
**Intelligent transport systems —
Automated valet parking systems
(AVPS) —**

**Part 1:
System framework, requirements
for automated driving and for
communications interface**

*Systèmes de transport intelligents — Systèmes de parking avec
voiturier automatisé (AVPS) —*

*Partie 1: Cadre du système, exigences relatives à la conduite
automatisée et à l'interface de communication*



This document is a preview generated by ELS



COPYRIGHT PROTECTED DOCUMENT

© ISO 2023

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 at the 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

Published in Switzerland

Contents

	Page
Foreword.....	vi
Introduction.....	vii
1 Scope.....	1
2 Normative references.....	1
3 Terms and definitions.....	2
4 Symbols and abbreviated terms.....	6
4.1 Symbols.....	6
4.2 Abbreviated terms.....	7
4.2.1 Terms defined in ISO/SAE PAS 22736.....	7
4.2.2 Terms relating to names of system and sub-systems.....	7
4.2.3 Other terms.....	7
5 System framework.....	8
5.1 System description.....	8
5.1.1 Basic functionalities.....	8
5.1.2 Basic flow.....	8
5.2 System configuration.....	10
5.2.1 Sub-systems.....	10
5.2.2 System architecture.....	10
5.2.3 Interface.....	10
5.3 Functional allocation.....	11
5.4 Classification.....	12
5.4.1 Vehicle operation types.....	12
5.4.2 Traffic environment categories.....	13
5.5 Human interaction.....	13
5.5.1 General.....	13
5.5.2 Service provider.....	14
5.5.3 System operator.....	14
5.5.4 Facility manager.....	14
6 Requirements for automated vehicle operation functions.....	14
6.1 General.....	14
6.1.1 Principles for performing automated vehicle operation.....	14
6.1.2 Relationship of the operation functions.....	15
6.1.3 Operational design domain.....	15
6.2 Requirements for DDT.....	16
6.2.1 General.....	16
6.2.2 Basic performance requirements.....	16
6.2.3 Additional requirements for operation under a mixed traffic environment.....	17
6.3 Requirements for emergency stopping.....	18
6.3.1 General.....	18
6.3.2 DDT fallback ^[1]	19
6.3.3 Response to operation stop commands.....	19
6.3.4 Detection of human activities.....	19
6.4 Requirements for destination assignment.....	19
6.4.1 General requirements.....	19
6.4.2 Type 1 systems.....	20
6.4.3 Type 2 and 3 systems.....	20
6.5 Requirements for route planning.....	20
6.6 Requirements for localization accuracy.....	20
6.6.1 Accuracy requirement relative to the digital map.....	20
6.6.2 Accuracy requirement of the end position relative to the destination.....	21
6.7 Requirements for human activity recognition.....	21
7 Requirements for management functions.....	21

7.1	Functions that influence the automated vehicle operation.....	21
7.1.1	General.....	21
7.1.2	Remote engagement.....	21
7.1.3	Operation stop.....	21
7.1.4	Remote assistance.....	22
7.1.5	Remote disengagement.....	22
7.1.6	Central control.....	22
7.2	Other management functions.....	22
7.2.1	Compatibility and occupancy check.....	22
7.2.2	SV identification.....	23
7.2.3	Response to incapacitation of the operation functions.....	23
7.2.4	Maintaining environmental conditions.....	23
8	Requirements for the environment within parking facilities.....	24
8.1	General.....	24
8.2	Common requirements.....	24
8.2.1	Operation zone.....	24
8.2.2	Drop-off and pick-up area.....	24
8.2.3	SV identification area.....	24
8.2.4	Wireless communication.....	24
8.2.5	Operation stop device.....	25
8.2.6	Lighting.....	25
8.3	Vehicle-operation-type-dependent requirements.....	26
8.3.1	Detection capabilities of the R sub-system.....	26
8.3.2	Localization markers.....	26
8.3.3	Digital maps.....	27
8.4	Traffic environment category dependent requirements.....	29
8.4.1	Mixed traffic.....	29
8.4.2	Exclusive traffic.....	29
9	Requirements for overall system operation.....	29
9.1	General.....	29
9.2	Requirements for the communication interface.....	30
9.2.1	General requirements.....	30
9.2.2	Security goals.....	31
9.2.3	Security requirements.....	31
9.3	System states and transition diagram.....	31
9.3.1	State transition diagram.....	31
9.3.2	Definition and requirements of system states.....	33
9.3.3	Transition conditions.....	36
9.4	Suspend condition codes.....	40
9.5	Object and event detection data reporting.....	41
9.6	Data recording.....	41
9.7	Information to the user.....	42
9.8	Development process and management.....	42
10	Test scenarios for automated vehicle operation.....	42
10.1	General.....	42
10.1.1	Purpose.....	42
10.1.2	Test sites.....	43
10.1.3	Environmental conditions.....	43
10.1.4	Example test setups.....	43
10.1.5	Values of each figure.....	44
10.1.6	Test targets.....	44
10.1.7	Observing designed values at a preparation run.....	45
10.1.8	Means to limit the designed values.....	45
10.1.9	Common pass criteria.....	46
10.1.10	List of test scenarios and scenes.....	46
10.2	Basic scenarios.....	47
10.2.1	Scenario A: Entering.....	47

10.2.2	Scenario B: Re-parking	48
10.2.3	Scenario C: Exiting	50
10.3	Basic scenes	51
10.3.1	Scene 01: Climbing a ramp at slow speed	51
10.3.2	Scene 02: Ramp down	52
10.3.3	Scene 03: Operation on spiral ramps (up/down)	53
10.3.4	Scene 04: Out of drop-off area	55
10.3.5	Scene 05: SV identification	55
10.3.6	Scene 06: Out of operation zone	56
10.4	Traffic rules and behaviours	57
10.4.1	Scene 11: Stopping location	57
10.4.2	Scene 12: Intersection passing	58
10.4.3	Scene 13: Blocked intersection	59
10.4.4	Scene 14: Give way in two-way traffic	60
10.4.5	Scene 15: Vehicle in front is reversing towards SV	61
10.5	Static object avoidance	62
10.5.1	Scene 21: Smallest object in the direction of travel (forward/reverse)	62
10.5.2	Scene 22: Overhanging object	64
10.5.3	Scene 23: Infant in parking spot (reverse/forward)	65
10.5.4	Scene 24: Infant lying near ramp (up/down)	66
10.5.5	Scene 25: Infant behind a curve	68
10.5.6	Scene 26: Infant in front of parked vehicle (forward/reverse)	69
10.5.7	Scene 27: Infant beside parked vehicle	70
10.5.8	Scene 28: Infant lying partly underneath parked vehicle	71
10.6	Dynamic object avoidance	72
10.6.1	Scene 31: Forward vehicle braking hard	72
10.6.2	Scene 32: Parked vehicle rushing out	73
10.6.3	Scene 33: Cross-cutting child	75
10.6.4	Scene 34: Irregular movement of an adult	77
10.6.5	Scene 35: Bicyclist approaching	79
10.7	Emergency stopping	80
10.7.1	Scene 41: Operation stop command	80
10.7.2	Scene 42: Communication failure	80
	Annex A (normative) Communication sequences	81
	Annex B (normative) Test targets	108
	Annex C (informative) Description of localization markers	110
	Annex D (informative) Guidance in placing coded markers in parking facilities	117
	Annex E (informative) Example of line markings detectable by on-board sensors	123
	Annex F (informative) Parking facility dimension	125
	Annex G (informative) Examples for system implementation	128
	Annex H (informative) Type 3 implementation example	129
	Bibliography	153

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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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

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

The aim of this document is to contribute to the realization of safe and reliable level 4 driverless operation of vehicles within parking facilities, and to support a fast and smooth market introduction by achieving interoperability among vehicles provided by different manufactures and within different parking facilities managed by different organizations.

An automated valet parking system (AVPS) will automatically operate unoccupied vehicles from the drop off area (where the driver and passengers leave the vehicle) to a parking destination, and will also send the vehicle to a pickup area upon the user's request.

An AVPS will not only provide enhanced user experiences, but is also expected to contribute to accident reduction, lowering energy consumption and CO₂ emissions of vehicles searching for available parking spaces, and effectively utilize land by densely parking vehicles in the available space.

An AVPS can be utilized in places such as the large-scale public parking facilities of shopping malls, airports, large apartment buildings, time-based small public parking lots, or fleet management carpools. By implementing the system in parking facilities, the service provider will gain the opportunity to add other related services such as moving electric vehicles to and from charging stations or providing access to the trunk for the delivery of goods. Rather than having fully-automated vehicles driving around and searching for space, the system allows the service provider to govern the vehicles for improved traffic management.

In order to contribute to the realization of safe and reliable level 4 driverless operation, the requirements specified in this document are based on the performance of state-of-the-art technologies that are available at the time of publication. Thus, this document will be revised in the future in accordance with relevant technology enhancement.

Within this document, specific technological solutions for the communications interface (e.g. communication method, message protocol) are intentionally left open due to differences in available and commonly-used technology (e.g. spectrum allocation) around the world. Therefore, it is recommended that the communications interface be further discussed at the national/regional level to ensure interoperability.

Intelligent transport systems — Automated valet parking systems (AVPS) —

Part 1: System framework, requirements for automated driving and for communications interface

1 Scope

Automated valet parking systems (AVPSs) perform level 4 automated driving of individual or multiple unoccupied vehicles within a prescribed area of a parking facility. This document specifies performance requirements for the operation functions, the environmental conditions within parking facilities where automated vehicle operation is performed, and the test procedures to verify the performance requirements.

An AVPS is comprised of physically separated sub-systems distributed among vehicles, facility equipment and user domains. The functionalities of AVPSs are realized by cooperation of these sub-systems, which are, in many cases, provided by different organizations. This document defines the system architecture and the communication interfaces between the sub-systems at the logical level.

An AVPS manages its system participants (i.e. AVPS-compliant vehicles and parking facilities) and provides interfaces to other facility users and involved persons (e.g. system operators, facility managers). This document contains requirements for the management functions such as checking compatibility between vehicles and parking facilities, performing remote assistance and recovery when automated driving cannot be performed, and executing operation stop commands in response to the actions of other facility users.

AVPSs are intended for use by a service provider upon receiving authority over vehicles from individual service recipients. This document does not include parking automation technologies that are solely based on usage by an individual user. If the vehicle is put into driverless operation directly by the user, this is not considered to be part of the AVPS.

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 20900, *Intelligent transport systems — Partially-automated parking systems (PAPS) — Performance requirements and test procedures*

ISO 8608, *Mechanical vibration — Road surface profiles — Reporting of measured data*

ISO 19206-2, *Road vehicles — Test devices for target vehicles, vulnerable road users and other objects, for assessment of active safety functions — Part 2: Requirements for pedestrian targets*

ISO 19206-3, *Road vehicles — Test devices for target vehicles, vulnerable road users and other objects, for assessment of active safety functions — Part 3: Requirements for passenger vehicle 3D targets*

ISO 19206-4, *Road vehicles — Test devices for target vehicles, vulnerable road users and other objects, for assessment of active safety functions — Part 4: Requirements for bicyclist targets*

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

IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

ISO 21448, *Road vehicles — Safety of the intended functionality*

ISO/SAE 21434, *Road vehicles — Cybersecurity engineering*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/SAE PAS 22736 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 service provider

organization that hands over or receives authority to or from users through an automated valet parking system (AVPS)

Note 1 to entry: See [5.5.2](#) for further information.

3.2 user

<of an automated valet parking system> individual service recipient that hands over or retrieves authority to or from service providers through an automated valet parking system (AVPS)

Note 1 to entry: Both the owner of a personal vehicle and a user of a car share service can be a user of an AVPS.

Note 2 to entry: Within ISO/SAE PAS 22736, the term “user” is defined as the human role specifically in relation to driving automation systems. An AVPS is a system that includes system participant management functions in addition to level 4 automated driving functions. Within this document, the term “system operator” (see [3.28](#) and [5.5.3](#)) is used as a role which performs dispatching and remote assistance in relation to the level 4 automated driving functions of an AVPS. The term “user” is assigned to the individual service recipient, and not to the dispatcher or remote assistant.

3.3 authority

rights and ability to perform certain tasks on the subject vehicle

Note 1 to entry: Within this document, authority is transferred between the user and the service provider, and does not exist among the two at the same time. One always has priority regarding the management and operation of the subject vehicle (SV).

Note 2 to entry: See [5.1.2.2](#) for further information.

3.4 subject vehicle

SV
light vehicle^[1] which is equipped with the vehicle operation sub-system of an automated valet parking system (AVPS)