

OBU-201U Specification

V2X On-Board Unit, IEEE 1609.x protocol stack



Overview:

An automotive-grade V2X on-board unit with IEEE 1609.2/3/4 stack running on ThreadX RTOS, OBU-201U enables direct V2X application software porting on the SDK and API to meet “Tomorrow’s V2X Innovation, Today.”

Integration of module-structured DSRC V2X sub-system module, GNSS/HSM carrier board, and IEEE 1609.x stack in an aluminum enclosure with feature rich I/O, OBU-201U provides highest application flexibility to seed V2X innovation.

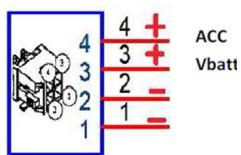
Benefits to deploy off-the-shelf OBU-201U:

- » standard compliance IEEE 1609.2/3/4 protocol stack ensures the best performance and compatibility.
- » the open innovation approaches can turn around much more quickly to bridge the development time and time-to-market of V2X and software-enabled service.
- » automotive-grade design meets vibrational and environmental reliability.
- » feature rich I/O ports provide flexibility to explore V2X application feasibility.
- » flexibility to enable V2X on existing outdoor Wi-Fi Access Point through Ethernet.

Key Features:

System:

- » Complete DSRC V2X elements of communication processor, DSRC RF, GNSS positioning, and hardware security in an aluminum enclosure enables innovative V2X applications.
- » Preloaded firmware of IEEE 1609.2, 1609.3, 1609.4 protocol stack and SAE J2735 message sets. The SDK and User's Guide enable direct V2X-enabled applications on API and reference sample codes.
- » Autotalks® Craton 3-core communication processor, Pluton RF transceiver, Telit® SL869 GNSS receiver, Infineon® SLE97 HSM, 128MB DDR3, and 32MB NOR in a standalone box, no external CPU and GNSS required.
- » High-performance Telit® SL869 GNSS receiver supports GPS/Glonass/Galileo/QZSS constellations and provides accurate positioning.
- » Infineon® SLE97 Hardware Security Module (HSM) provides ECDSA 256 signing and secure private key storage in a tamper proof device.
- » Automotive-grade 4-pin power input support a wide DC 6-32V range.
- » Vbatt supports GNSS RTC hot start for embedded automotive applications.



- » Onboard programmable delay ON (default 200ms) enables cranking delay ON.
- » Three power management modes of Idle, ON, and OFF.
- » Safe FAT supports 8GB microSD flash protects file system integrity on abrupt power-down.
- » Automotive-grade -40°C ~ +85°C design and components (Infineon SLE97® -20°C ~ +85°C now) ensure environmental reliability.
- » Two detachable FAKRA type Z DSRC antennas enable robust performance in automotive application.
- » One detachable FAKRA type C active GNSS antenna.

Performance:

- » More than +20dBm Class C RF spectrum mask compliant with margins.
- » Superior fading sensitivity in the typical ETSI defined C2C multipath scenarios increases wireless coverage.
- » Internal 40MHz BW filter provides immunity to out-of-band radio interferences in multi-channel operation.
- » Dual DSRC PHY supports concurrent dual channel operation.
- » Dedicated oscillator provides high frequency accuracy at $\pm 6.0\text{ppm}$ in $-40^\circ\text{C} \sim +85^\circ\text{C}$ temperature range.
- » Dynamic and accurate power control in a wide $4.5\text{dBm} \sim 25\text{dBm}$ output range provides superior performance stability.
- » GNSS positioning supports 1.5m accuracy (CEP50 with SBAS) and 10Hz refresh rate.
- » Hardware verification engine in Craton supports over 2,000 ECDSA 256-bit verifications per second.
- » HSM supports less than 50ms latency on ECDSA 256-bit signing.
- » High ESD protection design ensures immunity and robustness of all ports in ESD events. (IEC 61000-4-2 Level 4, Contact $\pm 8\text{kV}$, Air $\pm 15\text{kV}$)

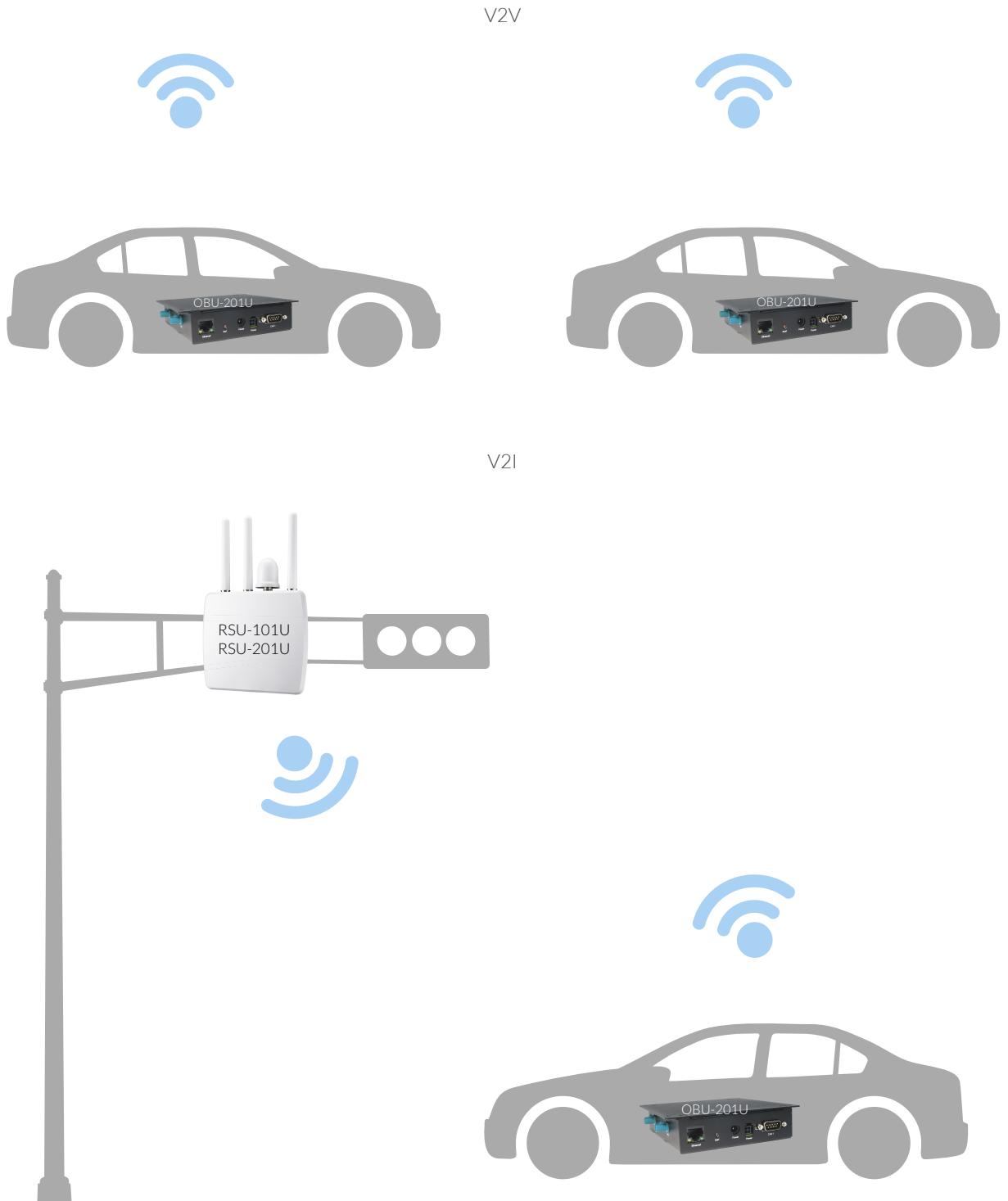
Flexibility:

- » Feature rich I/O ports provide the most flexible options to integrate with variable devices.
- » External GNSS support through RS-232 provides high application flexibility, in addition to default on-board Telit GNSS module.
- » On-board MMCX connector can be configured as GNSS RF input, in addition to the default external FAKRA C connector.
- » 4-pin and round jack DC 6-32V dual power inputs provide high application flexibility.
- » MicroSD supports up to 8GB SDHC for data logging and storage.
- » Painlessly enable V2X on external host device via Ethernet/UDP connection and OSLink.
- » Module-structured architecture provides high application flexibility to easily customize PCB-201 carrier board on the same architecture and software environment, no impact on V2X protocol stack and DSRC performance in VTX-201 sub-system.

Using Cases:

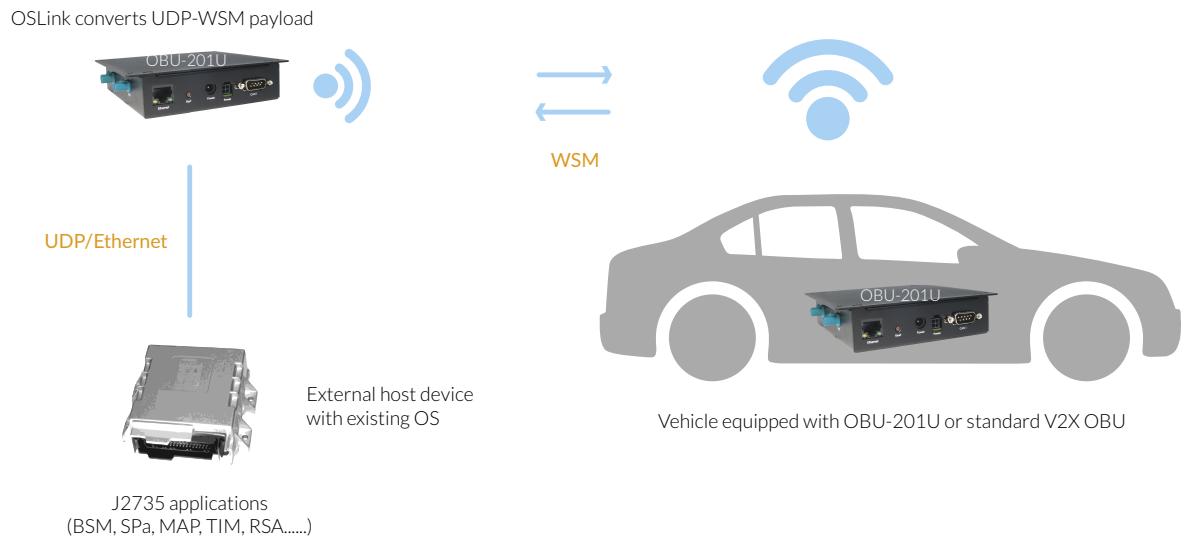
1. Typical:

a standalone V2X on-board unit running on ThreadX OS in vehicle. Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I) applications improve road safety and reduce congestion in standard compliance 1609.2/3/4 stack and J2735 messages.



2. Enables V2X on external host device with no impact on existing system architecture:

Simply connects OBU-201U to external host device and programs preloaded OSLink firmware to provide software interfaces via UDP/Ethernet connection. The OSLink will behave as a relay of UDP/WSM payload which allows the external host device to send and receive J2735 compliant messages over DSRC.



3. Use DSRC V2X to forward data stream through UDP/Ethernet

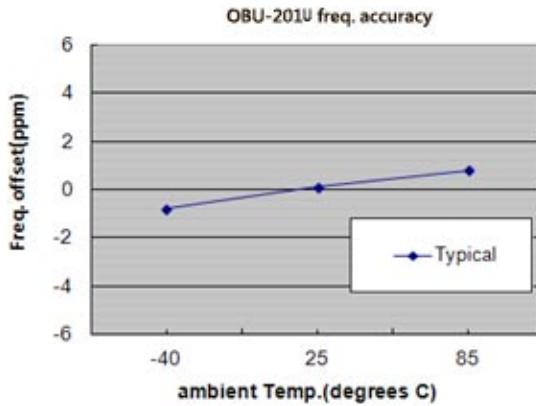
The OBU-201U/OSLink will behave as a relay of UDP/WSM payload to forwards data stream of software-enabled applications over DSRC between two OBU-201U connected nodes.



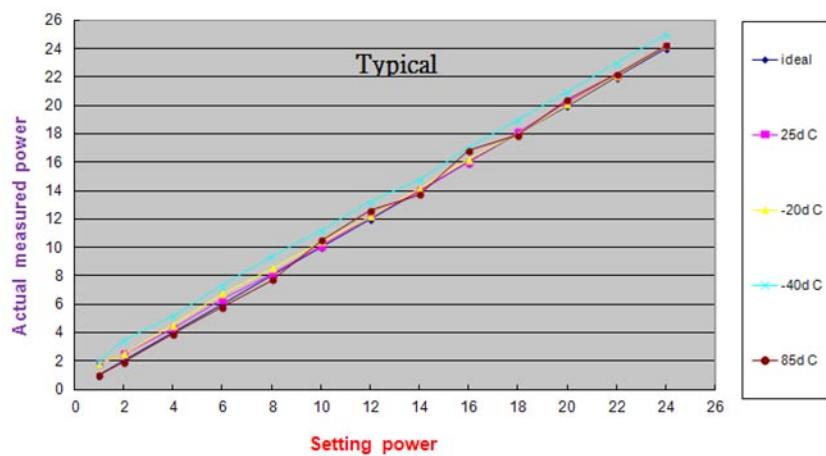
Remarks: OSLink is only valid on version IEEE 1609.2/3/4 -2010 stack.

Critical Facts of OBU-201U

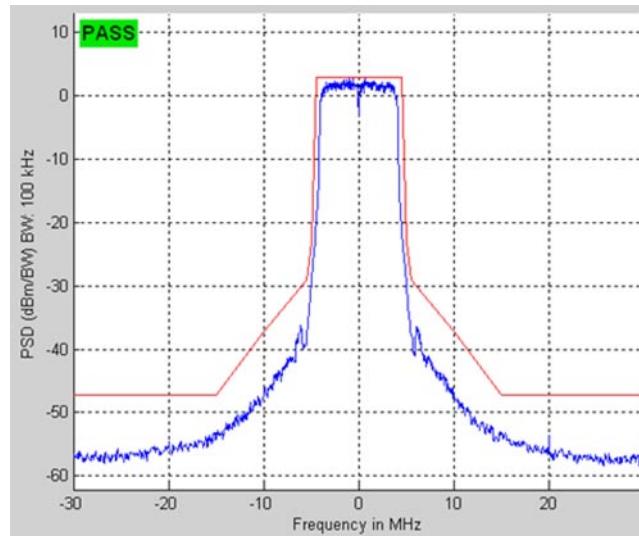
1. Frequency Accuracy:



2. Power Control Accuracy:



3. Class C mask performance at +20dBm from -40°C ~ +85°C:



4. Consistent EVM performance over a wide 5~22dBm power levels and -40°C~+85°C temperature range provide high channel efficiency.

| | 25 degrees C | | 85 degrees C | | -40 degrees C | |
|------|--------------|-------|--------------|-------|---------------|-------|
| | TX2 | TX1 | TX2 | TX1 | TX2 | TX1 |
| dut1 | -28 | -28 | -29 | -27.8 | -27.7 | -27.5 |
| dut2 | -30.5 | -27.5 | -30 | -27 | -30 | -27.4 |
| dut3 | -31.4 | -26.3 | -30.2 | -28.8 | -28 | -27 |

Deployment:

1. Connect OBU-201U RS-232 to PC USB port. Directly compile and deploy V2X applications on OBU-201U based on Unex's SDK.



2. Innovative V2X safety, mobility, and environment applications on OBU-201U.

Vehicle-to-Vehicle (V2V):

- Intersection Movement Assist (IMA)
- Left Turn Assist (LTA)
- etc..

Vehicle-to-Infrastructure (V2I):

- Curve Speed Warning (CSW)
- Transit Pedestrian Warning
- etc..

Mobility:

- Transit Signal Priority
- Fleet Management
- etc..

Environment:

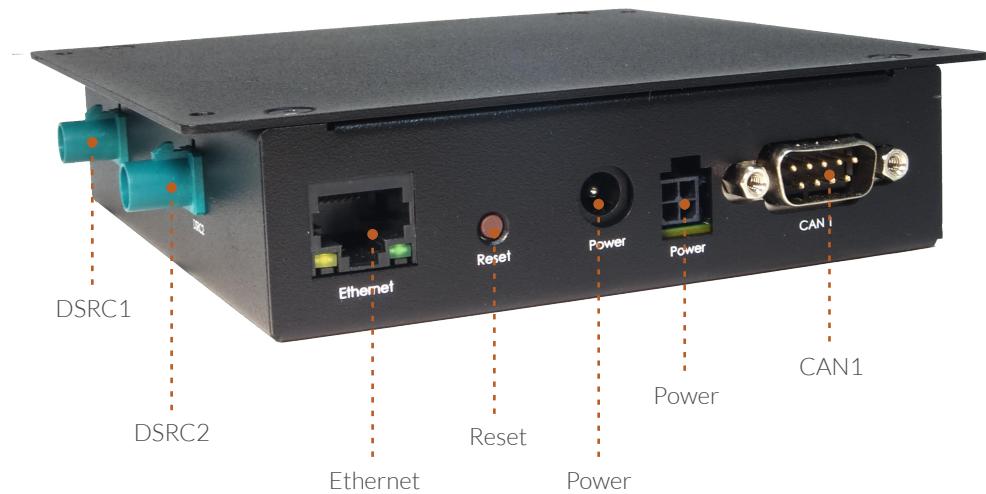
- Eco Cooperative Adaptive Cruise Control
- Eco-traffic signal timing
- etc..



Main Interfaces of OBU-201U

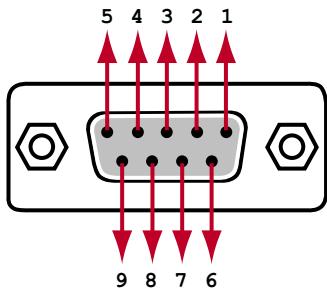
Dimension: 125mm (L) x 109.5mm(W) x 30mm (H)

Housing: zinc coating steel plate (1mm thickness) in black color



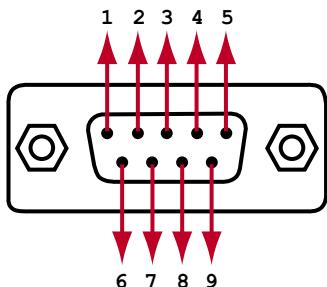
Pin Definition:

RS-232 (Female)



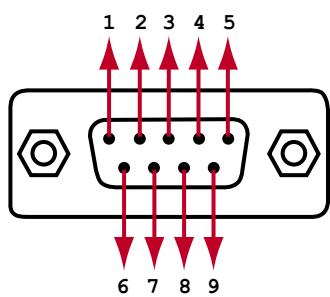
| Pin No. | Pin Name | Type | Description |
|---------|----------|------|----------------------|
| 1 | NC | - | Not connected |
| 2 | RXD | O | Serial data to DTE |
| 3 | TXD | I | Serial data from DTE |
| 4 | NC | - | Not connected |
| 5 | GND | G | Ground |
| 6 | NC | - | Not connected |
| 7 | NC | - | Not connected |
| 8 | NC | - | Not connected |
| 9 | NC | - | Not connected |

CAN1 (Male)



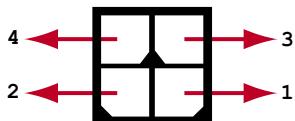
| Pin No. | Pin Name | Type | Description |
|---------|----------|------|---------------|
| 1 | NC | - | Not connected |
| 2 | CAN_L | I/O | CAN Low |
| 3 | GND | G | Ground |
| 4 | NC | - | Not connected |
| 5 | NC | - | Not connected |
| 6 | NC | - | Not connected |
| 7 | CAN_H | I/O | CAN High |
| 8 | NC | - | Not connected |
| 9 | NC | - | Not connected |

CAN2 (Male)



| Pin No. | Pin Name | Type | Description |
|---------|----------|------|---------------|
| 1 | NC | - | Not connected |
| 2 | CAN_L | I/O | CAN Low |
| 3 | GND | G | Ground |
| 4 | NC | - | Not connected |
| 5 | NC | - | Not connected |
| 6 | NC | - | Not connected |
| 7 | CAN_H | I/O | CAN High |
| 8 | NC | - | Not connected |
| 9 | NC | - | Not connected |

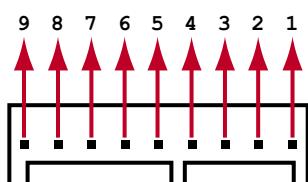
4-pin Power Input



| Pin No. | Pin Name | Level | Description |
|---------|----------|----------------|--|
| 1 | GND | - | Ground |
| 2 | GND | - | Ground |
| 3 | VBatt. | 6~32V 0.1mA | Automotive battery voltage (GNSS RTC power)* |
| 4 | ACC | 6~32V 0.5A | Vehicle accessories power (System main power) |

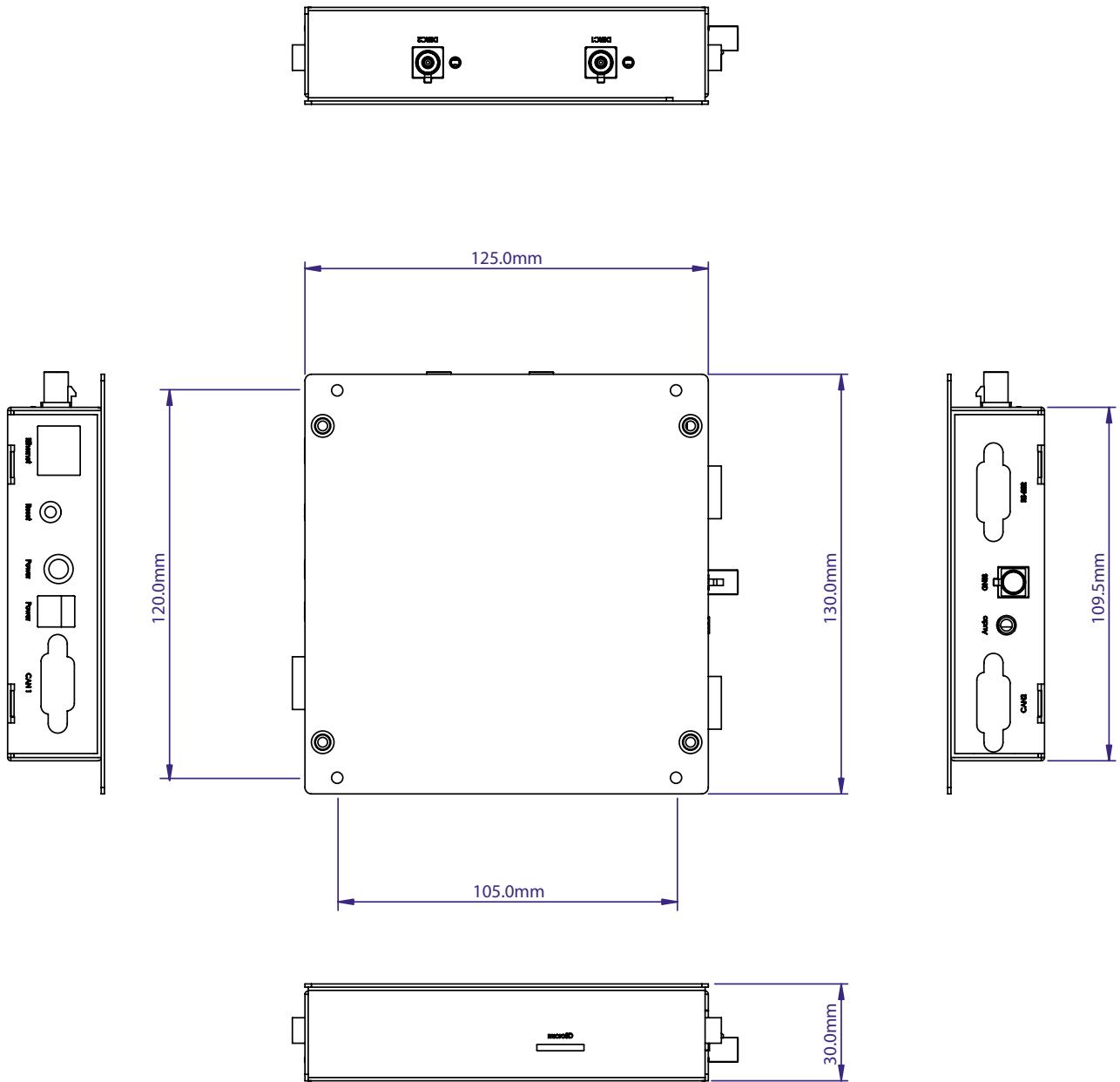
* RTC power allows hot start for faster startup upon reapplication of main power.

9-pin GPIO Headers (on-board JP14)



| Pin No. | Pin Name | Level | Description |
|---------|----------|-------|--|
| 1 | EX_PPS | 3.3V | External 1PPS signal |
| 2 ~ 8 | GPIO | 3.3V | High-level output current: -10mA Low-level output current: 25mA |
| 9 | GND | - | Ground |

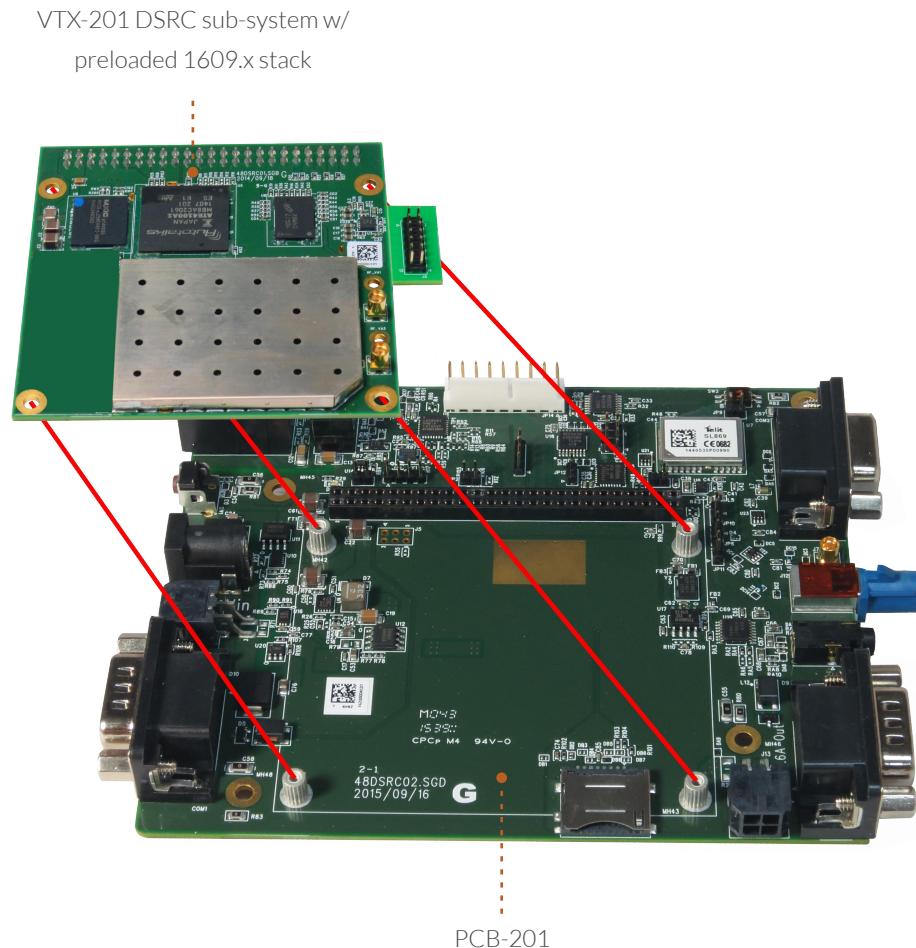
Mechanical Outline



Module-Structure Enables Variable OBUs:

OBU-201U is an automotive-grade V2X OBU which integrates VTX-201 DSRC sub-system, PCB-2011 GNSS/HSM carrier board, and 1609.x stack in an aluminum enclosure. Module-structured architecture provides high application flexibility to:

1. easily customize PCB-201 carrier board to create own unique V2X On-board unit.
2. smoothly integrate VTX-201 sub-system to other platform to speed V2X innovation, no impact on existing V2X software, services, and RF performance.



Specifications:

Software:

| | |
|------------------|---|
| Operation System | ThreadX RTOS |
| Firmware | Preloaded standard compliance stack and firmware including: <ul style="list-style-type: none">» IEEE 802.11p - 2010» IEEE 1609.2 - 2016» IEEE 1609.3 - 2016» IEEE 1609.4 - 2016» SAE J2735_201603» OSLink: WSM-UDP converter |
| Development Tool | <ol style="list-style-type: none">1. Unex's SDK (contains header files (.h), archived object codes (.a), example codes (.c), makefile, API guide, environment setup guide, quick start guide)2. GCC cross compiler to compile ThreadX OS image under Linux3. Hardware Guide4. User's Guide |
| System Service | RS-232 console port (baud rate 115200 bps) |

Hardware:

| | |
|---------------|--|
| Chipset | <ul style="list-style-type: none">» Autotalks® CRATON V2X communication processor, three 240MHz CPU cores» Autotalks® PLUTON V2X RF Transceiver» Telit® SL869 GNSS module» Infineon SLE97 Hardware Security Module (HSM) |
| System Memory | 32MB NOR, 128MB DDR3 |
| DSRC | <ul style="list-style-type: none">» frequency band: 5.85 ~ 5.925 GHz (ITS-DSRC)» radio mode: 802.11p, ITS-G» channel: 172, 174, 176, 178, 180, 182, 184» channel bandwidth: 10MHz (5MHz & 20MHz by project)» data rate: 3, 4.5, 6, 9, 12, 18, 24, 27Mbps for 10MHz BW signal» RF transmit power: > +20dBm, Class C RF spectrum mask compliant with margins.» frequency accuracy: ± 6.0ppm |

**DSRC Static
Sensitivity (Typical)
(typical, tolerance
+2 / -2dB)**

| Conditions | -40°C | +25°C | +85°C |
|------------|--------|--------|--------|
| 3Mbps | -97dBm | -93dBm | -92dBm |
| 4.5Mbps | -97dBm | -93dBm | -92dBm |
| 6Mbps | -95dBm | -91dBm | -91dBm |
| 9Mbps | -93dBm | -89dBm | -89dBm |
| 12Mbps | -90dBm | -86dBm | -85dBm |
| 18Mbps | -86dBm | -83dBm | -83dBm |
| 24Mbps | -80dBm | -75dBm | -75dBm |
| 27Mbps | -78dBm | -74dBm | -73dBm |

**DSRC Fading
Sensitivity**

Power @ 10% PER sensitivity (6Mbps, 1000B packet), fading channels as 5 typical C2C multipath scenarios defined by ETSI: ± 2dBm

- » Rural LOS: -92.5dBm
 - » Highway LOS: -91.5dBm
 - » Urban Approaching LOS: -91.5dBm
 - » Crossing NLOS: -89.5dBm
 - » Highway NLOS: -88.5dBm
-

GNSS

- » refresh Rate: 10Hz
 - » sensitivity: -135dBm
 - » NMEA Standard: NMEA 0183
 - » accuracy: 1.5m (CEP50 with SBAS)
-

Hardware Security

- » ECDSA 256-bit signing (<50ms)
 - » private key and public key verification (over 2,000 ECDSA 256-bit verifications per second)
 - » secure storage of private keys in HSM
-

| | |
|-----------------------|---|
| External Connector | <ul style="list-style-type: none"> » two 500 kbps CAN 2.0b DE-9 (DB-9) male ports » one 10/100Mbps Ethernet port » one RS-232 DE-9 (DB-9) female for system debug (baud rate 115200 bps) or external GNSS inputs of NMEA and PPS. » one audio jack » one reset button » one microSD (SafeFAT support for up to 8GB) |
| On-Board Interface | <ul style="list-style-type: none"> » 9 GPIO pins (JP14) » MMCX connector |
| Antenna | <ul style="list-style-type: none"> » two detachable FAKRA type Z DSRC 5dBi Omni Dipole » one detachable FAKRA type C active GNSS antenna, cable length: 5 meters <p>Remarks: OBU-201 uses default FAKRA type C GNSS antenna (set U18 GPIO pin P1 at 1), but can be configured to use on-board MMCX connector (set U18 GPIO pin P1 at 0) as GNSS RF input.</p> |
| External GNSS Support | <ul style="list-style-type: none"> » use RS-232 pin1 or onboard JP14 GPIO pin1 to route external PPS to CRATON » RS-232 pin2 as NMEA UART Rx » RS-232 pin3 as NMEA UART Tx |
| Power Supply | <p>dual power input:</p> <ol style="list-style-type: none"> 1. power round jack 2. 4-pin power connector, supporting Vbatt to enable GNSS RTC hot start |
| Operation Voltage | DC 6-32 V± 5% |

| Power Consumption | 12V power input | | | |
|--------------------------------------|--|-------|--------|-------|
| | Condition | 25°C | 85°C | -40°C |
| Tx @ 20~8dBm (RF duty cycle = 7%) | | 0.3A | 0.315A | 0.3A |
| Idle | | 0.29A | 0.3A | 0.29A |
| Power Management | three states of Idle, ON, and OFF | | | |
| Operation Temperature Range | ambient: -40°C ~ +85°C (Infineon SLE97 Hardware Security Module supports -20°C ~ +85°C) | | | |
| Operating Humidity | 10% ~ 95%, non-condensing | | | |
| Storage Humidity | max. 95%, non-condensing | | | |
| System Service | RS-232 console port (baud rate 115200 bps) | | | |
| Housing | aluminum plate, thickness: 1.0mm | | | |
| Product Dimension | 125mm (L) x 109.5mm(W) x 30mm (H) | | | |
| Packing Box Size | 305mm (L) x 212mm (W) x 68mm (H) | | | |
| Carton Packing | 4 boxes in one carton | | | |

Package contents:

1. OBU-201U x 1 with preloaded IEEE 1609.2/3/4 stack running on ThreadX
2. Two DSRC omni dipole detachable antennas, 5.9GHz FAKRA type Z
3. One GPS active detachable antenna, FAKRA type C, cable length 5 meters
4. One 4-pin power cable
5. One 12V/1A 110~240V round-jack power adaptor
6. SDK, Hardware Guide and User's Guide downloaded from Unex server.

Ordering Information:

| | |
|----------|--|
| OBU-201U | V2X On-Board Unit, 1609.x protocol stack |
| OBU-201E | V2X On-Board Unit, ETSI TC-ITS protocol stack |
| OBU-201 | V2X On-Board Unit |
| EX-20 | USB (A-male) to RS-232 (DE-9 male) cable, Prolific PL2303 chipset, cable length 1.8 meters |

Recommended Software Option:

MISRA C: 2012 compliance facilitates software code to ensure safety, portability and reliability in Unex's V2X embedded systems.

VAS-201x

CAMP VSC-A or ETSI TC-ITS Day-One or field V2X applications

VVT-201

V2X Diagnostic Firmware

V2X Turn-Key Pilot Deployment

by project request.