depicts how the entire system is architected and interconnected.

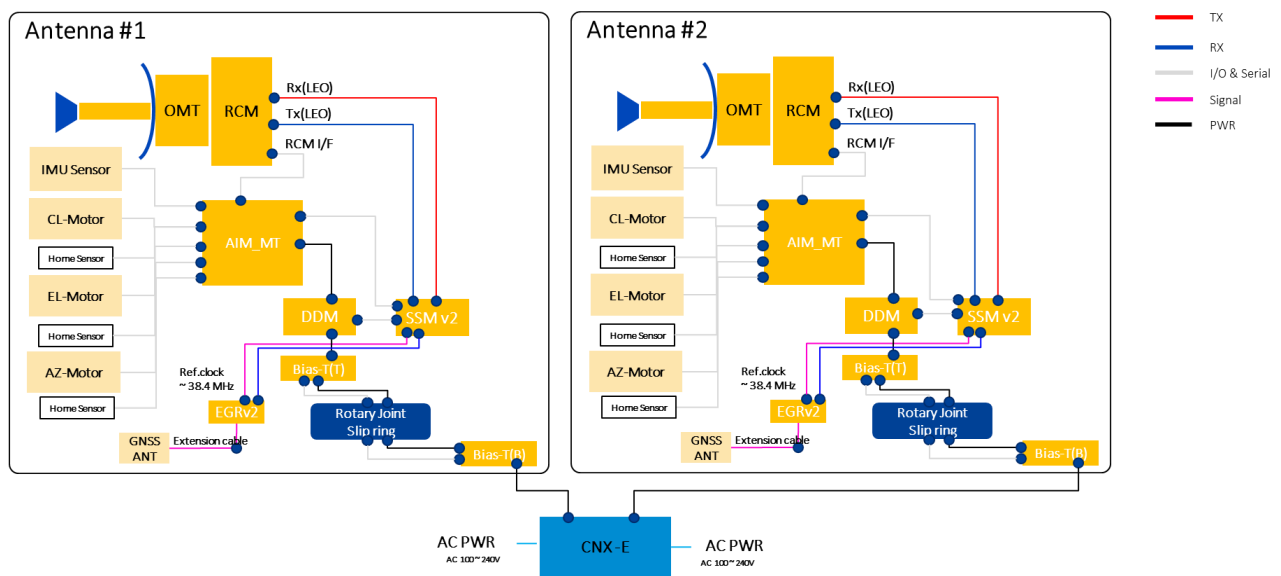
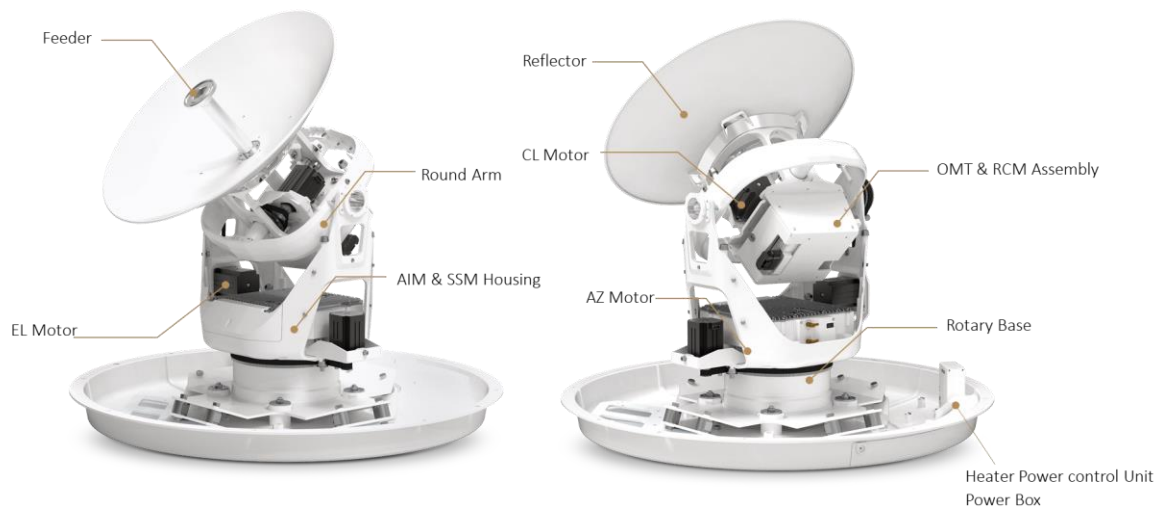


Figure 2. Antenna Configuration System Diagram

### 4.1 Antenna

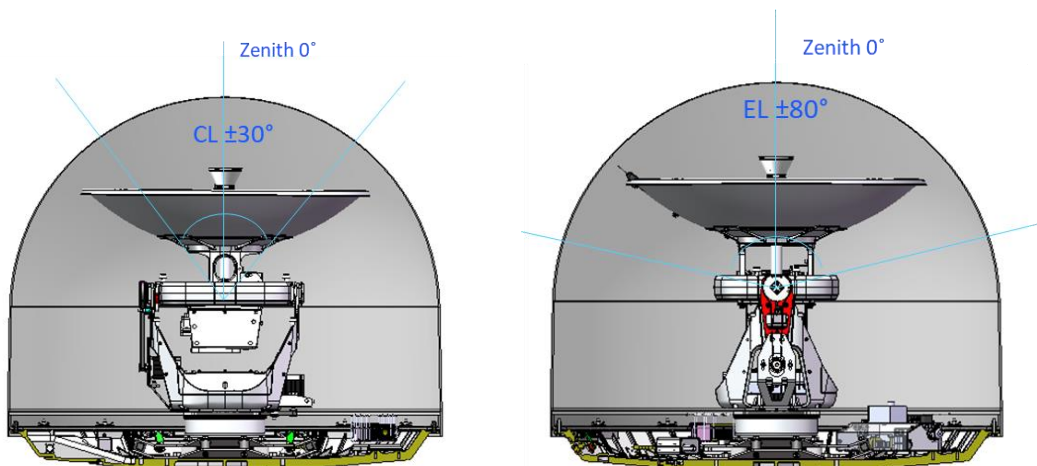
Single antenna is comprised of a 53 cm aperture reflector and feed assembly mounted on a 3-axis stabilized antenna pedestal. The feed assembly itself consists of a feeder for transmitting and receiving Ku-band RF signals and a polarizer to convert linear-polarized into circular-polarized signals, and vice versa. The antenna components are identified in Figure 3. The entire assembly is perfectly balanced along each axis of rotation for minimal wear and tear and minimal power consumption.



**Figure 3. Antenna Components**

Independent motors physically move the reflector and feed assembly for peak alignment when OneWeb LEO satellite passing overhead. Together, the motors provide enough antenna slew rate to track satellites across the field of view and adjust position in anticipation of upcoming satellites.

The full operating range is  $\pm \infty$  in azimuth (AZ),  $\pm 80^\circ$  field of view,  $\pm 80^\circ$  elevation &  $\pm 30^\circ$  cross level (EL & CL) (see Figure 4), supporting the OneWeb LEO satellite network in any geographic & coverage location. The position sensor also detects base platform motion quickly and accurately, allowing the system to feedback compensation adjustments to the motor to maintain optimal pointing.



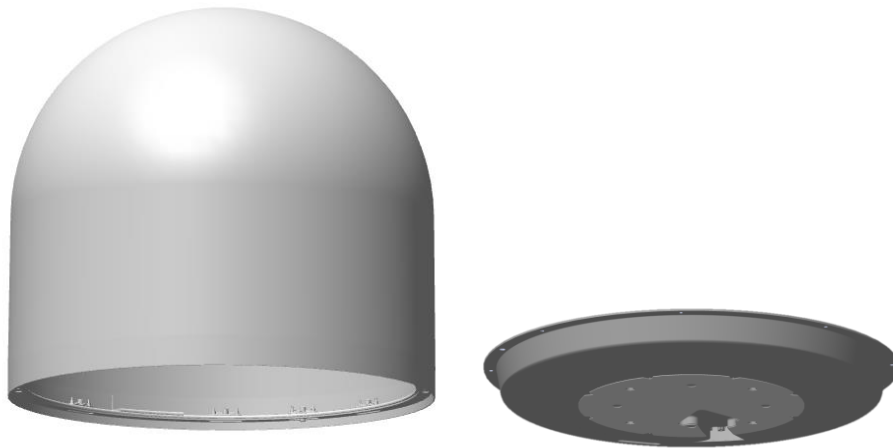
**Figure 4. Pedestal Operating Range of Motion**

## 4.2 Radome

The radome is the outer enclosure that protects the electronic and mechanical components within the antenna from the environment. Measuring  $\Phi$  85.6 x 85 cm (33.7" x 33.46"), the radome is attached to the baseplate (Radome bottom plate) with fasteners and brackets, compressing a gasket along the perimeter of the base. Once installed, the enclosed antenna

provides protection against external conditions such as rain, hail, lightning, ESD (Electrostatic Discharge), etc.

A rendering and a photograph of the radome are shown in Figure 5.



**Figure 5. Radome Top & Bottom**

The baseplate includes waterproof connectors for linking to the CNX.

### **4.3 Satellite Subscriber Module (SSM+DDM)**

The SSM is the core engine of the antenna subsystem, controlling the interoperability among the modules and subcomponents. It performs a number of functions including, but not limited to, the following:

- Hosts the Qualcomm modem chipsets that implement the OneWeb air interface
- Communicates pointing commands to the AIM via Ethernet
- Implements a host processor subsystem to manage and interface with all the UT sub-component
- Manages the independent operation of AIM and RCM

The DDM is a DC to DC power module that supplies power to SSM and AIM. DDM also working for monitor temperature in the SSM through the temperature sensor in the DDM board.

### **4.4 Antenna Interface Module (AIM)**

The AIM's major function is to perform antenna steering based on commands received from the SSM. This involves not only motor control but also stabilization, sensor I/F, and tracking operations. It also provides the RCM monitor & control functions such as mute on/off, Tx/Rx local RF frequency, beam switching, and Tx/Rx gain reporting via SSM connection. Other functions such as motor control and sensor control (IMU Sensor I/F) also support.

### **4.5 RF Converter Module (RCM) with OMT**

The 3.0 W RCM receives power from the AIM and converts RF to IF and vice versa. More specifically, on the forward link, 10.7-12.7 GHz Ku-band is converted into the SSM baseband frequency, and on the return link the SSM baseband frequency is converted to

14.0-14.5 GHz Ku-band. These two functions occur simultaneously for full duplex operation. In addition, the RCM also tunes frequency synthesizers in order to adjust channel frequencies while utilizing variable attenuators to compensate for cable losses.

## 4.6 External GNSS Receiver (EGR)

The EGR is used to deliver more reliable location, frequency, timing, and time-of-day information. Power to the EGR comes from the DDM via the SSM.

## 4.7 Customer Network Exchange (CNX)

The CNX provides end user access to OneWeb services. (Note: this service depends on the product variant and the agreement with OneWeb.) The CNX-E, which can be installed indoor or outdoor, also converts power from the local interface to the power type required for the DDM.

## 4.8 Heater Module

OW50M-Rac is also available for deployments in areas with extremely cold weather conditions (temperature below -25°C). Heater added model, the OS-OW50P-H variant is equipped with Heater Modules allowing the UT to be operational and function correctly down to -30°C. The pre-fitted (at the factory) heater modules use a conduction heating method to provide heat to the SSM and the pedestal. Heater controller turn the heaters on/off as required. If the UT is used in ambient temperatures outside the "operational temp range" (i.e. 0°C to +55°C) the behavior of the UT is "undefined" and the functionalities of the antenna subsystem's components might be severely affected. Long exposure to out-of-range environmental conditions will inevitably affect the Mean Time Before Failure (MTBF) of the UT and might have an impact on the validity of the warranty.

# 5. Functional Specification

## 5.1 FOV Compliance

The antenna pedestal architecture and drive mechanism are designed to mitigate kinematic keyhole effects. This keyhole phenomenon occurs when a satellite passes directly overhead and due to the EL motor travel limit, the AZ motor cannot continuously track a satellite without approaching infinite acceleration, also known as gimbal lock.

OW50M-Rac structure also designed to cover continuous tracking of satellites. From the constellation analysis of total 288 satellites, Motion range cover +/- 80 deg FOV (considered ship motion)

|             |              |
|-------------|--------------|
| Azimuth     | $\pm \infty$ |
| Elevation   | -80° to +80° |
| Cross level | -30° to +30° |

**Table 2 Motion Range**

## 5.2 SSM-AIM Communication

The SSM and AIM handle the roles of server and client and have a bidirectional link whereby both sides can send messages asynchronously. The AIM communicates with the SSM for control commands regarding the pointing and operation of the OneWeb system. It also interacts with the SSM for local or remote configuration, diagnostics, and software/firmware upgrades. All of this is accomplished over an Ethernet interface.

## 5.3 Fault detection & recovery, Diagnostics

The OW50M-Rac detects any faults that might occur during operation, based on changes in status from periodic vs. non-periodic system monitoring. The web-based user interface, which is available via REST based APIs on the host processor, will provide control, monitoring, and troubleshooting parameters over-the-air, so that local users are able to install, control, and recover (from fault assurance) the antenna subsystem and modem.

In terms of the antenna module, the Antenna Subsystem proceed self-diagnosis for the parts such as Motors, sensors, power line and some parts for temperature. The diagnosis can be performed by accessing the Antenna Subsystem's LUI or Over-The-Air. Alternatively, the Antenna Subsystem can also run an SNMP (Simple Network Management Protocol) agent.

# 6. Technical Specification

## 6.1 RF Specification

| Item                                         | Specification                      |
|----------------------------------------------|------------------------------------|
| <b>Rx Frequency</b>                          | Rx : 10.7 – 12.7 GHz               |
| <b>Rx Gain(@11.8GHz with radome)</b>         | Rx: 33.4 dBi                       |
| <b>G/T<br/>(@ 11.8 GHz, @ &gt;30deg. EL)</b> | 9.3 dB/K                           |
| <b>Tx Frequency</b>                          | Tx: 14.0 – 14.5 GHz                |
| <b>Tx Gain (@14.25GHz with radome)</b>       | 34.9dBi                            |
| <b>EIRP</b>                                  | 33.6dBW/20MHz (Single Carrier)     |
| <b>Cross pol Isolation</b>                   | Min 15 dB (Antennas Field of view) |
| <b>Polarization</b>                          | Circular (Rx: RHCP, Tx: LHCP)      |

## 6.2 RF Component Specification

| Item |                                          | Specification                                                                |
|------|------------------------------------------|------------------------------------------------------------------------------|
| RCM  | Size                                     | 128.1 mm x 107.8 mm x 20.2 mm (w/o interface connector)                      |
|      | Weight                                   | 0.5 kg                                                                       |
|      | RF Frequency Range                       | 10.7 – 12.7 GHz (Rx RF)<br>14.0 – 14.5 GHz (Tx RF)                           |
|      | IF Frequency Range                       | Rx: 1850 – 2100 MHz<br>Tx: 4050 – 4175 MHz                                   |
|      | Max. Operational Power in Transmit Chain | 30.5 dBm (1.1 Watt)                                                          |
|      | ACLR                                     | -22 dBc @ +/-20 MHz frequency offset<br>-28 dBc @ +/-40 MHz frequency offset |
|      | Receive Noise Figure                     | Max. 1.3 dB over all environmental operations                                |
|      | Input P1dB                               | Min. -51 dBm                                                                 |
|      | Local Oscillator Frequency               | 10.700 – 10.950 GHz: 8.850 GHz                                               |
|      |                                          | 10.950 – 11.200 GHz: 9.100 GHz                                               |
|      |                                          | 11.200 – 11.450 GHz: 9.350 GHz                                               |
|      |                                          | 11.450 – 11.700 GHz: 9.600 GHz                                               |
|      |                                          | 11.700 – 11.950 GHz: 9.850 GHz                                               |
|      |                                          | 11.950 – 12.200 GHz: 10.100 GHz                                              |
|      |                                          | 12.200 – 12.450 GHz: 10.350 GHz                                              |
|      |                                          | 12.450 – 12.700 GHz: 10.600 GHz                                              |
|      | Local Oscillator Reference Frequency     | 25 MHz                                                                       |
|      | Power Consumption                        | 25 W max. (+24Vdc)                                                           |
| OMT  | Size                                     | 167 mm x 124 mm x 72.1 mm                                                    |
|      | Weight                                   | ~ 1 kg                                                                       |
|      | Cross-pol Discrimination                 | Rx: Min. 35 dB<br>Tx: Min. 35 dB                                             |

|  |                                     |                                        |
|--|-------------------------------------|----------------------------------------|
|  | <b>Insertion Loss</b>               | Rx: 0.5 dB (Min.)<br>Tx: 0.5 dB (Min.) |
|  | <b>Tx band-to-Rx band Isolation</b> | 80 dB                                  |
|  | <b>Return loss</b>                  | 19 dB                                  |
|  | <b>Radar band rejection</b>         | >60dB @10GHz                           |

## 6.3 System Specification

| Item                                                       |                                  | Specification                                                |
|------------------------------------------------------------|----------------------------------|--------------------------------------------------------------|
| <b>Platform</b>                                            |                                  | Three Axis: Azimuth, Elevation, Cross-level                  |
| <b>Positioning</b>                                         |                                  | 3-axis Velocity Mode Servo : Azimuth, Elevation, Cross-Level |
| <b>Pedestal Motion Range</b>                               | <b>Azimuth</b>                   | unlimited                                                    |
|                                                            | <b>Elevation</b>                 | -80° to +80° (FOV -80° to +80°)                              |
|                                                            | <b>Cross-Level</b>               | -30° to +30°                                                 |
| <b>Ship Motion</b>                                         | <b>Roll</b>                      | +/- 25° at 6 sec                                             |
|                                                            | <b>Pitch</b>                     | +/- 15° at 6 sec                                             |
|                                                            | <b>Yaw</b>                       | +/- 10° at 6 sec                                             |
|                                                            | <b>Turning rate</b>              | 12 degree/sec                                                |
| <b>Power Module (Inside CNX)<br/>(for Each 1 Antenna)</b>  |                                  | Max ~ 250W(Total : Max ~ 500W)                               |
| <b>CNX Input Power</b>                                     |                                  | 100 – 240 VAC, 50 – 60 Hz                                    |
| <b>Power to Antenna Subsystem<br/>(for Each 1 Antenna)</b> |                                  | Current 1.9 A average/3 A peak @ 32-60 V, 56 V nominal       |
| <b>EGR</b>                                                 | <b>GPS L1 Frequency</b>          | 1574.397 – 1576.443 MHz                                      |
|                                                            | <b>GLONASS Frequency</b>         | 1597.5515 – 1605.886 MHz                                     |
|                                                            | <b>Communication Protocol</b>    | NMEA 0183                                                    |
|                                                            | <b>Reference Clock Frequency</b> | 38.4MHz sinusoidal reference clock output to the SSMv2       |
|                                                            | <b>Supply Voltage</b>            | Nominal 5.5V (Min. 5.2 V, Max. 5.8 V)                        |

|                                 |                                      |                         |                                                                                                                              |  |
|---------------------------------|--------------------------------------|-------------------------|------------------------------------------------------------------------------------------------------------------------------|--|
|                                 |                                      | Power Consumption       | Max. 8 W                                                                                                                     |  |
|                                 |                                      | Antenna Power Interface | Min. 3 V, Max. 5 V                                                                                                           |  |
|                                 |                                      | Surge Protection        | IEC 61000-4-5, Class 3                                                                                                       |  |
|                                 |                                      | Connections             | SMA                                                                                                                          |  |
| Digital Signals                 |                                      |                         | Tx-ON : LVDS                                                                                                                 |  |
|                                 |                                      |                         | Rx-ON : LVDS                                                                                                                 |  |
|                                 |                                      |                         | Frequency Reference: LVDS                                                                                                    |  |
|                                 |                                      |                         | Reset: LVDS                                                                                                                  |  |
| Ant. Monitor, Control Interface |                                      |                         | Ethernet, 10/100 Base T                                                                                                      |  |
| CNX-E                           | Antenna Subsystem Interface          |                         | Eight GigE RJ-45 Ethernet(1 Management Port)                                                                                 |  |
|                                 | Encryption                           |                         | MoCA 2.0<br>E-band (400-700MHz)                                                                                              |  |
|                                 | AC Input Voltage                     |                         | AC 100V ~ 240V/50Hz ~ 60Hz                                                                                                   |  |
|                                 | Operating Power                      |                         | Max. 30 W                                                                                                                    |  |
|                                 | DC output range                      |                         | DC 56V +/- 5%                                                                                                                |  |
|                                 | Output Power (for Each Power Module) |                         | Max ~ 250W(Total : Max ~ 500W)                                                                                               |  |
|                                 | LEDs                                 | Power                   | Operational – Solid GREEN<br>Fault Condition – PWR GREEN Off<br>Operating with Backup S/W – Blinking GREEN<br>Off – No power |  |
|                                 |                                      | Ethernet                | Ready – Solid GREEN<br>Activity – Blinking GREEN<br>Off – No device connected or device connected not operational            |  |
|                                 |                                      | Internet                | Operational – Blinking GREEN (MoCA Connected)<br>Fault Condition – Solid GREEN (MoCA not Connected)                          |  |
| RF Cable                        |                                      |                         | RG6(30m) or RG11(100m)                                                                                                       |  |
| Heater Power Consumption        |                                      |                         | Max ~ 400W(220 Vac)                                                                                                          |  |
| Ethernet Cable                  |                                      |                         | CAT5(CNX to User terminal)                                                                                                   |  |

## 6.4 Mechanical Specification

| Item               |                                     | Specification                 |
|--------------------|-------------------------------------|-------------------------------|
| Radome Height      |                                     | 850 mm (33.5 Inch)            |
| Radome Diameter    |                                     | Ø 856 mm (33.7 Inch)          |
| Reflector Size     |                                     | 53 cm (20.8 Inch)             |
| Radome Color       |                                     | White                         |
| Antenna Safety Gap |                                     | 30 mm                         |
| Antenna Weight     |                                     | ~ 52 Kg<br>~ 54 Kg (w Heater) |
| Package            | Size                                | 1000 mm * 1110 mm * 1126mm    |
|                    | Package weight (Antenna+Package+HM) | ~ 106 kg                      |

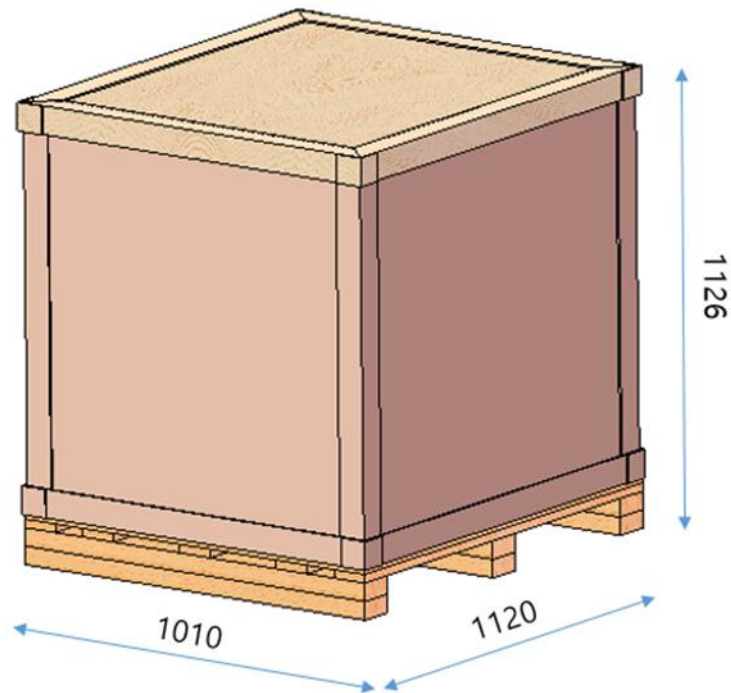


Figure 6. Packaging Example

## 6.5 Environmental Specification

| Item                                              |            | Specification                                                                                                                  |
|---------------------------------------------------|------------|--------------------------------------------------------------------------------------------------------------------------------|
| Operational Temperature                           |            | - 40°C to + 55°C (w/ optional heating device)                                                                                  |
| Storage Temperature                               |            | -40°C to +85°C                                                                                                                 |
| Operational Humidity                              |            | Relative humidity range of 20% to 95% non-condensing in accordance with IEC60068-2-30 for a period of 96 hours.                |
| Non-operational Humidity                          |            | IEC 60068-2-78, Method Db for a period of 96 hours.                                                                            |
| Operational Vibration                             |            | EN60945<br>5~13.2Hz/ 1mm, 13.2~100Hz/0.7g                                                                                      |
| Non-operational Vibration                         |            | IEC60721-3-6 Class 6M3<br>2~18Hz/1.5mm<br>18~200Hz/2G (Sweep Rate: 1.0 Oct/min)<br>5 sweeps at each Axes                       |
| Operational Shock                                 |            | IEC 60068 2 27 Method Ea<br>2G/20ms, 4G/20ms, 10G/11ms, 20G/7ms                                                                |
| Non-operational Shock                             |            | IEC 60721 3 6 Class 6M3<br>10G, 11ms (half sine), 3 cycles<br>30G, 6ms (half sine), 3 cycles<br>50G, 3ms (half sine), 3 cycles |
| Bump shock                                        |            | IEC 607213 6 Class 6M3<br>25g/6ms (half sine), 100cycles                                                                       |
| Weather Tightness                                 |            | IP56 per IEC 60529                                                                                                             |
| Lightning Protection<br>(UT system include CNX-E) |            | IEC 61000-4-5 Class 4                                                                                                          |
| Hail Impact                                       |            | ASTM E822                                                                                                                      |
| Operating<br>Wind<br>Resistance                   | Wind Load* | 148 km/hr (80 Kt)                                                                                                              |
| Survival Wind<br>Resistance                       | Wind Load* | 265 km/hr (143 kt)                                                                                                             |
| Salt Erosion                                      |            | IEC 60068-2-52 Severity Lv 3                                                                                                   |

## 6.6 Regulatory Compliance

| Item           | Specification                                                                                                                 |
|----------------|-------------------------------------------------------------------------------------------------------------------------------|
| Safety         | IEC/EN 62368-1                                                                                                                |
| EMI/EMC        | FCC CFR47 Part 15, Class-A<br>FCC CFR47 Part 1.1310 (Limits)<br>EN 62368-1<br>EN 303 980<br>EN 301 489-1/12<br>EN 301 843-1/6 |
| Radio Spectrum | FCC CFR47 Part 25, Subpart C                                                                                                  |

## 7. Glossary

|      |                                      |
|------|--------------------------------------|
| AIM  | Antenna Interface Module             |
| AZ   | Azimuth                              |
| CL   | Cross Level                          |
| CNX  | Customer Network Exchange            |
| EL   | Elevation                            |
| FOV  | Field of View                        |
| GNSS | Global navigation satellite system   |
| IF   | Intermediate Frequency               |
| IMU  | Inertial Measurement Unit            |
| LEO  | Low Earth Orbit                      |
| LUI  | Local User Interface                 |
| OMT  | Orthomode Transducer                 |
| RCM  | RF Converter Module                  |
| RF   | Radio Frequency                      |
| Rx   | Receive                              |
| SINR | Signal to Interference & Noise Ratio |
| SSM  | Satellite Subscriber Module          |
| Tx   | Transmit                             |
| UT   | User Terminal                        |
| XCVR | Antenna Subsystem                    |