TCU-FITAX-3.5

DSRC OBU User Manual

Version 01.04

Version:	V01.00	V01.01	V01.02	V01.03	V01.04			
Author:	MVT	MVT	MVT	MVT	MVT			
Date:	23/03/20	11/05/20	20/05/20	22/05/20	22/06/20			

Revision History:

Date	Version	Description
23/03/2020	V01.00	First Draft
11/05/2020	V01.01	Added Review Comments: • **Section 2.2** – Label Design modified to include Part name, Model Name, FCC ID and FCC Id of the LTE Module. • **Section 2.5** – Added information related to maximum gain for a permitted Antenna. • **Section 10.1** – Added Details for a "Permitted Antenna"
20/05/2020	V01.02	Updates following review comments: • **Section 10.1** – Remove Antenna Type information from table. • **Section 10.1** – Include Max Gain Data for GSM, WCDMA, and LTE Technology. • **Section 10.1** – Include Unlicensed Bands information. • **Section 5.1** – Remove PCB Photo.
22/05/20	V01.03	Updates following review comments: • **Section 10.1 –** Added comment about operational mode of DSRC channels.
22/06/20	V01.04	Updates following review comments: • **Section 10.3 –** Update Regulatory Information to reflect Class A compliance.

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Acronyms

OBU	On Board Unit
DSRC	Dedicated Short Range Communications
V2X	Vehicle-To-Everything
HV	Host Vehicle
RV	Remote Vehicle
EEBL	Emergency Electronic Brake Lights
FCW	Forward Collision Warning
BSW	Blind Spot Warning
LCW	Lane Change Warning
DNPW	Do Not Pass Warning
IMA	Intersection Movement Assist
LTA	Left Turn Assist
RTA	Right Turn Assist
SPD	Speed Limit Warning
CSW	Curve Speed Warning

1. Introduction

The purpose of this document is to describe and list all the functionalities and capabilities of DSRC OBU from an end user point of view.

The acronyms DSRC stands for “Dedicated Short Range Communications” which is the technology that allows V2X communications based on Standard 802.11p.

The following data is related to the DSRC OBU for what concerns FCC Certification.

- Model Name: TCU-FITAX-3.5
- FCC ID: 2AVOU-AAA2020FTX35

In addition, the Main Board contains an LTE Module with P/N being SC20ASA-8GB-STD, the FCC ID of which is: ***XMR201706SC20A***

2. DSRC OBU System Description

2.1 DSRC OBU - General Assembly Overview

The following pictures show an overview of the DSRC On-Board-Unit from Top and Bottom Side.

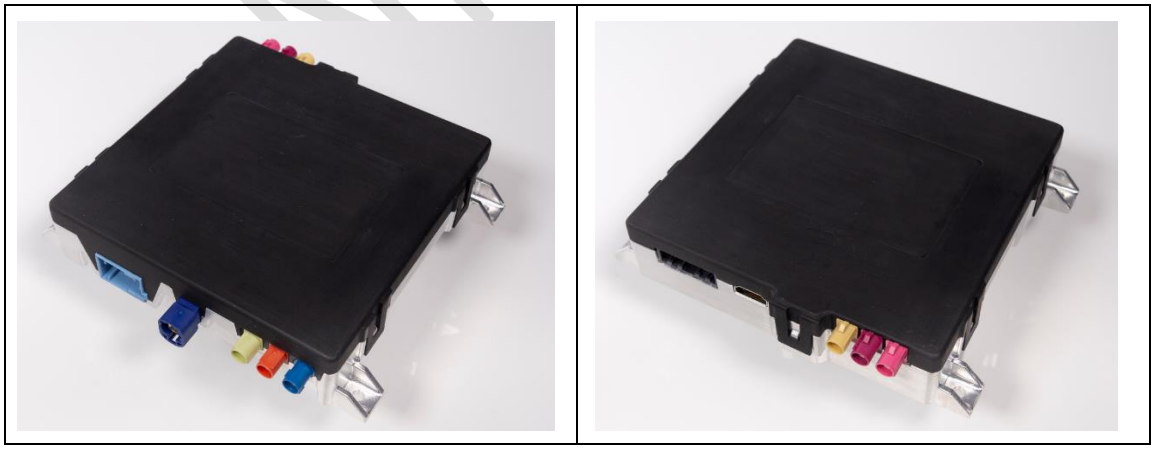

Figure 1. Top View of the DSRC Units (Plastic side).

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Author:	MVT	MVT	MVT	MVT	MVT			
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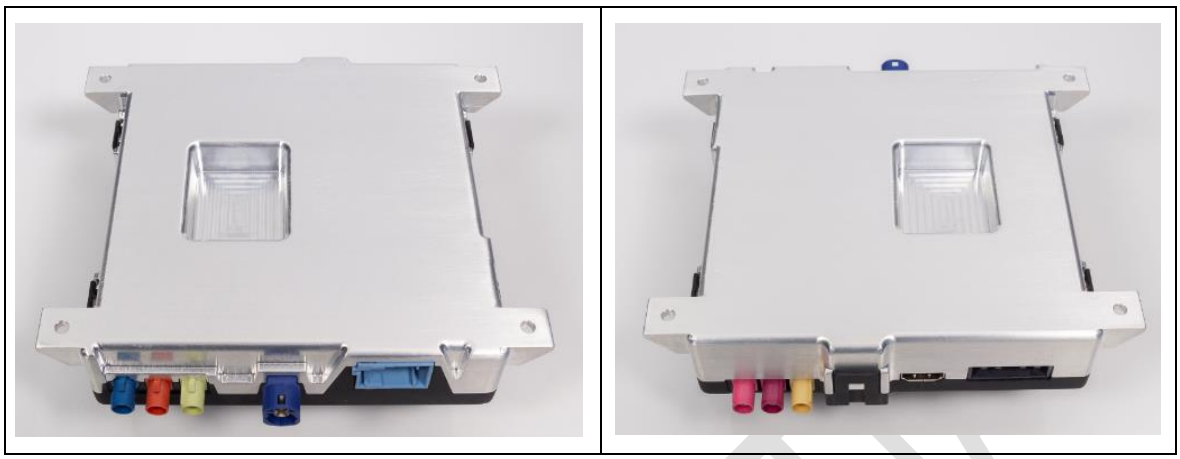

Figure 2. Bottom View of the DSRC Units (Metal side)

The OBU Bottom side is made of metallic material in order to ease thermal dissipation of the most critical components.

In addition, below is shown a breakdown of the DSRC OBU Mechanical Assembly along with the weight for each individual item.

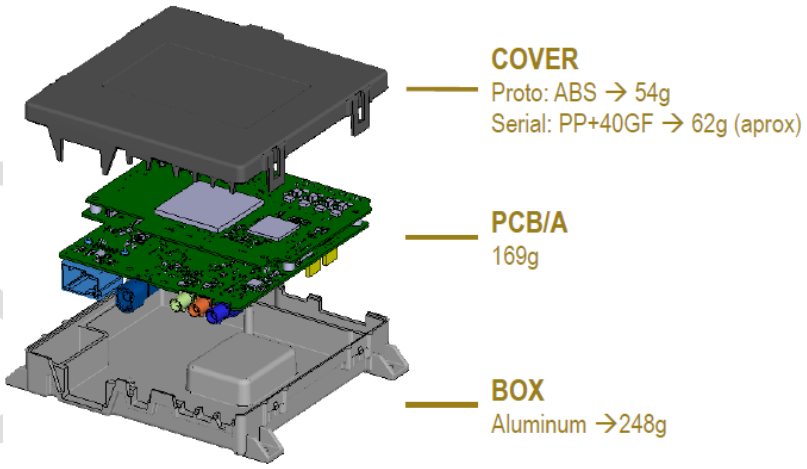

Figure 3. DSRC OBU Mechanical Breakdown and Weight

The Total Weight of the Unit is **470 g.**

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Author:	MVT	MVT	MVT	MVT	MVT			
Date:	23/03/20	11/05/20	20/05/20	22/05/20	22/06/20			

2.2 DSRC OBU - Label Details

The template of the DSRC OBU label is captured in Figure 4 along with the relevant dimensions.

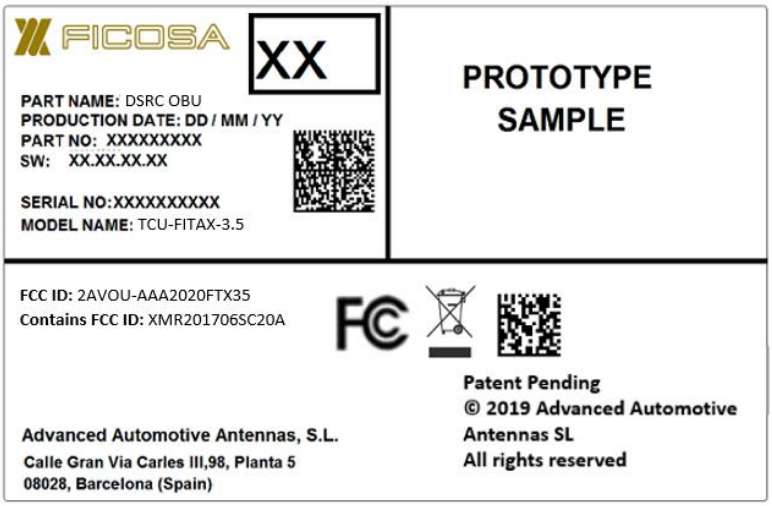

Figure 4. DSRC OBU Label Description

There is a specific area on the Top Side of the DSRC OBU to allocate the Label as shown below.

Figure 5. DSRC OBU Label Placement and Dimensions

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Author:	MVT	MVT	MVT	MVT	MVT			
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2.3 DSRC OBU - External Dimensions

Below are shown the overall dimensions of the DSRC OBU.

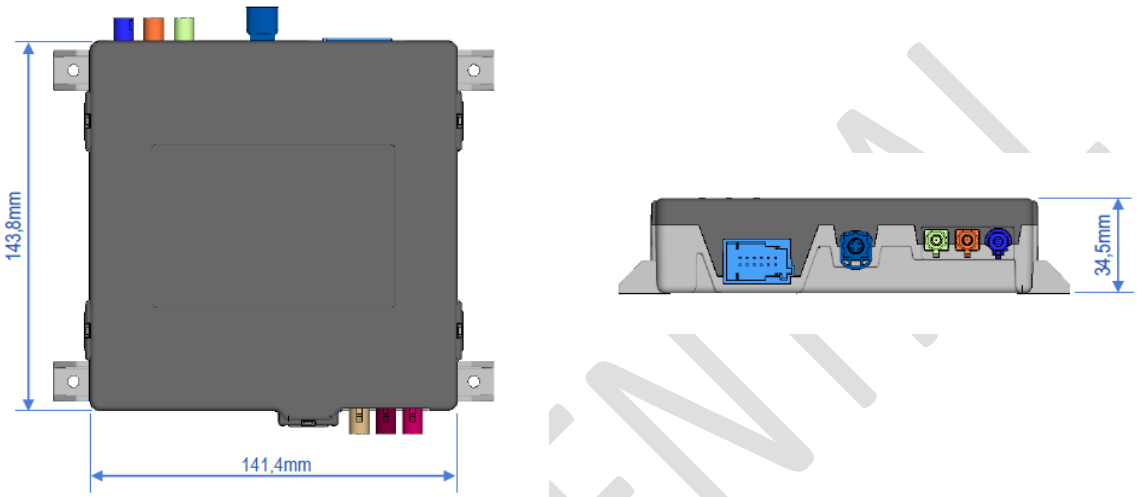

Figure 6. DSRC OBU Overall Dimensions

2.4 DSRC OBU - Boards

The DSRC OBU consist of two boards:

- **Main Board:** This Board provides the V2X Communications capability. It contains mainly the Main Processor, the RF Front-End, GNSS Receiver and Power Management.
- **HMI Board:** The HMI Board provides the Wifi/BT, LTE connectivity, HDMI, Audio and Ethernet interfaces as well as CAN interfaces. In addition, it includes an Android Microprocessor to develop 3er Party Applications.

2.5 DSRC OBU - System Architecture Overview

The below picture shows the System Architecture of the V2X Main Board.

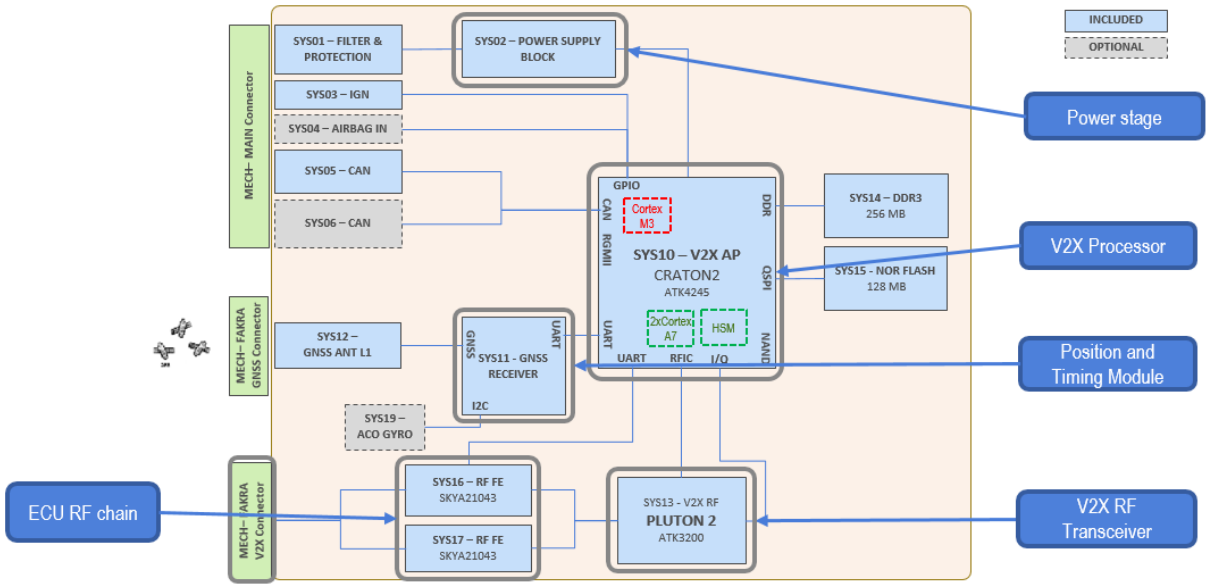

Figure 7. Main Board System Architecture

The following Figure shows the Architecture of the OBU as Assembly, V2X Main Board + HMI Board.

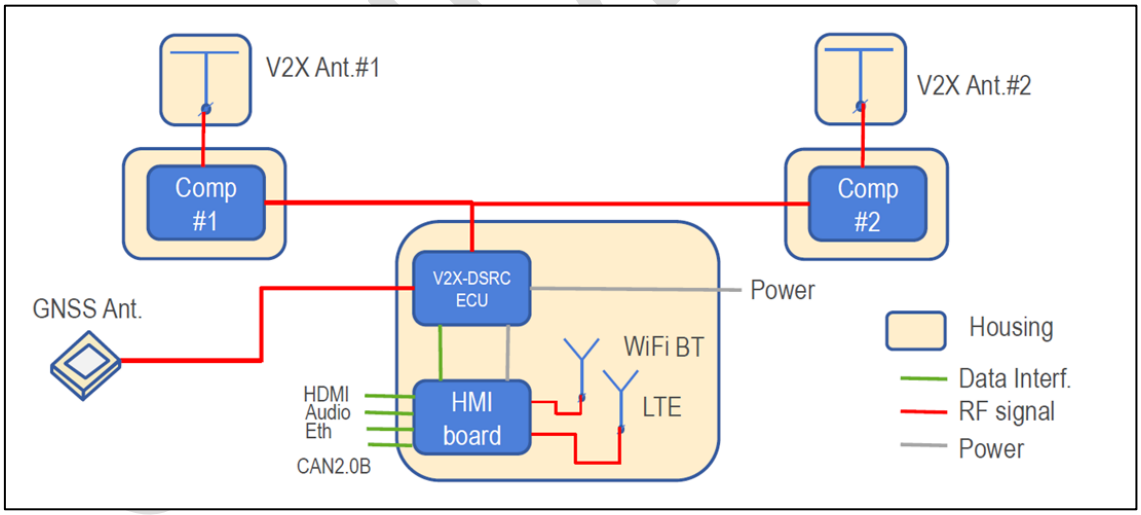

Figure 8. DSRC OBU System Architecture (Main + HMI Board)

Although the Antennas are shown in the above diagram to aid understanding of the overall system, these particular items are not supplied as part of DSRC OBU Product. The OBU will provision Antenna Interfaces but the Antennas themselves are responsibility of the party in charge of vehicle integration.

Version:	V01.00	V01.01	V01.02	V01.03	V01.04			
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If the device operates in the specified bands (as per Section 10.1), an Antenna with maximum gain of 3dBi must be used.

2.6 DSRC OBU – Interfaces Description

Below are identified all the interfaces of the DSRC OBUs.

There are ten external interfaces:

- Main connector
- Ethernet BroadR-Reach
- GNSS (active antenna with phantom feeding)
- V2X Channel 0
- V2X Channel 1
- LTE 1
- LTE 2
- WiFi/Bluetooth
- HDMI
- CAN

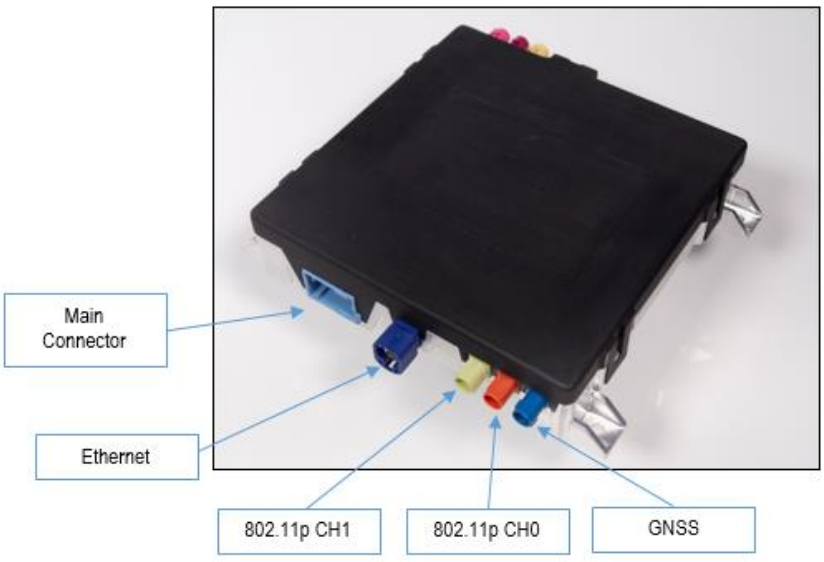


Figure 9. DSRC OBU Interfaces

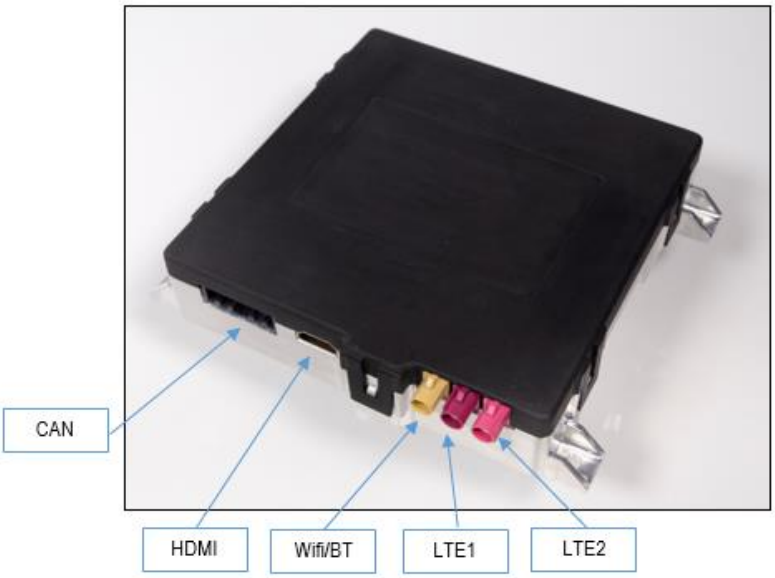


Figure 10. DSRC OBU Interfaces

2.6.1 MAIN Connector Pin-Out

The main connector provides the OBU a direct line from the Vehicle Battery of 12 Volts, it can also be connected to the Ignition line for IGN based wake-up of the OBU.

Below are shown the Pin_Out Details of the Main Connector.

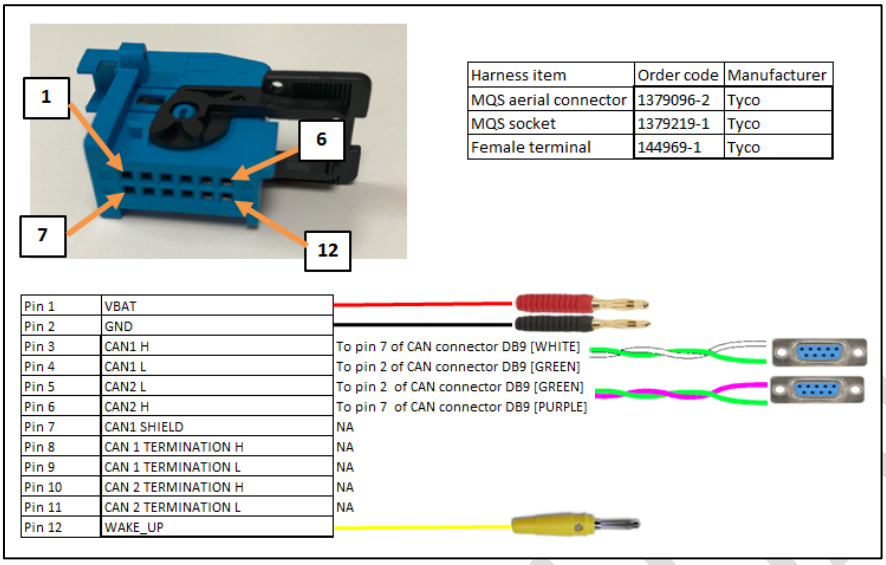
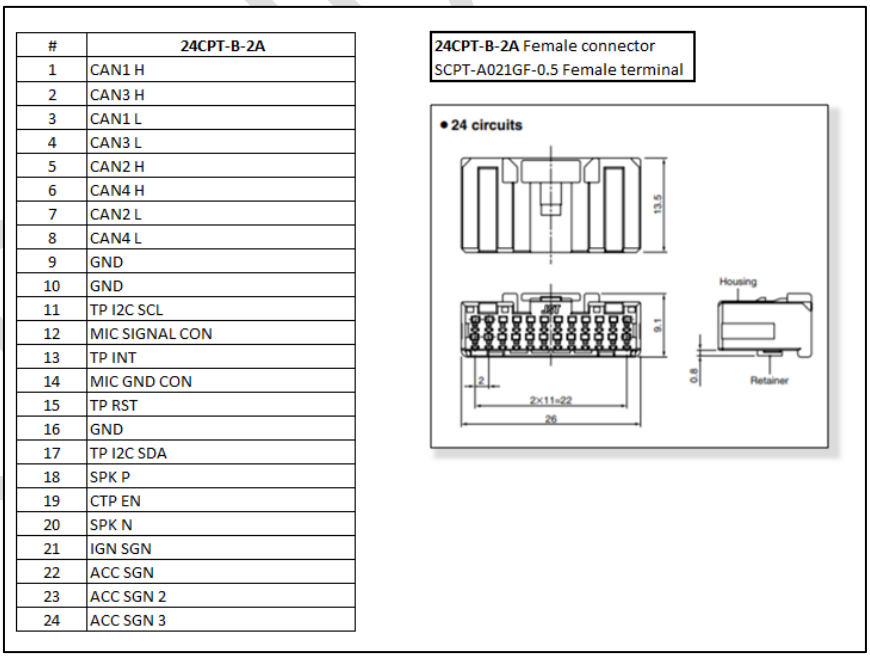


Figure 11. Main Connector Pin-Out

2.6.2 HMI & CAN Connector Pin-Out

The HMI/CAN Connector provides the OBU connection to the Internal CAN Network of the vehicle, it can also be used to map audio and microphone.



#	24CPT-B-2A
1	CAN1 H
2	CAN3 H
3	CAN1 L
4	CAN3 L
5	CAN2 H
6	CAN4 H
7	CAN2 L
8	CAN4 L
9	GND
10	GND
11	TP I2C SCL
12	MIC SIGNAL CON
13	TP INT
14	MIC GND CON
15	TP RST
16	GND
17	TP I2C SDA
18	SPK P
19	CTP EN
20	SPK N
21	IGN SGN
22	ACC SGN
23	ACC SGN 2
24	ACC SGN 3

Figure 12. HMI/CAN Connector Pin-Out

Version:	V01.00	V01.01	V01.02	V01.03	V01.04			
Author:	MVT	MVT	MVT	MVT	MVT			
Date:	23/03/20	11/05/20	20/05/20	22/05/20	22/06/20			

3. Electrical Characteristics

		Min	Typ	Max	Units
Operating temperature range		-40	25	70	ºC
Operating voltage range		9	12	18	V
Current consumption ON mode [Vin=12V8, T=25ºC]	Average	-	446	-	mA
	Peak	383	-	813	mA
Current consumption BOOTA mode [Vin=12V8, T=25ºC]	Average	-	161	-	mA
	Peak	149	-	179	mA
Current consumption BOOTB mode [Vin=12V8, T=25ºC]	Average	-	412	-	mA
	Peak	193	-	780	mA
Current consumption OFF mode		-	-	3,4	mA

4. DSRC OBU Power up Procedure

The DSRC OBU must be powered up at 12 V. In case the maximum Amperage was to be limited, it would be set, at least, to 1 A. Note that positive (Red), IGN Line (Blue) and negative (Black) line connectors must be plugged to the power source as shown below.

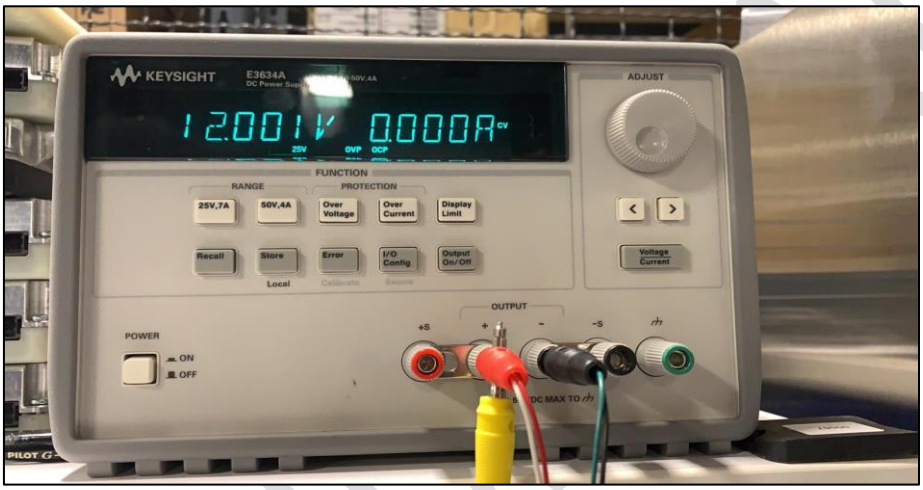


Figure 13. DSRC OBU Power up using Power Supply

5. DSRC OBU Boot Up Procedure

This Section provides a detailed Functionality of the Booting Procedure.

The DSRC OBU Platform operates in the 5.9GHz range with the capacity to construct, Tx and Rx Basic Safety Messages (BSM) compliant with standard SAE J2735.

5.1 Connecting to the Unit

Note: This Section will be updated, since currently it is focused on debugging mode rather than from an end user point of view.

The DSRC OBU has a Serial (RS232) Port on the Main Board that is used to connect the to the OBU via any suitable terminal (Linux) or Teraterm/Putty(Windows).

5.2 DSRC OBU Software Version

Once connected to the OBU it is recommended to check the software version of the OBU. The SW version information from the OBU can be retrieved using the following command: ***cat /mnt/firmware/versions***

This command returns the specific firmware version active on each of the Microcontrollers.

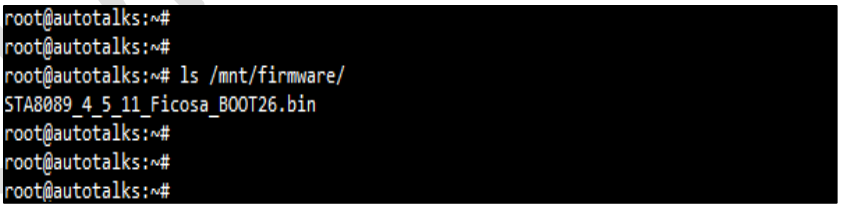


Figure 14. DSRC OBU SW Version

Version:	V01.00	V01.01	V01.02	V01.03	V01.04			
Author:	MVT	MVT	MVT	MVT	MVT			
Date:	23/03/20	11/05/20	20/05/20	22/05/20	22/06/20			

5.3 ADB

The HMI Board has ADB for communication between the PC or Main Processor.

Figure 15. ADB Devices Connected to Main Processor

5.4 GNSS Fix Acquisition

The GNSS Receiver is responsible to provide accurate GPS information to the Main Processor, for construction of a meaningful BSM.

The Unit has to get a GPS fix in GNSS Receiver (Refer to SYS-11 in Figure 7) module. It is possible to monitor the fix is acquired via MQTT Channels or the **cpgps api** of GNSS Receiver.

The command to be used is "***mosquito_sub –t GNSS_Event***" / "***cgps -s***"

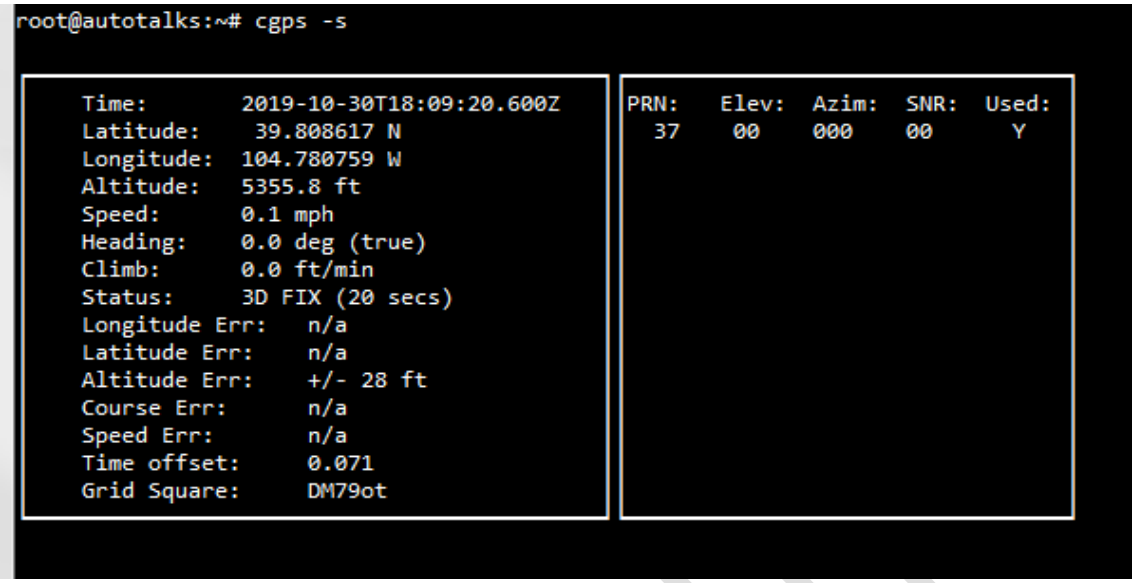


Figure 16. Example of GNSS Fix

5.5 Basic Safety Message

In order to monitor BSM, the recommended way is to monitor system logs.

Command: logread –f | grep –i bsm

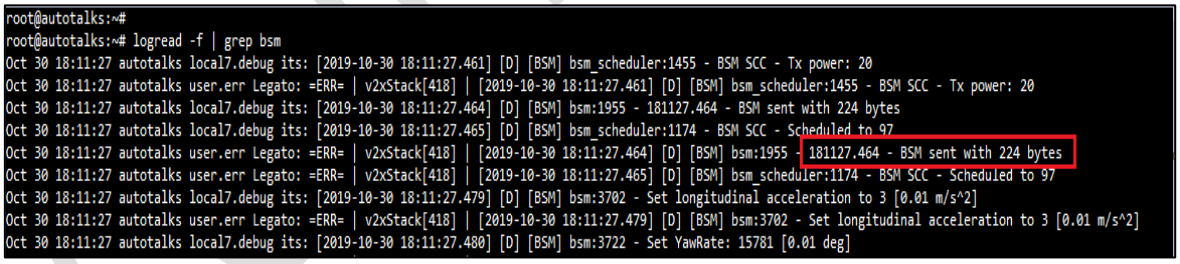


Figure 17. System Log showing Transmission of BSM's

Note: For Tx or Rx of BSM it is necessary to acquire GPS Fix and also for the unit to have a valid certificate.

Version:	V01.00	V01.01	V01.02	V01.03	V01.04			
Author:	MVT	MVT	MVT	MVT	MVT			
Date:	23/03/20	11/05/20	20/05/20	22/05/20	22/06/20			

5.6 Connecting to the HMI board with ADB over USB

The DSRC OBU provides an external interface as shown in Figure 2, to connect to the HMI board with ADB via the HMI USB interface.

Figure 18. Interface to connect to HMI Board and ADB

Note: It is necessary to have the latest version of adb and fastboot drivers to be installed on the host PC.

The HMI board has a single USB connection, so it is either connected to the Main Processor or to the PC (disconnected from the Main Processor). Once the connection is established, using this interface it is possible to host a hotspot and enable forwarding to the HMI board following the procedure described in the Annex 11.

5.7 Android SDK

The HMI module is running Android version 7.1.2 Nougat. This version of Android corresponds to API level 25. To start developing applications for this platform, we will need the Android SDK consisting of a set of command line tools, build tools and platform sources.

5.8 Getting Android SDK for Linux

Download Android SDK tools for Linux from: *https://developer.android.com/studio*

Open a terminal and go to the directory where the file has been downloaded. Decompress the zip file and go to the uncompressed folder directory. This directory will be our new SDK folder. At this point, only SDK tools are available, so the next step

is to get the rest of necessary things to build an Android app. Run the following commands from the root of the SDK to get all the necessary sources and tools to start using Android SDK in Linux:

- Download and install platform sources for API level 25:

  $ tools/bin/sdkmanager "platforms;android-25"

- Download and install Android sources for API level 25:

  $ tools/bin/sdkmanager "sources;android-25"

- Download and install build tools:

  $ tools/bin/sdkmanager "build-tools;28.0.3"

5.9 Set SDK environment var

Set 'ANDROID HOME' environment variable to the new SDK location. This path will be used by some IDEs like Android Studio or Eclipse and other build tools like Gradle. If Gradle is being used to build the application, in addition to the environment variable the following file must be created "local.properties" under the project root folder and add the following line:

sdk.dir=/path/to/your/sdk/

If the relevant project has external or additional dependancies, Gradle will automatically resolve them (when possible) using the SDK tools on the specified SDK path.

Find more information on the Android Developers website: https://developer.android.com/docs

6. Capturing Basic Safety Messages

Section Pending to be Updated

Version:	V01.00	V01.01	V01.02	V01.03	V01.04			
Author:	MVT	MVT	MVT	MVT	MVT			
Date:	23/03/20	11/05/20	20/05/20	22/05/20	22/06/20			

7. DSRC OBU - Safety Applications

The DSRC OBU supports the below Safety Applications as per standard SAE J2945.

7.1 Emergency Electronic Brake Lights (EEBL)

The EEBL safety application warns the driver of the Host Vehicle (HV) in case of a hard-braking event by a Remote Vehicle (RV) that is ahead and in the same lane or an adjacent lane. The remote vehicle (RV) broadcasts a hard-braking event in the BSM upon a hard braking maneuver. Upon receiving such event information, the HV determines the relevance of the event to its own travel path and provides a warning to the driver, if appropriate.

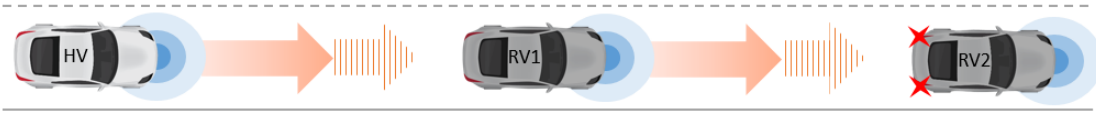


Figure 19. EEBL Use Case #1

EEBL Use Case 1: When remote vehicle abruptly brakes hard, then the host vehicle receive a warning from the EEBL feature.

7.2 Forward Collision Warning (FCW)

The FCW safety application warns the driver of the host vehicle (HV) in the case of an impending rear-end crash with a remote vehicle (RV) directly ahead in the same lane and direction of travel. The FCW is intended to help drivers avoid or mitigate rear-end vehicle crashes in the forward path of travel.

Figure 20. FCW Use Case #1

FCW Use Case 1: When remote vehicle in the same lane stops, then host vehicle receives a warning from the FCW.

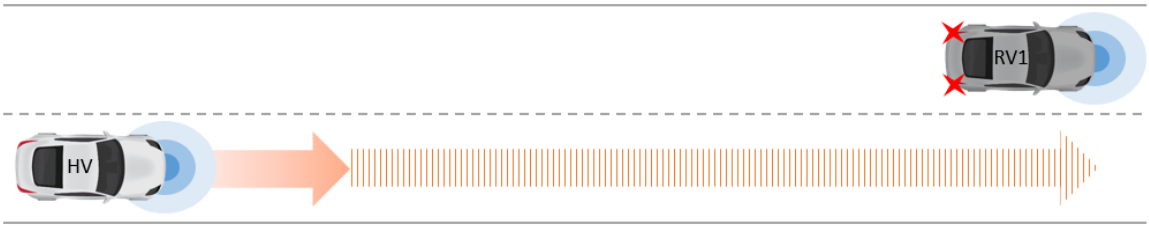


Figure 21. FCW Use Case #2

FCW Use Case 2: When remote vehicle in the adjacent lane stops, then host vehicle does not receive a warning from the FCW.

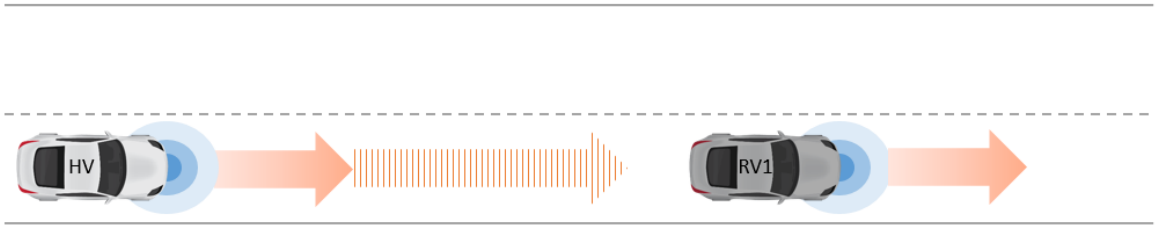


Figure 22. FCW Use Case #3

FCW Use Case 3: When remote vehicle decelerates in the same lane, then host vehicle receives a warning from the FCW Safety Application.

Version:	V01.00	V01.01	V01.02	V01.03	V01.04			
Author:	MVT	MVT	MVT	MVT	MVT			
Date:	23/03/20	11/05/20	20/05/20	22/05/20	22/06/20			

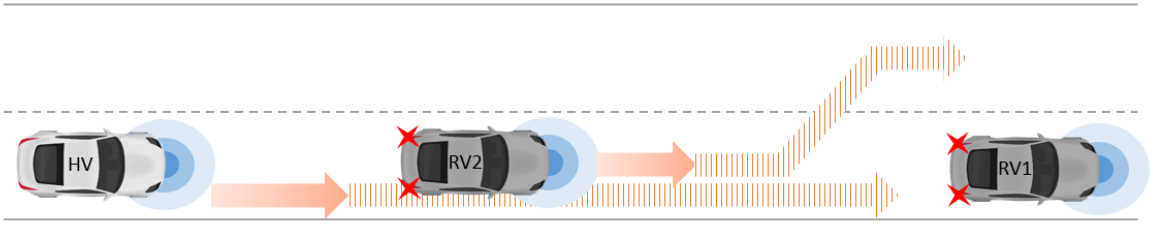


Figure 23. FCW Use Case #4

FCW Use Case 4: When the remote vehicle is obstructed by another remote vehicle that is stopped in the same lane, then host vehicle receives a warning from the FCW.

7.3 Blind Spot Warning/Lane Change Warning (BSW/LCW)

The BSW/LCW safety application warns the driver of the HV during a lane change attempt if the blind-spot zone into which the HV intends to move is, or will soon be, occupied by another vehicle travelling in the same direction. Moreover, the application may also provide advisory information that is intended to inform the driver of the HV that a vehicle in an adjacent lane is positioned in a blind-spot zone of the HV when a lane change is not being attempted.

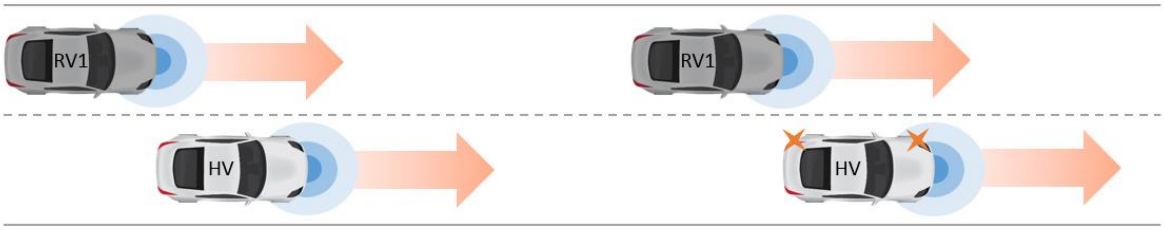


Figure 24. BSW/LCW Use Case #1

BSW/LCW Use Case 1: When remote vehicle is in the blind-spot zone and host vehicle detects the driver's intent to change lanes, then the host vehicle receives an advisory warning from the BSW/LCW.

Version:	V01.00	V01.01	V01.02	V01.03	V01.04			
Author:	MVT	MVT	MVT	MVT	MVT			
Date:	23/03/20	11/05/20	20/05/20	22/05/20	22/06/20			

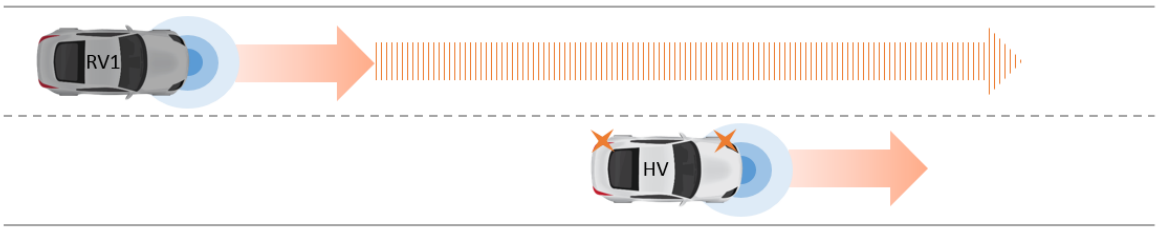


Figure 25. BSW/LCW Use Case #2

BSW/LCW Use Case 2: When a faster moving remote vehicle is in the adjacent lane, then host vehicle receives an advisory warning from the BSW/LCW.

7.4 Do Not Pass Warning (DNPW)

The Do Not Pass Warning (DNPW) application is intended to warn the driver of the vehicle during a passing maneuver attempt when a slower moving vehicle, ahead and in the same lane, cannot be safely passed using a passing zone which is occupied by vehicles in the opposite direction of travel. In addition, the application provides advisory information that is intended to inform the driver of the vehicle that the passing zone is occupied when a vehicle is ahead and in the same lane even if a passing maneuver is not being attempted.

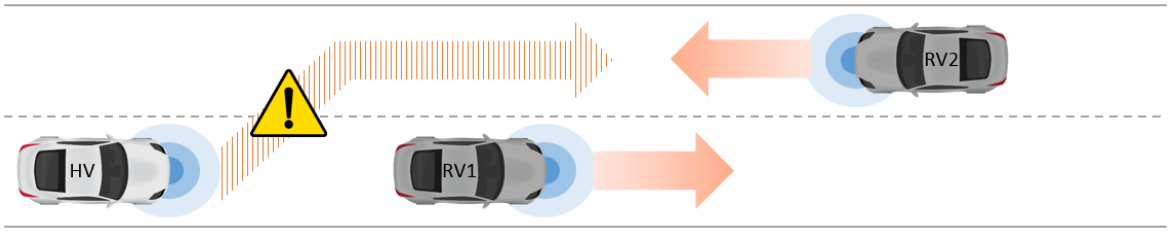


Figure 26. DNPW Use Case #1

DNPW Use Case 1: When remote vehicle is in the same lane driving slowly and another remote vehicle is in the adjacent lane and drives in the opposite direction, then host vehicle receives a warning from the DNPW.

7.5 Intersection Movement Assist (IMA)

IMA warns the driver of the HV when there is imminent danger of a crash with a remote vehicle that is approaching the same intersection. The relevant RV zones for the IMA feature are illustrated in figures below.

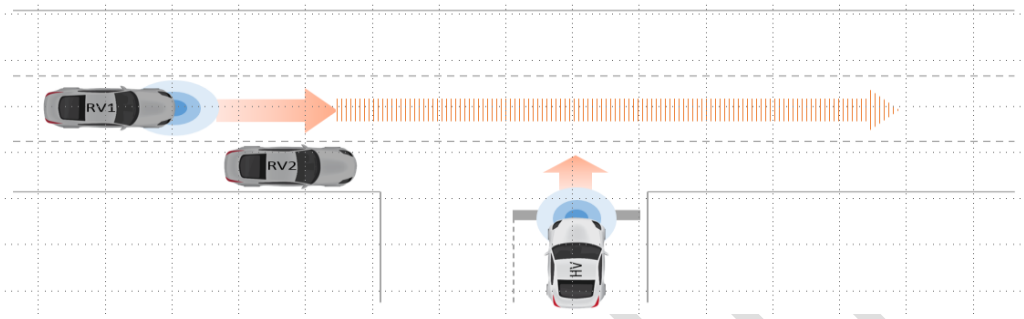


Figure 27. IMA Use Case #1

IMA Use Case 1: When the host vehicle is stopped at intersection and a remote vehicle approaches the intersection, then a warning from the IMA feature shall be raised.

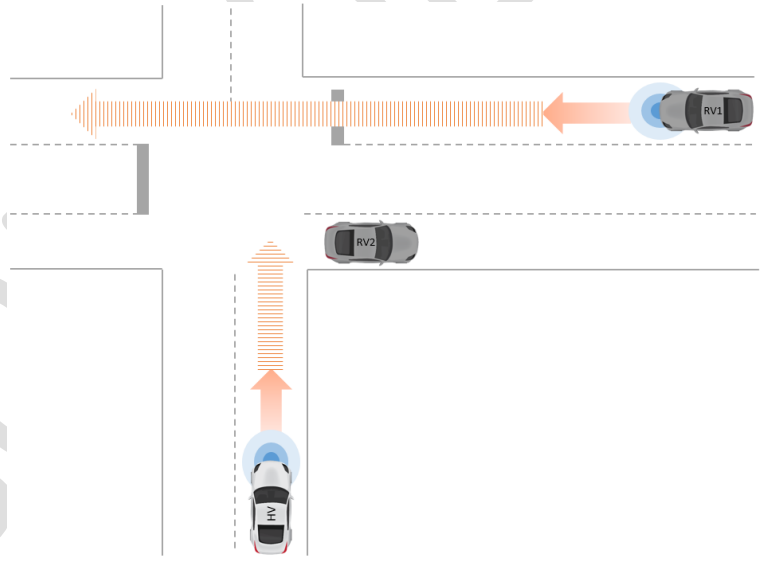


Figure 28. IMA Use Case #2

IMA Use Case 2: When the host vehicle approaches the intersection and the visibility may be limited, and a remote vehicle approaches the intersection, then a warning from the IMA shall be raised.

Version:	V01.00	V01.01	V01.02	V01.03	V01.04			
Author:	MVT	MVT	MVT	MVT	MVT			
Date:	23/03/20	11/05/20	20/05/20	22/05/20	22/06/20			

7.6 Left Turn Assist (LTA)

The LTA safety application warns the driver of an HV that, due to oncoming traffic, it may not be safe to proceed when attempting a left turn.

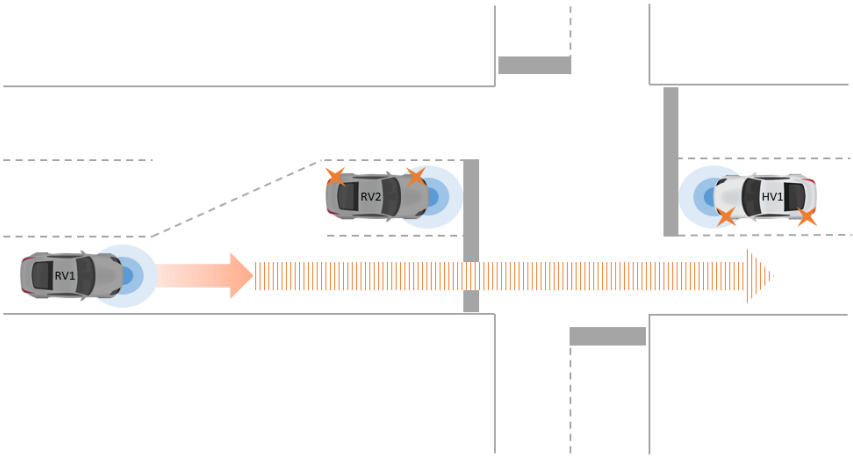


Figure 29. LTA Use Case #1

LTA Use Case 1: When the host vehicle approaches an intersection to make a left turn and a remote vehicle approaches the intersection from the opposite direction, then a warning from the LTA shall be raised.

7.7 Right Turn Assist (RTA)

The RTA application warns the driver about the possible dangers of a right turn maneuver in an intersection. In the RTA case, the remote vehicle approaches from the left direction, crossing the intended path of the host vehicle.

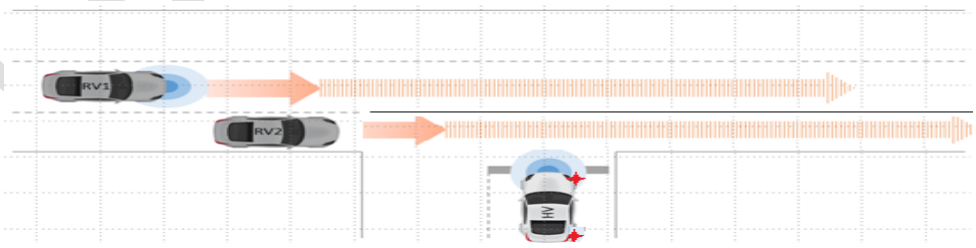


Figure 30. RTA Use Case #1

Version:	V01.00	V01.01	V01.02	V01.03	V01.04			
Author:	MVT	MVT	MVT	MVT	MVT			
Date:	23/03/20	11/05/20	20/05/20	22/05/20	22/06/20			

RTA Use Case 1: When a HV approaches an intersection to make a right turn and a RV approaches the intersection in a perpendicular direction, then a warning for RTA is issued.

7.8 Speed Limit Warning / Curve Speed Warning (SPD/CSW)

The Speed Limit Warning (SPD) is a V2I safety application that provides a notification message to the driver of the host vehicle, received from the road infrastructure about applicable speed limitations valid for the given road segment (normally conveyed through static or variable message signs along the road).

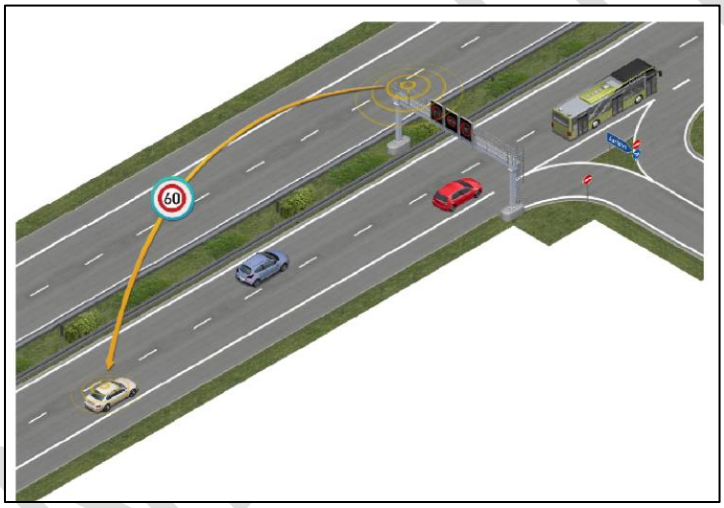


Figure 31. SPD/CSW Functional Representation

8. Dead Reckoning

Although Dead Reckoning Functionality is still pending to be implemented at the time of issue of the present document, this is planned to be functional in the coming months.

Dead Reckoning is the process of calculating one's current position by using a previously determined position, or fix, and advancing that position based upon known or estimated speeds over elapsed time and course.

The Dead Reckoning will use some CAN information from vehicle in order to support the necessary calculations such as inertial's data, vehicle speed, etc.

The Dead Reckoning Functionality will start working automatically when coverage level goes below a specific threshold. This provides a way to estimate the GNSS position of the vehicles when there isn't good GNSS coverage.

9. Vehicle Integration

9.1 DSRC OBU - Mechanical Vehicle Integration

The DSRC OBU must be installed into the vehicle by using the 4 feet indicated below.

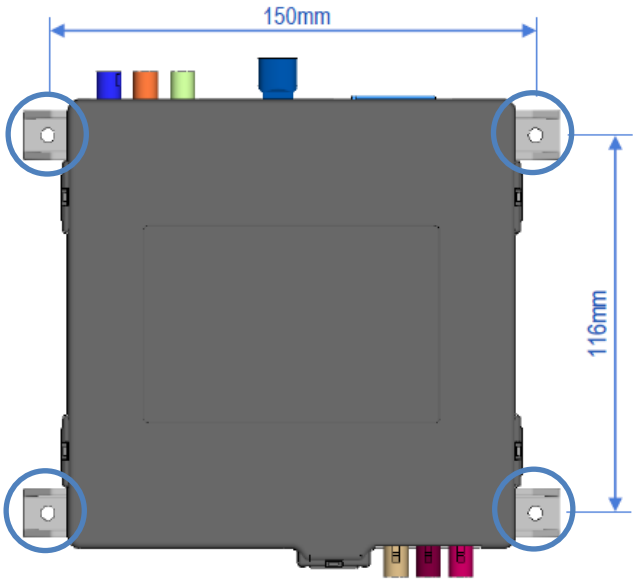


Figure 32. DSRC OBU Mounting Feet

The Fasteners to be used are the following ones:

- 4 x M3 Screws
- 4 x M3 Washers

9.2 DSRC OBU - Electrical Vehicle Integration

For the transmission of SAE J2735 compliant BSM's it is necessary for the DSRC OBU to be integrated into a Vehicle, in order to be able to receive Vehicle specific information through the vehicle's CAN Network.

Since the DSRC OBU is not a vehicle specific solution, the unit has a Read-only Virtual-CAN Protocol which can be mapped and customized to Multiple Models and OEM's

The units Boot Wake up condition depends on the following inputs:

- The +ve (+12V) connected to the Positive of the Battery.
- The –ve line (-12V) connected to the Negative of the Battery.
- The IGN Line Cascaded with the IGN line of the Car.
- The OBD-2 port Split to the Harness, so the unit is able to read signals of the Network.

9.3 Virtual CAN Protocol

The Virtual CAN Protocol adopted as part of the DSRC OBU, is Compliant with ISO 11898-2 (upto 1Mb/s) / 3(up to 125kb/s)

The below table is High-Level Description of different Signals the unit is able to manage.

can_id	Signal_name	bit_position	bit_length
0x700	PRNDL	7	3
0x700	VehiclePowerMode	4	3
0x700	HornStatus	1	2
0x701	CruiseTargetSpeed	7	8
0x701	OdometerReading	15	32
0x702	BrakeBoostApplied	7	2
0x702	ABS_Precharging	5	1
0x702	StabilityControlActive	4	2
0x702	AirbagActivated	2	1
0x702	ABS_Active	1	2
0x702	BrakesActive	15	5
0x702	ExtendedBrakeSwitch	10	2
0x702	TractionControlActive	8	2
0x702	CrashImminent	22	1
0x702	ExteriorVRU_AirbagActive	21	1
0x702	SafetyWarningActive	20	1
0x702	RR_CrossTrafficAlert	19	1
0x702	LRCrossTrafficAlert	18	1
0x702	CruiseOverride	17	1

0x702	IcySurfaceActive	16	1
0x702	StopLineViolation	31	1
0x702	HazardousMaterials	30	1
0x702	EventDisableVehicle	29	1
0x703	BrakePedalPosition	7	4
0x703	BrakePedalAngularRate	3	8
0x703	BrakeDriverRequestedPressure	11	8
0x703	SteeringWheelAngle	19	8
0x703	AcceleratorPedalPosition	27	4
0x703	SteeringwheelAngularRate	39	8
0x704	VehicleSpeed	7	13
0x704	CruiseSetSpeed	10	8
0x704	CruiseEngaged	18	1
0x704	LeftTurnSignal	17	1
0x704	RightTurnSignal	16	1
0x704	LowBeamStatus	31	1
0x704	HighBeamStatus	30	1
0x704	AutoLightControlOn	29	1
0x704	HazardLightsOn	28	1
0x704	DaytimeRunningLightsOn	27	1
0x704	FogLightsOn	26	1
0x704	ParkingLightsOn	25	1
0x705	LF_Wheel_RPM	7	16
0x705	RF_Wheel_RPM	23	16
0x705	LR_Wheel_RPM	39	16
0x705	RR_Wheel_RPM	55	16
0x706	TirePressureLF	7	8
0x706	TirePressureRF	15	8
0x706	TirePressureLR	23	8
0x706	TirePressureRR	31	8
0x706	DriverSafetyBelted	39	1
0x706	PassengerSeatOccupied	38	1
0x706	PassengerSafetyBelted	37	1
0x706	VehicleIsUnocuppied	36	1
0x706	AdaptiveCruiseControlActive	35	1
0x706	HoodOpen	34	1
0x706	TrunkOpen	33	1
0x706	VisibilityRange	32	10
0x706	DriverDoorLocked	54	1
0x706	PassengerDoorLocked	53	1

0x706	DriverDoorOpen	52	1
0x706	PassengerDoorIsOpen	51	1
0x706	LR_DoorOpen	50	1
0x706	RR_DoorOpen	49	1
0x707	VehicleWidth	7	10
0x707	VehicleLength	13	12
0x707	VehicleHeight	17	7
0x707	BumperHeightFront	26	7
0x707	BumperHeightRear	35	7
0x707	VehicleMass	44	8
0x707	VehicleType	52	4
0x708	EmergencySirenActive(GPIO_1bluewire)	7	1
0x708	LightBarInUse(GPIO_2redwire)	6	1
0x708	StrobesOn(GPIO_0yellowwire)	5	1
0x708	SaltThrowerOn(GPIO_3pinkwire)	4	1
0x708	SandThrowerOn	3	1
0x708	SnowplowBladeActive	2	1
0x708	MultiVehicleResponse	1	2
0x708	ResponseType	15	3
0x708	Role	12	5
0x708	ResponseEquip	23	8
0x708	ResponderType	31	8
0x709	CrashleftVehInverted	7	1
0x709	CrashRollCount	6	3
0x709	CrashFlipCount	3	3
0x709	CrashMaxDeccel	0	10
0x709	ObstDetectionDistance	22	15
0x709	ObstDetectionDirection	39	15
0x70A	TCS_IndicatesInpaved	7	1
0x70A	FrontWiperStatus	6	3
0x70A	FrontWiperRate	3	7
0x70A	RearWiperStatus	12	3
0x70A	RearWiperRate	9	7
0x70A	FrontWiperDelayRequested	18	3
0x70A	RearWiperDelayRequested	31	3
0x70A	InteriorLightDimmingActive	28	1
0x70A	OutsideAirTemperature	27	8
0x70B	MapMatchDriveOnLeftSide	7	1
0x70B	MapMatchSpeedLimit	6	7

0x70B	MapMatchCurveSpeed	15	7
0x70B	MapShowsSurfaceIsPaved	8	1
0x70B	ElevationIsMapMatchedFlag	23	1
0x70C	IsRaining	7	2
0x70C	RainRate	5	16
0x70C	PrecipSituation	21	4
0x70C	SolarRadiation	17	16
0x70C	Friction	33	7
0x70C	RoadFriction	42	6
0x70C	AirPressure	52	8
0x70C	RainRates	60	3
0x70D	DisabledVehicle	7	10
0x70D	Classification	13	8
0x70D	ITIS_Codes	21	16
0x70D	SSP	37	5
0x70D	PrivilegedEvents	32	4
0x70E	antOffsetX	7	12
0x70E	antOffsetY	11	9
0x70E	antOffsetZ	18	10
0x70F	UTC_NTP	7	64
0x711	Diag_Gpio0YellowWire	7	1
0x711	Diag_Gpio1BlueWire	6	1
0x711	Diag_Gpio2RedWire	5	1
0x711	Diag_Gpio3PinkWire	4	1

10. Regulatory Information USA

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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.

10.1 Permitted Antenna

This radio transmitter has been approved by the FCC to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Interface and frequency range	Type	Max Gain
Licensed bands		
DSRC (802.11p)		≤13dBi (bands 172, 174, 176, 178, 184) ≤ 3dBi (bands 180, 182)
GSM850		3.0 dBi*
GSM1900		2.5 dBi*
WCDMA – Band II		2.5 dBi*
WCDMA – Band IV		5.0 dBi*
WCDMA – Band V		3.0 dBi*
LTE – Band 2		2.5 dBi*
LTE – Band 4		5.0 dBi*
LTE – Band 5		3.0 dBi*
LTE – Band 7		8.5 dBi*
LTE – Band 12		6.0 dBi*
LTE – Band 13		6.0 dBi*
LTE – Band 25		2.5 dBi*
LTE – Band 26		3.0 dBi*
Unlicensed bands		

Wi-Fi – 2.4GHz/Bluetooth	Wi-Fi/BT Flexible Antenna (Manufacturer: Ficosa S.L)	2.3 dBi
Wi-Fi – 5GHz		4 dBi

*Maximum Gain Data for GSM, WCDMA and LTE is taken from Quectel LTE Module SC20 supplier Datasheet, the FCC IF of which is XMR201706SC20A.

Additional Notes:

- The DUT needs external antennas to be properly used and are not included in the scope of this certification. For test purposes, a representative antenna model has been used with 7dBi Gain on the 802.11p frequency range and 5dBi on the GNSS frequency ranges.

- If the device operates in the specified bands, an Antenna with maximum gain of 3dBi must be used.

- The device has two operative DSRC channels which can not operate simultaneously in normal mode of operation.

10.2 RF exposure safety

This device complies with the FCC RF exposure limits and has been evaluated in compliance with mobile exposure conditions.

The equipment must be installed and operated with minimum distance of 20 cm of the human body.

10.3 FCC Statement

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to

provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Additional Note: The testing to prove Class A compliance has been carried out under a continuous transmission state. In case the device is set up in its normal mode of operation (active listening), it meets Class B limits.

11. Annex #1

11.1 Host a Hotspot

The DSRC OBU with an Active SIM is capable of hosting a Hotspot, to enable the hotspot on the OBU please follow the following procedure:

- Connect the USB reworked cable.
- Power on the board.
- Connect HDMI display (720p).
- Open tethering settings in Settings app (all the commands below will input using ADB prepend 'adb shell' to all the commands)

  # am start -n com. android . settings /. TetherSettings
- Scroll down to 'Set up WLAN Hotspot':

  input keyevent 20 *// DOWN (as many times as needed)*
- Press Enter:

  input keyevent 66 *// ENTER*

- TAB until you reach 'Security' options:

  input keyevent 61 *// TAB (as many times as needed)*

- ENTER security options:

  input keyevent 66 *// ENTER*

- Scroll UP and select Security ! None to disable Wi_AP password:

  input keyevent 19 *// UP (as many times as needed)*

- Press ENTER to con_rm selection:

  input keyevent 66 *// ENTER*

- TAB until you reach 'Save' option, then press ENTER to save the settings:

  input keyevent 61 *// TAB (as many times as needed)*

  input keyevent 66 *// ENTER*

- Scroll UP and enable hotspot(ENTER):

  input keyevent 19 *// UP (as many times as needed)*

  input keyevent 66 *// ENTER*

Now the hotspot will be active with **no password.**

11.2 Enabling Forwarding on SC20

With the DSRC OBU it is possible to have a session with the Main Processor for Logging purposes via MQTT channels by enabling forwarding from Main Processor to SC20

To do so, the following commands need to be executed on the SC20

```
su                                          // gain root access
iptables -F
iptables -X
iptables -t nat -F
iptables -A FORWARD -o rmnet_data0 -i rndis0 -j ACCEPT
iptables -A FORWARD -o rmnet_data1 -i rndis0 -j ACCEPT
iptables -A FORWARD -o rndis0 -i rmnet_data0 -j ACCEPT
iptables -A FORWARD -o rndis0 -i rmnet_data1 -j ACCEPT
iptables -A FORWARD -o rmnet_data0 -i rndis0 -j ACCEPT
iptables -A FORWARD -o rmnet_data1 -i rndis0 -j ACCEPT
iptables -A FORWARD -m state --state ESTABLISHED , RELATED -j ACCEPT
iptables -t nat -A POSTROUTING -j MASQUERADE
```

After implementing the forwarding feature the MQTT API described in the following section it can be accessed via the HMI board.

11.3 MQTT API

11.3.1 Overview

MQTT is a lightweight machine-to-machine connectivity protocol. It is an application level protocol. That means that it is able to work over any kind of lower layers, for

instance and Ethernet connection. MQTT protocol provides mechanisms to publish and subscribe to/from multiple topics and to define policies and access rules for every topic. Together with the MQTT support for SSL this option allows to setup a security configuration over this protocol.

11.3.2 MQTT Application

The system consists of 5 applications: 1 broker (ECUServer) and at least 5 MQTT clients (CANService, GNSSService, sysMng, sysLogger, V2xStack).

1. **MQTT Manager:** Legato application to run MQTT Broker. This application ensures proper MQTT broker running status.

   This application provides the following API:

Figure 33. MQTT Manager API

2. **GNSSService:** This legato application takes GNSS parameters and publishes to MQTT-brocker.

3. **CANService:** Legato application to publish CAN message (read from socket CAN) to MQTT brocker.

   This application provides the following API:

```
root@ficosa-cdot:~# le_can
le_can usage
=========

To start a connection between Can_spi and the MQTT broker
        le_can connect

To check Can_spi status
         le_can status

To disconnect the Can_spi from MQTT broker:
        le_can disconnect

To cleanup all Can_spi data:
        le_can cleanup

To get PMC binary version:
        le_can bin_version

To get PMC calibrate version:
        le_can cal_version

root@ficosa-cdot:~#
```

Figure 34. CAN Service API

4. **sysMng:** sysMng (short for System Manager) can be present from one to more microcontrollers inside the OBU system, each being responsible of reporting status information and enabling or disabling functionalities of its own microcontroller.

   For example the sysMng application running on the OBU's NAD can enable or disable functionalities related to the modem, such as turning the radio off, or enabling mobile data. sysMng provides the following basic functionality on the main board:

   a) Retrieve Temperature stats.
   b) Retrieve Disk usage (storage) stats.
   c) Retrieve CPU usage stats.
   d) Retrieve Memory usage stats.

This application does not provide a command line interface and its functionality shall be exploited through the usage of MQTT API as described in this section.

5. **sysLogger:** sysLogger (short for System Logger) is an application running on OBU's main board that periodically collects OBU system logs, primarily by requesting status information to sysMng applications present on the MQTT network.

   Applications can request log historics to the sysLogger through specific MQTT topics.

   This application does not provide a command line interface and, as sysMng, its functionality has to be exploited through the usage of MQTT API.

11.3.3 API over MQTT

The API defines two channels:

1. **Response/Event topics:** An application can subscribe to these topics in order to get notified when some event triggers or to get the answer to given request.
2. **Request topics:** An application can publish to this topic to control the OBU or some of the components or to inject DATA to CAN or to V2X stack.

11.3.4 MQTT Channels specification

The API offers a MQTT tree structure for topics. Applications can subscribe to the root of the tree or to a specific leaf getting different results. Below it is shown an example in order to ease understanding.

MQTT Channels example

Let's asume that there is a channel called *LOG*

This topic has 2 sub-topics: *MQTT* and *SYS*

Application A subscribes to *LOG/MQTT* This application will receive all MQTT logs but no systems logs

Application B subscribes to *LOG* This application will receive all log messages published on *LOG/SYS* and all logs published on *LOG/MQTT*

11.3.5 Command execution

Some of the MQTT topics accept commands. To execute a command, the specified string should be published to the topic that accepts the command. If the command requires some parameters, those should be provided together with the command using as a delimiter a blank space.

MQTT command

Let's assume that the topic LOG_Request accepts the command mqtt

In order to get mqtt log, an application A will publish to "LOG_Request" the payload "mqtt"

If the command mqtt accepts as a parameter the log level, it will be passed as a string part.

Application A will publish to "LOG_Request" the payload "mqtt WARN"

11.3.6 Request/Response format

The information could be published over MQTT topics in different formats:

1. **String format:** Some data will be published over MQTT topic as a string (RAW data).
2. **JSON format:** Some data will be published over MQTT topic using a JSON format to ease data parsing.

11.3.7 Channel List

- Can_Event
  - Can_Event/data
  - Can_Event/700
  - Can_Event/701
  - Can_Event/702
  - Can_Event/703
  - Can_Event/704
  - Can_Event/705
  - Can_Event/706
  - Can_Event/707
  - Can_Event/708
  - Can_Event/709
  - Can_Event/70A
  - Can_Event/70B
  - Can_Event/70C
  - Can_Event/70D
  - Can_Event/70E
  - Can_Event/70F
  - Can_Event/710
  - Can_Event/711
- SYS_CMD_Request
- SYS_CMD_Response
  - SYS_CMD_Response/temperature
  - SYS_CMD_Response/radio
  - SYS_CMD_Response/disk
  - SYS_CMD_Response/memory
  - SYS_CMD_Response/cpu
  - SYS_CMD_Response/version
- LOG_Request
- LOG_Response
  - LOG_Response/mqtt
  - LOG_Response/sys mng
  - LOG_Response/sys event
  - LOG_Response/v2x
  - LOG_Response/temperature
  - LOG_Response/radio
  - LOG_Response/disk
  - LOG_Response/memory
  - LOG_Response/cpu
  - LOG_Response/gnss

- GNSS_Event
- V2X_APP
  - V2X_APP/EBBL
  - V2X_APP/FCW
  - V2X_APP/BSW
  - V2X_APP/LCW
  - V2X_APP/DNPW
  - V2X_APP/CSW
  - V2X_APP/IMA
  - V2X_APP/XTA
  - V2X_APP/BHI
- BSM Request
- BSM Response