Road vehicles — Partial driving automation — Technical characteristics of conditional hands-free driving systems

Véhicules routiers — Automatisation partielle de la conduite — Caractéristiques techniques des systèmes de conduite mains-libres conditionnels

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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 documentsdocument 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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This document was prepared by Technical Committee ISO/TC 22, *Road Vehicles*, Subcommittee SC 33, *Vehicle dynamics, chassis components and driving automation systems testing*.

A list of all parts in the ISO 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

This document can be used as a system level standard by other standards, which extend the combination of ACC according to ISO 15622:2018 and PADS according to ISO 21717:2018 with additional requirements motivated by costumer use-cases and by safety to a more detailed standard for a higher level of functionality which will include the hands-free use case in certain conditions.

The main functionality of a "L2 –hands-free –system" is to control and limit the vehicle –behaviour for longitudinal and lateral control, as it is described in ISO 15622:2018 and ISO 21717:2018, with respect onto the performance, the intended ODD and the driver's capabilities. Together with an appropriate driver monitoring, which is typically realized with a driver monitoring camera and in addition a hands-on/off detection regarding to the steering wheel, it is possible for a system to operate while the driver can take the hands away from the steering whithoutwithout losing the ability and the responsabilityresponsibility to control the DDT.

This document contains the basic control strategy, basic driver interface elements and a minimum set of requirements for a L2 –hands-free –system. This document is applicable for, but not limited to, passenger cars. It is not applicable to automated driving systems of Level 3 according to ISO/SAE PAS 22736:2021or or higher.

While a lane change functionality is not specified in this document, it is explicitly considered.

Regional regulation, e.g.,. UN/ECE R79, can limit the applicability of parts of this standarddocument.

Road vehicles — Partial driving automation — Technical characteristics of conditional hands-free driving systems

1 Scope

This document provides technical characteristics of partial driving automation system according to ISO/SAE PAS 22736~~:2021~~ and associated control strategies enabling hands-free driving.

These technical characteristics, together with an appropriate operational design domain enable the proper usage of such partial driving automation systems which is supervised by drivers.

This document does not address performance limits, verification and validation of such systems.

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 15622:2018, *Intelligent transport systems — Adaptive cruise control systems — Performance requirements and test procedures*~~

~~ISO 21717:2018, *Intelligent transport systems — Partially Automated In-Lane Driving Systems (PADS) — Performance requirements and test procedures*~~

~~ISO/SAE PAS 22736:2021, *Taxonomy and definitions for terms related to driving automation systems for on-road motor vehicles*~~

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
ODD
operational design domain
~~ODD~~
operating conditions under which the driving automation system is specifically designed to function, including, but not limited to, environmental, geographical, and time-of-day restrictions, and/or the requisite presence or absence of certain traffic or roadway characteristics

[SOURCE: ISO/SAE PAS 22736:2021~~, 3.21, modified —The notes to entry and examples have been removed.]~~

3.2
EOR
eyes-on request
~~EOR~~
request by the L2 ~~Hands-Free System~~ hands-free system to the driver to monitor the traffic situation

3.3
HOW
hands-on warning
~~HOW~~

warning by the L2 ~~Hands-Free-System~~ hands-free system to the driver to *direct control* (3.12) the vehicle, at least by lateral steering control of the vehicle

Note 1 to entry: ~~A~~ An HOW could be represented by a yellow warning signal accompanied by an acoustic warning.

3.4
HOA
hands-on alert
~~HOA~~

alert by the L2 -hands-free -system to the driver to *direct control* (3.12) the vehicle immediately, at least by lateral steering control of the vehicle

Note 1 to entry: A HOA could be represented by a red warning signal accompanied by an acoustic warning.

3.5
DMS
driver-monitoring system
~~DMS~~

system that detects the presence of a driver, assesses the driver's attention to the traffic and assesses hands-on/off detection on steering wheel

Note 1 to entry: One part of a driver-monitoring system is typically a *driver-monitoring camera* (3.6) and/or other suitable means, e.g. capacitive hands-on/off detection.

3.6
DMC
driver-monitoring camera
~~DMC~~

camera as part of the *driver-monitoring system* (3.5~~(3.5)~~) which can determine the driver's attention on the traffic

3.7
driver information and warning system
system that informs the driver about the system status and warns the driver when actions are required by the driver

EXAMPLE: *Eyes-on request* (3.2~~(3.2),~~). *hands-on warning* (3.3-).

3.8
overrule
action by the driver to *direct control* (3.12~~Direct Control~~) of lateral and/or longitudinal motion of the vehicle which deactivates the L2 -hands-free -system

Note 1 to entry: Overrule is a possibility to deactivate the L2 -hands-free -system.

3.9
override
direct control (3.12) of lateral and/or longitudinal motion of the vehicle within a defined threshold without deactivation of the L2 -hands-free -system

3.10
hands-free
system condition under which the driver is permitted to remove his hands from the steering wheel

Note 1 to entry: Part of the system condition is that the vehicle is in a specified *operational design domain* (3.1~~(3.1);~~, the driver monitors the traffic situation and system behaviour while the system monitors the driver.

3.11
hands-on
condition of the driver to hold the steering wheel

Note 1 to entry: During "L2 -hands-on -driving -mode", the driver directly controls the vehicle either with or without support by a " L2 -hands-free -system " or a "L2 -hands-on -system".

3.12
direct control
control of the vehicle by the driver by holding or moving the steering wheel or using brake or driving pedal

Note 1 to entry: Within this ~~standard there is~~ document the acceleration is always positive ~~if~~and the negative acceleration is called deceleration.

3.13
DDT
dynamic driving task
~~DDT~~
control and execution of longitudinal and lateral movements of the vehicle

3.14
mode
~~behavior~~behaviour of the driver in interaction with the system which depends on system states

EXAMPLE   In ~~a~~an L2 -hands-on -driving -mode the driver's hands are on the steering wheel, while the system can either be in L2 -hands-on -state or in L2 -hands-free -state with the corresponding technical requirements.

Note 1 to entry: The mode may differ from the *state* (3.15) of the system.

3.15
state
execution of implemented requirements depending on system and environmental conditions

4   Functionality

4.1   Overall system context

This ~~standard~~document focus on requirements of the "L2 -hands-free -state" with the corresponding transitions as shown in Figure 1. The other states beside "lateral only" are briefly described only for ~~completness~~completeness in this ~~chapter~~clause and those are defined ~~inISO~~in ISO 15622~~:2018~~ and ISO 21717~~:2018~~.
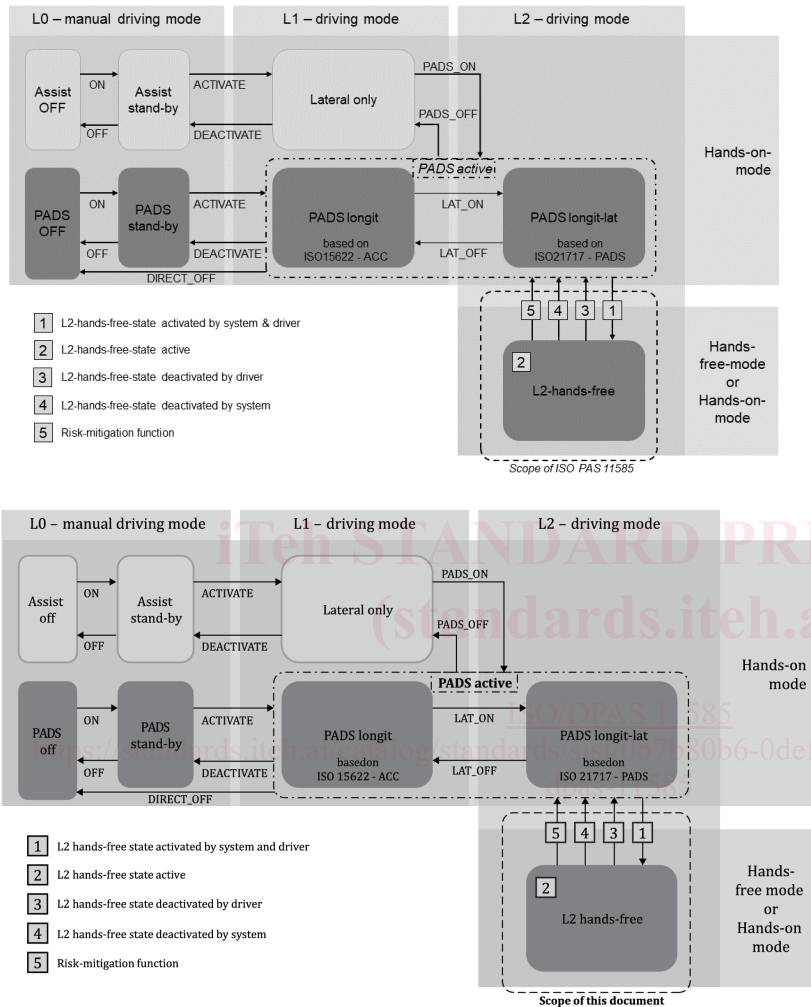
Figure 1 — L2 -hands-free -system modes, states and transitions in interaction with ACC (ISO 15622~~:2018~~), PADS (ISO 21717~~:2018~~) and lateral only

In this ~~standard~~document the overall functionality of ~~a~~an "L2 -hands-free -system" is represented by an overall system-state-diagram with states and transitions. Therefore, it is possible to describe ~~a "~~an L2 -hands-free -system with function modes from a customer perspective and with states and transition from a technical point of view. Functionality-like features or ~~sub-features~~subfeatures can be distributed via several or other states.

Transitions will describe the trigger conditions which are needed to leave or to enter a state.

State "PADS ~~Off" [~~off" (ISO 21717:2018, ~~chapter~~ 6.1.1~~]:~~):

— ~~In~~in the state "PADS off" there is no action performed;

— ~~The~~the "ON" transition from state "PADS off" to state "PADS stand-by" can be performed by the driver or automatically, e.g.~~,~~ after the ignition is switched on.

State "PADS stand-by" ~~[~~(ISO 21717:2018, ~~chapter~~ 6.1.2~~]~~:):

— ~~In~~in the state "PADS stand-by" the system is ready to be activated while the driver is performing the DDT manually;

— ~~The~~the transition "ACTIVATE" from "PADS stand-by" to "PADS active" can be initiated by the driver. The transition "ACTIVATE" could lead to "PADS –longitudinal" or to "PADS –longitudinal –lateral" state as a part of the "L2 –hands-on –driving –mode". A possible transition to "lateral –only" is not described in any ISO ~~Standard~~standard yet;

— ~~A~~a transition to activate "L2 –hands-free –state" could be initiated automatically or by the driver when the conditions for the option for "L2 –hands-free –driving –mode" are fulfilled.;

— ~~The~~the transition "OFF" from "PADS stand-by" to "PADS off" can be performed by the driver or automatically, e.g.~~,~~ after the ignition is switched off or a system failure has occurred.

State "lateral –only":

— ~~In~~in "lateral –only" the system does not perform accelerating or decelerating actions. This state is not described in any ISO ~~Standards,~~standards, it is typically not used in context of this ~~standard~~document;

— ~~If~~if the driver initiated all of the selected activation criteria for long-lateral~~ are met~~, the system shall perform the transition lateral state to PADS longitudinal-lateral state;

— ~~If~~if the driver initiated all of the selected activation criteria for long-lateral, the system can perform the transition lateral state to PADS longitudinal-lateral state.

State "PADS active" - (L2 –hands-on –mode) ~~[~~(ISO 21717:2018, ~~chapter~~ 6.1.3~~]~~:):

— ~~In~~in both ~~sub-states~~substates, "longitudinal-lateral" and "longitudinal", of the "PADS active" state the system provides speed and distance control in accordance with ISO 15622~~:2018~~. Therefore, longitudinal control is always active in "PADS active" state as long as the driver does not intervene;

— ~~In~~in both ~~sub-states~~substates, "longitudinal-lateral" and "longitudinal~~";~~", of the "PADS active" state the system evaluates the conditions for lateral control;

— ~~Depending~~depending on the ~~sub-states~~substates, "longitudinal-lateral" and "longitudinal", the system within "PADS active" evaluates the activation criteria for lateral control or lat-long control which are typically the related ODD, speed, lane boundaries of the lane and/or relative distance to forward vehicles and the drivers vehicle control;

— ~~Under~~under certain driving conditions (ODD, driver, vehicle, monitoring systems active) it is possible to take the hands off from steering wheel and switch to "~~Hands~~hands-free" state which is described ~~deeper~~ in ~~Chapter~~more detail in Clause 4~~ff~~;;

— "PADS active" in both ~~sub-states~~substates could be left to "PADS-off" or "PADS stand by" by "~~Inactive~~inactive" or "~~Direct~~direct-off" due to the ~~driver~~driver's action, ~~e.g.~~for example, brake, or automatically~~,~~ for instance after a system failure has occurred.

State "PADS active" with "longitudinal" state as a ~~sub-state~~substate (L2-hands-on-mode) ~~[~~(ISO 21717:2018, ~~chapter~~6.1.4~~]~~:):

— ~~In "Longitudinal~~in "longitudinal state" (ACC) the system performs longitudinal control with or without vehicle in front from standstill to a defined vehicle ~~max.~~maximum speed;