User Manual

THEUS C-V2X OBU User Manual [ETF-PRO-OC02]

Version 1.0

Revision History

Name	Version	Date	Comment
Jack	V 1.0	March 14, 2025	Initial Version

Table of Contents

1. Introduction

This document provides the following information:

- THEUS C-V2X OBU product package information
- How to access OBU for checking/changing OBU configuration settings
- How to set pre-configuration for V2X communication
- How to transmit/receive data packets with test application.

1.1. THEUS C-V2X OBU Package

The package contains parts as below.

Table 1: THEUS C-V2X OBU package parts

Part	Type	Quantity
ETF-PRO-OC02	THEUS C-V2X OBU	1
LAN cable	UTP Cat5e	1
Power gender	MX81A004SF1	1
V2X & GPS Antenna	FAKRA	1

ETF-PRO-OC02   **V2X & GPS ANT X1**

LAN Cable X1   **Power Gender X1**

Figure 1: THEUS C-V2X OBU Package

1.2. Hardware Setup
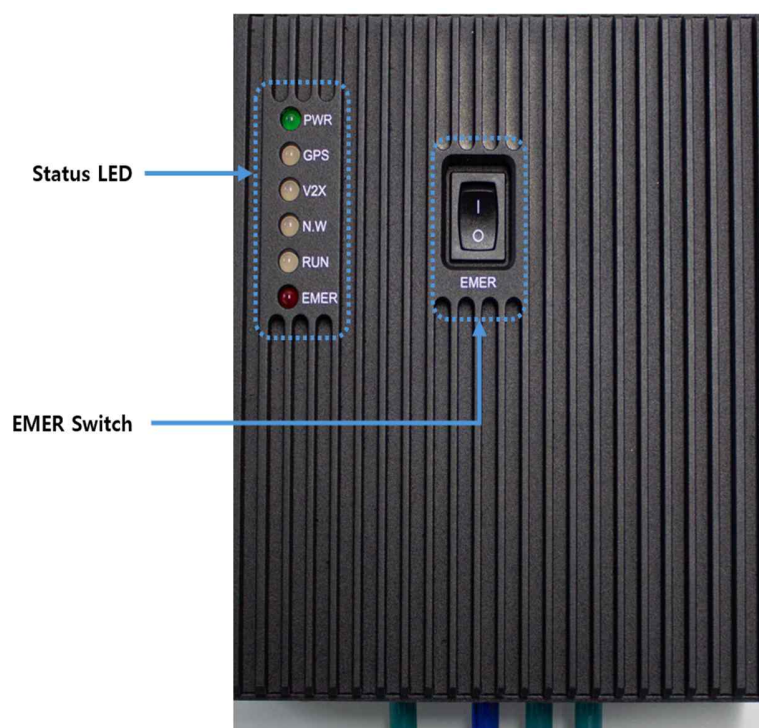
1.2.1. Exterior View [Front]

Figure 2: Front Panel

Six LEDs for status indication and an emergency switch are on the front panel of THEUS C-V2X OBU.

Table 2: LED Description

Part	Description	
PWR	Green ON	Power is ON.
	Green OFF	Power is OFF.
GPS	Green ON	GPS signal is locked.
	Amber ON	GPS signal is unlocked.
V2X	Green ON	V2X Tx/Rx is ready.
	Amber ON	V2X Tx/Rx is not ready.
N.W	Green ON	Ethernet communication is normal.
	Amber ON	Ethernet communication is abnormal.
RUN	Green ON	Processors are normally operating.
	Amber ON	Processors are abnormal.
EMER	Red Blinking	EMER switch is ON.

| | Red OFF | EMER switch is OFF.T |

Part	Description	
EMER	Switch ON/OFF	In any emergency, turn on the switch. In normal situations, turn off the switch.

1.2.2. Exterior View [Top]

The antenna ports are on the top panel of THEUS C-V2X OBU.
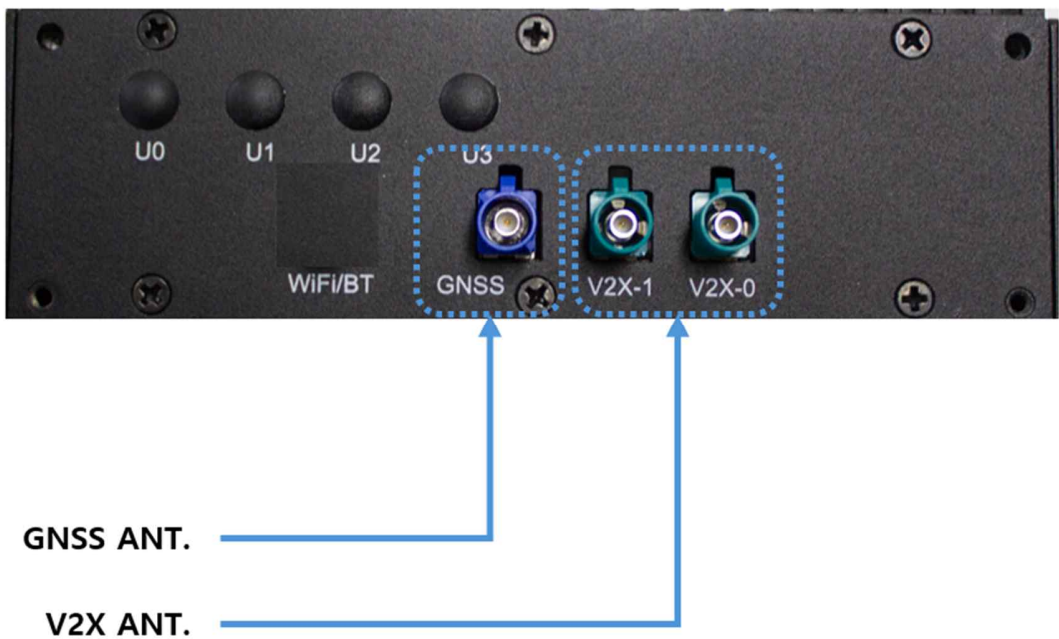
Figure 3: Antenna ports for THEUS C-V2X OBU

Table 4: Antenna description

Antenna port	Type	Description
V2X ANT	Fakra	2 x V2X antenna port
GNSS ANT	Fakra	GNSS antenna port

1.2.3. Exterior View [Bottom panel with I/O Interfaces]

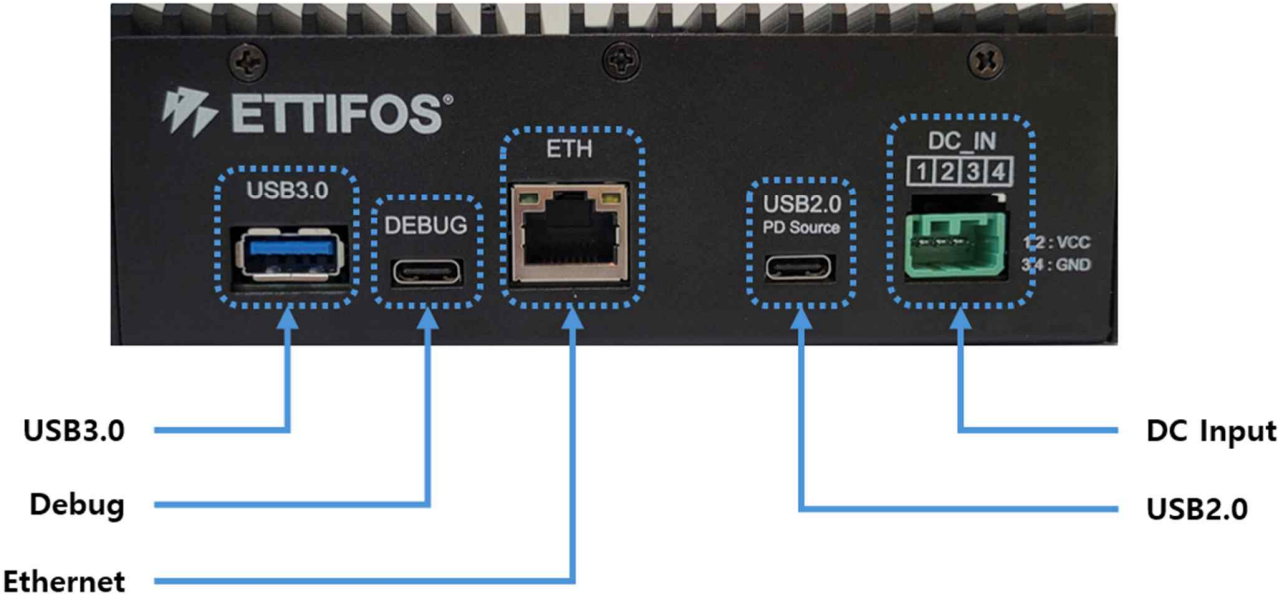The I/O interfaces and DC power connector are on the bottom panel of THEUS C-V2X OBU.

Figure 4: I/O interfaces for THEUS C-V2X OBU

Table 5: I/O interfaces

Interface	Type	Description
USB	USB 3.0	External interface supporting USB 3.0
Debug	USB-C	Debug port for serial debug (115200n8)
Ethernet	RJ-45	Ethernet port to connect user computers and switches
USB	USB 2.0	External interface supporting USB2.0
POWER	MX81	Power input DC +9 ~ 36V

1.2.4. Exterior View [Side panel with I/O Interfaces]

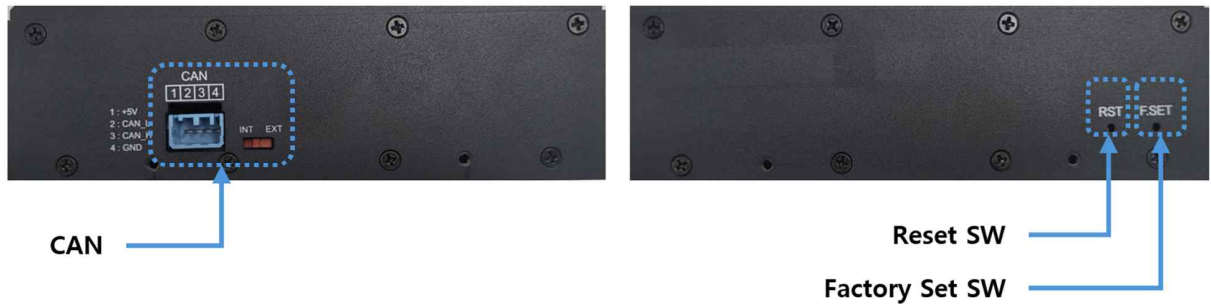A CAN interface and two reset pins are located on the side panels of THEUS C-V2X OBU.

1.2.5. 1.2.5   Dimensions

The dimensions of V2X-AIR CV2X (W x H x D) are 145.4 x 167.1 x 61.2 mm.
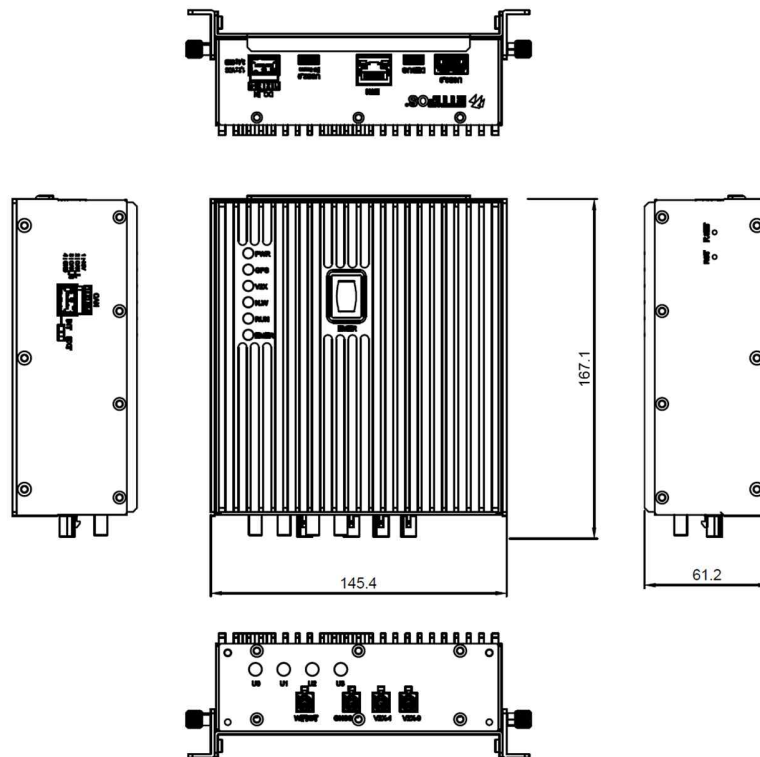

Figure 6: Dimensions of THEUS C-V2X OBU

1.3. Power supply

- Connect the power cable to the DC input port.
- The rated voltage is DC+9 ~ 36V.
- When power is applied the Power LED lights up
  And, when the system is operating the RUN LED lights up.

1.4. GNSS antenna connection

- Connect the GNSS antenna cable to the **GNSS** antenna port in the top panel.

- GPS signals are essential for the time synchronization in V2X communications system, in other words, V2X communication is only available under the test environment where OBU can receive good GPS signals.

1.5. V2X antenna connection

- Connect the V2X antennas provided with V2X-AIR to the **V2X-0** and **V2X-1** antenna port in the top panel.

2. Configuration settings

OBU provides three methods for access to OBU. Users can change OBU configuration settings or control OBU through Ethernet, USB-C (UART serial) and Wi-Fi connection. This chapter explains about the three ways for access and the way how to change LTE-V2X frequency setting.
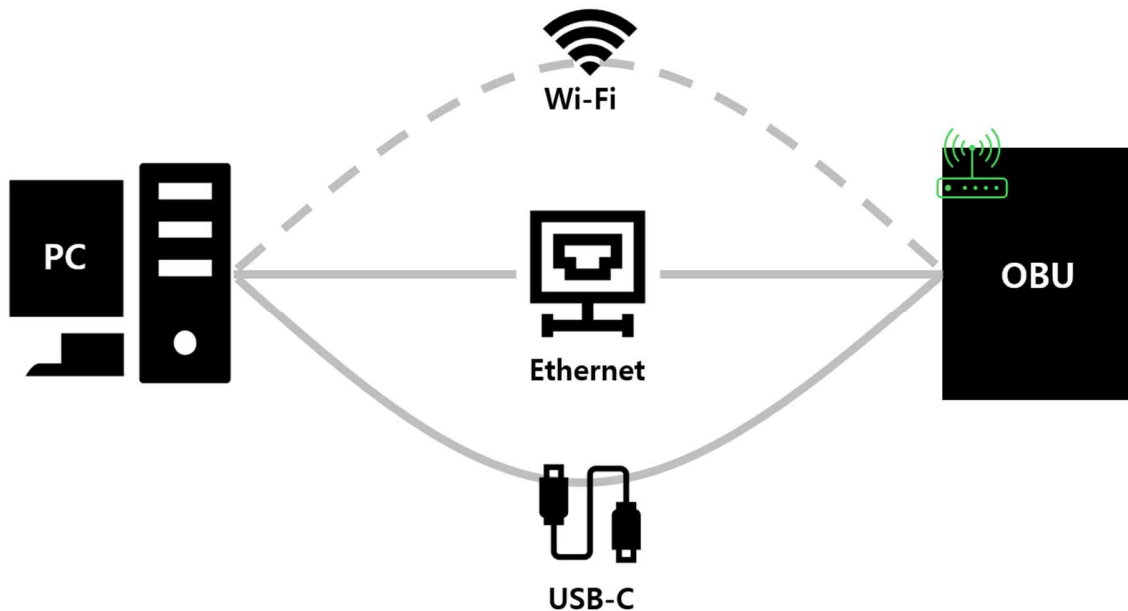
Figure 7: Overview of THEUS C-V2X OBU

2.1. Access to OBU

2.1.1. Access via Ethernet

The procedure for access to OBU via Ethernet is as below:

(1) Directly connect the ethernet port of the OBU to the PC.

(2) Set a static IP address in the Network Manager of the PC. The default IP address of ethernet interface inside OBU is **192.168.70.234**, hence, the allowed address to the PC ranges from 192.168.70.1 to 192.168.70.254 with the exception of 192.168.70.234.

(3) Access OBU via SSH applications such as Putty and Tera Term with the default IP address and the default port number **22**. (refer to   for more detail)
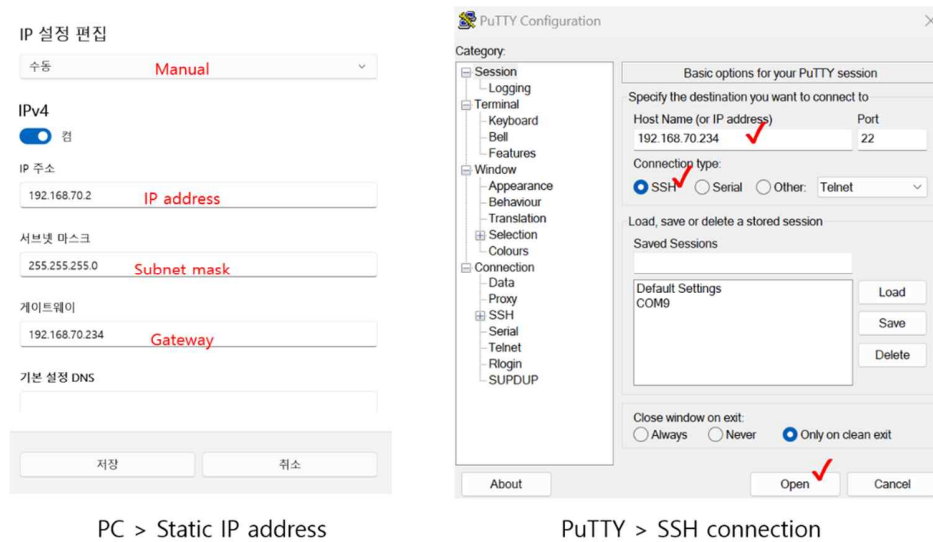
Figure 8: Static IP setting & SSH connection

In case the IP address of the ethernet interface needs to be changed, follow the instructions below.

(1) Open the '50-eth.network' file and change 'Address' and 'Gateway' (Line 14 to 15) values to new ones.

```
root@Ettifos:~# vi /lib/systemd/network/50-eth.network

…

# Press 'i' to enter insert mode

11 Name=th0

~

13 [Network]
```

(2) Open the 'resolv.conf' file and change 'nameserver' (Line 0) values to new ones.

```
root@Ettifos:~# vi /etc/resolv.conf

…

# Press 'i' to enter insert mode

0 nameserver 8.8.8.8

…

# Press ':wq!' to save the changes and quit

:wq!
```

(3) Restart 'system-networkd' or reboot DUT to apply changes.

```
# Restart systemd-networkd or Reboot DUT
$ systemctl restart systemd-networkd
```

(4) Open the '/lib/system/system/ssh.socket' and configure the port number (optional)

```
ListenStream=22
```

Restart the DUT to apply network configuration.

2.1.2. Access via Wi-Fi(Option)

OBU works as a Wi-Fi AP (Access Point) and the other way for the PC to connect to OBU is to connect through Wi-Fi SSID. The default IP address of Wi-Fi interface inside OBU is 192.168.80.1 and users can change Wi-Fi settings such as IP address, SSID and password by editing 'etc/create_ap_ettifos.conf' file. After Wi-Fi connection, users can access OBU via SSH application like ethernet connection.

- IP Address: 192.168.80.1
- SSID (Access Point): ETF-AP
- PW: 1234567890

```
root@Ettifos:~# vi etc/create_ap_ettifos.conf'


GATEWAY=192.168.80.1
…
SSID=ETF-AP
PASSPHRASE=1234567890
```

2.1.3. Access via USB-C (UART serial)

OBU supports UART serial connection for debugging through USB-C debug port. The procedure for the serial connection is as below:

(1) Directly connect the **USB-C** debug port in the rear panel of OBU to a computer.
(In case of the device being recognized as an unknown device on Windows Device Manager) Download CP210x USB to UART Bridge VCP driver at <u>CP210x USB to UART Bridge VCP Drivers – Silicon Labs (silabs.com)</u>, and install it by doing a 'driver update' in Windows Device Manager.

(2) Once installed, check the COM port which responds to Enhanced COM 'Port (COM & LPT)' of Device Manager as shown below.

(3) Access OBU via a terminal program (such as Tera Term and Putty) with the COM port (e.g., COM88) and baud rate 115200.
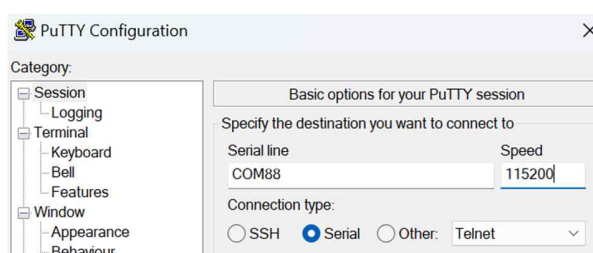
2.2. Configuration guide

In LTE-V2X communication, a pre-configuration XML file typically contains configurations and parameters for the network communication between vehicles, infrastructure, and other elements in the system. The XML file helps configure settings for V2X applications, security parameters, network interfaces, and communication protocols. For LTE-V2X sidelink communications, pre-configuration parameters including C-V2X channel should be matched between devices. The first time you conduct a C-V2X communication test between THEUS C-V2X OBU and another platform, you might need to provide Ettifos with the pre-configuration XML file used for the other platform. However, in most cases, users only need to consider C-V2X channel (frequency & bandwidth) information in the pre-configuration XML file, which is simply changeable by using the Ettifos-predefined XML files (refer to Table 6). This chapter introduces the method for configuring the device to other V2X channels.

Currently, THEUS C-V2X OBU provides four XML files in '/etc/v2x/cv2x' directory and each of them have different V2X channel information as shown below.

Table 6: Predefined XML files

Channel Info	Channel	Bandwidth	Center Freq(EARFCN)
V2X_Ch183_20MHz_EARFCN55140.xml	CH. 183	20MHz	55140

Users can easily change the LTE-V2X channel using 'cv2x-config' program in OBU. The 'cv2x-config' provides the functions explained in Table 7.

```
Usage: cv2x-config --<command name><command parameters>
```

Table 7: cv2x-config command list

command name	command parameters	Description
get-v2x-status		Read the V2X radio status.
start-v2x-mode		Start V2X radio.
stop-v2x-mode		Stop V2X radio.
update-config-file	<filepath>	Update pre-configuration xml file.

The procedure to change LTE-V2X channel is as follows.

(1) Stop V2X radio: Turn off V2X radio before channel change.

```
$ cv2x-config --stop-v2x-mode

    [I][init_qmi_services:490] Initialized QMI clients

    [I][stop_v2x_radio:637] Stopped V2X radio

    [I][deinit_qmi_services:501] De-initialized QMI clients
```

(2) Set pre-configuration xml file: Choose one of four xml files in   .

```
$ cv2x-config --update-config-file [path/xml]

    e.g., cv2x-config -update-config-file V2X_Ch178_10MHz_EARFCN54890.xml

    [I][init_qmi_services:490] Initialized QMI clients

    [I][update_v2x_config_file:1572] Sent V2X config file successfully
```

(3) Start V2X radio: Turn on V2X radio.

```
 $ cv2x-config --start-v2x-mode

    [I][init_qmi_services:490] Initialized QMI clients

    [I][start_v2x_radio:617] Started V2X radio

    [I][deinit_qmi_services:501] De-initialized QMI clients
```

3. Test application 'acme'

'acme' (Automotive Communications Modem Emulator) is a test application developed by LTE-V2X chipset vendor and designed to provide a platform for testing and validating V2X modems in real-world scenarios. This tool assists in evaluating the performance, reliability, and compliance of V2X communication devices.

The way for users to do packet transmission/reception using 'acme' is introduced below.

3.1. Usage of 'acme'

The options that 'acme' supports are as follows.

```
$ acme <option>
```

Table 8: acme options

Option	Ref.	Description
-h	--Help | Usage	Print this Usage
-A		ASCII dump packet data after sequence#
-a		Additional SPS/Event Flow Pair. Subsequent -E, -I, -r, -o flow params will apply to new reservation
-d		Dump raw packet
-k	<qty>	Quit after <qty> packets are received or transmitted
-l	<bytes [bytes] ...>	The maximum length of the sequence is 1000.
-P	<V2X ID>	V2X session ID to be used
-R		RECEIVE mode, default is Tx
-V		Increase verbosity level +1 for each -V, default=0

3.2. Tx/Rx Test Guide

One OBU works as a transmitter, and the other one works as a receiver. The default mode of 'acme' is Tx(transmission) mode, hence, -R' option is needed for the receiver. The followings are simple examples of the 'acme' commands for Tx/Rx.

Example of Tx Command: $ acme

```
$ acme
```

```
 [W][radio_listener:556] TX/RX Status Changed to <Active> ****
 Modem rmnet_data1 capabilities:
         non IP MTU: 8188 (rmnet_data1)
         IP MTU: 1500 (rmnet_data0)
         min periodicity: 100 ms
         max periodicity (lowest reserved Freq): 1000 ms
         highest priority number supported: 7 (lower # is more urgent)
         lowest priority number supported: 0 (lower # is more urgent)
         tx pool ids supported:
                 ID: 0, min_freq: 55090, max_freq: 55190
# SPS Interval periodicity not specified, using packet-gen interval: 100 ms.
Flow#0: type=3 file-desciptors:(-1 -1) sps_port=2500 evt_port=2600, 100 ms, 287 bytes
# traffic class=3
Setup traffic class=3 on the event socket completed.
Setup traffic class =3 completed the SPS flow socket.
Flow#0: type=3 27 28 sps_port=2500 evt_port=2600, 100 ms, 287 bytes
# interval=100000000 ns (approximately 10 per second)
TX count: 1, len = 287
TX count: 2, len = 187
```

Example of Rx Command: $ acme -R

```
$ acme -R
   [W][radio_listener:556] TX/RX Status Changed to <Active> ****
   Modem rmnet_data1 capabilities:
         non IP MTU: 8188 (rmnet_data1)
         IP MTU: 1500 (rmnet_data0)
         min periodicity: 100 ms
         max periodicity (lowest reserved Freq): 1000 ms
         highest priority number supported: 7 (lower # is more urgent)
         lowest priority number supported: 0 (lower # is more urgent)
      tx pool ids supported:
      ID: 0, min_freq: 55090, max_freq: 55190
Epoch-ms     | Tot-pkts   | New-pkts  |   PPS  | Latency | RV's | CBP %
<1698743818326242> | 0 | + 0 packets | 0.00 packets per second (PPS)| 0.00 ms avg latency |
RV Count=0 | CBP= 0%
<1698743819326244> | 0 | + 0 packets | 0.00 packets per second (PPS)| 0.00 ms avg latency |
RV Count=0 | CBP= 0%
|#1   |l=287|UE#1|<latency= 13.70 ms> |total missed=0| per UE lost/sent=|0|1|    0.0%|
|#2   |l=187|UE#1|<latency= 13.25 ms> <ipg= 99.56 ms>|total missed=0| per UE lost/sent=|0|2|
0.0%|
|#3   |l=187|UE#1|<latency= 16.79 ms> <ipg=103.53 ms>|total missed=0| per UE lost/sent=|0|3|
0.0%|
```

4. Troubleshooting

4.1. Troubleshooting with RF Tx/Rx

■ No RF signal is transmitted

- Make sure that V2X antennas are correctly connected to the V2X-1 and V2X-2 antenna ports.

C-V2X Status Check

V2X Status: [0: Initial / 1: Normal / 2: Error]

4.2. Safety Precautions

- Always turn off the power before moving, installing, or connecting/disconnecting the cables and connectors.
- Make sure that the power source matches the required input power of the device.
- Do not modify any part of the device and do not open the housing case as this may cause malfunctions or electric shocks. Opening the housing case will void your warranty.
- Keep the device dry. Humidity and all types of liquid or moisture may corrode electric circuits.
- Be sure that the ventilation holes are not obstructed during operation, as this may cause malfunctions due to overheating.
- Make sure that all antenna ports are connected with antennas or properly terminated (e.g., with a 50 Ω coaxial termination resistor) during operation. Unterminated ports may cause RF signal distortion or hardware damage due to excessive reflected energy.

5. FCC Statement

Regulatory Compliance

C-V2X OBU

IMPORTANT NOTE:

FCC RF exposure statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. End users must follow the specific operating instructions for satisfying RF exposure compliance. This transmitter must be at least 20 cm from the user and must not be co-located or operating in conjunction with any other antenna or transmitter.

The FCC ID of the product is: 2BHJL-ETF-PRO-OC02

OBU firmware prevents the end user from adjusting power or channel settings that could result in a violation of FCC rules.

The end user is warned that any un-authorized adjustment to OBU firmware could result in a violation of FCC rules. Firmware update may only be performed by or under the immediate supervision and responsibility of a person certified as technically qualified to perform transmitter maintenance by Ettifos Co.

Any modifications made to this product, including the use of unauthorized antennas could result in violation of the FCC regulations and is strictly prohibited.

This product is operated under FCC license, please contact Ettifos Co. regarding all licensing requirements to ensure ongoing regulatory compliance during use.

Caution

Any changes or modifications (including the antenna) made to this device that are not expressly approved by the manufacturer may void the user's authority to operate the equipment.

Antenna Information

Antenna Type: External vehicle composite antenna (Fakra)

Antenna Max Gain: 8 dBi

FCC Compliance Statement

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

FCC Interference Statement

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 in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

▪ Reorient or relocate the receiving antenna.

▪ Increase the separation between the equipment and receiver.

▪ Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

▪ Consult the dealer or an experienced radio/TV technician for help

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New customers: please email pr@ettifos.com for any assistance.

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