V2X mPCIe System-on-Module

SOM-352EC

C-V2X system-on-module, V2Xcast® ETSI C-ITS stack and SDK
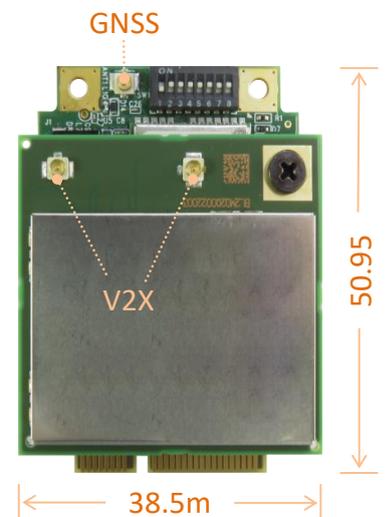
SOM-352ED

DSRC-V2X system-on-module, V2Xcast® ITS-G5 stack and SDK

SOM-352UC

C-V2X system-on-module, V2Xcast® IEEE 1609/SAE J2735 stack and SDK

SOM-352UD

DSRC-V2X system-on-module, V2Xcast® IEEE 1609/SAE J2735 stack and SDK

SOM-352 is a complete V2X function sub-system. With an embedded V2X stack and SDK in mPCIe, its design can easily perform secondary software development for V2X；and effortlessly embedded into any existing vehicle/industrial PC, communication platform, or I/O carrier board with a mPCIe slot, enabling V2X or V2X-sensor fusion applications for vehicle aftermarket, intelligent transportation, and smart road traffic application and deployment.

Global V2X supported, SOM-352 can flexibly shift between DSRC-V2X or C-V2X with one V2X stack (IEEE 1609 or ITS-G5 V2X standard) through a firmware update, reducing the cost and complexity for global deployment. Consistent V2Xcast® API preserves all the value of software add-ons for any future technology change or protocol standard update.

With embedded C-ITS or ITS-G5 or IEEE 1609 stack/SAE J2735 Messages and ready-to-use V2X service profiles, users can directly configure the profiles to compose J2735 or ITS Messages per service requirements, and develop V2X applications without the hassle of handling or setting the V2X protocol details from scratch.

Advanced GNSS functions include Dead Reckoning with integrated IMU, update rate over 20Hz GNSS and multiple concurrent constellations; these provide better positioning accuracy, time synchronization, and lane-leveled position accuracy for smoother vehicle trajectory on urban roads.

- ❖ Complete V2X system in small 50.95 x 38.5 mm product size with standard mPCIe pin-definition, containing CRATON2/PLUTON2 V2X chipsets, GNSS, eHSM, 256MB DDR3 RAM, 512MB NAND, and V2Xcast® software.

- ❖ A rich V2Xcast® firmware containing:

  - ◆ Standard compliant V2X stacks.

  - ◆ User friendly APIs for Service, Tx/Rx, PoTi, J2735 or ITS-G5 compliant Messages encode/code.

  - ◆ Application example codes, including Event Detector to detect remote vehicle and roadside events, Traffic Signal Detector to detect current position's signal phase, RTK Sample Application to improve GNSS accuracy.

- ❖ Dead Reckoning with integrated IMU, update rate over 20Hz GNSS and multiple concurrent constellations provide better positioning accuracy and time synchronization for V2X applications.

- ❖ Secured V2X communication supports SCMS or CCMS including the V2X PKI certificate management and the private key operation on the embedded Hardware Security Module (eHSM).

- ❖ In addition to standard mPCIe connection, an additional external Molex 7-pin onboard connector can be used as a supplement to support the inputs which is not supported directly from the host mPCIe slot.

- ❖ Antenna detection and diagnose supported.

- ❖ Support DFU mode using command from the host platform to update the SOM firmware.

- ❖ Wide-ranged -40°C ~ +85°C operating temperature complies with industrial application requirements.

- ❖ Software-defined design lets the SOM flexibly shift between DSRC-V2X or C-V2X with one V2X stack (IEEE 1609 or ITS-G5 V2X standard) through a firmware update.

- ❖ Lowest entry and total ownership cost: bundle license right to use the software on the hardware (per MAC address) at one fixed price, no extra license fee or royalty required.

System Block Diagram
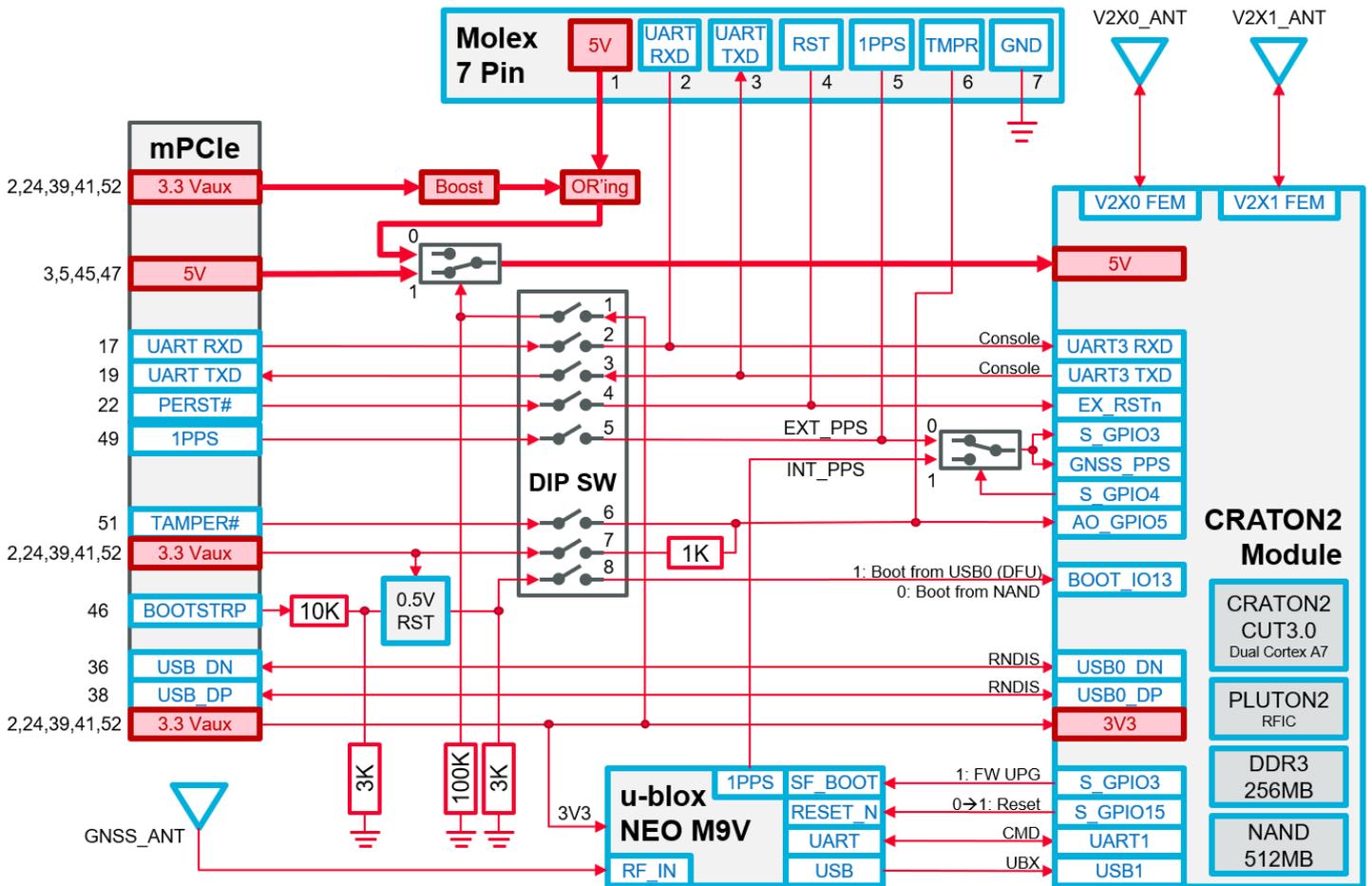
Computing Host Platform Requirements
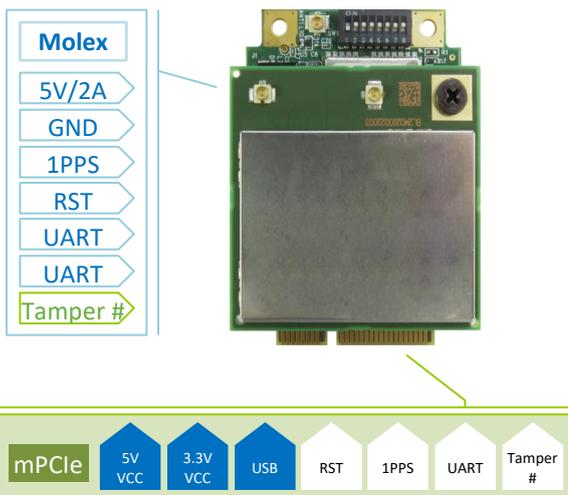
Host platform system requirements:
1. OS: Linux v4.x or above.
2. Library: ARM v8 64-bit or ARM v7a 32-bit or x86 64-bit.
3. USB host mode.
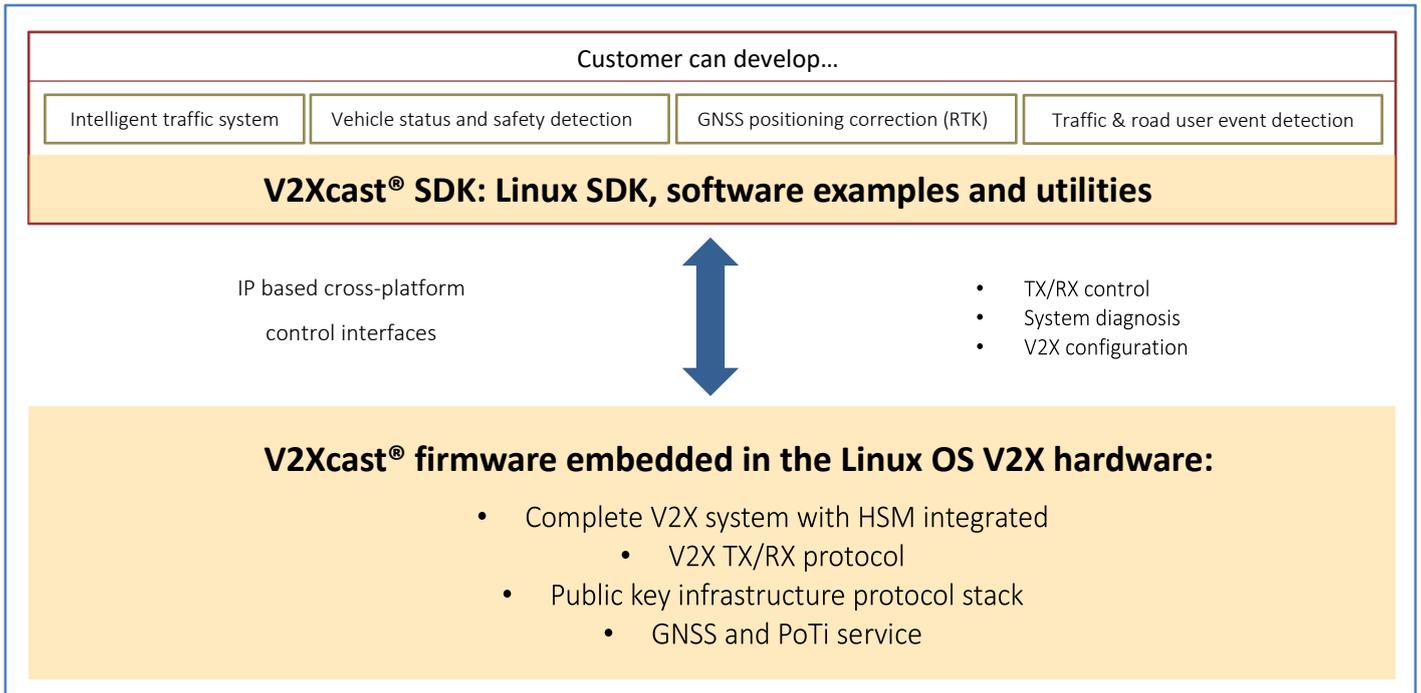4. RNDIS to support Ethernet over USB, no driver porting required.
5. One free mPCIe slot

Power supply requirements:
In addition to 3.3V power & USB inputs from standard mPCIe pins, supply DC 5V/2A power either to mPCIe or to Molex is recommended.
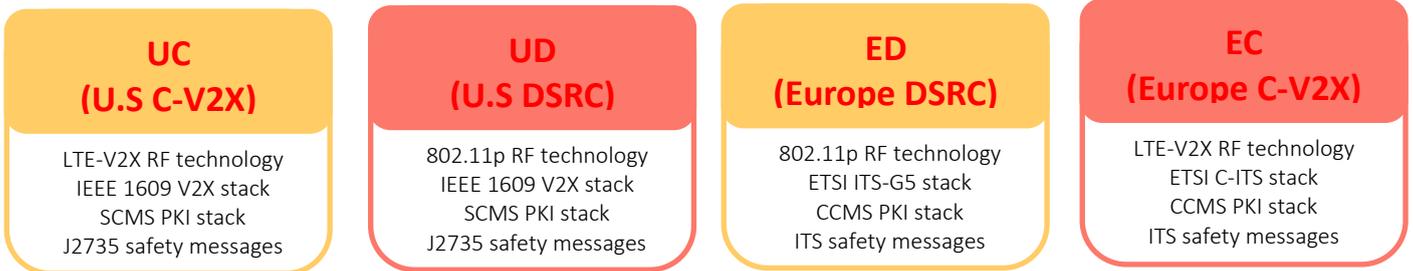
Note: Typical power consumption is 4W.

- 🟦 mandatory inputs: 3.3V and USB; recommended input: 5V
- ⬜ non-mandatory inputs.
- ⬜ external Molex connector as alternatives.

V2Xcast® Firmware

Customer can develop…

| Intelligent traffic system | Vehicle status and safety detection | GNSS positioning correction (RTK) | Traffic & road user event detection |

V2Xcast® SDK: Linux SDK, software examples and utilities

IP based cross-platform

control interfaces

- TX/RX control
- System diagnosis
- V2X configuration

V2Xcast® firmware embedded in the Linux OS V2X hardware:

- Complete V2X system with HSM integrated
- V2X TX/RX protocol
- Public key infrastructure protocol stack
- GNSS and PoTi service

*4 versions existed. Firmware update fee required.

UC (U.S C-V2X)
LTE-V2X RF technology
IEEE 1609 V2X stack
SCMS PKI stack
J2735 safety messages

UD (U.S DSRC)
802.11p RF technology
IEEE 1609 V2X stack
SCMS PKI stack
J2735 safety messages

ED (Europe DSRC)
802.11p RF technology
ETSI ITS-G5 stack
CCMS PKI stack
ITS safety messages

EC (Europe C-V2X)
LTE-V2X RF technology
ETSI C-ITS stack
CCMS PKI stack
ITS safety messages

■ ■ Unex V2X platform SOM, OBU, RSU   ■ Unex's Software & SDK (V2Xcast®)   □ Custom's Add-on Software

Global V2X solution in mPCIe form

Innovative software-defined design lowers the total ownership cost in field application, the same SOM can flexibly shift between DSRC-V2X or C-V2X with one V2X stack (IEEE 1609 or ITS-G5 V2X standard) through local/remote firmware update.

Remarks: For shifting requirements from DSRC-V2X to C-V2X on the same MAC address (vice-versa) V2X hardware, extra license fee would be required.
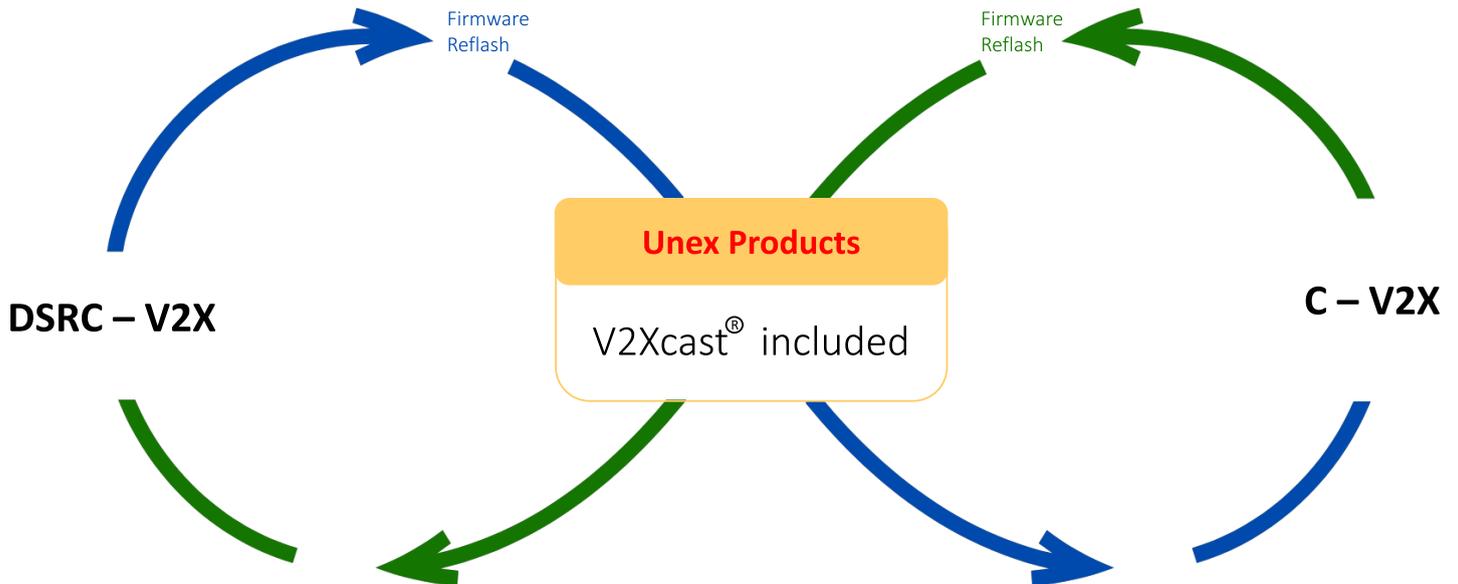
Specifications

Chipset

- ❖ Autotalks® CRATON2 V2X communication processor
- ❖ Autotalks® PLUTON2 V2X RF Transceiver
- ❖ Embedded Hardware Secure Module (eHSM)
- ❖ u-blox® NEO-M9V GNSS module

Operation System

Linux Yocto

Form Factor

PCI Express Mini Card (Mini PCIe), 51.0 mm x 38.5 mm PCBA size, 8.5 mm wider than the standard

Host Interface

USB 2.0 (480 Mbits/s)

System Memory

512MB NAND, 256MB DDR3

Preloaded Firmware

- ❖ SOM-352EC: V2Xcast® ETSI C-ITS stack including LTE-V2X (PC5), CAM/DENM, GN/BTP, Security, PoTi, *ETSI C-ITS standard over LTE-V2X is still draft only.
- ❖ SOM-352ED: V2Xcast® ITS-G5 stack including IEEE802.11p, Facility Message, GN/BTP, DCC, Security, PoTi, C2C-BSP
- ❖ SOM-352UC: V2Xcast® C-V2X stack including 1609.2, 1609.3, IEEE1609.2.1, SAE J2735, PoTi
- ❖ SOM-352UD: V2Xcast® IEEE1609/SAE J2735 stack for 802.11p WAVE including 1609.2, 1609.3, 1609.4, IEEE1609.2.1, SAE J2735, PoTi

Development Tool

V2Xcast® SDK, including Service, Tx/Rx, PoTi, J2735 or ITS-G5 compliant Message APIs and application example codes

Hardware Security

- ❖ Dedicated ROM containing certified secure V2X signing firmware
- ❖ Secure encrypted off-chip storage of private keys
- ❖ Private material is inaccessible outside HSM
- ❖ Capable of >110 signatures / second, with <9ms signing latency for ECDSA NIST P256 or ECDSA Brain pool P256R1

- ❖ Line-rate ECDSA verification engine (>2500 ECDSA NIST P256 verifications / second)
- ❖ Tamper detection*

(*. Support by project)

V2X

- ❖ Supported Frequency band: 5.895 ~ 5.925 GHz
- ❖ DSRC-V2X Radio mode: 802.11p
- ❖ C-V2X Radio mode: 3GPP LTE-V2X Rel.14/15 PC5 sidelink
- ❖ RF transmit power: max. +20dBm on antenna port, Class C RF spectrum mask compliant with margins
- ❖ RF receive power: typ. < -92dBm

Remarks: For legacy DSRC WAVE applications, 1). channel switch in 1609.4, and 2). WSA broadcast for ETC are not supported.

GNSS

- ❖ Update rate: max. 20Hz
- ❖ Sensitivity:
  - ◆ Acquisition: -146dBm
  - ◆ Navigation: -159dBm
  - ◆ Tracking: -159dBm
- ❖ NMEA Standard: NMEA 0183

- ❖ Accuracy: sub-meter (CEP50 with SBAS)
- ❖ Constellation support: GPS L1, GLONASS L1, Galileo E1, Beidou B1, and QZSS L1.
- ❖ SBAS L1 C/A support: WAAS (US), EGNOS (EU), MSAS/SLAS (JP), and GAGAN (IN).

Power Consumption

typical 2Watt~4Watt

On-board Interface

- ❖ Mandatory mini PCIe interfaces used:
  - ◆ USB 2.0 (480Mbits/s)
  - ◆ 3.3V mini PCIe power input
  - ◆ 5V power input (proprietary)
- ❖ RF interfaces:
  - ◆ two MHF I RF connectors (V2X)
  - ◆ one MHF I RF connector (GNSS)

- ❖ Optional Proprietary interface:
  - ◆ one UART, one 1PPS, one Reset, one Tamper on mPCIe
  - ◆ one external Molex connector as mPCIe inputs back-up

ESD design

ESD protects all ports in ESD events. (IEC 61000- 4-2 Level 4, Contact ±8kV, Air ±15kV)

Operation Temperature Transmission Distance

- ❖ ambient: -40°C ~ +85°C
- ❖ typical 300 meters, may reach 1,000 meter in open space

EMC RF Regulation

- ❖ CE, FCC Class B, CISPR25 Class 5 (Q2/2024)
- ❖ E-MARK(E13) (Q2/2024)

Storage Humidity

max. 95%, non-conde

Dimension

50.95 mm(L) x 38.5 mm(W) x 11.7 mm (H)

mPCIe Pin Supported and Definition:

Row	Pin	Symbol	Type	Description	Status
0	3	5V	P	5V/2A Power Input (originally reserved)	Proprietary
0	5	5V	P	5V/2A Power Input (originally reserved)	Proprietary
0	9	GND	G		
0	15	GND	G		
0	-	KEY	-	Mechanical Key	
0	17	UART_RX	I	UART receive data input (originally reserved)	Proprietary
0	19	UART_TX	O	UART transmit data output (originally reserved)	Proprietary
0	21	GND	G		
0	27	GND	G		
0	29	GND	G		
0	35	GND	G		
0	37	GND	G		
0	39	3.3 Vaux	P	Max 115mA	
0	41	3.3 Vaux	P	Max 115mA	
0	43	GND	G		
0	45	5V	P	5V/2A Power Input (originally reserved)	Proprietary
0	47	5V	P	5V/2A Power Input (originally reserved)	Proprietary
0	49	1PPS	I	GNSS 1 pulse per second input (active HIGH, originally reserved)	Proprietary
0	51	TAMPER#	I	Tamper detection (active LOW)	Proprietary
1	2	3.3 Vaux	P	Max 115mA	
1	4	GND	G		
1	-	KEY	-	Mechanical Key	
1	18	GND	G		
1	22	PERST#	I	Module Reset (Internally pulled up. Active LOW, pulse)	
1	24	3.3Vaux	P	Max 115mA	
1	26	GND	G		
1	34	GND	G		
1	36	USB_D-	I/O	USB 2.0 differential data (-)	
1	38	USB_D+	I/O	USB 2.0 differential data (+)	
1	40	GND	G		
1	46	BOOTSTRP	I	DFU mode	Proprietary
1	50	GND	G		
1	52	3.3 Vaux	P	Max 115mA	

Molex on-board connector
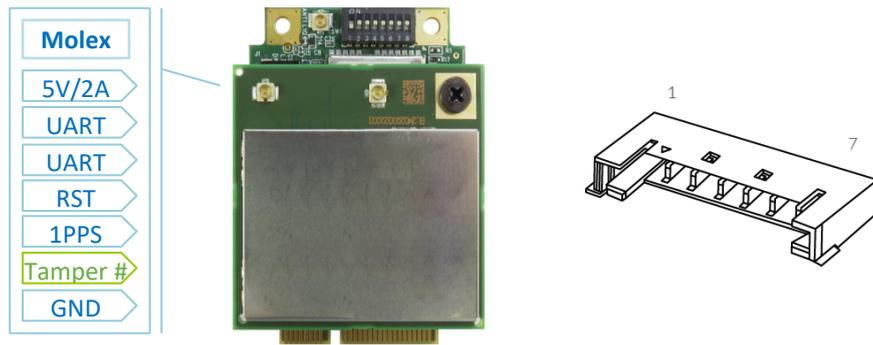
Function	Pin	Name	Type	Level	Description
Power	1	5V	P	5	5V power
UART	2	RXD	I	3.3	UART RXD
	3	TXD	O	3.3	UART TXD
Reset	4	EX_RSTn	I	3.3	CRATON2 (active LOW) Min assertion time: 10ms
1PPS	5	1PPS	I	3.3	1PPS
Tamper	6	TAMPER#	I	3.3	Tamper switch signal (active LOW)
Ground	7	GND	G		Ground

Product SKU and Ordering Information

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SOM-352EC

C-V2X system-on-module, V2Xcast® ETSI C-ITS stack and SDK

SOM-352ED

DSRC-V2X system-on-module, V2Xcast® ITS-G5 stack and SDK

SOM-352UC

C-V2X system-on-module, V2Xcast® IEEE 1609/SAE J2735 stack and SDK

SOM-352UD

DSRC-V2X system-on-module, V2Xcast® IEEE 1609/SAE J2735 stack and SDK

SOM-352EC/SOM-352ED/SOM-352UC/SOM-352UD Package contents

❖ One SOM with pre-loaded V2X stack & firmware (C-V2X or DSRC-V2X technology with one ITS-G5 or IEEE 1609 stack/SAE J2735 Messages).

❖ Hardware / Software User's Guide and V2Xcast® SDK download email link after shipping.

Optional Accessory

EX-31: active GPS antenna	EX-55: V2X antenna	80-00043: MHF-FAKRA cable

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