SYSTEM DESCRIPTION

For Volvo Prevost

V2.3
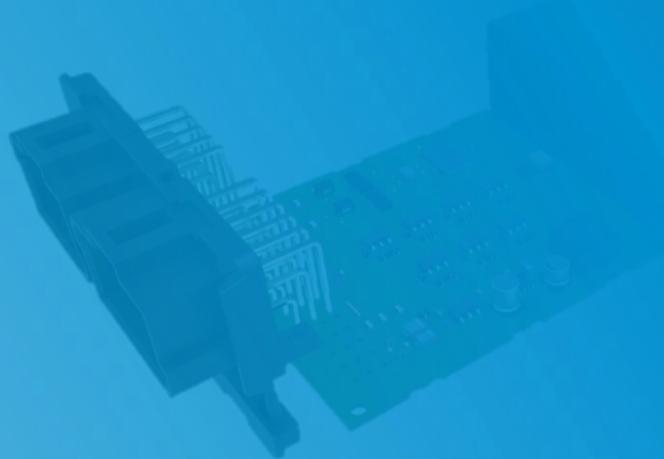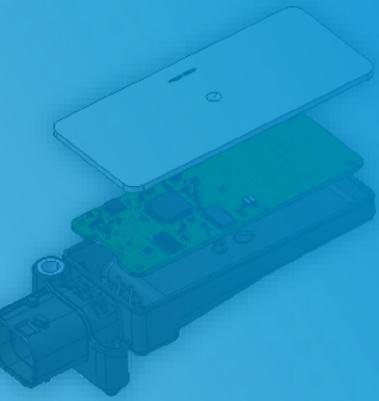
Sensata Technologies

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Abbreviations

Term	Expansion/Meaning
DTC	Diagnostic Trouble Code
eRX	External Receiver
HVOR	Heavy-Vehicle / Off-Road
iECU	Internal Electronic Control Unit
LF	Low Frequency
PCB	Printed Circuit Board
TPM	Tyre Pressure Monitoring
TPMS	Tyre Pressure Monitoring System
UDS	Unified Diagnostic Services
WU	Wheel Unit

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1   Introduction

The Sensata Direct TPM system provides comprehensive tyre data directly to a vehicle's heads-up display.

With a TPM sensor mounted directly within each of the vehicle's tyres, the Sensata TPM system regularly measures, evaluates and provides actual tyre air pressure and temperature information to the system user.

2   System Overview

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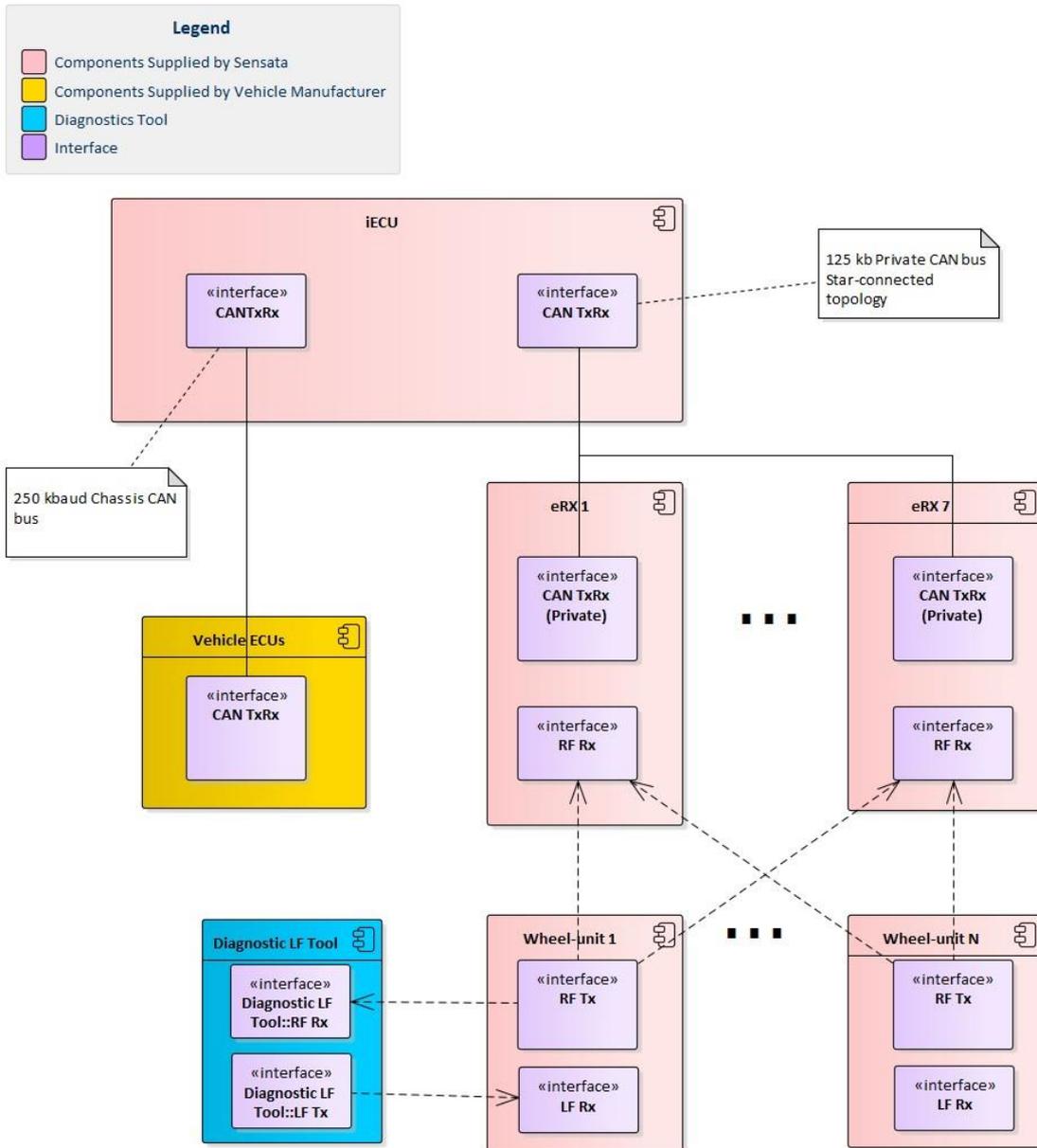
3   System Components

3.1 TPM Wheel-Unit

The Sensata HVOR wheel-unit mounts directly to the end of the tyre valve and is hosted entirely within the tyre. The wheel-unit is battery-powered.

Main Functions of wheel-unit:

✦ Regularly measure tyre pressure and temperature.
✦ Periodically transmit tyre data to wireless receiver
✦ Detect if wheel is in motion
✦ Monitor battery condition and transmit to the system during the RF transmission
✦ Respond to handheld diagnostics (125 kHz LF) tool

✦ Sample pressure at a faster rate if leak is detected
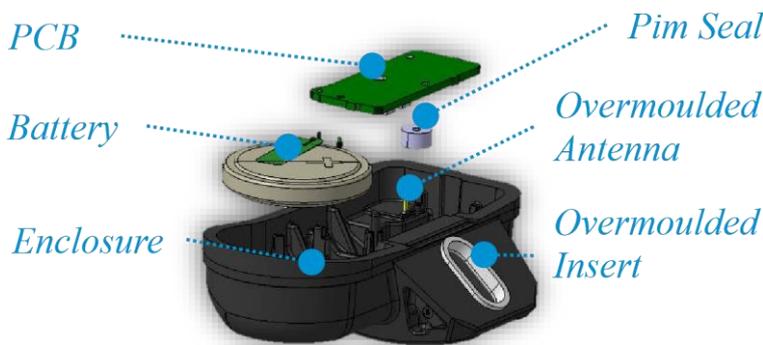
3.1.1   RF interface

The wheel-unit transmits tyre data to the TPM receiver ECU via an RF interface.

Parameter	Value
Carrier Frequency	433.92 MHz
Baud Rate	9.6 kb
Modulation	FSK
RF Protocol	Sensata HVOR

Table 1 RF Protocol

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3.1.2   Measurement and data transmission

The TPM wheel-unit continually measures and transmits pressure and temperature when stationary or in motion.

Mode	Sample period	Transmission period
Stationary	15s	120s
Motion	15s	120s
OFF	60s	-

There also is a Delta-P mode whereby a detected pressure delta (-275mbar when in motion and ±220mbar when stationary) will cause an instant transmission of pressure and temperature.

3.1.3   Resolution and Accuracy

Parameter	Resolution	Reporting Range	Accuracy
Pressure	55mBar per bit	0 … 13.915 mBar	+- 220mBar
Temperature	1 °C per bit	-40°C … 120 °C	+- 3 °C

3.1.4   LF interface

For diagnostic and End-Of-Line configuration purposes the wheel-unit supports remote interaction via a modulated LF interface. LF operation is described in the Sensata TPM MLF specification.

3.1.5   Battery Lifetime

The TPM wheel-unit is fitted with an automotive grade internal coin cell battery (CR2450HR) which provides a lifetime of approximately 7 years.

The actual wheel-unit battery lifetime remaining figure is made available to the system user periodically during operation and is updated every 120 seconds.

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3.2   eRX

External receivers (eRXs) are laser-welded modules   which
are mounted externally on the vehicle chassis.

Main Functions of eRX:

- ✦ Receive RF data frames from wheel units.
- ✦ Interface with the Private CAN bus to communicate the data frames to the TPM iECU.
- ✦ Protection against unwanted conducted interference on signal and power connections
- ✦ Report error conditions

The electronics inside the eRX consist of an antenna with matching components, receiver IC, microprocessor, CAN interface, voltage regulator and protection components.

Compression limiting Metal Insert

Lid (laser Weld)

PCB trace antenna

Rugged 4 Pin Connector for HVOR

PCB

Moulded anti-rotation pin
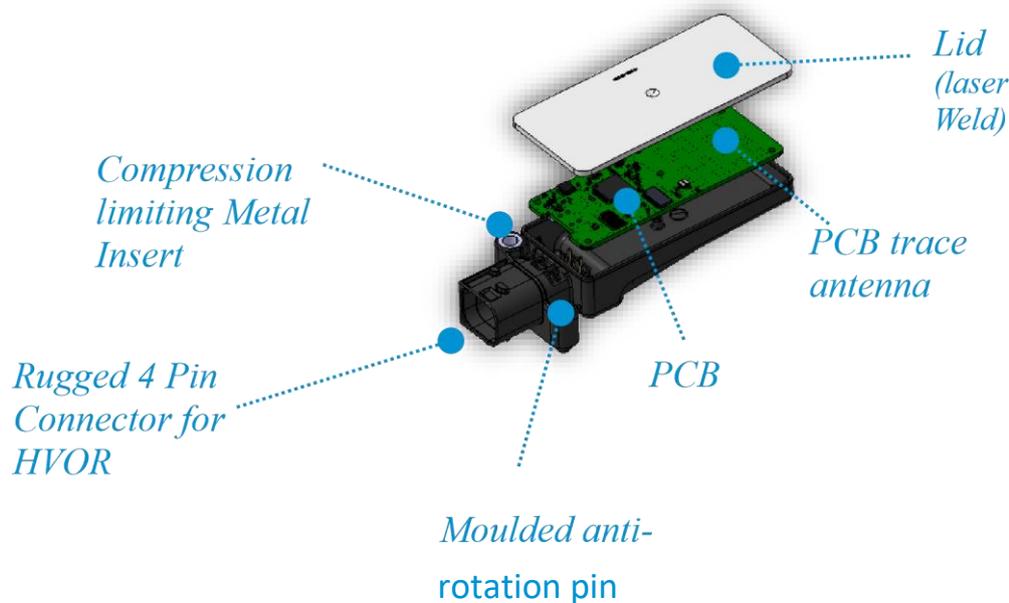
3.2.1   eRX Power Supply

Each receiver operates from a nominal +9V DC voltage, which is supplied from the iECU; this is switched off when the ignition is inactive to ensure the system meets supply current requirements. The eRX will operate without resetting over the supply range of 6.0 to 15.0V. Under normal battery voltage to the iECU (8 to 32V), the nominal supply voltage to the receiver will be +9.0V +/- 1.0V.

The external receiver shall draw a maximum operating current of less than 40mA over the full operating voltage and temperature range.

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3.2.2   eRX CAN Bus Interface

The eRX mating connector is part number TE 1-1418390-1.
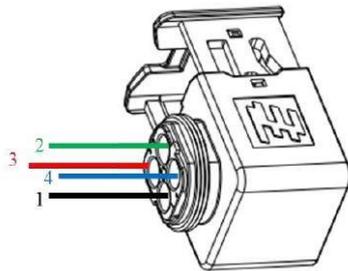
1   Ground
2   CAN LOW
3   Switched VDD supply from TPMS iECU 4 CAN HIGH

The private eRx CAN bus to the iECU operates at 125Kbits/s. The CAN bus is terminated within the eRX with two 2.2kΩ resistors in series across the CAN LOW - CAN HIGH connector pins, with a 47nF capacitance to GROUND. When no power is applied to the receiver, the impedance presented to the Private CAN bus is 4k4 differential resistance +/- 20% and differential capacitance < 20 pF.

3.2.3   eRX Mechanical

The eRX is be no larger than 39mm × 28mm × 119mm and weighs no more than 50g.

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3.3   iECU

The Internal Electronic Control Unit (iECU) is mounted internally in the vehicle. It requires a local connection to power-ground, the vehicle CAN bus and each eRX that is mounted on the vehicle (up to a maximum of 7 eRXs).

Main functions of iECU:

- ✦ Receive data over the Private CAN bus from each of the eRXs.
- ✦ Provides pressure, temperature, battery data by position to the vehicle's instrument cluster / HMI. TPM data is displayed for all learned / programmed positions for up to 5 axles (21 wheels including the spare wheel position)
- ✦ Monitors TPM data when vehicle is stationary and provides up-to-date TPM data for all positions to the driver within 2 minutes of key-on.
- ✦ Generates temperature-compensated pressure warnings for under-pressure, extreme under-pressure, dangerous under-pressure warnings and over-pressure.
- ✦ Generates an over-temperature warning when a tyre's temperature exceeds a pre-set overtemperature threshold.
- ✦ Presents the TPM sensor battery lifetime to the vehicle's instrument cluster in 10% grades.
- ✦ Is compliant with the UDS standard for diagnostics, and stores DTCs for pressure and temperature warnings. Additional DTCs are provided for low-battery (positional warning), missing-wheel-units, implausible / non-programmed axle nominal pressures, implausible / non-programmed wheel unit IDs, low/high local supply voltage and external antenna ECU communication failures (per antenna).

The electronics inside the iECU consist of a microcontroller, two CAN interfaces, voltage regulators and protection components.

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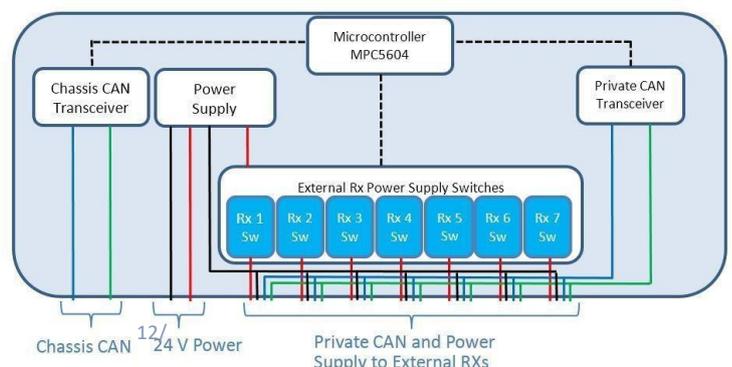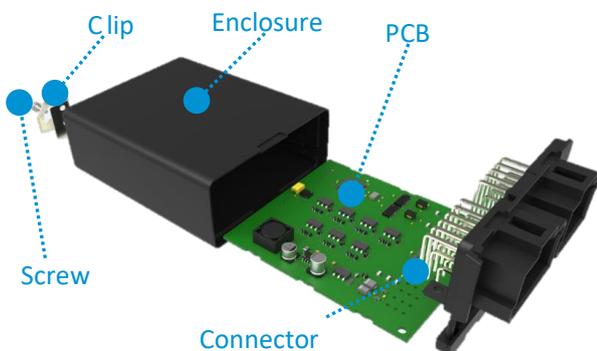
3.3.1   iECU Power Supply

The iECU must be supplied by a permanent unswitched battery voltage supply of nominally either 12V or 24V via pins KL30 (+V) and KL31 (GND). The iECU is fully functional in the range of 6.5-32V.

An active overvoltage limiter is in-line with the supply to clamp the voltage during load dump to 36V max, provided the supply has already been clamped to less than 58V by the central protection in the vehicle. The iECU supply interface also has spike and reverse polarity protection.

The iECU also provides nominal 9V power rails to provide power to each eRX.

With all 7 eRX ports supplying typical loads (35mA continuous) and software operating normally, the iECU supply current should be less than 250mA (continuous) at a supply voltage of 28.0V. At 8.0V supply (during the lowest point of cold cranking), the current should be less than 350mA (continuous).

The iECU shall draw less than 200uA in sleep mode over the range -40 to +40 °C and less than 400uA over the range +40 to +85 °C.

3.3.2   iECU CAN Interfaces

The iECU has two CAN bus interfaces:

1. 250 kb/s Chassis CAN interface (towards the vehicle).
2. 125 kb/s Private CAN interface (towards the TPM receivers)

The Chassis CAN data transmission shall conform to the requirements of ISO 11898-5. The iECU presents a high impedance to the vehicle CAN.

The iECU powers up on receipt of CAN traffic on the Chassis CAN bus, and powers down via software after receipt of the Ignition Off message. The minimum messages from the vehicle required on the TPM Chassis CAN bus for the Sensata TPMS to function are as follows:

• PropB_VehicleMode (18FF2232) KL15 (Ignition)

• TCO1 Vehicle Speed (CFE6CEE)

• TD time and date (18FEE6EE)

The Private CAN bus is implemented using a star topology with 7 external ports for eRXs, with central 60Ω DC termination (equivalent to 120Ω at both ends of a linear bus). Each connection to a receiver on the private CAN bus should be made using cable with a characteristic impedance of 120Ω on the CANHIGH-CANLOW transmission line.

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TPMS_01 CAN Message Description

This is the message used by the TPMS to indicate to the vehicle the current wheel unit information for all configured wheel locations, as well as the warning status and associated failure flags associated with each position.

SPN524149_Wheel_location_ID

The TPMS Tyre location parameter will follow that which is defined by ISO 11992. Values in hex equate to location on the vehicle chassis, independent of vehicle wheel configuration.

Value	Description
0x8	Location 0x08 - spare wheel
0x17	Location 0x17 - axle 1 IL
0x19	Location 0x19 - axle 1 IR
0x26	Location 0x26 - axle 2 OL
0x27	Location 0x27 - axle 2 IL
0x29	Location 0x29 - axle 2 IR
0x2A	Location 0x2A - axle 2 OR
0x36	Location 0x36 - axle 3 OL
0x37	Location 0x37 - axle 3 IL
0x39	Location 0x39 - axle 3 IR
0x3A	Location 0x3A - axle 3 OR

SPN524150_Tyre_Temperature

Signal relays the reported tyre temperature for the indicated position

SPN524151_Tyre_Pressure

Signal relays the reported tyre pressure for the indicated position

SPN524152_WU_Battery_Status

Signal relays the battery status for the Wheel Unit in the indicated position. Battery level is reported in 10% increments:

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Value	Description
0x0	Reserved
0x1	10% Remaining
0x2	20% Remaining
0x3	30% Remaining
0x4	40% Remaining
0x5	50% Remaining
0x6	60% Remaining
0x7	70% Remaining
0x8	80% Remaining
0x9	90% Remaining
0xA	100% Remaining
0xB	Reserved
0xC	Reserved
0xD	SignalNotSupported
0xE	Error
0xF	SNA

SPN524153_Fast_Pres_Loss_Status

Indicates whether or not a fast pressure loss event is occurring for the indicated position (not utilised within the Volvo Prevost TPMS System)

SPN524154_TC_Target_Nom_Pres

Relays the TPMS temperature compensated target nominal pressure i.e. the set axle placard pressure, compensated using the system's reference temperature.

SPN524155_Tyre_Pressure_Status

Relays status of tyre pressure and whether any pressure warnings currently exist for the indicated position. Terminology of warning levels follows J1939 standard.

Value	Description
0x0	NominalPressureRange
0x1	ECO_OverPressure
0x2	OverPressure
0x3	ExtremeOverPressure
0x4	ECO_UnderPressure
0x5	UnderPressure
0x6	ExtremeUnderPressure
0x7	NotDefined
0x8	NotDefined
0x9	NotDefined
0xA	NotDefined
0xB	NotDefined
0xC	NotDefined
0xD	SignalNotSupported
0xE	Error
0xF	SNA

SPN524156_Tyre_Burst_Status

Indicates whether or not a tyre burst is occurring for the indicated position (not utilised within the Volvo Prevost TPMS System).

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SPN524157_Tyre_Over_Temp_status

Indicates whether or not a tyre over temperature condition is occurring for the indicated position.

Value	Description
0x0	NoTireOverTempEvntDetected
0x1	TireOverTempEvntDetected
0x2	Error
0x3	SNA

SPN524158_Tyre_Lock_Det_Status

Indicates whether or not a tyre lock condition is occurring for the indicated position (not utilised within the Volvo Prevost TPMS System).

SPN524159_TFA_Status

Indicates whether or not a tyre fill operation is occurring for the indicated position (not utilised within the Volvo Prevost TPMS System).

3.3.3   iECU Harness Connector

The following contains details of the signals by which the iECU interfaces to the vehicle wiring harness of the vehicle and the private eRX network.

The iECU includes a connector pair with a total of 33 pins (split into an 18 pin connector and a 15 pin connector). The iECU shall connect to the vehicle harness and eRX network via these 2 connectors with the following pinout:

Connector 1 18-pin		
Pin No.	Description	Ext. RX
1	Kl. 30 [+ 12/24v]	All
2	Kl. 31 [GND]	All
3	Kl. 15 (n.c.) [switched + 12/24v]	All
4	XDA_GND_A	18
5	XDA_GND_B	27
6	XDA_GND_C	29
7	XDA_CAN_L_A	18
8	XDA_CAN_L_B	27
9	XDA_CAN_L_C	29
10	XDA_CAN_H_A	18
11	XDA_CAN_H_B	27
12	XDA_CAN_H_C	29
13	XDA_VDD_A	18
14	XDA_VDD_B	27
15	XDA_VDD_C	29
16	CHASSIS_CAN_High	N/A
17	XDA_GND_G	49
18	CHASSIS_CAN_Low	N/A

Connector 2 15-pin		
Pin No.	Description	Ext. RX
1	XDA_VDD_G	49
2	XDA_CAN_H_G	49
3	XDA_CAN_L_G	49
4	XDA_VDD_D	37
5	XDA_VDD_E	39
6	XDA_VDD_F	47
7	XDA_CAN_L_D	37
8	XDA_CAN_L_E	39
9	XDA_CAN_L_F	47
10	XDA_CAN_H_D	37
11	XDA_CAN_H_E	39
12	XDA_CAN_H_F	47
13	XDA_GND_D	37
14	XDA_GND_E	39
15	XDA_GND_F	47

The eRX references are based on the wheel positions closest to their chassis location, as according to ISO 11992, as shown below:

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Position	6	7	8	9	A
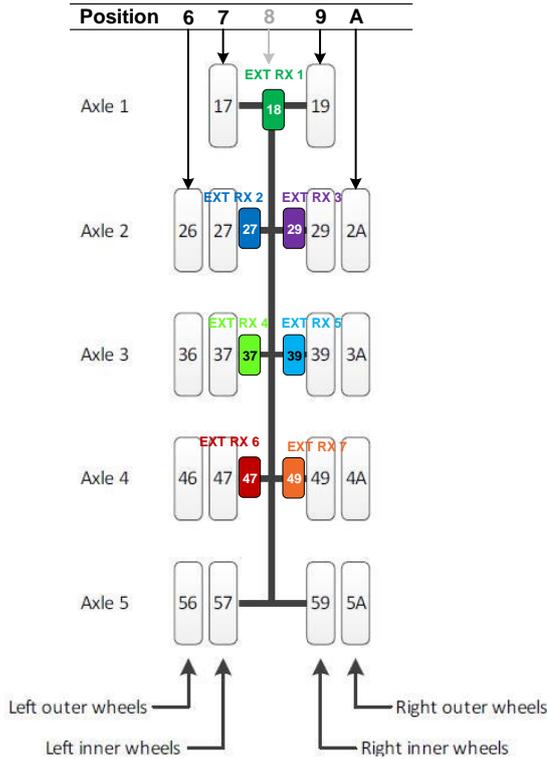
The iECU's 18 pin female mating connector has part number TE 1-967624-1 and 15 pin has part number TE 1-967623-1.

3.3.4   iECU Mechanical

The iECU is suitable for use within the driver cabin of the vehicle. It is rated to IP30 (as per ISO 16750) when it has mating connectors connected. Therefore, it should be mounted in a dry environment e.g. splash-proof area in vehicle cab.

A clamping device with a tensioned spring supports the ECU housing.

The iECU shall not weigh more than 180g.

The iECU housing dimensions in mm are as shown below:

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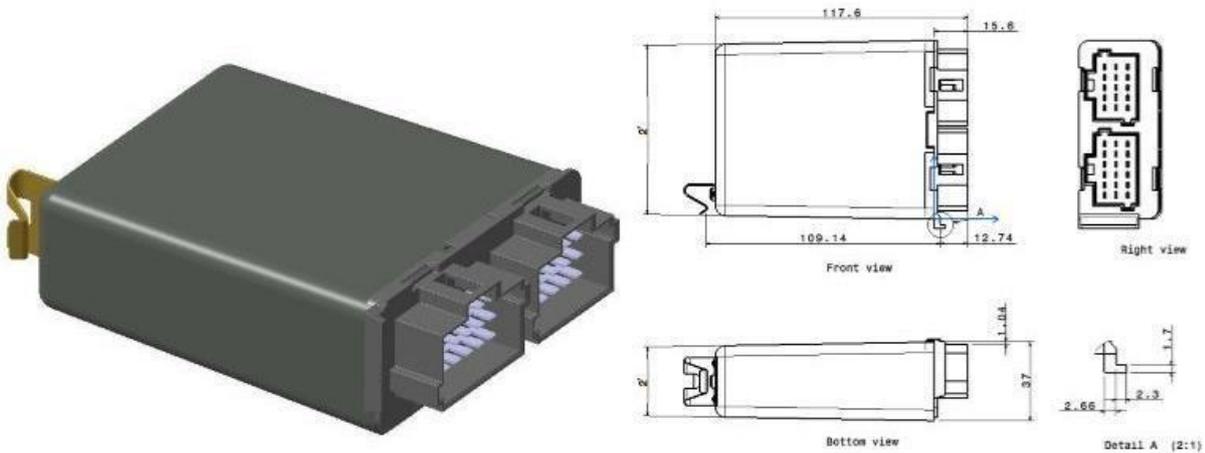
4   TPMS Features

4.1   Up-to-date Tyre Data by Position

Tyre data is measured directly from the air within the tyre cavity and presented to the user periodically or via a triggered update in response to an alert condition. The following raw tyre data is provided for each individual wheel position:

Raw tyre data

- Tyre Pressure
- Tyre Temperature

Diagnostic data

- TPM wheel-unit sensor battery lifetime
- TPM wheel-unit sensor Identification
- TPM wheel-unit sensor current mode of operation

4.2   TPM Warnings

The robust Sensata HVOR vehicle TPM system is based upon market leading experience with global TPM warning legislation such as UN ECE R64 (EU) and FMVSS (US) in the passenger car market along with HVOR customisations developed as part of HVOR OE TPM systems currently in production.

Figure 1 TPMS Warning Thresholds

* If ambient outside air temperature is available on the vehicle (on Chassis CAN message AMB_Engine 0x18FEF517) then warning isochores can be calibrated by temperature.

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4.2.1   Under-pressure warnings

The TPMS generates multi-severity under-pressure warnings when the pressure for a given wheel position falls below pre-set thresholds.

Under-pressure

When the pressure is less than 10% below temperature compensated placard pressure, the system generates a "Soft" or "Yellow" warning. This under-pressure warning can be transmitted to the driver via the SPN524155_Tyre_Pressure_Status signal (with value 0x5) within the TPMS_01 CAN Message.

This warning will remain active until the pressure returns above the warning clear threshold, 4% below temperature compensated placard pressure.

Extreme-Under-pressure

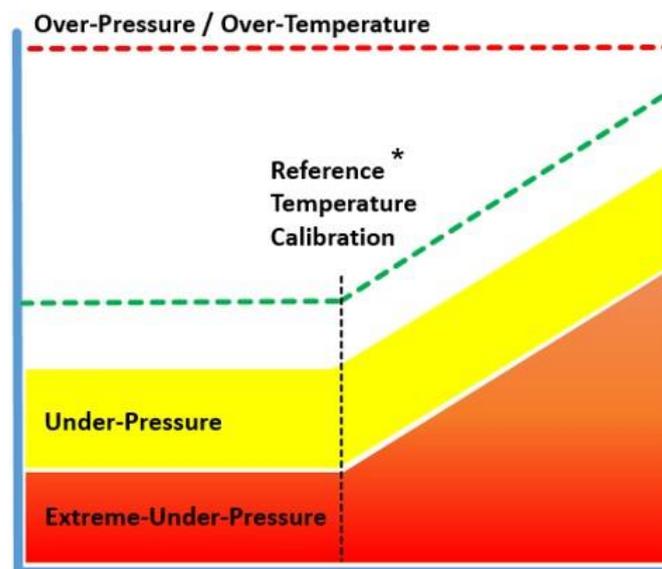When the pressure is less than 20% below temperature compensated placard pressure, the system generates a "Hard" or "Red" warning. This under-pressure warning can be transmitted to the driver via the SPN524155_Tyre_Pressure_Status signal (with value 0x6) within the TPMS_01 CAN Message.

This warning will remain active until the pressure returns above the warning clear threshold, 4% below temperature compensated placard pressure.

4.2.2   Over-pressure warning

When the pressure is greater than 30% above temperature compensated placard pressure, the system generates an over pressure warning. This pressure warning can be transmitted to the driver via the SPN524155_Tyre_Pressure_Status signal (with value 0x2) within the TPMS_01 CAN Message.

This warning will remain active until the pressure returns below the over pressure warning clear threshold, 8% above temperature compensated placard pressure.

4.2.3   Over-temperature warning

The TPMS generates an over-temperature warning when the measured temperature for a given wheel position rises above a pre-set over-temperature threshold (90 °C). This over temperature warning can be transmitted to the driver via the SPN524157_Tyre_Over_Temp_status (with value 0x1) within the TPMS_01 CAN Message.

This warning will remain active until the temperature returns below the over temperature warning clear threshold, (80 °C).

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4.3   Manual Learn

Manual Learn provides a way for the driver to update the Vehicle TPMS Sensor configuration without requiring access to Diagnostic Tools.   It is a process that can be initiated by the Driver whenever a new TPMS Sensor has been fitted to a tyre, or when a previously learnt TPMS sensor has been moved to a different wheel location on the vehicle.

Sensor IDs will be programmed into the vehicle's TPM system as part of the OEM factory end of line procedures using Diagnostic Routines. However, it is reasonable to expect sensors to require replacement or relocation over the vehicle lifetime. The Manual Learn feature is provided to remove the need for the driver to take the vehicle back to a dealership to reprogram a Sensor ID using a Diagnostic Tool.

This feature allows the driver to initiate the Manual Learn process through the Vehicle Instrument Cluster by selecting a specific Wheel unit location where a TPMS Sensor ID has been changed. Once a location has been selected, the System will monitor for RF transmissions from the Sensor. The driver is expected to force RF transmissions from the Sensor at the identified wheel location using one of two methods:

(A) Inducing a Pressure Change in the Tyre (positive or negative) .

OR

(B) Using a LF tool.

On successful completion of the process, the System will store the new Sensor ID against the selected wheel location. This information will be used by other TPMS System features such as Warning Strategy and displaying pressures/temperatures by position.

In scenarios where a sensor has been moved from an existing vehicle tyre location, then on a successful completion of the learn process, the system will automatically remove the association of the sensor ID against the old location.

4.4   PGN 65310

PGN 65310 is required by Prevost to support older vehicles which will not support the programming of sensor IDs into the TPM iECU. In these vehicles the logic to determine the sensors present on the vehicle is contained within a CANtrack display or Prevost's "TPMS Lite" component. Therefore, the TPM system will be required to output any valid transmissions received on PGN 65310.
However, to limit the number of IDs the ECU will output on the PGN an active list of sensors will be implemented that temporarily stores received sensor data.

For the Sensata implementation the Active Sensor List can accommodate 20 unique sensors and will have a timeout of 5 minutes.

- 20 sensors were chosen as this can accommodate the maximum number of sensors present on a Prevost Bus.

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- 5 minutes was chosen as the timeout as the transmission rate of the sensor is 2 minutes. Therefore, each sensor has two opportunities to remain on the list before being removed.

4.5   Setting Placards via HMI

4.5.1   HMI Placard Setting Mechanism Messages
Two messages shall be used for setting axle placard pressures via the vehicles HMI.
These are:
The HMI Placard Pressure message (TPMS_02_TPMS) which is sent by the TPMS ECU and is defined as a "periodic" and "on-change" message.
The HMI Placard Pressure message (TPMS_02_VIC) which is sent by the HMI and is defined as an "on request" message.
Note: the Highline message mentioned throughout the document is TPMS_01

TPMS_02_TPMS transmission rate
The TPMS shall transmit a periodic transmission of TPMS_02_TPMS every 60 seconds.

Additionally, this message shall be transmitted upon event (i.e. upon receiving TPMS-02-VIC) but no faster than every 200ms.

The TPMS shall transmit the first periodic transmission of TPMS_02_TPMS not earlier than 1000 and not later than 2000ms following ignition on.

TPMS_02_VIC transmission rate
The TPMS_02_VIC message shall not be sent periodically by the HMI.
TPMS_02_VIC shall only be sent on event (e.g. user entering placard menu, programming a new axle placard, exiting the placard menu) but no more often than once every 200ms.

4.5.2   Criteria for TPMS to apply new placards
The TPMS may apply new placard pressures when any of the following criteria have been met:
• TPMS receives TPMS_02_VIC indicating that no further axle placard pressure requests are coming (user has exited placard pressure menu)
• Vehicle ignition has been cycled (transitioned from on -> off -> on)
Note: If the TPMS has received a TPMS_02_VIC informing it that the placard pressure menu is active but has not received another TPMS_02_VIC for a specified time (3 minutes) any changes made prior to this timeout will be implemented after an ignition cycle.

4.5.3   Setting Placard Pressure Message Exchange
The exchange of messages between HMI and TPMS ECU to allow the updating of axle placard pressures in the TPMS ECU is detailed below.
TPMS_02_TPMS is sent periodically when there is no input from the end user (or TPMS ECU stored placard pressures are diagnostically changed), with each message iteration relaying information on all currently stored axle placards.
Following the reception of a TPMS_02_VIC requesting a placard pressure update, the TPMS ECU will prohibit sending any further periodic TPMS_02_TPMS messages until its criteria to apply new placards has been met. At this point it will start sending periodic TPMS_02_TPMS messages and reinitialise its periodic timer.

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When the end user enters new values for an axle placard pressure into the HMI, this
triggers a request TPMS_02_VIC from the HMI. The TPMS ECU captures the updated placard pressure from this message in volatile memory but does not update its stored placard pressures. This also triggers an on-change TPMS_02_TPMS from the TPMS ECU, relaying back the status of the update operation and the pending placard pressures for all axles. The message contents are then used by the HMI to update the driver on the status of the placard pressure change operation.

The TPMS ECU will only update its stored placard pressures by committing the new pending placard pressures to non-volatile memory and use them as part of the warning strategy only once the criteria for the TPMS to apply new placards has been met.

If the requested placard pressure value is outside the plausibility bounds stored in the TPMS, it will be rejected by the TPMS ECU, and it will report the old placard pressure and indicate to the HMI that the requested placard pressures were rejected by using the TPM communicated placard pressure status within the HMI Placard Pressure Message.

The plausibility limits are pre-set in the TPMS ECU software and cannot be adjusted by the driver.

Their purpose is to prevent the user from setting an extreme value (i.e. very high or very low) which would either leave the system setup such that the vehicle could operate with unsafe pressures without warning, or would result in an unfavourable user experience i.e. warning when the vehicle's tyres are within normal operating parameters.

The value for plausibility bounds are: Lower plausibility bound = 4 bar. Upper plausibility bound = 10 bar. Therefore pressures in the range of 4-10bar (inclusive) are acceptable as placard pressures.

High Line TPMS data messages sent after a request TPMS_02_VIC with new placard pressures, for wheels located on an axle that has had its placard pressure changed, will still report TPMS Temperature compensated target nominal pressure parameter values using the old placard pressures as reference until the criteria for TPMS to apply new placards has been met.

If the ECU receives multiple successive requests from the HMI for the same axle that are accepted, the ECU will discard all but the last accepted request prior to the criteria being met for TPMS to apply new placards.

The ECU will timeout if it does not receive any of the Criteria for TPMS to apply new placards after 3 consecutive minutes from the last request TPMS_02_VIC, and treat this timeout as if it had achieved this criteria.

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sd Set Placard Pressures V2

Driver

HMI

TPMS ECU

First periodic TPMS_02_TPMS shall be sent between 1000 and 2000ms of IGN on being transmitted on CAN bus.

Ignition On()

IGN On Message (PropB_VehicleMode)

Startup()

Periodic TPMS_02_TPMS()

Periodic Tx sent every 60 seconds when no change occurs.

Upon placard menu entry the HMI transmits TPMS_02_VIC with all pressures SNA and HMI placard menu signal = Active. This causes TPMS to inhibit warnings while menu is active.

Periodic TPMS_02_TPMS()

Periodic TPMS_02_TPMS()

User enters HMI placard menu()

TPMS_02_VIC (on event, no faster than 200ms) - All pressures SNA and HMI placard menu active

Ack/Nack TPMS_02_TPMS (All values as previously set, Tx trigger = Ack tx)

Placard pressures for any axle(s) that user wishes to change are transmitted. Axle placards that are not changed are transmitted as SNA. HMI Placard pressure menu status = Active.

User enters new axle placard()

TPMS_02_VIC with new axle placard pressures()

Pressures valid and stored in volatile memory (not yet used)

Ack/Nack TPMS_02_TPMS (New placard pressures but placard press status = Not used - Awaiting further changes)

TPMS sends updated placard pressures once so HMI can confirm it was correctly received. TPMS Placard pressure status = Currently reported values are not used by TPMS; awaiting further changes.

User exits HMI placard menu()

TPMS_02_VIC with all pressures SNA and HMI placard menu not active()

Ack/Nack TPMS_02_TPMS (All new placard values are used to evaluate measurements)

When user exits HMI placard menu the HMI informs the TPMS that the placard setting menu is no longer active.
Once the TPMS receives this message it uses the new placards and reinitialises the warning strategy.

4.6   CAN Message Layout

The TPMS_02_VIC and TPMS_02_TPMS share a common format (except for the value descriptions for the TPM placard pressure status signal which is dependent on the message.). The messages contains placard pressure values for all axles (up to a maximum of 4 axles plus spare tyre). Their meaning changes dependent on sending node i.e. they are either new placard values to be set (TPMS_02_VIC), or the stored / in use placard pressures (TPMS_02_TPMS). Transmission Repetition Rates:
TPMS_02_TPMS: Every 60 seconds and on response to every received TPMS_02_VIC message but no faster than every 200ms.
TPMS_02_VIC - In response to every placard pressure set instruction from the driver, but no faster than every 200ms.

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Start Position	Length	Parameter Name	SLOT	Notes	Intention of data i.e. what other vehicle nodes will utilise the reported information for
1-2.1	10 bits	Placard Pressure value for axle 1		2kPa/count Operation Range: 0.00 kPa to 2036 kPa 0x000 = 0 kPa 0x001 = 2 kPa 0x002 = 4 kPa … 0x3F9 = 2034 kPa 0x3FA = 2036 kPa 0x3FB = Signal Not Supported (Parameter specific indicator) 0x3FC = Reserved for future use 0x3FD = Reserved for future use 0x3FE = Error 0x3FF = Signal Not available	Meaning changes dependent on node sending message For periodic/on-change update message from TPMS ECU (TPMS_02_TPMS), the currently in use placard pressure value for this axle stored in the TPMS ECU is contained in this parameter. For HMI on-request message (TPMS_02_VIC), the value that the HMI is requesting the TPMS ECU should use as placard pressure for this axle is contained in this parameter.
2.3	4 bits	Reserved for trailer use		Reserved for trailer use	Reserved for trailer use
2.7-3	10 bits	Placard Pressure		2kPa/count	Meaning changes dependent on node sending message

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		value for axle 2		Operation Range: 0.00 kPa to 2036 kPa 0x000 = 0 kPa 0x001 = 2 kPa 0x002 = 4 kPa ... 0x3F9 = 2034 kPa 0x3FA = 2036 kPa 0x3FB = Signal Not Supported (Parameter specific indicator) 0x3FC = Reserved for future use 0x3FD = Reserved for future use 0x3FE = Error 0x3FF = Signal Not available	For periodic/on-change update message from TPMS ECU (TPMS_02_TPMS), the currently in use placard pressure value for this axle stored in the TPMS ECU is contained in this parameter. For HMI on-request message (TPMS_02_VIC), the value that the HMI is requesting the TPMS ECU should use as placard pressure for this axle is contained in this parameter.
4-5.1	10 bits	Placard Pressure value for axle 3		2kPa/count Operation Range: 0.00 kPa to 2036 kPa 0x000 = 0 kPa 0x001 = 2 kPa 0x002 = 4 kPa ... 0x3F9 = 2034 kPa 0x3FA = 2036 kPa 0x3FB = Signal Not Supported (Parameter specific indicator) 0x3FC = Reserved for future use 0x3FD = Reserved for future use 0x3FE = Error 0x3FF = Signal Not available	Meaning changes dependent on node sending message For periodic/on-change update message from TPMS ECU (TPMS_02_TPMS), the currently in use placard pressure value for this axle stored in the TPMS ECU is contained in this parameter. For HMI on-request message (TPMS_02_VIC), the value that the HMI is requesting the TPMS ECU should use as placard pressure for this axle is contained in this parameter.

5.3	2 bits	HMI Placard pressure menu status		Acceptable values from	Information sent from HMI to TPMS to inform the TPMS of
				TPMS (TPMS_02_TPMS message): 00 = Reserved for future use 01 = Reserved for future use 10 = Reserved for future use 11 = Not available / Not installed Acceptable values from HMI (TPMS_02_VIC message): 00 = Placard pressure menu is not active in HMI 01 = Placard pressure menu is active in HMI 10 = Error (HMI should never send this value) 11 = Not available / not installed	the current placard pressure menu status within the HMI.

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| 5.5 | 2 bits | TPMS Message Trigger | | Valid values from HMI (TPMS_02_VIC message):

00 = Reserved
01 = Reserved
10 = Reserved 11 = Not available / Not installed

Valid values from TPMS (TPMS_02_TP MS message): | Message from TPMS To HMI to inform HMI of what caused the TPMS to send this transmission (I.E. Sent in response to a HMI update request or sent as part of a periodic transmission from the HMI) |

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				00 = Scheduled (Periodic) transmission 01 = Ack/Nack Transmission 10 = Error 11 = Not available / Not installed	
5.7-6	10 bits	Placard Pres sure value for axle 4		2kPa/count Operation Range: 0.00 kPa to 2036 kPa 0x000 = 0 kPa 0x001 = 2 kPa 0x002 = 4 kPa ... 0x3F9 = 2034 kPa 0x3FA = 2036 kPa 0x3FB = Signal Not Supported (Parameter specific indicator) 0x3FC = Reserved for future use 0x3FD = Reserv ed for future use 0x3FE = Error 0x3FF = Signal Not available	Meaning changes dependent on node sending message For periodic/on-change update message from TPMS ECU (TPMS_02_TPMS), the currently in use placard pressure value for this axle stored in the TPMS ECU is contained in this parameter. For HMI on-request message (TPMS_02_VI C), the value that the HMI is requesting the TPMS ECU should use as placard pressure for this axle is contained in this parameter.

| 7 | 10 bits | Placard Pressure value for spare tyre | | 2kPa/count Operation Range: 0.00 kPa to 2036 kPa 0x000 = 0 kPa 0x001 = 2 kPa 0x002 = 4 kPa ... 0x3F9 = 2034 kPa 0x3FA = 2036 kPa 0x3FB = Signal Not Supported (Parameter specific indicator) | Meaning changes dependent on node sending message

For periodic/on-change update message from TPMS ECU (TPMS_02_TPMS), the currently in use placard pressure value for this axle stored in the TPMS ECU is contained in this parameter.

For HMI on-request message (TPMS_02_VIC), the value that the HMI is requesting the TPMS ECU should use as placard pressure for this axle is contained in this parameter. |
| | | | | 0x3FC = Reserved for future use 0x3FD = Reserved for future use 0x3FE = Error 0x3FF = Signal Not available | |

| 8.3 | 2 bits | TPM placard pressure status | | Acceptable values from HMI (TPMS_02_VIC Message):

00 = Reserved for future use 01 = Reserved for future use 10 = Reserved for future use 11 = Not available / Not supported

Acceptable values from TPMS (TPMS_02_TP MS message):

00 = Currently reported pressure values are not used by TPMS; awaiting further changes 01 = Currently reported pressure values are used by TPMS 10 = Currently reported pressure values are not used by TPMS; placard pressure out of range 11 = Currently reported pressure values are not used by TPMS; one or | Signal from TPMS to HMI. When responding to an HMI update request this provides additional information to the HMI about the status of the update. |

				more placards have not been configured yet	
8.5	4 bits	Reserved	N/A	Reserved	Reserved

If a placard pressure update operation fails within the TPMS ECU for the following reasons, the appropriate axle will report "Error":

- Requested pressure invalid due to plausibility limits
- Requested axle is invalid for current vehicle chassis configuration

The OE customer's HMI must be aware of the plausibility limits and/or the correct number of vehicle axles in order to correctly differentiate between the two error conditions.

If no change is being made to the axle pressure placard by the user, the HMI will report SNA for any placards that are not being changed in TPMS_02_VIC. The TPMS will respond with the placard pressures which it is currently using. (Always a valid value if the axle has been programmed at some point in the TPMS ECU's lifetime).

For any axle that is not configured as being present on the vehicle, its placard pressure will always be SNA in both TPMS_02_VIC and TPMS_02_TPMS.

The TPMS will respond to an initial TPMS_02_VIC request update within 100ms of receiving a request. However, this time can extend to longer than this to respect a Transmission Repetition Rate minimum time of 200ms.

4.7   Impact of placard pressure update on other features

Performing a placard pressure update will impact several other system features. These are:

- TPMS Warning strategy (Applying new placards)
- TPMS Warning strategy (Handling warnings)
- TPMS Highline Message

These system features will only be affected when a valid placard pressure update is received by the

TPMS from the HMI (In the TPMS_02_VIC message). If, for example, a user enters and exits the HMI without setting a placard then the system shall not be reinitialised as no placard pressure update has taken place.

4.7.1 Impact of placard pressure update on TPMS Warning Strategy (Applying new placards)

The TPMS ECU shall only update its stored placard pressures by committing the new pending placard pressures to non-volatile memory and use them as part of the warning strategy when the following occurs:

- TPMS_02_VIC is received from HMI with "HMI Placard pressure menu status" = "Placard Pressure menu is not active in HMI" with pressure value for all axles (Axle 1-4 and spare) populated in the message as "SNA" (Any new placards will be applied when this transmission is received).
- Vehicle Ignition is switched off. (Any new placards will be used upon ignition on).

Note: If user enters placard pressure setting menu and then exits without changing placards then the system shall not reinitialise the warning strategy in any way.

4.7.2 Impact of placard pressure update on TPMS Warning strategy (Handling warnings)

Once new placards have been applied by the system (See" Impact of placard pressure update on TPMS Warning Strategy (Applying new placards)") the system shall do the following:

When an axles placard pressure is updated within the TPMS, all pressure and temperature warning thresholds for that axle are updated based on the new placard level. Any warning that was raised prior to the placard change will be set/cleared in accordance with the normal warning strategy behaviour.

4.7.3 Impact of placard pressure update on TPMS Highline Message

Once placard pressures are updated, the TPMS shall continue with the pre-defined output order for the TPMS Highline message i.e. all TPMS highline messages sent post update shall not have their order changed.

In these messages the new placard pressure values shall be used e.g. the TPMS Temperature compensated target nominal pressure parameter values will change as they will use the new placard pressures as reference.

4.8 Upper and lower placard pressure bounds

The TPMS ECU will have placard pressure plausibility bounds as part of its software, to prevent the end user entering unsafe limits.

These values are:

- Lower bound = 400 kPa
- Upper bound = 1000 kPa

Any placard pressure values >= 400 kPa and <= 1000 kPa shall be allowed by the system.

4.9   Customer HMI Requirements

- The OE customers HMI must be aware of the correct number of vehicle axles in order to correctly populate the HMI and send the correct signals to the TPMS ECU.

- Before the first periodic message is received by the HMI on start-up, the HMI should not permit the setting of any placard pressure values, and should not display any default values to the user, as it is not known what the placard values are. This is to avoid the scenario where a default value is displayed on the HMI which then changes when the TPMS sends its first periodic placard pressure message. Note: TPMS will transmit the currently programmed placard values within 2000ms of KL15 on.

- If no change is being made to the axle pressure placard by the user, the HMI will report SNA for any placards that are not being changed in TPMS_02_VIC. The TPMS will respond with the placard pressures which it is currently using. (Always a valid value if the axle has been programmed at some point in the TPMS ECU's lifetime).

- If an axle is not fitted to a vehicle the placard pressure for that axle must always be transmitted as SNA by the vehicle HMI in the TPMS_02_VIC message.

- The TPMS will respond to an initial TPMS_02_VIC request update within 100ms of receiving a request. However, this time can extend to longer than this to respect a Transmission Repetition Rate minimum time of 200ms. Therefore, the HMI should only timeout on awaiting a response for a TPMS_02_VIC request after 200ms from sending the request and inform the user. The timeout may occur if the TPMS ECU missed the request or it could not action an update or response to request for any reason e.g. busy.

- The HMI should not send subsequent TPMS_02_VIC requests within 200ms of the previous message. This is to avoid a scenario where the HMI would send another TPMS_02_VIC request before it has received a response TPMS_02_TPMS to the first TPMS_02_VIC request, or the HMI has timed out on awaiting a response from the first TPMS_02_VIC request. If more than one TPMS_02_VIC request is received by the TPMS before it has sent its TPMS_02_TPMS response to the first, all subsequent requests to the first will be ignored by the TPMS.

- Upon TPMS system start-up it can take up to 2 seconds from ignition on for the first TPMS_02_TPMS to be output on the bus, during which the HMI is expected to inhibit the user from accessing the menu containing placard pressure update functionality, or it can allow access to view the menu but it must replace the current placard pressure value with a indication that current values are unknown. HMI must avoid populating last known data from previous power cycle in case placard pressures have been changed via diagnostics.

4.10   DTCs

4.10.1 Wheel Unit Battery Low

Parameter	Detail
DTC Name:	Wheel Unit Battery Low WUXX
DTC Code (HEX):	WU17 = 0x120DB5 WU19 = 0x120DB6 WU26 = 0x120DB7 WU27 = 0x120DB8 WU29 = 0x120DB9 WU2A = 0x120DBA WU36 = 0x121405 WU37 = 0x121406 WU39 = 0x121407 WU3A = 0x121408 WU46 = 0x121409 WU47 = 0x12140A WU49 = 0x12140B WU4A = 0x12140C WU08 = 0x12140D
General Description	This DTC is raised to indicate the presence of configured wheel unit IDs that have battery capacity of <=10%
Condition to set to Active	When currently configured wheel unit has currently reported battery status of <=10% for >=5 consecutive transmissions
Condition to set to Healed	When currently configured wheel unit has currently reported battery status of >10% >=5 consecutive transmissions
Condition to set to Cleared	Can only be cleared upon diagnostic DTC clear. Note: when it was cleared diagnostically, and a new RF message is received with battery low, this DTC should be triggered again without waiting the full 5 consecutive transmission.
Error/Fault text	WU_Batt_Low XX
SPN	WU17 = 3509 WU19 = 3510 WU26 = 3511 WU27 = 3512 WU29 = 3513 WU2A = 3514 WU36 = 5125 WU37 = 5126 WU39 = 5127 WU3A = 5128 WU46 = 5129 WU47 = 5130 WU49 = 5131 WU4A = 5132 WU08 = 5133
FMI (number + text explanation)	18
Occurrence / Fault	Occurrence
Warning Indicator	Active
Mature Time (Value, Unit)	0 seconds

Monitor Type	continuous
Monitor Rate (Value, Unit)	depends on receiving of information
Lamp Raised	Yellow

4.10.2 Wheel Unit Reception Disturbed

Parameter	Detail
DTC Name:	Wheel Unit Reception Disturbed
DTC Code (HEX):	WU17 = E9EF41 WU19 = E9EF42 WU26 = E9EF43 WU27 = E9EF44 WU29 = E9EF45 WU2A = E9EF46 WU36 = E9EF47 WU37 = E9EF48 WU39 = E9EF49 WU3A = E9EF4A WU46 = E9EF4B WU47 = E9EF4C WU49 = E9EF4D WU4A = E9EF4E
General Description	This DTC is raised to indicate the presence of configured wheel unit IDs that have reception disturbed status
Condition to set to Active	When any currently configured wheel unit ID has not been received for cumulative time of 9 minutes where vehicle speed >=25km/h and axle has been deployed, status unavailable or in error (i.e. not lifted/unavailable/error) within an operating cycle
Condition to set to Healed	When wheel unit ID has been received again
Condition to set to Cleared	Can only be cleared upon diagnostic DTC clear
Error/Fault text	Wheel Unit Reception Disturbed
High Line Behaviour	All current RF data is cleared for sensor and error raised (for those supported) TPMS Tire Temperature = 0xFE TPMS Tire Pressure = 0x3FE TPMS Wheel unit battery status = 0xE TPMS Fast Pressure Loss Status Flag = 0x3 (not supported) TPMS Temperature compensated target nominal pressure = 0x3FE TPMS Tire Pressure Status = 0xE TPMS Tyre Burst Status = 0x3 (not supported) TPMS Tyre Over Temperature Status = 0x2 TPMS Tyre Lock Detected Status = 0x3 (not supported) TPMS Tyre Fill Assistant Status = 0xF (not supported) Sensor ID programmed status = 0x0 (must be configured with ID for reception disturbed to occur)
SPN	WU17 = 520001 WU19 = 520002 WU26 = 520003 WU27 = 520004

	WU29 = 520005 WU2A = 520006 WU36 = 520007 WU37 = 520008 WU39 = 520009 WU3A = 520010 WU46 = 520011 WU47 = 520012 WU49 = 520013 WU4A = 520014
FMI (number + text explanation)	9
Occurrence / Fault	Fault
Warning Indicator	Active
Mature Time (Value, Unit)	540 seconds
Monitor Type	continuous
Monitor Rate (Value, Unit)	depends on receiving of information
Lamp Raised	Yellow

4.10.3 Placard Pressure Settings Error

Parameter	Detail
DTC Name:	Placard pressure settings error
DTC Code (HEX):	0x001E2A
General Description	This DTC is raised to indicate invalid or out of range values for any configured axle placard pressure values
Condition to set to Active	When placard pressures for any configured axle are determined as being outside plausible range/invalid value i.e. <4 bar or >10 bar
Condition to set to Healed	All configured axles have placard pressures in plausible range/valid value i.e. >=4 bar and <=10 bar
Condition to set to Cleared	Can only be cleared upon diagnostic DTC clear
Error/Fault text	Placard pressure settings error
SPN	241
FMI (number + text explanation)	10
Occurrence / Fault	Occurrence
Warning Indicator	Active
Readiness Indicator	supported
Mature Time (Value, Unit)	0 seconds
Monitor Type	On demand

Monitor Rate (Value, Unit)	Once after ignition on
Lamp Raised	Yellow

4.10.4 eRx Auto Configuration Error

Parameter	Detail
DTC Name:	eRX autoconfiguration error
DTC Code (HEX):	0xEBE775
General Description	This DTC is raised to indicate the presence of an error in autoconfiguration of the eRXs
Condition to set to Active	When autoconfiguration fails for any reason
Condition to set to Healed	When autoconfiguration completes without error
Condition to set to Cleared	Can only be cleared upon diagnostic DTC clear
Error/Fault text	eRX autoconfiguration error
SPN	518005
FMI (number + text explanation)	11
Occurrence / Fault	Occurrence
Warning Indicator	Active
Readiness Indicator	supported
Mature Time (Value, Unit)	0 seconds
Monitor Type	on demand
Monitor Rate (Value, Unit)	Once after ignition On
Lamp Raised	Yellow

4.10.5 CAN Bus Off

Parameter	Detail
DTC Name:	CAN Bus off
DTC Code (HEX):	0x09027F
General Description	This DTC is raised to indicate that a CAN Bus off condition has been detected
Condition to set to Active	CAN Bus off has been detected
Condition to set to Healed	CAN Bus off is no longer present i.e. CAN Bus on
Condition to set to Cleared	Can only be cleared via diagnostic clear or ECU reset
Error/Fault text	CAN Bus off
SPN	639
FMI (number + text explanation)	9
Occurrence / Fault	Fault
Warning Indicator	Active

Readiness Indicator	supported
Mature Time (Value, Unit)	5 seconds
Monitor Type	continuous
Lamp Raised	Yellow

4.10.6 ECU Battery Supply Undervoltage

Parameter	Detail
DTC Name:	ECU Battery Supply Undervoltage
DTC Code (HEX):	0x0400A8
General Description	This DTC is raised to indicate that a Battery Supply under voltage condition exists
Condition to set to Active	Supply undervoltage condition exists i.e. <8V for >=5 seconds
Condition to set to Stored	Supply undervoltage condition no longer exists i.e. >=8.5V for >5 seconds
Condition to set to Cleared	Can only be cleared via diagnostic clear or ECU reset
Error/Fault text	ECU Battery Supply Undervoltage
SPN	168
FMI (number + text explanation)	4
Occurrence / Fault	Occurrence
Warning Indicator	Active
Readiness Indicator	supported
Mature Time (Value, Unit)	5 seconds
Monitor Type	continuous
Monitor Rate (Value, Unit)	100ms
Lamp Raised	Yellow

4.10.7 ECU Battery Supply Overvoltage

Parameter	Detail
DTC Name:	ECU Battery Supply Overvoltage
DTC Code (HEX):	0x0300A8
General Description	This DTC is raised to indicate that a CAN overvoltage condition exists
Condition to set to Active	CAN Bus overvoltage condition exists i.e. >16V for >=5 seconds
Condition to set to Stored	CAN Bus overvoltage condition no longer exists <=15.5V for >= 5 seconds
Condition to set to Cleared	Can only be cleared via diagnostic clear or ECU reset
Error/Fault text	ECU Battery Supply Overvoltage
SPN	168

FMI (number + text explanation)	3
Occurrence / Fault	Occurrence
Warning Indicator	Active
Readiness Indicator	supported
Mature Time (Value, Unit)	5 seconds
Monitor Type	continuous
Monitor Rate (Value, Unit)	100ms
Lamp Raised	Yellow

4.10.8 eRx A Supply Short Circuit

Parameter	Detail
DTC Name:	eRX A supply short circuit
DTC Code (HEX):	0xE4EB59
General Description	This DTC is raised to indicate that a configured eRX A has a supply short circuit
Condition to set to Active	ECU detects that eRX A, when configured as enabled, has a supply short circuit i.e. A/D voltage < 1000mV for >= 5 seconds
Condition to set to Healed	ECU detects that eRX A, when configured as enabled, does not have a supply short circuit i.e. A/D voltage > 2500mV for >= 5 seconds
Condition to set to Cleared	Can only be cleared via diagnostic clear
Error/Fault text	eRX A supply short circuit
SPN	519001
FMI (number + text explanation)	4
Occurrence / Fault	Fault
Warning Indicator	Active
Readiness Indicator	supported
Mature Time (Value, Unit)	5 seconds
Monitor Type	continuous
Monitor Rate (Value, Unit)	0.5 seconds
Lamp Raised	Yellow

4.10.9 eRx XX Missing

Parameter	Detail
DTC Name:	eRX missing
DTC Code (HEX):	eRX18 = 0xE9EB59 eRX27 = 0xE9EB5A eRX29 = 0xE9EB5B eRX37 = 0xE9EB5C eRX39 = 0xE9EB5D eRX47 = 0xE9EB5E eRX49 = 0xE9EB5F
General Description	This DTC is raised to indicate that an eRX heartbeat has not been received

Condition to set to Active	An eRX, which is configured, heartbeat is missing i.e. ECU receives no heartbeat message from eRX XX for >=10 seconds, whilst TPM_POWER_STAT = 0x01, where XX can be 18, 27, 29, 37, 39, 47, or 49
Condition to set to Healed	An eRX, which is configured, heartbeat is not missing i.e. ECU receives heartbeat message from eRX XX, where XX can be 18, 27, 29, 37, 39, 47, or 49
Condition to set to Cleared	Can only be cleared via diagnostic clear
Error/Fault text	eRX XX missing
SPN	eRX18 = 519001 eRX27 = 519002 eRX29 = 519003 eRX37 = 519004 eRX39 = 519005 eRX47 = 519006 eRX49 = 519007
FMI (number + text explanation)	9
Occurrence / Fault	Fault
Warning Indicator	Active
Readiness Indicator	supported
Mature Time (Value, Unit)	10 seconds
Monitor Type continuous	continuous
Monitor Rate (Value, Unit)	1 seconds
Lamp Raised	Yellow

4.10.10   eRx B Supply Short Circuit

Parameter	Detail
DTC Name:	eRX B supply short circuit
DTC Code (HEX):	0xE4EB5A
General Description	This DTC is raised to indicate that a configured eRX B has a supply short circuit
Condition to set to Active	ECU detects that eRX B, when configured as enabled, has a supply short circuit i.e. A/D voltage < 1000mV for >= 5 seconds
Condition to set to Healed	ECU detects that eRX B, when configured as enabled, does not have a supply short circuit i.e. A/D voltage > 2500mV for >= 5 seconds
Condition to set to Cleared	Can only be cleared via diagnostic clear
Error/Fault text	eRX B supply short circuit
SPN	519002
FMI (number + text explanation)	4
Occurrence / Fault	Fault
Warning Indicator	Active
Readiness Indicator	supported

Mature Time (Value, Unit)	5 seconds
Monitor Type	continuous
Monitor Rate (Value, Unit)	0.5 seconds
Lamp Raised	Yellow

4.10.11   eRx C Supply Short Circuit

Parameter	Detail
DTC Name:	eRX C supply short circuit
DTC Code (HEX):	0xE4EB5B
General Description	This DTC is raised to indicate that a configured eRX C has a supply short circuit
Condition to set to Active	ECU detects that eRX C, when configured as enabled, has a supply short circuit i.e. A/D voltage < 1000mV for >= 5 seconds
Condition to set to Healed	ECU detects that eRX C, when configured as enabled, does not have a supply short circuit i.e. A/D voltage > 2500mV for >= 5 seconds
Condition to set to Cleared	Can only be cleared via diagnostic clear
Error/Fault text	eRX C supply short circuit
SPN	519003
FMI (number + text explanation)	4
Occurrence / Fault	Fault
Warning Indicator	Active
Readiness Indicator	supported
Mature Time (Value, Unit)	5 seconds
Monitor Type	continuous
Monitor Rate (Value, Unit)	0.5 seconds
Lamp Raised	Yellow

4.10.12   DTC – AMB_Engine Timeout

Parameter	Detail
DTC Name:	AMB_Engine timeout
DTC Code (HEX):	0x0900AB
General Description	This DTC indicates that the the AMB_Engine message has timed out
Condition to set to Active	AMB_Engine message timesout i.e. has not been received by ECU for 5000ms
Condition to set to Healed	AMB_Engine message received
Condition to set to Cleared	Only on diagnostic clear
Error/Fault text	AMB_Engine timeout
System Behaviour	System will then use 15degC as its sampled OAT value whilst DTC is active
SPN	171

FMI (number + text explanation)	9
Occurrence / Fault	Occurrence
Warning Indicator	Active
Readiness Indicator	supported
Mature Time (Value, Unit)	5000ms
Monitor Type	Continuous
Monitor Rate (Value, Unit)	1000 ms
Lamp Raised	Yellow

4.10.13   DTC – EEC1 Timeout

Parameter	Detail
DTC Name:	EEC1 timeout
DTC Code (HEX):	0xE9E771
General Description	This DTC indicates that the EEC1 message has timed out
Condition to set to Active	EEC1 message times out i.e. has not been received by ECU for 2500ms
Condition to set to Healed	EEC1 message received
Condition to set to Cleared	Only on diagnostic clear
Error/Fault text	EEC1 timeout
System Behaviour	ECU uses 0 as value for engine speed
SPN	518001
FMI (number + text explanation)	9
Occurrence / Fault	Occurrence
Warning Indicator	Active
Readiness Indicator	supported
Mature Time (Value, Unit)	250ms
Monitor Type	Continuous
Monitor Rate (Value, Unit)	10ms
Lamp Raised	Yellow

4.10.14   DTC – PropB_VehicleMode Timeout

Parameter	Detail
DTC Name:	PropB_VehicleMode timeout
DTC Code (HEX):	0xE9E772
General Description	This DTC indicates that the PropB_VehicleMode message has timed out
Condition to set to Active	PropB_VehicleMode message times out i.e. has not been received by ECU for 5000ms
Condition to set to Healed	PropB_VehicleMode message received

Condition to set to Cleared	Only on diagnostic clear
Error/Fault text	PropB_VehicleMode timeout
SPN	518002
FMI (number + text explanation)	9
Occurrence / Fault	Occurrence
Warning Indicator	Active
Readiness Indicator	supported
Mature Time (Value, Unit)	5000ms
Monitor Type	Continuous
Monitor Rate (Value, Unit)	1000ms
Lamp Raised	Yellow

4.10.15   DTC – TCO1 Timeout

| Parameter	Detail
DTC Name:	TCO1 timeout
DTC Code (HEX):	0xE9E773
General Description	This DTC indicates that the TCO1 message has timed out
Condition to set to Active	TCO1 message times out i.e. has not been received by ECU for 1000ms
Condition to set to Healed	TCO1 message received
Condition to set to Cleared	Only on diagnostic clear
Error/Fault text	TCO1 timeout
System Behaviour	Set vehicle speed to 0km/h
SPN	518003
FMI (number + text explanation)	9
Occurrence / Fault	Occurrence
Warning Indicator	Active
Readiness Indicator	supported
Mature Time (Value, Unit)	1000ms
Monitor Type	Continuous
Monitor Rate (Value, Unit)	50ms
Lamp Raised	Yellow

4.10.16   DTC – TD Timeout

Parameter	Detail
DTC Name:	TD timeout
DTC Code (HEX):	0xE9E774
General Description	This DTC indicates that the TD message has timed out

Condition to set to Active	TD message times out i.e. has not been received by ECU for 10000ms
Condition to set to Healed	TD message received
Condition to set to Cleared	Only on diagnostic clear
Error/Fault text	TD timeout
System Behaviour	ECU uses last known time and date stamp If unknown, use minimum value according to time and date message - 00:00:00 01/01/1985
SPN	518004
FMI (number + text explanation)	9
Occurrence / Fault	Occurrence
Warning Indicator	Active
Readiness Indicator	supported
Mature Time (Value, Unit)	10000ms
Monitor Type	Continuous
Monitor Rate (Value, Unit)	1000ms
Lamp Raised	Yellow

5   Fitment & Installation

5.1   Wheel-unit Fitment Guidelines

The TPM wheel-unit must rest on the rim to prevent damage during tyre fitment and removal.

Suitable valve designs for all TPM-equipped trailer variants should be defined at the start of development.
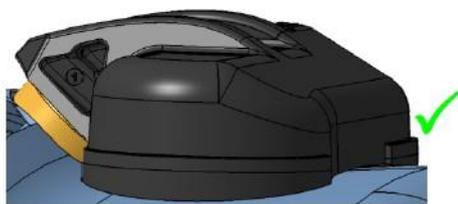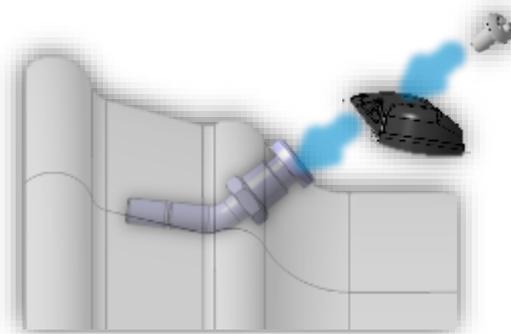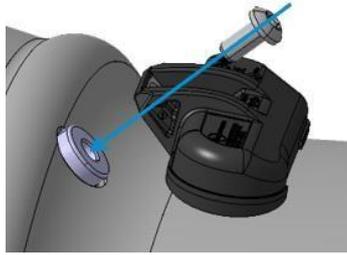

Correct Fitment   Incorrect Fitment

The wheel-unit is secured to the valve stem using a M6 x 10 torque head   screw.

5.2   eRX Fitment Guidelines

Positioning of the eRXs on the vehicle is dependent on the vehicle configuration. The eRXs must be placed to achieve adequate RF performance from all wheel units.

RF testing has been performed at Volvo Prevost in the configuration opposite.

In this configuration eRX18 is mounted on the underside of the chassis, as close as possible to the middle of the front axle.

eRX27 is installed on the left side of the chassis, between the second and third axles.

eRX29 is installed on the right side of the chassis, between the second and third axles.

Sensata deem this configuration as having adequate performance for a manual-learn system.
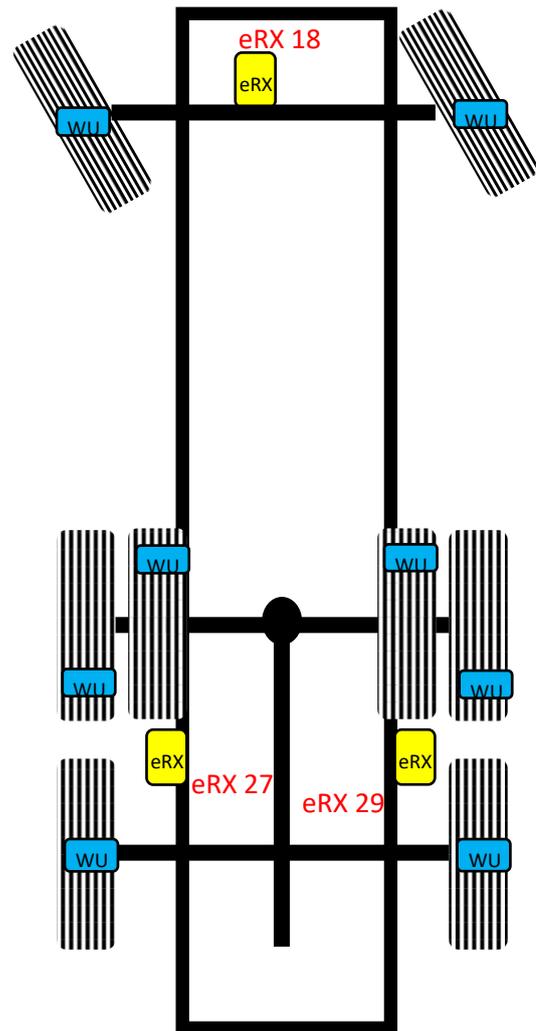
5.2.1   General Rules

- eRX's mounted on the second axle should be mounted on outside of chassis rail.
- eRx's are generally mounted to the outside of chassis rail using brackets.
- The bracket is shaped such that the antenna is orientated at a 45° angle from the chassis rail with the lid facing the inside of the inner wheel.
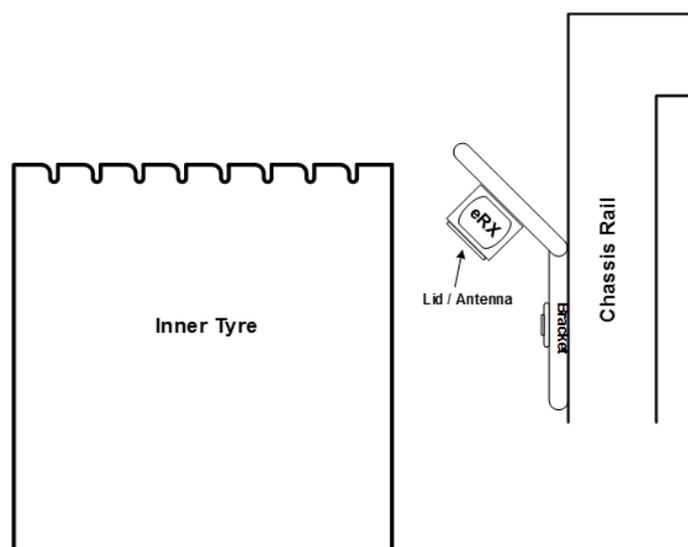
6   System Configuration

The TPM System is configurable via the CAN interface.

The TPMS iECU supports UDS standard ISO 14229 diagnostic communication via the J1939 Chassis CAN bus. The system user can initiate a diagnostic session with the ECU as long as power is provided to the ECU and ignition-on signal is available on the Chassis CAN bus.

6.1   Configurable Parameters

The following parameters may be configured via diagnostic session on the iECU's J1939 Chassis CAN communications bus:

Parameter Group	Parameter	Typical Value
Variant Coding	Axle1_Configuration_Current … Axle4_Configuration_Current	Liftable / Non- liftable axle Single / Dual wheels
Variant Coding	Manual Learn Enable State	Enabled / Disabled
Variant Coding	WU_ID_Location_Current	32 bit Wheel-Unit ID, programmed for each position
Variant Coding	TPMS_Warning_Parameters	GLOBALUnderPressureClearPercent, GLOBALOverPressureClearPercent, UnderPressureSetPercent, UnderPressureSetTime, ExtremeUnderPressureSetPercent, ExtremeUnderPressureSetTime, OverPressureSetPercent, OverPressureSetTime, OverTemperatureSetThreshold, OverTemperatureClearThreshold, OverTemperatureSetTime
Variant Coding	PlacardPressures	NominalPressureValueAxle1 … NominalPressureValueAxle4 NominalPressureValueSpareTyre
Variant Coding	eRxConfiguration	Pin_A_eRx_Present true/false … Pin_G_eRx_Present true/false
Variant Coding	eRxPinAssignment	eRX_A_ID ISO position … eRX_A_ID ISO position

Variant Coding	SpareTyreConfiguration	SpareTyre Unavailable/Available, SpareTyreAutoExchange unavailable/available
Variant Coding	SpareTyreID	32 bit Wheel-Unit ID of spare tyre
Variant Coding	Debug Message Status	Debug message disabled /enabled
Variant Coding	KeepAwakeTimer	Time which the ECU stays awake in NC mode before beginning to monitor for CAN silence
Variant Coding	Sensor_monitoring_Configuration_Current	Full – TPM system monitors all wheels / Basic – system monitors single-wheeled axles only