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

*Systèmes intelligents de transport — Systèmes de stationnement
partiellement automatisés — Exigences de performance et modes
opératoires d'essai*

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Foreword

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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

Partially Automated Parking Systems (PAPS) perform parking manoeuvres controlling both longitudinal and lateral movement of the vehicle to mitigate the driver's burden. Information about the intended parking space should be available by on-board sensors and potentially from external infrastructural information sources prior to starting the system operation to determine the strategic path to follow.

The system consists of driver command input device(s) and non-contact sensors to acquire external information. In addition, the system consists of automatic control of propulsion, brake, transmission and steering which manoeuvre the vehicle into intended relative position and stop within certain tolerances without the driver's direct manipulations.

A human machine interface (HMI) provides system information to the driver. The system function is initiated by a driver command. The system monitors the vicinity of the vehicle to detect and avoid hazards. The vehicle behaviour and safety conditions are supervised by the driver.

The driver is able to cancel / halt the system operation at any time necessary.

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Intelligent transport systems — Partially automated parking systems (PAPS) — Performance requirements and test procedures

1 Scope

This document addresses light vehicles^[1], e.g. passenger cars, pick-up trucks, light vans and sport utility vehicles (motorcycles excluded), equipped with partially automated parking systems (PAPS).

This document establishes minimum functionality requirements that the driver can expect and the manufacturer needs to take into account.

Possible system configuration includes the following two types:

- Type 1: System supervised by the conventional driver located in the driver's seat;
- Type 2: System supervised by the remote driver (present within or outside the vehicle) that is not necessarily located in the driver's seat. The vehicle remains in the line of sight of the remote driver.

For both types, minimum requirements and conditions of safety, system performance and function including HMI information content and description of system operating states are addressed.

The requirements include the driver who supervises the safety throughout the system manoeuvres.

System test requirements are also addressed including test criteria, method, and conditions.

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:

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

3.1

partially automated parking system PAPS

system capable of measuring the dimensions of a *parking space* (3.2)/*slot* (3.3)/*garage* (3.4), calculating an applicable trajectory, performing lateral and longitudinal (longitudinal in both directions) control of the vehicle while manoeuvring into the space/slot/garage and providing needed instructions to the driver

3.2

parking space

area which exists between two bordering vehicles and is available for parking

3.3

parking slot

allotted place which is delineated by lines or markings and is available for parking

3.4

garage

parking space (3.2) of adequate size for a single vehicle enclosed with walls or other structure

3.5

parking manoeuvre

operation to move a vehicle to a *parking space* (3.2)/*slot* (3.3)/*garage* (3.4)

3.6

leaving manoeuvre

operation to move a vehicle out from a *space* (3.2)/*slot* (3.3)/*garage* (3.4)

3.7

conventional driver

driver who is seated in the driver's seat and capable of the supervision of the safe operation of the vehicle

3.8

remote driver

driver who operates *PAPS* (3.1) using a remote control device

Note 1 to entry: The remote driver may be seated in the vehicle.

3.9

automated parking manoeuvre

automated lateral and longitudinal motion control of the vehicle by the *PAPS* (3.1) during the parking manoeuvre while the driver supervises

3.10

automated leaving manoeuvre

automated lateral and longitudinal motion control of the vehicle by the *PAPS* (3.1) during the leaving manoeuvre while the driver supervises

3.11

system activation

action of transitioning the system operation from a system ready state to an active state

3.12

test object

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

3.13

bordering vehicle

vehicle that delimits the *parking space* (3.2)

3.14

PAPS vehicle

vehicle which is equipped with *PAPS* (3.1)

4 Definition of PAPS types and requirements

4.1 PAPS types

For PAPS, the driver operates the vehicle until the parking location is determined.

Following this, until the parking operation is completed, the system performs all operations necessary to park the vehicle such as steering, acceleration, braking, transmission shifting and applying the parking brake.

The following two types of PAPS are defined in this document based on the scenarios in which the system is supervised by an on-board conventional driver or controlled remotely by a remote driver who is not necessarily located in the driver's seat.

4.2 Basic system functionality

4.2.1 Type 1 — System supervised by a conventional driver located in the driver's seat

- The system shall be supervised by a conventional driver seated in the car.
- The conventional driver shall request automated parking manoeuvres.
- The system searches for parking spaces/slots/garages.
- The search may be initiated automatically or by a conventional driver.
- In both cases, the system shall inform the conventional driver that it has identified a possible parking space/slot/garage.
- If multiple possible parking spaces/slots/garages are identified, the system shall present the candidates and the conventional driver may select one from the candidates.
- In the case where the conventional driver does not select any of the options from the multiple parking spaces/slots/garages identified by the PAPS, the search may continue.

With its automatic control of propulsion, brake, transmission and steering, the system shall move the vehicle, park the vehicle in the target parking space/ slot/ garage within the specified location accuracy limits, and finally release control.

4.2.1.1 System reactions for Type 1

System reactions corresponding to conventional driver intervention are specified in [Table 1](#).

Table 1 — System reactions corresponding to conventional driver intervention

Conventional driver intervention	Corresponding system reactions
Main switch OFF	Shall cancel parking manoeuvre and inform conventional driver, then should stop the vehicle
Shift transmission into Park	
Acceleration	Should cancel parking manoeuvre. If cancelled, shall inform conventional driver of the cancellation
Other shift operations	Shall stop the vehicle and inform conventional driver ^a
Steering	
Minimum torque to override the system applied by the conventional driver to the steering wheel shall be defined by the vehicle manufacturer. Typical value could be approximately 5 Nm.	
Braking	When the amount of braking by a conventional driver exceeds the amount of braking generated by the system, the system operates according to the amount of braking by the conventional driver.
^a In this case, the system shall immediately stop vehicle movement and provide the conventional driver with information which indicates both suspension of the system control and action for the conventional driver to take. After driver compliance, depending on the concept of the vehicle manufacturer or the driver's selection, the system can either re-start the automatic control or terminate it.	

4.2.2 Type 2 — System supervised by a remote driver

4.2.2.1 General

There are two main scenarios: entering a parking space/slot/garage and leaving a garage/perpendicular parking space/slot.

4.2.2.2 Entering a parking space/slot/garage

The system searches for parking spaces/slots/garages. The search may be initiated by the driver. The system should inform the driver that it has identified one or more possible parking spaces/slots/garages. The system may also be activated after the driver parks the car straight (e.g. 1 m) in front of the garage/perpendicular parking slot/space.

If multiple possible parking spaces/slots/garages are identified, the system should present candidates. The system proposes a parking space/slot/garage, but the driver shall be able to choose the intended parking space/slot/garage from the candidates. The proposed parking space/slot/garage may be used if the driver does not make a selection. The driver transfers the control method to the remote supervision device while the vehicle is stopped. The remote driver then activates the parking manoeuvre using the remote supervision device. Only while the remote driver is using the remote supervision device to continuously give authorization for the vehicle to move, shall the system automatically operate and park the vehicle in the target parking space/ slot/ garage within the specified location accuracy limits. The vehicle is stopped when the final parking position is reached or when the remote driver deactivates the system using the remote supervision device.

4.2.2.3 Leaving a garage/perpendicular parking space/slot

The system shall start the leaving manoeuvre when it receives and confirms a leaving manoeuvre request from the remote driver. Only while the remote driver is using the remote supervision device to continuously give authorization for the vehicle to move, shall the system automatically operate and move the vehicle from the parking space/slot/garage within the specified location accuracy limits. The vehicle is stopped when the specified position is reached or when the remote driver deactivates the system using the remote supervision device.

4.2.2.4 System reactions for Type 2

System reactions corresponding to remote driver intervention and system failure are specified in [Tables 2](#) and [3](#).

Table 2 — System reactions corresponding to remote driver intervention

Remote driver intervention	Corresponding system reactions
Main switch OFF (if available on remote device)	Shall stop the vehicle and cancel automatic control of the system ^a
Ignition OFF	
A door or trunk of the vehicle opens while the remote driver is giving the command to move by the remote supervision device.	Shall stop the vehicle ^b When the condition is cleared, the system may continue the parking manoeuvre.
^a In this case, the system shall immediately stop vehicle movement and provide the remote driver with information which indicates cancellation of the system control.	
^b In this case, the system shall immediately stop vehicle movement and provide the remote driver with information which indicates suspension of the system control. After driver compliance, depending on the concept of the vehicle manufacturer or the driver's selection, the system can either re-start the automatic control or terminate it.	

Table 3 — System reactions corresponding to system failure

System failure	Corresponding system reactions
The distance between the remote driver and the vehicle exceeds a threshold defined by the system designer.	Shall stop the vehicle ^a
The communication between the remote device and the system is interrupted or data is corrupted.	When the condition is cleared, the system may continue the parking/leaving manoeuvre.
^a In this case, the system shall immediately stop vehicle movement and provide the remote driver with information which indicates suspension of the system control. After driver compliance, depending on the concept of the vehicle manufacturer or the driver's selection, the system can either re-start the automatic control or terminate it.	

4.3 General requirements

4.3.1 Maximum speed during operation

The system shall only operate up to 10 km/h (+2 km/h tolerance).

4.3.2 PAPS termination conditions

PAPS shall abort the automated parking/leaving manoeuvres if there is a system failure detected by the PAPS.

The system shall cancel automated control and provide information to the driver upon detecting malfunctions.

4.3.3 User's manual

It is recommended that the vehicle user's manual (owner's manual) include an advisory note that clearly indicates how to use the system, and include a description of abort or pause criteria, driver's responsibility and limitations of the system.

The manual shall particularly emphasize the responsibility of the driver for safety while the system is operating. This includes identifying obstructions and other possible hazards that may not be detected by the PAPS. Especially in case of garage/perpendicular spaces/slots, the driver shall ensure the parking space/slot/garage is of sufficient depth.

5 Functional and performance requirements for PAPS

5.1 Supported parking types

PAPS shall support one or more parking types of the following:

1. parallel parking space;
2. parallel parking slot;
3. perpendicular parking space;
4. perpendicular parking slot;
5. garage parking space.

5.1.1 Parallel parking space

As a minimum requirement the parking manoeuvre shall be performed with a parallel parking space limited by either one or all of following definitions:

- Two bordering vehicles;

— (Option) kerb as lateral reference.

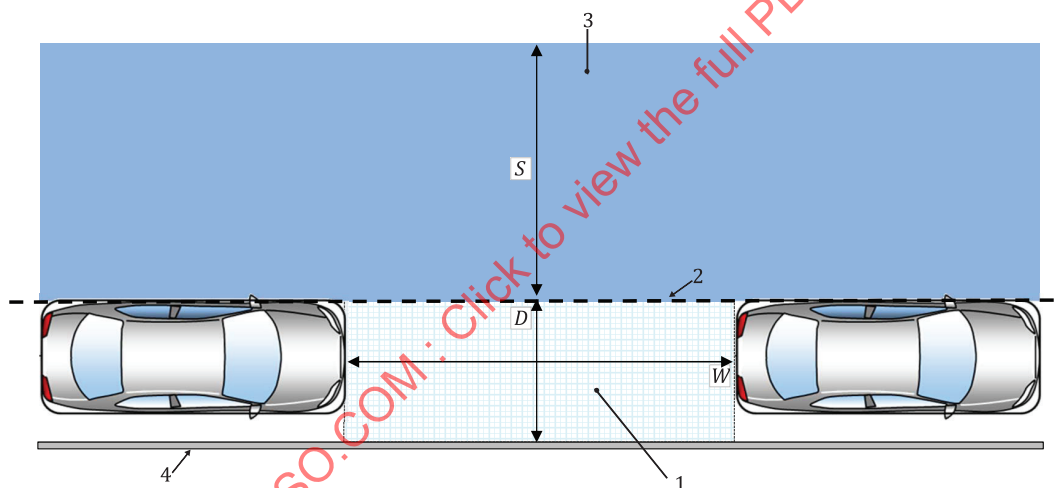
It is recommended that the system be able to detect a reference kerb, as described in [Figure 9](#).

For this parking type, it is recommended that the bordering vehicles be properly parallel parked. The standard parking space width, W , is defined as the length of the PAPS vehicle plus Δy and the space depth, D , is defined as the width of the PAPS vehicle plus 0,2 m without regard of the side view mirrors. Two parking scenarios 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 (without regard of the side view mirrors) of the two bordering parked vehicles projected onto the ground is the lateral reference line.

The parking space is defined by its width W and its depth D (as shown in [Figure 1](#)). W is the distance between the two bordering vehicles. The depth D is the distance between the lateral reference line and the width of the PAPS vehicle +0,2 m without regards of the side view mirrors.

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

The PAPS controlled vehicle is required to stay within the area where PAPS control is permitted as indicated in [Figure 1](#). It is also important to let users know how the system performs the parking manoeuvre and its performance limit. The description of how the system works and possible interference with surrounding objects shall at least be stated in the user's manual.



Key

- 1 target parking area
- 2 lateral reference line
- 3 area where PAPS control is permitted
- 4 (option) kerb
- W space width = length of PAPS vehicles + Δy
- D space depth = width of PAPS vehicles + 0,2 m without regards of the side view mirrors
- S width of area where PAPS control is permitted = 4,5 m

Figure 1 — Geometry of a parallel parking space

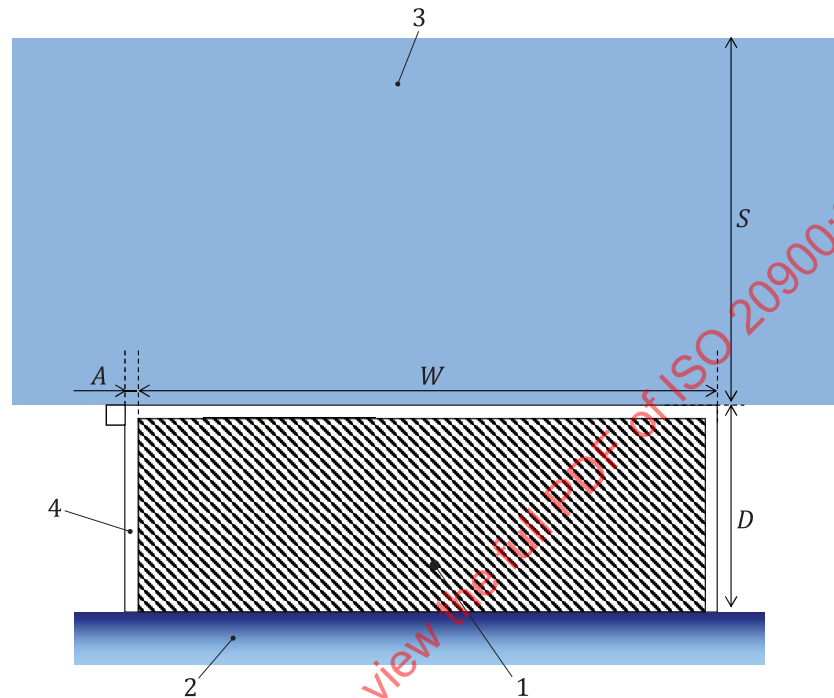
5.1.2 Parallel parking slot

As a minimum requirement the parking manoeuvre shall be performed with a parking slot limited by the following definition:

— Contrastive markings on the ground surface.

The contrastive markings should have a minimum contrast ratio of 5 (five). Recommended figure and size of the markings are shown in [Figure 2](#).

The PAPS controlled vehicle is required to stay within the area where PAPS control is permitted as indicated in [Figure 2](#). It is also important to let users know how the system performs the parking manoeuvre and its performance limit. The description of how the system works and possible interference with surrounding objects shall at least be stated in the user's manual.



Key

1	target parking area	3	area where PAPS control is permitted
2	the edge of road	4	parking slot line
W	width of the parking slot ($\approx 7,0$ m)	D	depth of parking slot ($\approx 2,5$ m)
A	width of parking slot line ($\approx 0,15$ m)	S	width of area where PAPS control is permitted ($\approx 4,5$ m)

Figure 2 — Geometry of parallel parking slot

5.1.3 Perpendicular parking space

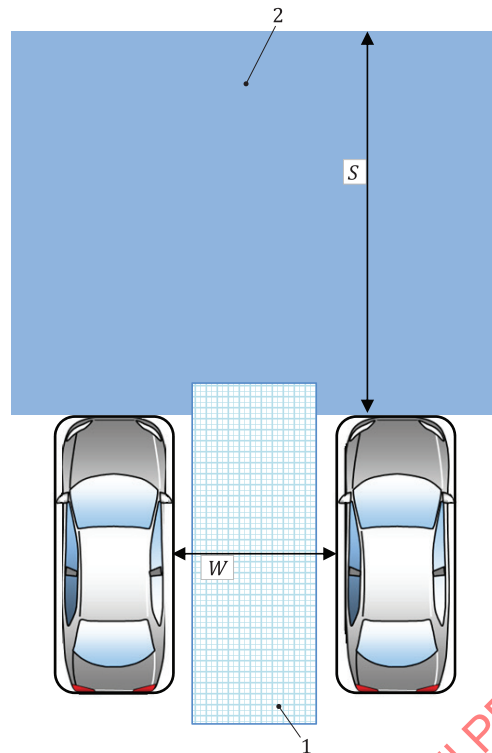
As a minimum requirement the parking/leaving manoeuvre shall be performed with a parking space limited by the following definition:

— Two bordering vehicles.

For this parking type, it is recommended that the bordering vehicles be properly perpendicularly parked. The standard parking space width W is defined as the width of the PAPS vehicle including side view mirrors plus Δx ($\approx 1,2$ m) as shown in [Figure 3](#).

The PAPS controlled vehicle is required to stay within the area where PAPS control is permitted as indicated in [Figure 3](#). It is also important to let users know how the system performs the parking/leaving manoeuvre and its performance limit. The description of how the system works and possible interference with surrounding objects shall at least be stated in the user's manual.

The details of the target parking area are shown in [Figure 15](#).

**Key**

- 1 target parking area
- 2 area where PAPS control is permitted
- W space width = width of PAPS vehicle + Δx (= 1,2 m)
- S width of area where PAPS control is permitted = 7 m

Figure 3 — Geometry of perpendicular parking space

5.1.4 Perpendicular parking slot

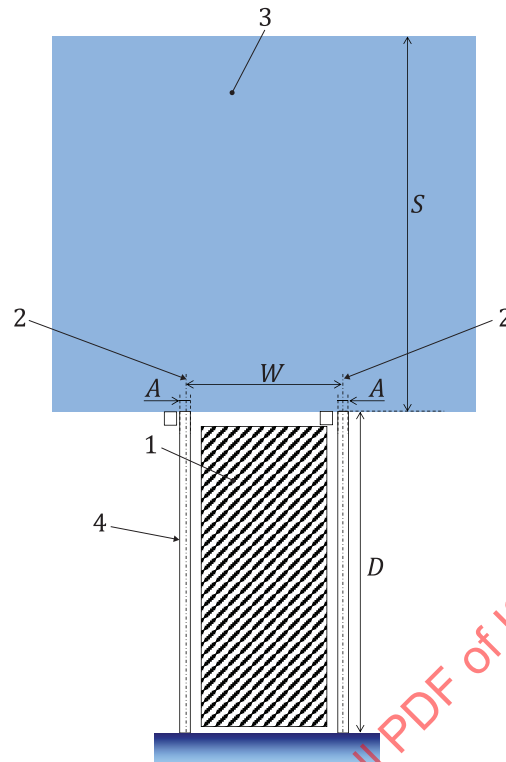
As a minimum requirement the parking/leaving manoeuvre shall be performed with a perpendicular parking slot limited by the following definition:

- Contrastive markings on the ground surface.

The contrastive markings should have a minimum contrast ratio of 5 (five). Recommended figure and size of the markings are shown in [Figure 4](#).

The PAPS controlled vehicle is required to stay within the area where PAPS control is permitted as indicated in [Figure 4](#). It is also important to let users know how the system performs the parking/leaving manoeuvre and its performance limit. The description of how the system works and possible interference with surrounding objects shall at least be stated in the user's manual.

The details of the target parking area are shown in [Figure 16](#).

**Key**

- 1 target parking area
- 2 centre of the slot line
- 3 area where PAPS control is permitted
- 4 slot line

W width of the parking slot opening ($=2,5\text{ m}$)^a

D depth of parking slot ($=6,0\text{ m}$)^b

A width of parking slot line ($=0,15\text{ m}$)

S width of area where PAPS control is permitted ($=7\text{ m}$)

^a For large cars whose width exceeds $1,9\text{ m}$ without regards of side view mirrors, W can be extended.

The target W for such cars should be “vehicle width (without regards of side view mirrors) plus $0,6\text{ m}$ ” ($0,3\text{ m}$ margin for each side).

^b For large cars whose length exceeds $5,0\text{ m}$ D can be extended. The target D for such cars should be “vehicle length plus $1,0\text{ m}$ ”.

The minimum requirement for the surface of a parking slot is a flat paved surface.

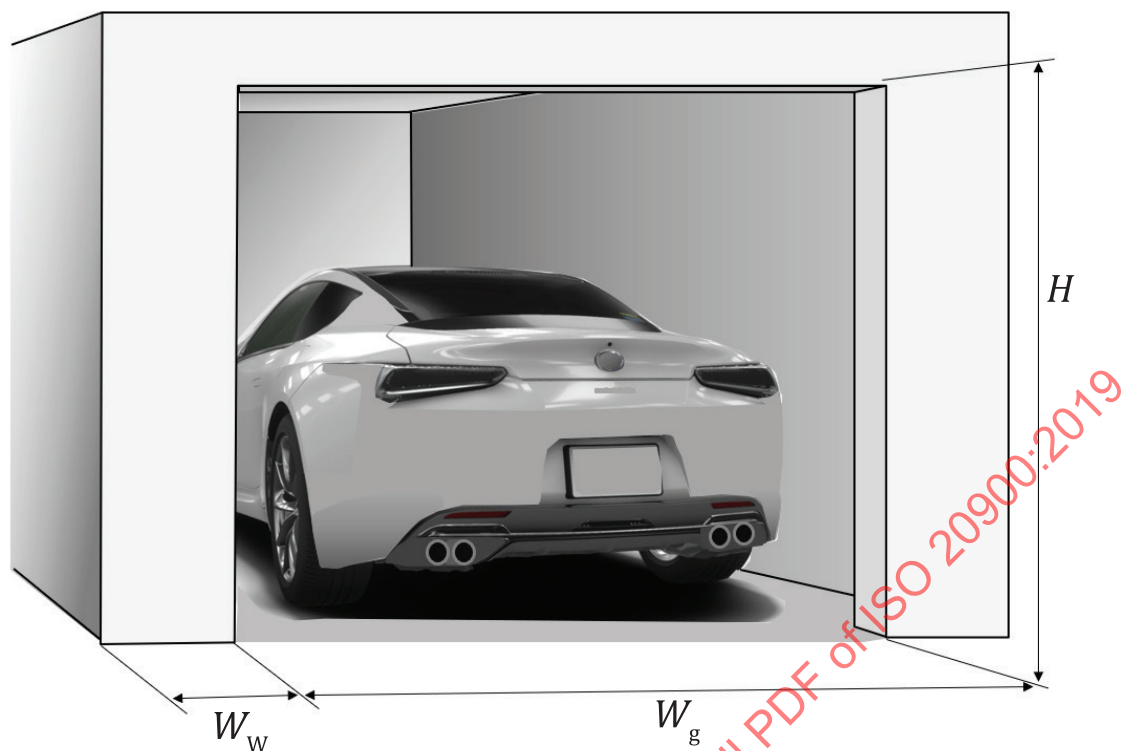
Figure 4 — Geometry of perpendicular parking slot

5.1.5 Garage parking space

As a minimum requirement the parking/leaving manoeuvre shall be performed with a common garage limited by the following definition:

- Garage gate;
- Garage front, side and back walls.

The garage parking space is defined by its gate width W_g , its park width W_p and its depth D as shown in [Figures 5](#) and [6](#).



Key

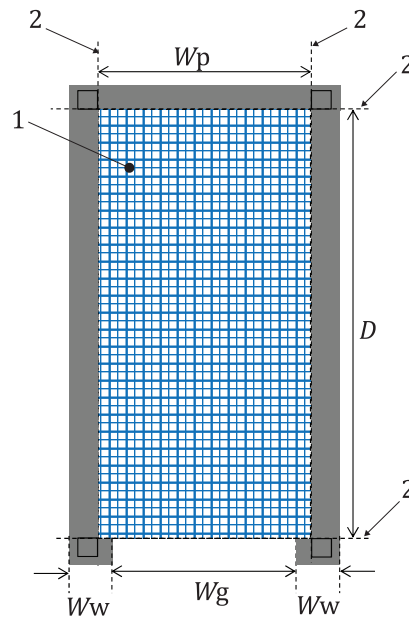
W_g garage gate width = width of PAPS vehicle (including side view mirrors) + 0,8 m

W_w width of garage front wall^a = 1,0 m

H garage height > height of PAPS vehicle

^a There needs to be a sufficient contrast between the wall and opening of the garage.

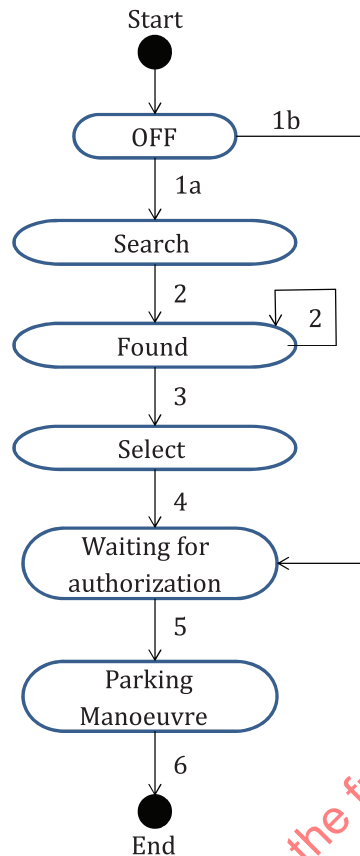
Figure 5 — Geometry of garage gate

**Key**

- 1 target parking area
- 2 inside line of the garage
- W_g garage gate width = width of PAPS vehicle (including door mirrors) + 0,8 m
- W_p garage park width ($W_g \leq W_p \leq W_g + 2 \times W_w$)
- W_w width of garage front wall^a = 1,0 m
- D garage depth = length of PAPS vehicle + 1,0 m
- ^a There needs to be a sufficient contrast between the wall and opening of the garage.

Figure 6 — Geometry of garage top view**5.2 States of operation and user interface****5.2.1 Parking manoeuvre**

[Figure 7](#) shows an example sequence of operating states for the case of a parking manoeuvre, the corresponding information presented to the driver in each operating state, and actions required of the driver.

**Key**

- 1a driver action (e.g. main switch ON) or System action (e.g. $0 < \text{speed} \leq \text{threshold}$)
- 1b in case the system is activated after the driver parks the vehicle in front of a garage/ perpendicular parking space/slot
- 2 system detects a parking space/slot/garage
- 3 OEM specific (e.g. driver stops the vehicle)
- 4 driver or system selects the target parking space/slot/garage
- 5 driver authorization (e.g. by pressing a button)
- 6 parking manoeuvre complete or cancel

Figure 7 — PAPS diagram of operating states in parking manoeuvre

Advancement to the next state is only possible when the driver has completed the specified action.

Upon system activation the system leaves the “OFF” state to “Search” state, starts searching the environment for parking spaces/slots/garages, evaluates the objects detected and generates appropriate feedback to the driver.

The system may switch its operating state between “Search”, “Found”, “Select”, and “Waiting for authorization”. If the operating state is “Waiting for authorization” and the driver gives authorization to PAPS, the state transits to “Parking manoeuvre” and performs an automated parking manoeuvre.

5.2.1.1 OFF state

System starts from OFF state.

The system shall inform the driver that the system is ready for use.

If the system is not available due to a failure or other causes, the driver shall be informed of such a system condition.

When manufacturer-specified conditions are satisfied (for example, when the driver presses a button or the vehicle speed goes below the threshold), the system transitions to the search state.

In case the system is activated after the driver parks the vehicle in front of a garage/ perpendicular parking space/slot, the system may transition to the waiting for authorization state.

5.2.1.2 Search state

The system shall search for possible parking spaces/slots/garages. When the system finds a space/slot/ garage or obtains such information, the system transitions to the found state.

5.2.1.3 Found state

This is the state in which the system has detected one or more possible parking spaces/slots/garages.

The system shall inform the driver of one or more parking spaces/slots/garages detected as a result of the search.

When manufacturer-specified conditions are satisfied (for example, when the driver has stopped the vehicle), the system transitions to the select state.

For Type 2 systems, the driver may get out of the vehicle at this point, and use the remote supervision device for further parking operation. If the width of the parking space/slot/garage is very narrow, the system may inform the driver that the driver should get out of the vehicle.

5.2.1.4 Select state

When the system has detected only one space/slot/garage, the system selects it.

When the system has detected two or more spaces/slots/garages, depending on the manufacturer design specifications, the driver or the system may select one of them.

For Type 2 systems, the driver may get out of the vehicle at this point, and use the remote supervision device for further parking operation. If the width of the parking space/slot/garage is very narrow, the system may inform the driver that the driver should get out of the vehicle.

5.2.1.5 Waiting for authorization state

This is the state in which the system is waiting for authorization from the driver for automated manoeuvre.

For Type 2 systems, the driver may get out of the vehicle at this point and use the remote supervision device for further parking operations. If the width of the parking space/slot/garage is very narrow, the system may inform the driver that the driver should get out of the vehicle.

When manufacturer-specified conditions are satisfied (for example, when the driver presses a button), and the driver gives authorization to the system to move the vehicle, the system transitions to the parking manoeuvre state.

5.2.1.6 Parking manoeuvre state

When the authorization from the driver to start system control is received, the system shall control propulsion, brake, transmission and steering to move the vehicle into the selected parking space/ slot/garage.

For Type 1 systems, the conventional driver shall indicate the intention to continue system control to the system.

For Type 2 systems, the remote driver shall continuously indicate the intention to continue system control to the system. As an example, the system should possess the functionality for continued control when the remote driver continually presses the command switch, and the system pauses control when the remote driver releases the switch.

While the system is controlling the vehicle movement, collisions with objects in the surrounding area should be avoided. When the system detects any obstacles, it should inform the driver of the possibility of collision. Intervention or action by the driver to avoid a collision overrides system operations at any time. If the obstacle is removed, PAPS may continue the manoeuvre as soon as the driver gives authorization.

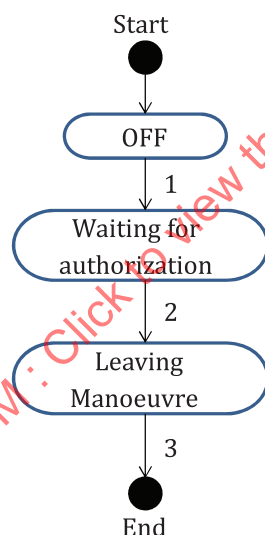
When the vehicle reaches the final target position, the system shall stop the vehicle, keep the PAPS vehicle stationary, and simultaneously inform the driver of completion of the control.

For Type 1 systems, the system shall transition to the OFF state after completion of parking.

For Type 2 systems, when control is completed, with the remote driver's confirmation of completion, the system shall transition to the OFF state. Engine OFF or door lock command may be executed.

5.2.2 Leaving manoeuvre for Type 2

Figure 8 shows an example sequence of operating states for the case of a leaving manoeuvre.



Key

- 1 remote driver action (e.g. main switch ON)
- 2 remote driver authorization (e.g. by pressing a button)
- 3 leaving manoeuvre complete or cancel

Figure 8 — PAPS diagram of operating states in leaving manoeuvre

Advancement to the next state is only possible when the driver has completed the described activity.

Upon system activation, the system transitions from the “OFF” state to the “Waiting for authorization” state, and the system waits for the remote driver’s authorization.

Then, the remote driver gives authorization to the system, the system state transits to “Leaving manoeuvre” and the system performs an automated leaving manoeuvre.

5.2.2.1 OFF state

The system starts from the OFF state.

The system shall inform the remote driver that the system is ready for use.

If the system is not available due to a failure or other causes, the remote driver shall be informed of such a system condition.

When the command of the remote driver to start the engine is received and confirmed via a remote device, the PAPS Type 2 systems may offer an automated leaving manoeuvre function to the remote driver.

5.2.2.2 Waiting for authorization state

This is the state in which the system is waiting for authorization from the remote driver for automated manoeuvre.

The system needs to be able to move the vehicle from the parked position without a collision to a position where the remote driver can enter the vehicle. If it is possible for the system to perform the manoeuvre both forward and backward, the remote driver needs to select the direction.

When manufacturer specified conditions are satisfied (for example, when the driver presses a button), if the remote driver gives authorization to the system to move the vehicle, the system transitions to the leaving manoeuvre state.

5.2.2.3 Leaving manoeuvre state

When the authorization from the remote driver to start system control is received, the system shall control propulsion, brake, transmission, and steering, to move the vehicle to the desired direction.

The vehicle speed shall be 1 m/s or less.

When the system is in this state, the remote driver shall continuously indicate to the system the intention to continue system control. As an example, the system should possess the functionality for continued control by the system when the remote driver continually presses the command switch and the system pauses control when the remote driver releases the switch.

While the system is controlling the vehicle movement, collisions with objects in the surrounding area should be avoided. When the system detects any obstacles, it should inform the remote driver of the possibility of collision. If the obstacle is removed, PAPS may continue the manoeuvre as soon as the remote driver gives authorization.

When the vehicle reaches the final target position, the system shall stop the vehicle, keep the PAPS vehicle stationary, and simultaneously inform the remote driver of completion of the control.

As an alternative to this scenario it shall always be possible for the system to return to the vehicle's starting position if the remote driver gives this command via remote device.

When control is completed, with the remote driver's confirmation of completion, the system shall transition to the OFF state.

5.3 Information strategy

5.3.1 General

The system shall inform the driver of the operating state defined by the manufacturer.

The system shall provide the driver with instructions required for the parking/leaving manoeuvre defined by the manufacture.

The system shall provide information to the driver upon releasing automatic control, either when the automated parking/leaving manoeuvre is finished successfully or when it is aborted.

The method used to provide information/warning may be auditory, visual, haptic or a combination of these.

5.3.2 Information in “Search state”

It is the responsibility of the vehicle manufacturer to define what kind of information is provided from the PAPS to the driver in the space/slot/garage search state.

5.3.3 Information during “Found state” until “Waiting for authorization state”

The driver shall be informed about suitable spaces/slots/garages found by the PAPS.

It is the responsibility of the vehicle manufacturer to define what kind of information is provided to the driver when a suitable space/slot/garage is found before the automated parking manoeuvre is entered.

5.3.4 Information in “Waiting for authorization state”

It is the responsibility of the vehicle manufacturer to define actions the driver has to perform to enable the automatic control of the PAPS.

The driver is required to ensure that the intended parking space/slot/garage is suitable to the PAPS vehicle.

5.3.5 Information during “Parking/Leaving manoeuvre state”

The driver shall be informed when all prerequisites to start parking/leaving manoeuvring are fulfilled and PAPS switches to the automated parking/leaving manoeuvre.

When the vehicle is in the automated parking/leaving manoeuvre state the following information or warning needs to be provided to the driver:

- The system shall give information to the driver upon releasing the automatic control.
- If PAPS detects a malfunction, the driver shall be informed.

The driver shall be informed when PAPS has finished the parking/leaving manoeuvre and stops control of the vehicle.

6 Performance test requirements

6.1 General

In this clause, the minimum requirements for performance testing (environmental conditions, pass/fail criteria, etc.) are specified.

6.2 Environmental conditions

- The wind speed shall not exceed 5,4 m/s (wind force 3) during testing.
- Temperature shall be between 5 °C to 30 °C.
- Non-precipitating conditions (not raining, sleeting, snowing, etc.).
- Testing shall be conducted on a flat, dry, uniform, and (asphalt or concrete) paved surface.
- Walls, auxiliary test equipment, and other non-test objects (clutter) shall be removed from the test area in order to eliminate interference caused by their reflections (sonic and/or electromagnetic).
- The minimum illuminance shall be 100 lx.

Performance test may be conducted under ambient conditions different from the above specified conditions. However, if the system fails, the test shall be repeated under above specified conditions to prove compliance.

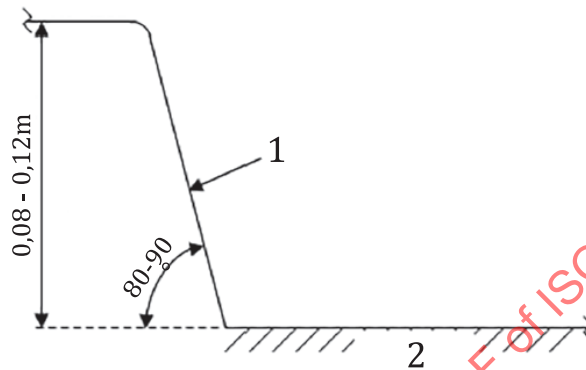
6.3 Test object

6.3.1 Bordering vehicle

Any light vehicles which are selected by the tester can be used.

6.3.2 Reference kerb

The shape of the reference kerb that shall be used for testing is shown in [Figure 9](#).



Key

- 1 kerb outward side
- 2 road

Figure 9 — Definition of reference kerb

6.3.3 Slot lines

The minimum luminance contrast ratio between the parking slot lines and road surface needed for recognition should be 5. The definition of the luminance contrast is as follows.

$$\text{Parking slot line luminance contrast} = (Lsl - Lrs) / Lrs$$

where

Lsl is slot line luminance;

Lrs is road surface luminance.

6.4 Test criteria

As specified in [5.1](#), PAPS supports one or more of the following parking types:

1. parallel parking space;
2. parallel parking slot;
3. perpendicular parking space;
4. perpendicular parking slot;
5. garage parking space.

Performance testing specified in [6.5](#) shall be performed according to the supported parking types, following the environmental conditions specified in [6.2](#), and using the test object specified in [6.3](#).

For parking test of Type 1 or Type 2, parking shall be done by using PAPS. When the parking is correctly completed satisfying all pass criteria, the test is passed successfully.

For leaving manoeuvre test for Type 2, the test shall be performed immediately after the parking manoeuvre test is completed, from the position at which the vehicle was parked.

An automated parking manoeuvre by the system shall be completed within 180 s from the time the system started the manoeuvre.

An automated leaving manoeuvre by the system shall be completed within 180 s from the time the system started the manoeuvre.

Parking/leaving manoeuvre tests shall be performed 10 times each with the same conditions and 9 times out of 10 shall be successful.

For PAPS which detects a parking space or slot, vehicle conditions at the time of detection (moving or stopped, location, moving speed, etc.) shall be in accordance with the requirements specified by the manufacturer.

6.5 Performance test

6.5.1 Parallel parking space

In this clause, performance test procedures and pass criteria for PAPS which supports parallel parking space specified in 5.1.1 are described.

6.5.1.1 Test procedure for parking manoeuvre

The location of the test object shall be as shown in Figure 1 in 5.1.1.

The distance D_r , D_f and the angle α shall be measured after reaching the end position at each trial.

In case of situations with a kerb, D_f , D_r is from the front wheel and the rear wheel to the kerb (see Figure 10). α is the angle between the vehicle and the kerb (see Figure 12).

In case of situation without kerb, D_f , D_r is from the front wheel and the rear wheel to the connecting line between the two bordering parked vehicles (see Figure 11). α is the angle between the vehicle and the connecting line between the two bordering parked vehicles (see Figure 13).

The target distance D_r , D_f (distance rear, front) to the kerb or to the connecting line may be PAPS internal parameters depending on the vehicle manufacturer's choice. Exact values are not defined in this document, but valid ranges are given.

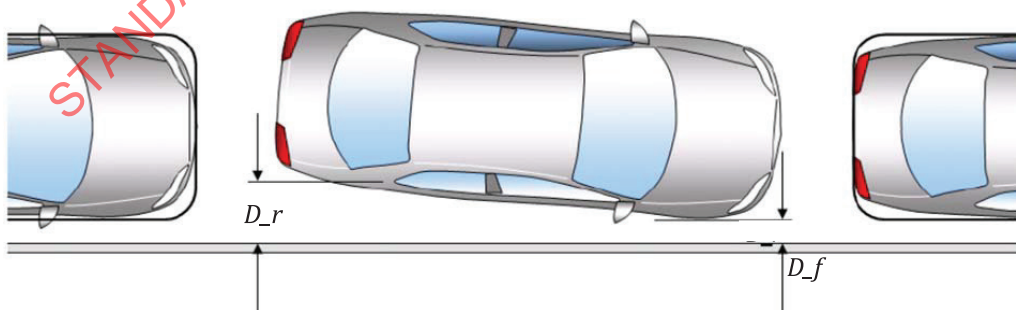


Figure 10 — Definition of D_r and D_f : distance vehicle rear/front to kerb

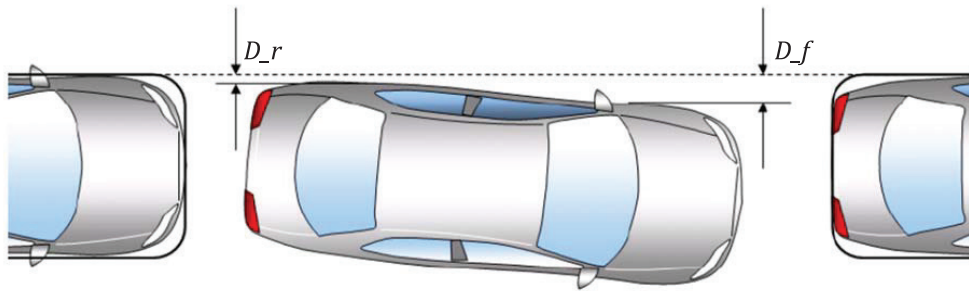
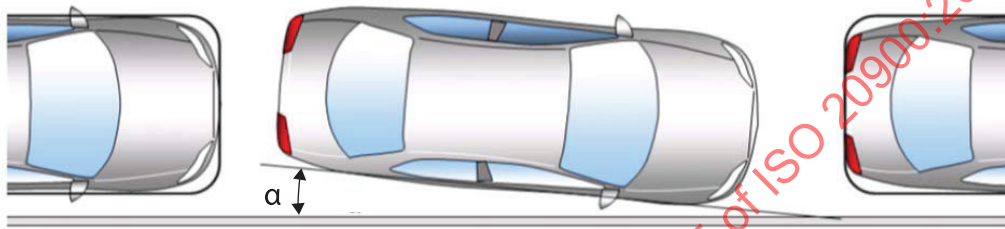
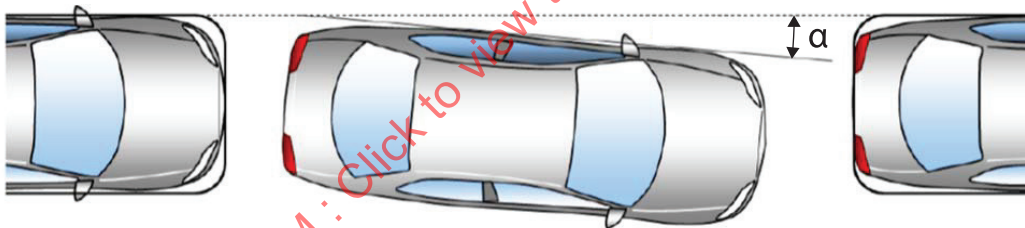


Figure 11 — Definition of D_r and D_f : distance vehicle rear/front to vehicle connecting line



NOTE The angle is positive in this example.

Figure 12 — Definition of α : orientation of vehicle to the kerb



NOTE The angle is positive in this example.

Figure 13 — Definition of α : orientation of vehicle to vehicle connecting line

6.5.1.2 Pass criteria for parking manoeuvre

1. Requirements for the angle (Figures 12 and 13).
 - The mean angle α to the kerb or vehicle connecting line shall be in the range $-3^\circ \leq \alpha \leq 3^\circ$.
 - The standard deviation of α based on the successful tests shall be not more than $1,5^\circ$.
2. Requirements for the distance from the referenced line:
 - The mean distance D_r, D_f from the kerb shall be in the range from 0,05 m to 0,3 m (Figure 10), or mean distance D_r, D_f from the vehicle connecting line shall be in the range determined by the vehicle manufacturer (Figure 11).
 - The standard deviation of D_r, D_f shall not be more than 0,1 m based on the successful tests.

6.5.2 Parallel parking slots

In this clause, performance test procedures and pass criteria for PAPS which support parallel parking slots specified in 5.1.2 are described.

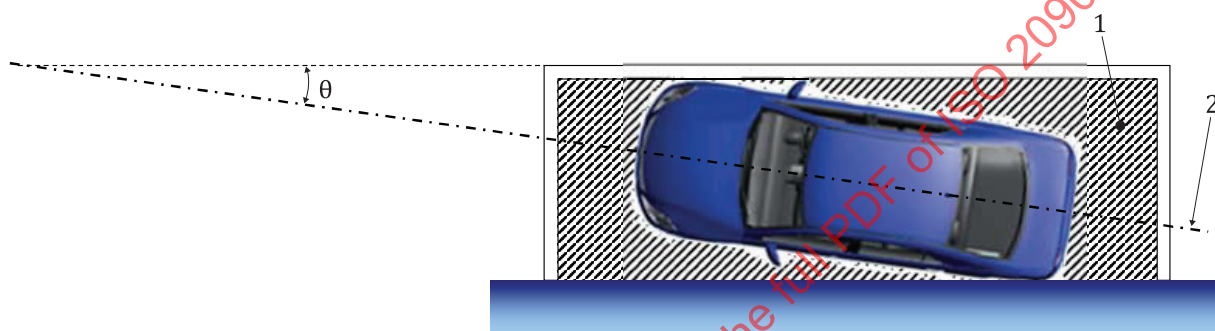
6.5.2.1 Test procedure for parking manoeuvre

The location of the test object shall be as shown in Figure 2.

At the end position, the outline of the PAPS vehicle projected on the ground without regard of the side view mirrors shall be measured.

The inclination angle (θ) relative to the road edge shall be measured after reaching the end position at each trial.

The definition of a border line of a parallel parking slot is shown in Figure 14.



Key

- 1 target parking area
- 2 centreline of the PAPS vehicle

Figure 14 — Definition of border line of Parallel parking slot

6.5.2.2 Pass criteria for parking manoeuvre

- The PAPS vehicle shall be positioned within the target area (Figure 14).
- The mean angle θ shall be in the range $-3^\circ \leq \theta \leq 3^\circ$ (Figure 14).
- The standard deviation of θ based on the successful tests shall be not more than $1,5^\circ$ (Figure 14).

6.5.3 Perpendicular parking space

In this clause, performance test procedures and pass criteria for PAPS which supports perpendicular parking spaces specified in 5.1.3 are described.

6.5.3.1 Test procedure for parking manoeuvre

The location of the test object shall be as shown in Figure 3.

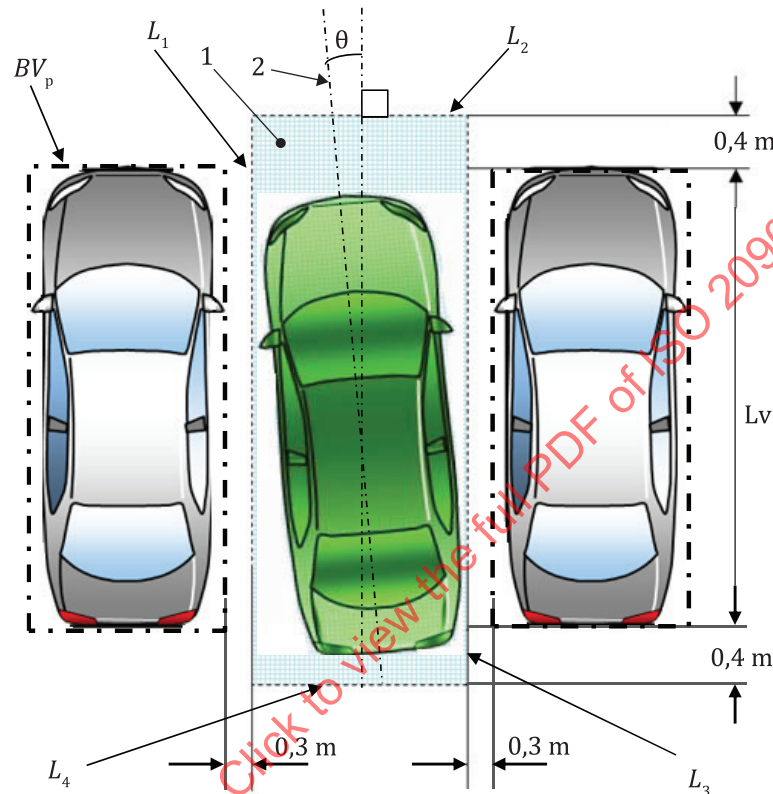
Two bordering vehicles used for the test shall be physically similar to the PAPS vehicle.

For the standard parking situations described in 5.1.3, the requirements for the end position reached by the PAPS vehicle at the end of the automated parking control is described by a the target area. The target area is delineated by 4 lines as shown in Figure 15. L_1 is parallel to the corresponding line of BV_p of the left bordering vehicle at a distance of 0,3 m and L_3 is parallel to the corresponding line of BV_p of the right bordering vehicle at a distance of 0,3 m. L_2 and L_4 are parallel to the front/rear lines of the BV_p of the bordering vehicles at a distance of 0,4 m.

At the end position, the outline of the PAPS vehicle projected on the ground without regard of the side view mirrors shall be measured.

The inclination angle (θ) relative to the parking space shall be measured after reaching the end position at each trial.

The definition of target area and angular alignment in a perpendicular parking space is shown in [Figure 15](#).



Key

- 1 target parking area
- 2 centre line of the PAPS vehicle
- L_v length of the bordering vehicle
- BV_p periphery of the bordering vehicle referencing the outermost edges

Figure 15 — Definition of target area and angular alignment in perpendicular parking space

6.5.3.2 Pass criteria for parking manoeuvre

- The PAPS vehicle shall be positioned within the target area ([Figure 15](#)).
- The mean angle θ shall be in the range $-3^\circ \leq \theta \leq 3^\circ$ ([Figure 15](#)).
- The standard deviation of θ based on the successful tests shall be not more than $1,5^\circ$ ([Figure 15](#)).

6.5.3.3 Test procedure for Type 2 leaving manoeuvre

The test shall be performed immediately after parking manoeuvre test ([6.5.3.1](#)) is completed. Continue testing until the pass criteria below ([6.5.3.4](#)) are met.