

PUBLICLY
AVAILABLE
SPECIFICATION

ISO/SAE
PAS
22736

First edition
2021-08

Taxonomy and definitions for terms related to driving automation systems for on-road motor vehicles

*Taxonomie et définitions des termes relatifs aux systèmes de conduite
automatisée des véhicules routiers à moteur*

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[ISO/SAE PAS 22736:2021](https://standards.iteh.ai/catalog/standards/iso/c97df05e-e362-42c9-baba-4adb530fc49c/iso-sae-pas-22736-2021)

<https://standards.iteh.ai/catalog/standards/iso/c97df05e-e362-42c9-baba-4adb530fc49c/iso-sae-pas-22736-2021>



Reference number
ISO/SAE PAS 22736:2021(E)

© ISO/SAE International 2021

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[ISO/SAE PAS 22736:2021](https://standards.iteh.ai/catalog/standards/iso/c97df05e-e362-42c9-baba-4adb530fc49c/iso-sae-pas-22736-2021)

<https://standards.iteh.ai/catalog/standards/iso/c97df05e-e362-42c9-baba-4adb530fc49c/iso-sae-pas-22736-2021>



COPYRIGHT PROTECTED DOCUMENT

© ISO/SAE International 2021

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced, or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO or SAE International at the respective address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11

Email: copyright@iso.org
Website: www.iso.org

SAE International
400 Commonwealth Dr.
Warrendale, PA, USA 15096
Phone: 877-606-7323 (inside USA and Canada)
Phone: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
Website: www.sae.org

Published in Switzerland by ISO, published in the USA by SAE International

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.

SAE International is a global association of more than 128,000 engineers and related technical experts in the aerospace, automotive and commercial-vehicle industries. Standards from SAE International are used to advance mobility engineering throughout the world. The SAE Technical Standards Development Program is among the organization's primary provisions to those mobility industries it serves aerospace, automotive, and commercial vehicle. These works are authorized, revised, and maintained by the volunteer efforts of more than 9,000 engineers, and other qualified professionals from around the world. SAE subject matter experts act as individuals in the standards process, not as representatives of their organizations. Thus, SAE standards represent optimal technical content developed in a transparent, open, and collaborative process.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1 and the SAE Executive Standards Committee Policy. In particular, the different approval criteria needed for the different types of ISO documents 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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and SAE International shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

SAE Executive Standards Committee Rules provide that: "This document is published to advance the state of technical and engineering sciences. The use of this document is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 jointly prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*, and SAE *On-Road Automated Driving Committee, Definitions Task Force*.

This document and its counterpart document published by SAE (SAE J3016 APR2021) are technically equivalent. The only difference between the documents is the standard number and name and minor editorial elements.

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. Alternatively, to provide feedback on this document, please visit https://www.sae.org/standards/content/j3016_202104/.

TABLE OF CONTENTS

1.	SCOPE	1
2.	REFERENCES	2
2.1	Applicable Documents	2
2.1.1	SAE Publications	2
2.1.2	ANSI Accredited Publications	2
2.1.3	Other Publications	2
2.2	List of Abbreviations	2
3.	DEFINITIONS	3
4.	TAXONOMY OF DRIVING AUTOMATION	22
5.	LEVELS OR CATEGORIES OF DRIVING AUTOMATION	28
5.1	Level or Category 0 - No Driving Automation	28
5.2	Level or Category 1 - Driver Assistance	28
5.3	Level or Category 2 - Partial Driving Automation	29
5.4	Level or Category 3 - Conditional Driving Automation.....	29
5.5	Level or Category 4 - High Driving Automation	29
5.6	Level or Category 5 - Full Driving Automation	30
6.	SIGNIFICANCE OF OPERATIONAL DESIGN DOMAIN (ODD).....	30
7.	DEPRECATED TERMS.....	32
7.1	Autonomous, Driving Modes(s), Self-Driving, Unmanned, Robotic.....	33
7.1.1	Autonomous.....	33
7.1.2	Driving Mode(s).....	33
7.1.3	Self-Driving	33
7.1.4	Unmanned	33
7.1.5	Robotic.....	33
7.2	Automated or Autonomous Vehicle	34
7.3	Control	34
8.	ADDITIONAL DISCUSSION.....	34
9.	NOTES.....	40
Figure 1	Examples of driving automation system features/types that could be available during a given trip	6
Figure 2	Schematic (not a control diagram) view of driving task showing DDT portion	7
Figure 3	.....	9
Figure 4	.....	9
Figure 5	.....	10
Figure 6	.....	10
Figure 7	.....	10
Figure 8	.....	11
Figure 9	Diagram showing vehicle axes of motion (SAE J670).....	12
Figure 10	Simplified logic flow diagram for assigning driving automation level to a feature	25
Figure 11	ODD relative to driving automation levels	32
Figure 12	ODD relative to driving automation levels	32
Figure 13	Use case sequence for a Level 3 feature showing ADS engaged, occurrence of a failure or out-of-ODD condition, and the fallback-ready user performing the fallback, or, if the fallback-ready user fails to do so, a failure mitigation strategy, such as stop-in-lane	37
Figure 14	Use case sequence at Level 4 showing ADS engaged, a catastrophic event (e.g., complete power failure) and the system achieving a minimal risk condition.....	37
Table 1	Summary of levels of driving automation.....	23
Table 2	Roles of human user and driving automation system by level of driving automation.....	26
Table 3	User roles while a driving automation system is engaged	28

Taxonomy and definitions for terms related to driving automation systems for on-road motor vehicles

1. SCOPE

This document describes [motor] *vehicle driving automation systems* that perform part or all of the *dynamic driving task (DDT)* on a *sustained* basis. It provides a taxonomy with detailed definitions for six levels of *driving automation*, ranging from no *driving automation* (Level 0) to full *driving automation* (Level 5), in the context of [motor] *vehicles* (hereafter also referred to as “*vehicle*” or “*vehicles*”) and their *operation* on roadways:

Level 0: No Driving Automation

Level 1: Driver Assistance

Level 2: Partial Driving Automation

Level 3: Conditional Driving Automation

Level 4: High Driving Automation

Level 5: Full Driving Automation

These level definitions, along with additional supporting terms and definitions provided herein, can be used to describe the full range of *driving automation features* equipped on [motor] *vehicles* in a functionally consistent and coherent manner. “On-road” refers to publicly accessible roadways (including parking areas and private campuses that permit public access) that collectively serve all road *users*, including cyclists, pedestrians, and *users* of *vehicles* with and without *driving automation features*.

The levels apply to the *driving automation feature(s)* that are engaged in any given instance of on-road *operation* of an equipped *vehicle*. As such, although a given *vehicle* may be equipped with a *driving automation system* that is capable of delivering multiple *driving automation features* that perform at different levels, the level of *driving automation* exhibited in any given instance is determined by the *feature(s)* that are engaged.

This document also refers to three primary actors in driving: the (human) *user*, the *driving automation system*, and other *vehicle* systems and components. These other *vehicle* systems and components (or the *vehicle* in general terms) do not include the *driving automation system* in this model, even though as a practical matter a *driving automation system* may actually share hardware and software components with other *vehicle* systems, such as a processing module(s) or *operating code*.

The levels of *driving automation* are defined by reference to the specific role played by each of the three primary actors in performance of the *DDT* and/or *DDT fallback*. “Role” in this context refers to the expected role of a given primary actor, based on the design of the *driving automation system* in question and not necessarily to the actual performance of a given primary actor. For example, a *driver* who fails to monitor the roadway during engagement of a Level 1 adaptive cruise control (ACC) system still has the role of *driver*, even while s/he is neglecting it.

Active safety systems, such as electronic stability control (ESC) and automatic emergency braking (AEB), and certain types of *driver* assistance systems, such as lane keeping assistance (LKA), are excluded from the scope of this *driving automation* taxonomy because they do not perform part or all of the *DDT* on a *sustained* basis, but rather provide momentary intervention during potentially hazardous situations. Due to the momentary nature of the actions of *active safety systems*, their intervention does not change or eliminate the role of the *driver* in performing part or all of the *DDT*, and thus are not considered to be *driving automation*, even though they perform automated functions. In addition, systems that inform, alert, or warn the *driver* about hazards in the driving environment are also outside the scope of this *driving automation* taxonomy, as they neither automate part or all of the *DDT*, nor change the *driver’s* role in performance of the *DDT* (see 8.13).

It should be noted, however, that crash avoidance *features*, including intervention-type *active safety systems*, may be included in *vehicles* equipped with *driving automation systems* at any level. For *automated driving system (ADS) features* (i.e., Levels 3 to 5) that perform the complete *DDT*, crash mitigation and avoidance capability is part of *ADS* functionality (see also 8.13).

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J670 *Vehicle* Dynamics Terminology

SAE J3063 Active Safety Systems Terms and Definitions

Shi, E., Gasser, T., Seeck, A., and Auerswald, R., "The Principles of Operation Framework: A Comprehensive Classification Concept for Automated Driving Functions," SAE Intl. J CAV 3(1):27-37, 2020, <https://doi.org/10.4271/12-03-01-0003>.

2.1.2 ANSI Accredited Publications

Copies of these documents are available online at <http://webstore.ansi.org/>.

ANSI D16.1-2007 Manual on Classification of Motor *Vehicle* Traffic Accidents

2.1.3 Other Publications

49 U.S.C. § 30102(a)(6) (definition of [motor] *vehicle*)

<https://standards.iteh.ai/catalog/standards/iso/c97df05e-e362-42c9-baba-4adb530fc49c/iso-sae-pas-22736-2021>

Crash Avoidance Metrics Partnership - Automated Vehicle Research Consortium, "Automated Vehicle Research for Enhanced Safety - Final Report," available at <https://www.regulations.gov/document?D=NHTSA-2014-0070-0003>.

Gasser, T. et al., "Legal Consequences of an Increase in Vehicle Automation," July 23, 2013, available at http://bast.opus.hbz-nrw.de/volltexte/2013/723/pdf/Legal_consequences_of_an_increase_in_vehicle_automation.pdf.

Michon, J.A., 1985, "A Critical View of Driver Behavior Models: What Do We Know, What Should We Do?" In Evans, L. and Schwing, R.C. (Eds.). Human behavior and traffic safety (pp. 485-520). New York: Plenum Press, 1985.

Smith, B.W., "Engineers and Lawyers Should Speak the Same Robot Language," in ROBOT LAW (2015), available at <https://newlypossible.org>.

2.2 List of Abbreviations

ACC Adaptive cruise control

ADAS Advanced driver assistance system

ADS Automated driving system

ADS-DV Automated driving system-dedicated vehicle