
**Intelligent transport systems —
Assisted parking system (APS) —
Performance requirements and test
procedures**

*Systèmes intelligents de transport — Système de stationnement assisté
(APS) — Exigences de performance et modes opératoires d'essai*

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Contents

	Page
Foreword	v
Introduction	vi
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Definition of APS type and common requirements	3
4.1 Basic system functionality.....	3
4.2 APS types.....	3
4.3 Common requirements.....	3
4.3.1 Maximum speed during operation.....	3
4.3.2 APS exit conditions.....	3
4.3.3 Advisory note.....	3
5 Functional and performance requirements of APS type 1	4
5.1 Basic system functionality.....	4
5.1.1 General.....	4
5.1.2 Parking slot type 1 parallel.....	4
5.1.3 Parking slot type 1 perpendicular.....	5
5.1.4 APS operation sequence.....	5
5.1.5 Basic operation procedure of APS.....	5
5.1.6 Quiescent mode.....	6
5.1.7 Slot search.....	6
5.1.8 Slot found.....	6
5.1.9 Target parking slot recognition.....	6
5.1.10 Assisted parking mode.....	6
5.1.11 End of assisted parking mode.....	6
5.1.12 APS diagram of operating modes (APS type 1).....	6
5.2 Driver interface and information strategy.....	7
5.2.1 General information presentation.....	7
5.2.2 Information in the slot search mode.....	7
5.2.3 Information during “slot found” until “start of assisted parking”.....	8
5.2.4 Driver request.....	8
5.2.5 Information during assisted parking.....	8
5.2.6 Information at “end of assisted parking”.....	8
5.3 Minimum performance requirements.....	8
5.3.1 Performance requirements during slot search mode.....	8
5.3.2 Performance requirements during assisted parking mode.....	8
5.4 Performance test requirements (APS type 1).....	11
5.4.1 Test objects.....	11
5.4.2 Ambient conditions — General.....	11
5.4.3 Test criteria.....	11
5.4.4 Slot search tests.....	11
5.4.5 Test of supported speed during assisted parking.....	12
5.4.6 End position tests.....	12
6 Functional and performance requirements APS type 2	13
6.1 Basic system functionality.....	13
6.1.1 Basic function.....	13
6.1.2 Geometric requirements.....	14
6.1.3 APS diagram of operating modes (APS type 2).....	15
6.2 Driver interface and information strategy.....	16
6.2.1 Operation procedure.....	16
6.2.2 Basic operation procedure of APS.....	16
6.3 Minimum performance requirements.....	17

6.3.1	Defined parking slot.....	17
6.3.2	Target slot recognition.....	18
6.3.3	Maximum speed during operation.....	18
6.3.4	Performance requirements for the end position.....	18
6.4	Performance test requirements.....	21
6.4.1	Performance test conditions.....	21
6.4.2	Parking slot recognition test.....	21
6.4.3	Environmental conditions — General.....	23
6.4.4	Test criteria.....	23
6.4.5	End position tests.....	23
Annex A (informative) Example of APS operation sequence.....		25
Bibliography.....		28

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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 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 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).

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

For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

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

This second edition ~~is a revision of~~ ^{ISO 16787:2017} ~~replaces the first edition (ISO 16787:2016)~~, of which it constitutes a minor revision.
 <http://www.iso.org/standard/83979aa045b5/iso-16787-2017>

The main changes compared to the previous edition are as follows:

- some editorial errors have been corrected, such as the term, “must”, replaced with the term, “shall”;
- the figures and keys have been updated for clarity.

Introduction

Assisted parking system (APS) consists of non-contact sensors and steering control which assist the driver in parking the vehicle. The assistance starts with searching a suitable parking area, getting information on the area around the vehicle (environmental map), calculating the trajectory and finishes with the lateral control of the vehicle. APS also assists the driver in recognizing obstacles while manoeuvring into the parking slot.

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Intelligent transport systems — Assisted parking system (APS) — Performance requirements and test procedures

1 Scope

This document covers the assisted parking system (APS) for light-duty vehicles, e.g. passenger cars, pick-up trucks, light vans and sport utility vehicles (motorcycles excluded) equipped with such APS. This document establishes minimum functionality requirements that the driver can expect of the system, such as the detection of suitable parking spaces, calculation of trajectories and lateral control of the vehicle. Information on the presence of relevant obstacles in the driving path of the vehicle can also be included in the functionality of such systems. This document also sets minimum requirements for failure indication as well as performance test procedures. It includes rules for the general information strategy, but does not restrict the kind of information or display system.

APS is intended to provide automated parking assistance functionality to the driver. The APS searches the environment adjacent to the vehicle for suitable parking areas between other parked vehicles or markings on the road such as painted lines, evaluates the required information to calculate parking trajectories and sends steering commands to an electronic interface of the steering system for lateral control of the vehicle during the parking manoeuvre.

The basic APS function is to assist the driver with lateral control of the vehicle during parking manoeuvres. As an optional extension, APS can also offer limited longitudinal control of the vehicle movement, e.g. braking assistance while manoeuvring into the parking slot.

This document contains requirements for the lateral control capability of APS. It does not address longitudinal control.

During the parking manoeuvre, the driver can take over the control of the vehicle movement at any time and is also fully responsible for the parking manoeuvre.

APS uses object-detection devices for detection and ranging in order to search the environment for suitable parking areas. Such devices can be sensors with distance information or vision-based systems. In addition, sensors or counters, as well as relevant data available on the vehicle network (e.g. CAN), may be used to calculate the position of the vehicle relative to the parking area.

APS is an extension of systems which inform the driver about obstacles in parking manoeuvres (e.g. ISO 17386 and ISO 22840).

This document does not include assisted parking systems, reversing aids and obstacle-detection devices for use on heavy commercial vehicles or on vehicles with trailers.

2 Normative references

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 terminological databases for use in standardization at the following addresses:

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

3.1
assisted parking system
APS

system capable of measuring the dimensions of a parking slot, calculating an applicable trajectory, performing lateral control of the vehicle while manoeuvring into the slot and giving needed instructions to the driver

3.2
slot search mode

operation mode in which the *APS* (3.1) searches the environment for suitable parking slots

3.3
assisted parking mode

automated lateral control (i.e. steering) of the vehicle by the *APS* (3.1) during the parking manoeuvre while the driver has control of the vehicle speed and driving direction

3.4
system activation

action of transitioning the system operation from a quiescent mode to an active one

3.5
driver assistance request

unique interaction between driver and user interface which is required to enable the *APS* (3.1) before each active parking manoeuvre

3.6
audible information and warning

acoustical signal (e.g. pulses, speech) which is used to present relevant information to the driver

3.7
visual information and warning

optical signal (e.g. a telltale or display) which is used to present relevant information to the driver

3.8
sensor system

component or set of components which detects objects in the monitoring range

3.9
test object

object with a specific material, geometry and surface for testing the monitoring range

3.10
searching range

minimum area in which *APS* (3.1) is able to search the environment for suitable parking slots

3.11
APS exit condition

condition after *system activation* (3.4) which causes the *APS* (3.1) to abort the manoeuvring support

3.12
APS end condition

assisted parking manoeuvre is finished and *APS* (3.1) gives the full control of the vehicle back to the driver

3.13
bordering vehicle

vehicle that limits the parking slot to the rear or the front

3.14
APS vehicle

vehicle which is equipped with *APS* (3.1)

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3.15 $V_{\text{search_max}}$

requirement up to which maximum speed *APS* (3.1) shall be able to search the environment for suitable parking slots

3.16**parking slot defining line(s)**

painted lines on the ground surface in a bright colour to identify the boundary of a defined parking slot

4 Definition of APS type and common requirements**4.1 Basic system functionality**

The APS recognizes a parking slot where the vehicle can be parked, determines the target parking position and calculates the parking trajectory.

The APS guides the vehicle to the target parking position by automatically controlling the steering during a parking manoeuvre. Upon completion of control, the vehicle's position relative to the target parking position shall fulfil a certain accuracy requirement.

4.2 APS types

This document addresses the practical systems available in the market because the driver's parking behaviour and urban parking conditions are unique issues for each country or district. Two APS type definitions according to the system's target parking slot follow:

- a) APS type 1: the APS whose target slot is the space between two vehicles;
- b) APS type 2: the APS whose target slot is defined by markings such as painted lines.

For both types, parallel and perpendicular slots are possible.

4.3 Common requirements**4.3.1 Maximum speed during operation**

It is recommended to limit the speed range during assisted parking and abort the assisted parking mode for safety when the driver exceeds this limit. The recommended range for the speed limit is (Forward: 10 km/h; Reverse: 7 km/h to 12 km/h). However, this speed limit shall conform to local regulatory requirements such as internal law, technical guidelines.

4.3.2 APS exit conditions

APS shall abort the assisted parking mode if one or more of the following conditions apply.

- The driver operates the steering to take over the control. Minimum torque to the steering wheel shall be defined by OEM. Typical value could be approximately 5 Nm.
- There is a system internal failure detected by the APS.
- The vehicle exceeds the speed limit for the assisted parking mode, as specified in 4.3.1.

The system shall cancel automatic steering control and give both audible and visual information to the driver upon detecting malfunctions.

4.3.3 Advisory note

The APS, as described in this document, is intended to detect suitable parking slots and steer the vehicle during the parking manoeuvre. It is recommended that the vehicle operator's handbook

(owner's manual) includes an advisory note that clearly indicates how to use the system and includes a description of abort criteria, the driver's responsibility and the limitations of the system.

It shall particularly remind the driver of his responsibility for safety while manoeuvring into the parking slot. This includes taking care of obstructions and other possible hazards that may not be detected by the APS. Especially in case of perpendicular parking slots, the driver shall ensure that the depth of the parking slot is sufficient. If there is an unsafe condition detected by the system, the driver shall be advised not to start the manoeuvre or to immediately take over the control of the vehicle movement.

The APS shall also assist the driver in recognizing obstacles while manoeuvring into the parking slot. Examples of such systems are described by MALSO (ISO 17386), ERBA (ISO 22840) International Standards or rear viewing camera systems.

5 Functional and performance requirements of APS type 1

5.1 Basic system functionality

5.1.1 General

APS type 1 shall support either parallel or perpendicular or both types of parking slots.

5.1.2 Parking slot type 1 parallel

The parking manoeuvre shall be performed with a parking slot limited by two vehicles of similar model as the APS vehicle and an optional kerb as a lateral reference. It is recommended that the system is able to detect a reference kerb, as described in [Figure 9](#).

For this document, it is recommended that the bordering vehicles are aligned in the same direction and parallel to each other. The document parking slot length, x_0 , is defined as the length of the APS vehicle plus Δx_p and the slot depth, y_0 , is defined as the width of the APS vehicle plus 0,2 m. For the test parking scene, two situations are considered, either with or without a reference kerb. In the case with a reference kerb, the vehicles are parked with a fixed distance parallel to it. In a situation without kerb, the virtual connecting line between the outer borders of the parked vehicles projected onto the ground is the lateral reference line.

The parking slot is defined by its length, x_0 , and its depth, y_0 (as shown in [Figure 1](#)). x_0 is the distance between the two reference vehicles. The depth, y_0 , is the distance between the outer border line of the reference vehicle and the kerb.

For APS vehicle length between 4 m and 6 m, Δx_p = length of APS vehicle multiplied by 0,25. For small vehicles, (≤ 4 m): $\Delta x_p = 4 \text{ m} \times 0,25 = 1,0 \text{ m}$ and for large vehicles, (≥ 6 m) $\Delta x_p = 6 \text{ m} \times 0,25 = 1,5 \text{ m}$.

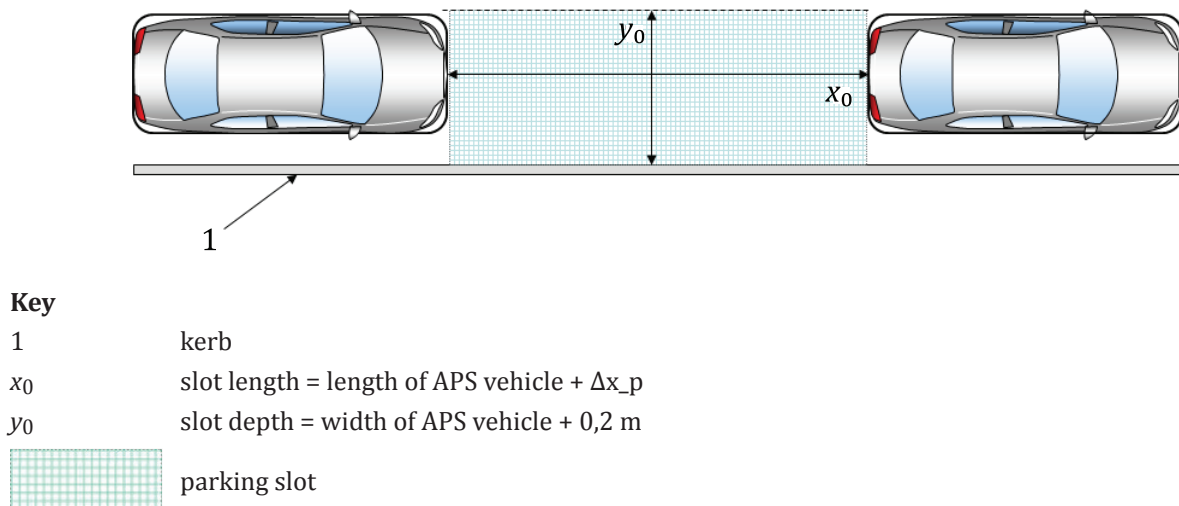


Figure 1 — Geometry of a parking slot type 1 parallel

5.1.3 Parking slot type 1 perpendicular

As a minimum requirement, the parking manoeuvre shall be performed with a parking slot limited by two vehicles of a similar model as the APS vehicle. Compliance with this document may also be proven using vehicles of different types.

For this document, it is recommended that the bordering vehicles are aligned in the same direction as the APS vehicle in its target position and parallel to each other. The parking slot width, x_0 , is defined as the width of the APS vehicle plus Δx_l and the slot depth, y_0 , is defined as the length of the APS vehicle. $\Delta x_l = 1,2$ m. See standards.iteh.ai/catalog/standards/sist/319381df-b846-4921-ae0b-83979aa045b5/iso-16787-2017

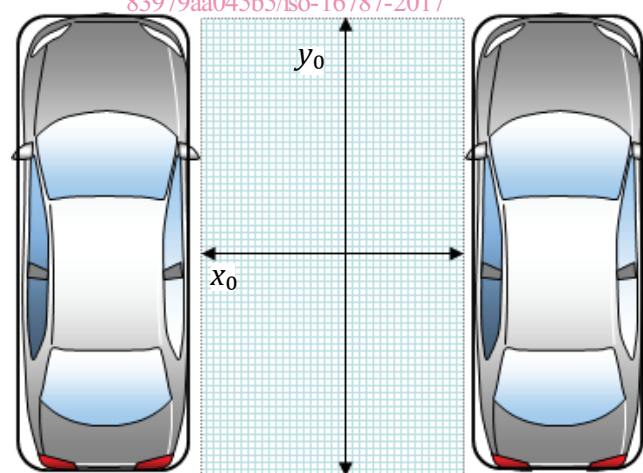


Figure 2 — Geometry of parking slot type 1 perpendicular

5.1.4 APS operation sequence

For APS type 1, see [Figure 3](#).

5.1.5 Basic operation procedure of APS

For APS type 1, see [Figure 3](#).

5.1.6 Quiescent mode

APS type 1: If activation conditions are not fulfilled, the APS shall not perform any action.

5.1.7 Slot search

APS type 1: Below a certain speed, $V_{\text{search_max}}$, and if activation conditions are fulfilled, the APS starts to search the environment for suitable parking slots. The system shall be able to search and park in the direction of both the driver and the passenger side. Depending on the system design, the driver may be able to choose the types of supported parking slots during slot search (for example, perpendicular only, parallel or perpendicular, driver side only, driver and passenger side, etc.). Due to physical limitations of the sensing system, there may be obstructions within the parking slot that are not detected by the APS, but may interfere with parking in the detected slot. Furthermore, in case of perpendicular parking slots, the obstacle detection systems may not cover the whole parking space depth.

5.1.8 Slot found

APS type 1: The system shall inform the driver about potentially suitable parking slots found. The driver needs to check the parking slot for obstructions before proceeding with the next step.

5.1.9 Target parking slot recognition

APS type 1: The APS informs the driver when the vehicle arrives at the position where parking assist is possible.

5.1.10 Assisted parking mode

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When the driver decides to park into the suitable parking slot and stops the vehicle, the APS shall assist the driver with advice and by actuating the steering during the parking manoeuvre. The ability of the system to support the parking manoeuvre will depend on the actual starting position of the APS vehicle relative to the parking slot. The limitations of the permissible starting positions shall be described in the owner's manual of the vehicle.

The actuation of the steering shall not start before the vehicle stands still.

The driver shall be able to finish the parking manoeuvre by taking over lateral control of the APS vehicle at any time. In this case, the APS shall terminate the automated actuation of the steering immediately.

5.1.11 End of assisted parking mode

The driver shall be informed when the parking manoeuvre is finished or aborted.

5.1.12 APS diagram of operating modes (APS type 1)

[Figure 3](#) shows an example sequence of operating modes, the corresponding information presented to the driver in each operating mode and also, which activity is required by the driver.