

---

---

**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*





## **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](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

Published in Switzerland

# Contents

Page

<b>Foreword</b>	<b>vi</b>
<b>Introduction</b>	<b>vii</b>
<b>1 Scope</b>	<b>1</b>
<b>2 Normative references</b>	<b>1</b>
<b>3 Terms and definitions</b>	<b>2</b>
<b>4 Symbols and abbreviated terms</b>	<b>6</b>
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
<b>5 System framework</b>	<b>8</b>
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
<b>6 Requirements for automated vehicle operation functions</b>	<b>14</b>
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 <sup>[1]</sup>	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
<b>7 Requirements for management functions</b>	<b>21</b>

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
<b>8</b>	<b>Requirements for the environment within parking facilities.....</b>	<b>24</b>
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
<b>9</b>	<b>Requirements for overall system operation.....</b>	<b>29</b>
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
<b>10</b>	<b>Test scenarios for automated vehicle operation.....</b>	<b>42</b>
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
	<b>Annex A (normative) Communication sequences .....</b>	<b>81</b>
	<b>Annex B (normative) Test targets .....</b>	<b>108</b>
	<b>Annex C (informative) Description of localization markers .....</b>	<b>110</b>
	<b>Annex D (informative) Guidance in placing coded markers in parking facilities .....</b>	<b>117</b>
	<b>Annex E (informative) Example of line markings detectable by on-board sensors .....</b>	<b>123</b>
	<b>Annex F (informative) Parking facility dimension .....</b>	<b>125</b>
	<b>Annex G (informative) Examples for system implementation .....</b>	<b>128</b>
	<b>Annex H (informative) Type 3 implementation example .....</b>	<b>129</b>
	<b>Bibliography .....</b>	<b>153</b>

## 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](http://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](http://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](http://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](http://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 CO<sub>2</sub> 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.