



BSI Standards Publication

Intelligent transport systems — Framework for collaborative telematics applications for regulated commercial freight vehicles (TARV)

Part 23: Tyre pressure monitoring (TPM)

National foreword

This British Standard is the UK implementation of ISO 15638-23:2025.

The UK participation in its preparation was entrusted to Technical Committee EPL/278, Intelligent transport systems.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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**Intelligent transport systems —
Framework for collaborative
telematics applications for
regulated commercial freight
vehicles (TARV) —**

**Part 23:
Tyre pressure monitoring (TPM)**

*Systèmes intelligents de transport — Cadre pour applications
télématiques collaboratives pour véhicules de fret commercial
réglementé (TARV) —*

Partie 23: Suivi de la pression des pneus

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

A list of all parts in the ISO 15638 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Many ITS technologies have been embraced by commercial transport operators and freight owners in the areas of fleet management, safety and security. Telematics applications have also been developed for governmental use. Such regulatory services in use or being considered vary from jurisdiction to jurisdiction, but include electronic on-board recorders, digital tachograph on-board mass monitoring, "mass" data for regulatory control and management, tyre pressure monitoring, vehicle access methods, hazardous goods tracking and eCall. Additional applications with a regulatory impact currently under development include fatigue management, speed monitoring and vehicle penalties imposed based on location, distance and time.

The ISO 15638 series addresses and defines the framework for a range of cooperative telematics applications for regulated vehicles such as access methods, driver fatigue management, speed monitoring, on-board mass monitoring, remote tachograph monitoring, ADR (agreement concerning the international carriage of dangerous goods by road) management, etc. The overall scope includes the concept of operation, legal and regulatory issues, and the generic cooperative provision of services to regulated vehicles, using an on-board ITS platform. The framework is based on a (multiple) service-provider oriented approach with provisions for the approval and auditing of service providers.

The ISO 15638 series provides both the means to achieve current requirements for telematics applications for regulated vehicles, and a basis for the future development of cooperative telematics applications for regulated vehicles.

The ISO 15638 series has been developed over several years with the objective of enabling telematics applications with whatever wireless communications are available at a given time and location, and providing a migration path to the cooperative ITS technologies and techniques that are steadily emerging.

Many new freight tractors/trucks use "tyre pressure monitoring systems" (TPMSs) to inform the operator of whether or not tyres on the vehicle are properly inflated (or are missing entirely). However, older freight tractors/trucks and most trailers do not use this technology. As a result, many freight vehicles operate with underinflated or missing tyres. These vehicles are potentially unsafe as their braking performance is degraded, their stability is compromised, their fuel efficiency is reduced, thus increasing greenhouse gas emissions, and they are non-compliant with roadway and bridge weight limitations, thus reducing pavement and bridge life resulting in increased roadway infrastructure costs. This document is designed to improve freight vehicle road transport safety and timely freight delivery while reducing accidents.

This document addresses the realization of safer road transport for freight vehicles utilizing the existing ISO 15638 series basic architecture framework, together with ISO 21750 and UNECE Regulation 141.^[22]

In the system described in this document, a vehicle on-board sensor identifies whether a tyre is underinflated or missing and provides these data to an in-vehicle system (IVS). Either at predetermined intervals, upon registering an anomaly, or on request from the service provider, the IVS sends the most recent TPMS data to a predetermined address provided by the service provider.

The service provider notifies vehicle operators or commercial vehicle enforcement agencies in order for corrective action to be taken to correct the tyre deficiency, as necessary.

This document provides specifications for tyre pressure monitoring and supports several defined communication profiles by which this function may be performed.

As with other parts of the ISO 15638 series, this document neither prescribes nor proscribes particular modes of operation, but instead provides a number of defined communication and data profiles within which jurisdictions and operators can achieve their objectives for tyre pressure monitoring within the objectives and constraints of their regulations. This document recognizes that those requirements and constraints will differ between jurisdictions.

NOTE 1 The ISO 15638 series has been developed for use in the context of regulated commercial freight vehicles (hereinafter referred to as "regulated vehicles"). There is nothing however to prevent a jurisdiction extending or adapting the scope to include other types of regulated vehicles, as it deems appropriate.

NOTE 2 The definition of what comprises a "regulated" vehicle is regarded as an issue for national decision and can vary from jurisdiction to jurisdiction. The ISO 15638 series does not impose any requirements on nations in respect of how they define a regulated vehicle.

NOTE 3 The definition of what comprises a "regulated" service is regarded as an issue for national decision and can vary from jurisdiction to jurisdiction. The ISO 15638 series does not impose any requirements on nations in respect of which services for regulated vehicles jurisdictions will require, or support as an option. Instead, it provides standardized sets of requirements for identified services to enable consistent and cost efficient implementations where implemented.

Subsequent versions of this document will potentially be able to support additional communication profiles.

NOTE 4 Jurisdictions requiring and regulating the use of remotely-monitored TPM systems are recommended to specifically regulate to determine which communications profiles are required to be supported, and can also wish to regulate regarding which application profiles are required to be supported. It is further recommended (but not required) that jurisdictions whose regulations require support of Communication profile C3 for regulatory enforcement purposes also at least encourage the ability to technically support Communication profile C1 in addition (for later potential migration purposes).

Intelligent transport systems — Framework for collaborative telematics applications for regulated commercial freight vehicles (TARV) —

Part 23: Tyre pressure monitoring (TPM)

1 Scope

This document addresses the provision of tyre pressure monitoring (TPM) services. It specifies the form and content of the transmission data required to support TPM systems (TPMS) and the access methods for these data.

This document provides specifications for common communications and data exchange aspects of the TPM application service that a jurisdiction regulator or operator can elect to require or support as an option, including:

- a) a high-level definition of the service that a service provider has to provide [the service definition describes common service elements (SEs), but does not specify the detail of how such an application service is instantiated, nor the acceptable value ranges of the data concepts defined];
- b) the means to realize the service;
- c) application data naming, content and quality that an in-vehicle system (IVS) has to deliver, including a number of TPM profiles or data (noting that requirements and constraints of what can/cannot be transmitted over the air can vary between jurisdictions);
- d) support for a number of defined communication profiles to enable remote inspection.

This document provides specifications for the following application profiles:

- Application profile A1: the cyclical initiation of TPM message by on-board equipment (TPM-C).
- Application profile A2: the exceptional initiation of TPM message by on-board equipment (TPM-E).
- Application profile A3: the provision of TPM data as the result of an off-board request (TPM-R).
- Application profile A4: The provision of TPM data as the result of an off-board reading of tyre pressures of vehicles which can potentially be unequipped (TPM-O).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 15638-1, *Intelligent transport systems — Framework for collaborative Telematics Applications for Regulated commercial freight Vehicles (TARV) — Part 1: Framework and architecture*

ISO 15638-2, *Intelligent transport systems — Framework for collaborative Telematics Applications for Regulated commercial freight Vehicles (TARV) — Part 2: Common platform parameters using CALM*

ISO 15638-3, *Intelligent transport systems — Framework for collaborative telematics applications for regulated commercial freight vehicles (TARV) — Part 3: Operating requirements, 'Approval Authority' procedures, and enforcement provisions for the providers of regulated services*

ISO/TS 15638-4, *Intelligent transport systems — Framework for cooperative telematics applications for regulated vehicles (TARV) — System security requirements*

ISO 15638-5:2013, *Intelligent transport systems — Framework for collaborative Telematics Applications for Regulated commercial freight Vehicles (TARV) — Part 5: Generic vehicle information*

ISO 15638-6, *Intelligent transport systems — Framework for collaborative Telematics Applications for Regulated commercial freight Vehicles (TARV) — Part 6: Regulated applications*

ISO 21177, *Intelligent transport systems — ITS station security services for secure session establishment and authentication between trusted devices*

UN Regulation No. 141 Tyre Pressure Monitoring Systems (TPMS): Uniform provisions concerning the approval of vehicles with regard to their Tyre Pressure Monitoring Systems (TPMS)

3GPP 21.101 Technical Specifications and Technical Reports for a UTRAN-based 3GPP system (Release 8)

3GPP 36 300 LTE; Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN) (Release 10)

3GPP 23.501 System architecture for the 5G System (5GS) (Release 17)

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 15638-1 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

app

small (usually) Java™ applets, organized as software bundles, that support application services by keeping the data pantry provisioned with up to date data

Note 1 to entry: Java™ is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

3.2

application profile

characteristics and specification of the information and transaction detail required to meet a set of user needs

Note 1 to entry: Within the common high-level framework of this document, the application profile allows different jurisdictions to receive different details of transactions or to specify a particular communications means.

3.3

application service

service provided by a service provider enabled by accessing data from the in-vehicle system (IVS) of a regulated vehicle via a wireless communications network

3.4

application service provider

ASP

party that provides an application service

3.5

app library

separately secure area of memory in an in-vehicle system (IVS) where apps are stored

Note 1 to entry: The app library has different access controls to the data pantry.

3.6

approval

formal affirmation that an applicant has satisfied all the requirements for appointment as an application service provider or that an application service delivers the required service levels

3.7

approval agreement

written agreement made between an approval authority (regulatory) and a service provider

Note 1 to entry: An approval authority (regulatory) approval agreement recognizes the fact that a service provider, having satisfied the approval authority's requirements for appointment as a service provider, is appointed in that capacity, and sets out the legal obligations of the parties with respect to the on-going role of the service provider.

3.8

approval authority (regulatory)

organization (usually independent) which conducts approvals and ongoing audits for service providers on behalf of a jurisdiction

3.9

architecture

formalized description of the design of the structure of telematics applications for regulated vehicles (TARV) and its framework

3.10

audit

auditing

review of a party's capacity to meet, or continue to meet, the initial and ongoing approval agreements as a service provider

3.11

basic vehicle data

data that are required to be maintained/provided by all in-vehicle systems (IVS), regardless of jurisdiction

3.12

CALM

communications access for land mobiles

layered solution that enables continuous or quasi continuous communications between vehicles and the infrastructure, or between vehicles, using such (multiple) wireless telecommunications media as are available in any particular location and which have the ability to migrate to a different available media where required

Note 1 to entry: Within this context, media selection is at the discretion of user-determined parameters based on ISO 21217 architecture and ISO 21210 C-ITS-station networking. This provides a common platform for a number of standardized media using ITS-stations to provide wireless support for applications, such that the application is independent of any particular wireless medium.

3.13

cold tyre inflation pressure

tyre pressure at ambient temperature, in the absence of any pressure build-up due to tyre usage

3.14

commercial application

intelligent transport systems (ITS) application in regulated vehicles for commercial (non-regulated) purposes

EXAMPLE Asset tracking, vehicle and engine monitoring, cargo security, driver management.

3.15

communications profile

characteristics and specification of the communication detail required to meet a set of user needs using a selected wireless medium

3.16

core data

basic vehicle data plus any additional data required to provide an implemented regulated application service

3.17

data pantry

secure area of memory in in-vehicle systems (IVS) where data values are stored, with different access controls to the app library

3.18

driver

person driving the regulated vehicle at any specific point in time

3.19

facilities layer

layer that sits on top of the communication stack and helps to provide data interoperability and reuse, and to manage applications and enable dynamic real time loading of new applications

3.20

framework

particular set of beliefs or ideas, or both, referred to in order to describe a scenario or solve a problem

3.21

in-vehicle system

IVS

ITS-station or connected tyre pressure monitoring (TPM) equipment, or both, on-board a vehicle during vehicle usage

3.22

interrogator

off-board device which can establish a wireless communications session with the in-vehicle system (IVS), including 5,8 GHz dedicated short-range communication (DSRC), and which can request the provision of tyre pressure monitoring (TPM) data

Note 1 to entry: This is often a mobile device under the control of an agent of the jurisdiction.

3.23

ITS-station

ITS-s

entity in a communication network, comprised of application, facilities layer, and networking and access layer components (as specified in ISO 21217) that operate within a bounded secure management domain

3.24

Java™

object oriented open source operating language developed by SUN systems

Note 1 to entry: Java™ is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

3.25

jurisdiction

government, road or traffic authority which owns the regulatory applications

EXAMPLE Country, state, city council, road authority, government department (customs, treasury, transport, etc.).

3.26

jurisdiction regulator

agent of the jurisdiction appointed to regulate and manage telematics applications for regulated vehicles (TARV) within the domain of the jurisdiction

Note 1 to entry: The jurisdiction regulator can also be, but is not necessarily, the approval authority (regulatory).

3.27

maximum axle load

maximum value, as indicated by the manufacturer, of the total vertical force between the contact surfaces of the tyres or tracks of one axle and the ground, resulting from the part of the vehicle mass supported by that axle

Note 1 to entry: This load can be higher than the "authorized axle load" laid down by the national administration. The sum of the axle loads can be greater than the value corresponding to the total mass of the vehicle.

3.28

operator

fleet manager of a regulated vehicle

Note 1 to entry: The operator also handles interrogation equipment.

3.29

physical roadside inspection

physical inspection of the tyre pressure monitoring (TPM) data of a stopped vehicle by agents of the application service provider

Note 1 to entry: The agents of the application service provider are usually police or inspectors appointed by the jurisdiction.

3.30

prime service provider

service provider who is the first contractor to provide regulated application services to the regulated vehicle, or a nominated successor on termination of that initial contract

Note 1 to entry: The prime service provider is also responsible for maintaining the installed in-vehicle system (IVS). If the IVS was not installed during the manufacture of the vehicle, the prime service provider is also responsible for installing and commissioning the IVS.

3.31

profile

common and consistent elaboration of content and sequence of a set of chosen classes, conforming subsets, options, parameters, and/or data concepts to accomplish a particular function/specification

3.32

recommended cold tyre inflation pressure

p_{rec}

pressure recommended for each tyre position by the vehicle manufacturer, for the intended service conditions (e.g. speed and load) of the given vehicle, as defined on the vehicle placard or the vehicle owner's manual, or both

3.33

regulated application

regulatory application

application arrangement using telematics applications for regulated vehicles (TARV) utilized by jurisdictions for granting certain categories of commercial vehicles rights to operate in regulated circumstances subject to certain conditions, or indeed to permit a vehicle to operate within the jurisdiction

Note 1 to entry: This may be mandatory or voluntary at the discretion of the jurisdiction.

3.34

regulated application service

telematics applications for regulated vehicles (TARV) application service intended to meet the requirements of a regulated application that is mandated by a regulation imposed by a jurisdiction, or is an option supported by a jurisdiction

3.35

regulated vehicle

vehicle that is subject to regulations determined by the jurisdiction as to its use on the road system of the jurisdiction in regulated circumstances, subject to certain conditions, and in compliance with specific regulations for that class of regulated vehicle

Note 1 to entry: At the discretion of jurisdictions, this can require the provision of information via telematics applications for regulated vehicles (TARV) or provide the option to do so.

3.36

service provider

party which is certified by an approval authority (regulatory) as being suitable to provide regulated or commercial ITS application services

3.37

session

wireless communication exchange between the ITS-station of an in-vehicle system (IVS) and the ITS-station of its application service provider to achieve data update, data provision, upload apps, or otherwise manage the provision of the application service, or a wireless communication provision of data to the ITS-station of an IVS from any other ITS-station

3.38

specification

explicit and detailed description of the nature and functional requirements and minimum performance of equipment, service or a combination of both

3.39

tachograph

sender unit, usually mounted to a vehicle gearbox, a tachograph head and a digital driver card, that records the regulated vehicle speed and the times at which it was driven and aspects of the driver's activity selected from a choice of modes

3.40

telematics

use of wireless media to obtain and transmit (data) from a distant source

3.41

tyre

pneumatic tyre, being a reinforced flexible envelope that is provided with, or forms in conjunction with the wheel on which it is mounted, a continuous, essentially toroidal, closed chamber containing a gas (usually air) or a gas and liquid, that is intended normally to be used at a pressure greater than atmospheric pressure

3.42

tyre pressure monitoring system

TPMS

system fitted on a vehicle, able to perform a function to evaluate the inflation pressure of the tyres or the variation of this inflation pressure over time by the generation of tyre pressure from equipment on-board (iTPM) or embedded in the tyre assembly (dTPM) and to transmit relevant information to relevant parties

3.43

user

individual or party that enrolls in and operates within a regulated or commercial application service

EXAMPLE Driver, transport operator, freight owner.

4 Symbols and abbreviated terms

ABS	antilock braking system
ADR	agreement concerning the international carriage of dangerous goods by road (UNECE)
AJ	agent of the jurisdiction
ANPR	automatic number plate recognition
app	applet (JAVA™ application or similar)
ASN.1	Abstract Syntax Notation One
ARIB	Association of Radio Industries and Businesses (Japan)
ASP	application service provider
BER	basic encoding rules (ASN.1)
CA	certification authority
CALM	communications access for land mobiles
CAN	controller area network
CPU	central processor unit
Dr	driver
DSRC	dedicated short-range communication
dTPM	direct tyre pressure management
HMI	human machine interface
HTTPS	hypertext transfer protocol secure
ID	identity
iTPM	indirect tyre pressure management
ITS-s	ITS station
IVS	in-vehicle system
LDT	local data tree
LTE	long term evolution
M1	UNECE category for cars
N1	UNECE category for light vans
OEM	original equipment manufacturer
OID	object identifier
OP	operator
PCB	printed circuit board

PSP	prime service provider
RF	radio frequency
RFID	radio frequency identification
SE	service element
SRE	strong radio evolution
TARV	telematics applications for regulated vehicles
TLAS	tyre leak alerting system
TPAS	tyre pressure alerting system
TPM	tyre pressure monitoring
TPM-C	cyclical tyre pressure monitoring from on-board equipment
TPM-E	exceptional tyre pressure monitoring from on-board equipment
TPM-R	tyre pressure monitoring from on-board equipment on request
TPM-O	tyre pressure monitoring by off-board equipment (vehicle may be unequipped)
TPWS	tyre pressure warning system
TTAK	Telecommunications Technology Association Korea
UTI	unique tyre identification
XER	ITU-T X.693 - XML encoding rules
XML	extensible markup language

5 Conformance

Requirements to demonstrate conformance to any of the general provisions or specific application services described in this document shall take into consideration regulations imposed by the jurisdiction where they are instantiated. Conformance requirements to meet the provisions of this document are therefore deemed to be under the control of, and to the specification of, the jurisdiction where the application service(s) is/are instantiated.

Systems claiming conformance with this document shall support at least one application (Application profiles A1, A2 and/or A3) as defined in [6.4](#), but may also support more than one of these options. Systems claiming conformance to this document shall clearly declare which application profiles of this document they support: A1 (TPM-C), A2 (TPM- E), A3 (TPM-R), A4 (TPM-O).

Systems claiming conformance with this document shall support at least one of Communication profiles C1, C2 and C3 as defined in [6.5](#), but may also support more than one of these options. Systems claiming conformance to this document shall clearly declare which communication profiles of this document that they support: C1, C2, C3 a-c.

6 General overview and framework requirements

6.1 General

This document addresses the provision of tyre pressure monitoring (TPM) services and specifies the form and content of the transmission of the data required to support TPM systems, and access methods for that data. The data may be transferred by a variety of means, for example, as ITS-station -> ITS-station data transfers in a C-ITS environment using 5,9 GHz DSRC-WAVE/G5; as cellular (3G, 4G LTE, 5G SRE or similar) transfers using interrogations from dedicated short-range communications systems (such as 5,8 GHz DSRC), etc.

6.2 TARV general principals

ISO 15638-1 provides a framework and architecture for TARV. It provides a general description of the roles of the actors in TARV and their relationships. See ISO 15638-1 for a complete explanation.

ISO 15638-6 provides the core requirements for all regulated applications. See ISO 15638-6 for further information on the general context into which the provision of this application service is delivered.

6.3 Tyre pressure monitoring systems (TPMS)

6.3.1 General

A pneumatic tyre is a flexible component which is deflected when loaded. A tyre needs to be sufficiently inflated in order to be used at a limited deflection adapted to carry the wheel load as part of an axle load at a given speed and to transmit the expected longitudinal and transversal forces. The deflection is at the origin of the fatigue of a pneumatic tyre. Repeated excessive deflection can lead to tyre failure.

In real driving conditions, the physical parameter that most correlates to the tyre deflection is the tyre inflation pressure. Therefore, the inflation pressure surveillance of pneumatic tyres for road vehicles has been identified as a major way to increase the active safety of the vehicles in service and to reduce the risks for the users.

The inflation pressure of pneumatic tyres for road vehicles shall be set by the vehicle users according to the vehicle manufacturer's recommendations in coherence with the applicable tyre standards and manufacturer's instructions. The vehicle user is responsible for setting the correct tyre inflation pressure and its maintenance.

Tyres can sometimes look normal even though they are underinflated. One or more significantly underinflated tyres reduce the vehicle's performance, especially in terms of safety-related behaviour. Tyre pressures outside of the range recommended by the tyre or the vehicle manufacturer can permanently alter the tyre characteristics and can be the cause of a sudden pressure loss.

A TPMS is an in-vehicle electronic system that warns the driver when tyre pressure drops. The primary objective of a TPMS is to alert the driver when an unsafe condition related to incorrect tyre inflation pressure is detected.

6.3.2 Types of TPMS

There are two types of TPMS available:

- Direct TPMS (dTPM) — sensors within each tyre monitor actual pressure levels and report any anomalies directly to the driver via the dashboard.
- Indirect TPMS (iTTPM) — the antilock braking system (ABS) uses wheel speed sensors to measure the rate of revolutions for each wheel. When the system detects that a wheel is spinning faster than expected due to it being under-inflated, it sends an alert to the driver.

Direct TPMSs use directly measuring, hardware-based systems. They provide a battery-driven pressure sensor in each wheel (most often on the inside of the valve). This transfers pressure information to a central

control unit which reports it to the vehicle's instrument cluster or a corresponding monitor. Some units also measure and create alerts concerning the temperature of the tyre. These systems can identify underinflation in any combination, be it one tyre or all, simultaneously. Although the systems vary in transmitting options, many TPMS products (both OEM and aftermarket) can display real time tyre pressures at each location monitored, whether the vehicle is moving or parked.

There are many different solutions. For example, some are powered by batteries (which limit their useful life). Others use an RFID wireless power system which solves the problem of limited battery life by electromagnetic induction (but limits the amount of data capacity).

If the sensors are mounted on the outside of the wheel, as in some aftermarket systems, they can be subjected to mechanical damage, aggressive fluids, as well as theft. When mounted on the inside of the rim, they are no longer easily accessible for battery change and the RF link is required to overcome the attenuating effects of the tyre which increases the energy need.

A TPMS (both dTPM and iTPM) is functionally composed of:

- sensing devices;
- information channel hardware;
- central information processing unit (CPU); and
- human machine interface (HMI).

A direct TPMS (dTPM) sensor consists of the following main features and requires only a few external components (e.g. battery, housing, PCB) to get the sensor module that is mounted to the valve stem inside the tyre:

- housing;
- unique reference ID;
- pressure sensor;
- analogue-digital converter;
- microcontroller;
- system controller;
- oscillator;
- radio frequency transmitter;
- low frequency receiver, and
- voltage regulator (battery management).

6.3.3 TPMS regulations and International Standards

6.3.3.1 Summary

ISO 21750 specifies electronic tyre pressure monitoring systems (TPMS) for tubeless tyres in association or not with an extended mobility system, with a reference pressure lower or equal to 375 kPa, fitted in single formation on four wheeled vehicles. The systems are able to survey all tyres in use (but not necessarily those in temporary use) and provide information to the driver. ISO 21750 specifically covers only cars and light vans.

ISO 21750 establishes overall performance guidelines for the systems and their components, independently of the physical principles and the technological solution which have been selected to monitor the tyre pressure, to compute the difference to the requested level and to deliver a relevant information to the driver

if the pressure of one, several or all tyres needs corrective action for the intended service conditions (cars and light vans).

It is stated in ISO 21750 that the objective is to expand the categories of vehicle included.

In June 2016 UN ECE's World Forum for Harmonization of Vehicle Regulations (WP.29) adopted a new Regulation on TPMSs which entered into force on 22 January 2017. The new UN Regulation No. 141 is to be seen as a stand-alone regulation on TPMSs. While the majority of the TPMS content was taken from UN Regulation No. 64 and imported to the new UN Regulation No. 141 without changes, some amendments were made. Such changes included a clarification that TPMS ought to be able to work not only under test conditions, but over a wide range of environmental conditions.

6.3.3.2 ISO 21750

6.3.3.2.1 General

TPM systems conforming to ISO 21750 monitor the tyre pressure at speeds exceeding 25 km/h after a successful learning phase, if this exists. The driver is notified if the system malfunctions. A ISO 21750 TPMS is designed to avoid false warnings or alarms. Data are provided to the driver, and there is no provision for communication to parties off-board.

Three types of system are specified:

- tyre pressure alerting system (TPAS);
- tyre pressure warning system (TPWS);
- tyre leak alerting system (TLAS).

TPM-C, TPM-R, TPM-O systems within this document most closely relate to TPAS.

TPM-E systems within this document most closely relate to TPWS if they provide actual pressures, and to TLAS if they provide only a warning. However, TLASs can identify pressure differences between tyres.

As this document deals with communications paradigms that are not covered in ISO 21750, and those paradigms require different reporting, this document deliberately does not use the terms TPAS, TPWS and TLAS in its specifications. The purpose of this is to avoid misinterpretation, and to make it absolutely clear that this document is not attempting to revise ISO 21750 specifications. The general terms TPM/TPMS are common to both this document and ISO 21750.

EXAMPLE In ISO 21750, the tyre position is optional information and there are only 4 possible positions. In most of the paradigms expounded in this document (all except Data concept TP07), the tyre position is required, and there can be 18 (or more) tyre positions.

For detailed information on TPAS, see ISO 21750:2006, 5.2.

For detailed information on TPWS, see ISO 21750:2006, 5.3.

For detailed information on TLAS, see ISO 21750:2006, 5.4.

For specifications concerning the lifetime, measurement accuracy, environmental characteristics and mechanical requirements in relation to wheel fitted components, see ISO 21750:2006, 6.2.

6.3.3.2.2 ISO 21750 tyre pressure alerting system (TPAS)

The purpose of the TPAS is to avoid driving too often and/or too far and/or at too high speed with one, several or all tyres underinflated/overdeflected by providing the driver with a warning or an alarm.

The alert delivered by a TPAS is related to the actual tyre pressure expressed, either as an absolute or as a relative pressure, of at least one tyre under control. It is not only related to pressure differences between

tyres or to parameter differences between tyres, even if this parameter directly correlates with the tyre pressure. The identification of the tyre at the origin of the alert is optional.

- A TPAS should separately take into account the recommended cold tyre inflation pressure, p_{rec} , for the tyres fitted on the front axle and for the tyres fitted on the rear axle.
- A TPAS shall not monitor the tyre pressure of the unfitted normal spare unit. If the spare unit is in use, the TPAS shall either monitor it in the same conditions as for the other tyres or notify the driver of partial monitoring of the vehicle tyres.
- A TPAS shall be able to take into account all sensors of the vehicle and only those of the vehicle (learn or auto-learn). The identification of the tyre position on the vehicle is optional (localization or auto-localization).
- Optionally, a TPAS may also monitor the tyre pressures when the engine is off.
- A TPAS shall deliver the alert independently of road and weather conditions.
- A TPAS shall include a self-diagnostic function, notifying the user when the system is out of function.

6.3.3.2.3 Tyre pressure warning system (TPWS)

The purpose of a TPWS is to allow the vehicle user to maintain the tyre pressures within the range of pressures for optimized tyre and vehicle performances by providing a warning when corrective action is recommended.

A TPWS is always intended as a complement to a TPAS or include a TPAS function. The alert delivered by a TPWS is related to the actual tyre pressure expressed, either as an absolute or as a relative pressure, of at least one tyre under control. It cannot only be related to pressure differences between tyres or to parameter differences between tyres, even if this parameter adequately correlates with the tyre pressure. The identification of the tyre at the origin of the alert is optional.

- A TPWS takes into account the different p_{rec} values between front- and rear-fitted tyres.
- A TPWS does not survey the tyre pressure of the unfitted normal spare unit. If the spare unit is in service, the TPWS either surveys it in the same conditions as for the other tyres or inform the driver for uncompleted survey of the vehicle.
- TPWS shall be able to take into account all sensors of the vehicle and only those of the vehicle (learn or auto-learn). The identification of the tyre position on the vehicle is optional (localization or auto-localization).
- A TPAS shall deliver the alert independently road and weather conditions
- Optionally, a TPWS may also survey the tyre pressures when the engine is off.
- A TPWS shall only include the self-diagnostic function of the associated TPAS

A TPWS shall provide an alert if one or more of the tyres need a corrective action. The actual pressure is not necessarily compensated in temperature. The alert conditions (threshold levels, time, interface) shall be related to the criticality of the individual situation to reduce the risk.

6.3.3.2.4 Tyre leak alerting system (TLAS)

A TLAS is a system that monitors the pressure differences between the tyres in use, or a parameter that adequately correlates, and delivers an alert if a significant pressure difference appears. The goal of the alert is to inform the driver to take proper corrective actions as soon as possible.

All tyre positions of the vehicle are monitored by the TLAS. The alert delivered by a TLAS may be unique for the set of tyres in use. The identification of the tyre at the origin of the alert is optional.

A TLAS does not need to directly measure the pressure of each tyre. The information about tyre pressure may be estimated by comparing all tyres in use. The system gives an alert if one of four tyres is under-inflated in relation to the other ones. It may also give an alert if two or more tyres are under-inflated. A TLAS is not required to monitor the tyre pressure of the unfitted tyre wheel assemblies or the spare unit even when fitted.

The alert provided by a TLAS can be unrelated to the minimum cold inflation pressure recommended by the tyre manufacturer's technical standards in relation to service conditions, but instead related to the tyre pressures set by the user when initializing the system. Therefore, a TLAS is not able to deliver an alert at a given minimum absolute pressure threshold.

A TLAS may use a reset program to tune the system. After all tyres in use have been inflated, the reset button shall be activated. After a learning phase, the system will be able to detect when the pressure of at least one tyre is below that of the others. The system is not able to detect that a wrong inflation pressure has been set.

6.3.4 Technological and legislative feasibility of TPMS for commercial vehicles.

A study for EC DG CLIMAE^[30] reviewed current products and their suppliers and concluded that tyre pressure monitoring for application in vans, trucks and buses is technically and economically mature at this stage, and that ideally TPMS:

- should be capable of detecting over a wide range of road and environmental conditions;
- should not be possible to deactivate;
- for UNECE M1/N1 vehicle categories, should detect a pressure of less than 1,5 bar¹⁾ or detect incorrect set/reset attempts;
- should cover any tyre of approved size, including after-market (different brand) replacement tyres.

The study concluded that UNECE Regulation 64 (now replaced by UNECE Regulation 141) contains the relevant prescriptions that can serve as a basis for the inclusion of vehicle categories in addition to M1/N1.

6.3.5 Conformance requirements for TARV-TPM systems

In the absence of a UNECE Regulation for TPM for large commercial vehicles, and taking into account the results of the study described in 6.3.4, this document is based on systems that conform to the general provisions of the following documents in providing data to an IVS (which may be an ITS-station, a standalone IVS, or part of some other vehicle management system):

- UNECE Regulation 141, and
- ISO 21750.

6.3.6 Unique identification of wheels

6.3.6.1 General

Commercial vehicles come with many different wheel combinations. In the case of rigid bodies, 6.3.6.4 and 6.3.6.5 specify how to uniquely identify each wheel.

The situation for demountable tractor+trailer (so called "semi's") and tractor+multiple trailer combinations (so called "road trains") is more complex for the following reasons:

- first, the tractor will frequently pull different trailers (often several per day);
- second, the number of trailers being pulled can also potentially vary;

1) 1 bar = 0,1 MPa = 10⁵ Pa; 1 MPa = 1 N/mm².

— third, most trailers do not have their own power supply.

This document presents three options.

- a) The towing vehicle IVS is able to read all tractor and trailer wheels (see [6.3.6.5](#)).
- b) Each trailer has its own IVS and can act as if it were a separate vehicle (see [6.3.6.4](#)).
- c) In the event of a short-range interrogation to determine if the vehicle should be stopped, only the presence of an exception (under/over-inflation warning), on any wheel, is passed back to the interrogator (see [10.3.6.3](#)).

6.3.6.2 General principles for unique identification

TPM systems are either dTPM (directly reading the tyre pressure by sensor) or iTPM (indirectly calculating the tyre pressure). dTPM systems are located on-board, whereas iTPM systems may be on-board or off-board (in-road) (TPM-O). See [6.3.2](#).

On-board TPM systems have a control system that collects the information from the tyre sensors or on-board equipment and relays that information, in the past, to the driver and/or fleet management software. In the instantiation of TARV-TPM (the use case specified in this document), in respect of the application profiles TPM-C, TPM-E, and TPM-R (see [6.4.3](#) – [6.4.5](#)), the in-vehicle control system is responsible for sending the data to the jurisdiction or operator, via wireless means, as required by the use-case.

This document does not seek to standardize the on-board equipment, which is of commercial proprietary design, it simply calls this on-board controlling system the “IVS” (in-vehicle system). While not specifying the design and features of the IVS on-board, this document specifies the communication from that IVS to the jurisdiction or operator, using one of the communication profiles defined in [6.5](#).

There are many different manufacturers of TPM systems, and their designs are proprietary, including their means to transmit data to the IVS. While it can be of commercial benefit for manufacturers to work together to standardize some aspects of on-board communication and messaging in TPM systems, this deliverable does not attempt to do this and is simply focussed on standardizing the information sent by the IVS to the jurisdiction and/or operator.

Commercial vehicles come in many shapes and forms, for example:

- electric powered tricycles;
- rigid 4, 6, 8, 12, 14 wheel rigid-chassis;
- semi-tractor-trailer truck (the combination of a tractor unit and one semitrailer and with different axle configurations possible);
- tractor units hauling more than one trailer;
- road trains used in some countries for long distance haulage.

A jurisdiction/operator needs to be able to identify which wheel is which, so there needs to be a tyre identification system that is independent of the wheel configurations.

6.3.6.3 Basic unique identification

Unique tyre identification (UTI) shall be reported according to the following requirements:

The front row of wheels (commonly called the front axle, though in some cases will not be a single axle) shall be identified as Row 1. The leftmost tyre on Row 1 shall be identified semantically as “1.1”.

The next leftmost tyre on Row 1 shall be identified semantically as “1.2”, and so on for all remaining wheels on that row.

The next row of wheels from the front shall be identified as Row 2. The leftmost tyre on Row 2 shall be identified semantically as “2.1”. The next leftmost tyre on Row 2 shall be identified semantically as “2.2”, and so on for all remaining wheels on that row.

This shall continue until, and include, the back row of wheels.

For clarity, examples are provided in the following subclauses.

6.3.6.4 Wheel identification for rigid vehicles

Following the requirements provided in 6.3.6.3, Figure 1 provides some typical examples of configurations for rigid vehicles, with their unique wheel identifications. Figure 2 provides an example for “semi” tractor/trailer combinations.



Figure 1 — Example wheel identifications for rigid vehicles

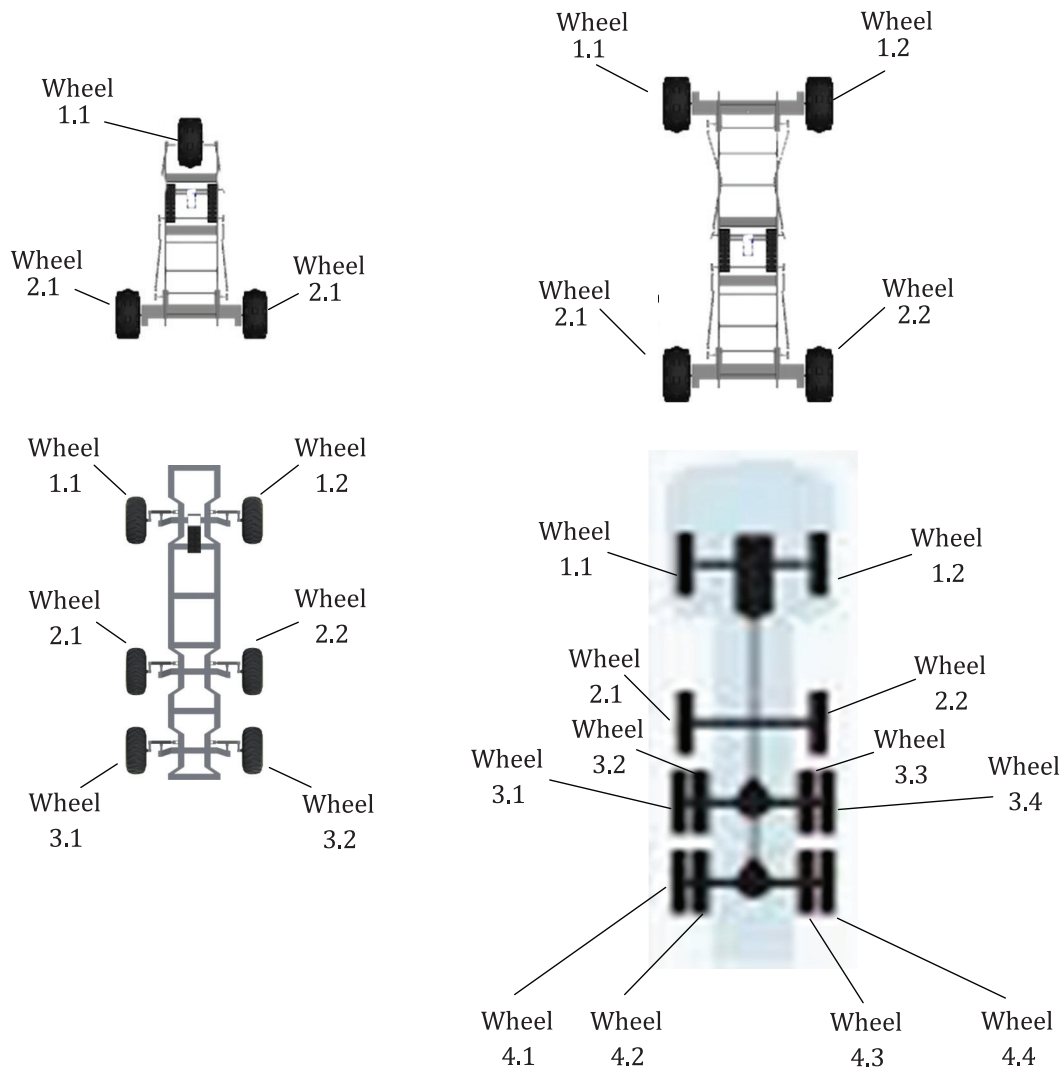


Figure 2 — Example wheel identifications for “semi” tractor units

6.3.6.5 Wheel identification for combination vehicles

6.3.6.5.1 General

The identification of the wheels is dependent on where the reporting IVS is installed.

6.3.6.5.2 Trailer reports through its own IVS

Historically, trailers obtain their power from the tractor and have little separate capability. However, with the development of low power devices based on smartphone technology, the ability to charge such devices from the general circuit used for lighting, or by solar power, and the addition of sensors, mean that the capabilities of trailer units are rapidly evolving and could support their own TPMS/IVS. As in many cases tractor/trailer combinations change trailers very frequently (sometimes several times per day), this can potentially provide a better option than the complexity of having the tractor IVS collect trailer TPM data.

In the event that a trailer has its own TPMS IVS, it shall report as a separate reporting unit, and in the same manner as though it was a rigid vehicle, regardless of whether it is a trailer or semi-trailer.

The trailer/semi-trailer shall report its tyres with its frontmost tyre row as Row 1 (regardless of the tractor tyres that precede it).