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Intelligent transport systems — Automated braking during low-speed manoeuvring (ABLS) — Requirements and test procedures

Systèmes de transport intelligents — Freinage automatique lors de manœuvres à basse vitesse (ABLS) — Exigences et procédures 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

Existing International Standards for automated emergency braking, such as ISO 22839 or ISO 19237, are focused on collision mitigation or avoidance at moderate vehicle speeds in the forward direction, typically using front sensors such as radar. The implementation and utilization of additional perception sensors (i.e. around the entire vehicle) creates the possibility of advanced collision mitigation and avoidance systems covering the whole area surrounding the vehicle.

Low-speed collisions during parking and especially during reversing manoeuvres represent a high share of road traffic accidents, including both accidents with material damage leading to high monetary expenses,[6] and accidents leading to injuries or even fatalities of human road users. This document addresses such collisions.

Intelligent transport systems — Automated braking during low-speed manoeuvring (ABLS) — Requirements and test procedures

1 Scope

This document provides minimum requirements and test procedures for automated braking at velocities below 2,8 m/s (10 km/h) with the specific aim of avoiding or mitigating collisions with pedestrians, other road users (e.g. vehicles) and stationary objects, including infrastructure elements (e.g. walls, pillars). These collisions mainly occur during reversing manoeuvres, but this document also addresses collisions in other directions during low-speed manoeuvring.

Automated braking during low-speed manoeuvring (ABLS) requires information about the position and motion of the object, the motion of the subject vehicle, and the driver actions. It then determines if the evaluated situation represents a collision risk. If an imminent collision risk exists, ABLS will automatically activate a brake action to avoid or at least mitigate the collision.

The document does not define test objects, but refers to the ISO 19206 series for test objects to be used.

The human driver is assumed to perform or at least supervise all driving manoeuvres because the ABLS application is restricted to support only systems of SAE Level 0 – 2. Evasive steering manoeuvres are not within the scope of this document.

This document applies to light vehicles[7] only. Vehicles equipped with trailers are not within the scope of this document.

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 17386, *Intelligent transport systems — Manoeuvring aids for low-speed operation (MALSO) — Performance requirements and test procedures*

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 20900:2023, *Intelligent transport systems — Partially-automated parking systems (PAPS) — Performance requirements and test procedures*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 17386, ISO 19206-2, ISO 20900 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
ABLS function
function capable of reducing the velocity of the vehicle to avoid or mitigate a collision during low-speed manoeuvring

3.2
ABLS types
types A to C which are related to the automation level of the driving function supported by ABLS

3.3
low-speed manoeuvring
LSM
driving manoeuvre of a vehicle at a velocity ≤ 2,8 m/s (10 km/h) mainly intended to park the subject vehicle

Note 1 to entry: Within the context of this document, continuous forward driving (e.g. in congested situations such as a traffic jam) where the velocity can potentially drop temporarily below 2,8 m/s (10 km/h) is not considered as low-speed manoeuvring.

3.4
vulnerable road user
VRU
human such as a pedestrian or cyclist, independent of age and size

3.5
subject vehicle
SV
vehicle under test in which ABLS is implemented

3.6
parked vehicle
PV
static vehicle that represents the boundary of an adjacent parking space or the obstacle within the driving path

3.7
manual driving
manoeuvre where the driver is in control of longitudinal and lateral movement of the vehicle and which corresponds to SAE Level 0 (no automation)

3.8
assisted parking system
APS
system which supports the driver during parking by controlling the lateral movement/steering of the vehicle and which corresponds to SAE Level 1 (Driver Assistance)

Note 1 to entry: See ISO 16787 for further information on APS.

3.9
partially automated parking system
PAPS
system which supports the driver during parking by controlling both the longitudinal and lateral movement of the vehicle and which corresponds to SAE Level 2 (Partial Automation)

Note 1 to entry: See ISO 20900 for further information on PAPS.

3.10
parking
parking in
manoeuvring into a parking space

3.11
leaving
parking out
manoeuvring out of a parking space

3.12
object
item representing any kind of thing or creature

3.13
obstacle
object in or close to the driving path of the subject vehicle (SV) which is deemed to be collision-relevant

Note 1 to entry: All vulnerable road users are considered as collision-relevant obstacles if they are in or close to the SV driving path.

Note 2 to entry: It is assumed that an obstacle can either be damaged by the SV or has a certain size which can cause damages to the SV within the situation of a collision.

3.14
toddler target
TT
test device representing a two-year-old toddler according to ISO/TS 19206-9:—[1)], used for testing ABLS

4 Basic system functionality

The ABLS function shall avoid or mitigate a collision during low-speed manoeuvring (LSM). The risk of a collision is determined based on the detection of objects. If necessary, the ABLS function automatically initiates braking to avoid or to mitigate a collision. If the driver does not intervene to override the function, ABLS continues the braking until the vehicle comes to a full stop.

This document concerns the achievement of collision avoidance via deceleration of the subject vehicle (SV) regardless of the specific braking method. Evasive steering intervention to avoid a collision is not considered within this document.

4.1 Operating conditions

The ABLS function shall be active during LSM [manoeuvring at or under 2,8 m/s (10 km/h)] regardless of the applied steering angle. If the vehicle velocity exceeds the upper limit, $v_{standby}$, specified by the manufacturer, the ABLS function shall no longer be active. The ABLS function may only be activated if an LSM event is detected. It is the responsibility of the manufacturer to identify criteria for an LSM event.

ABLS shall always be automatically activated without driver initiation.

The ABLS function may be deactivated by the driver. It is the responsibility of the manufacturer to determine a procedure for deactivation of the function. However, the procedure shall be designed to prevent an unintentional deactivation of ABLS function.

It shall be possible for the driver to override the ABLS function at any time. The specific detection and realization of an intended driver overriding intervention is not defined within this document and is left to the manufacturer's discretion.

The state transition of the ABLS function is shown in Figure 1.

The vehicle operator's handbook (owner's manual) should include an advisory note that clearly indicates the system availability conditions.

1) Under preparation. Stage at the time of publication: ISO/AWI TS 19206-9:2023.

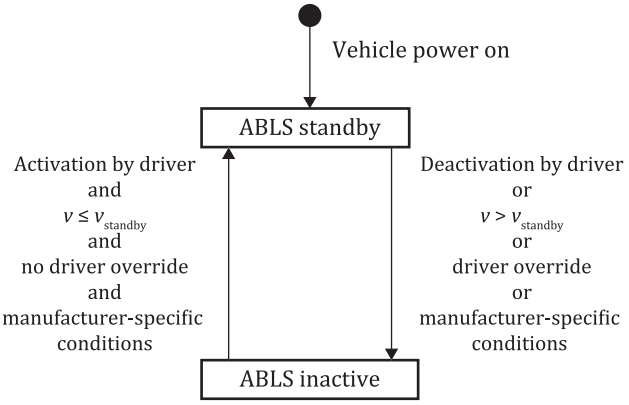


Figure 1 — State transition diagram of the ABLS function

4.2 Classification of ABLS

4.2.1 ABLS types

4.2.1.1 General

ABLS is classified into three types based on how the vehicle is being controlled prior to the activation of the ABLS function.

4.2.1.2 Type A — manual driving mode

ABLS type A is active during the manual driving of the vehicle. The longitudinal and lateral movement of the vehicle is under the control of the driver. This type of manoeuvring control corresponds to SAE Level 0.

4.2.1.3 Type B — assisted parking mode

ABLS type B is active when an SAE Level 1 parking automation system is engaged. The longitudinal movement is controlled by the driver. The lateral motion control is provided by the SAE Level 1 parking automation system and may be implemented in accordance with ISO 16787, for example.

4.2.1.4 Type C — partially-automated parking mode

ABLS type C is active when an SAE Level 2 parking automation system is engaged. Both longitudinal and lateral movement are provided by the SAE Level 2 parking automation system. This type of manoeuvring control corresponds to SAE Level 2 parking automation and may be implemented in accordance with ISO 20900.

4.2.2 Performance classification

4.2.2.1 General

The following ABLS performance classifications reflect the diversity of performance levels. Each ABLS type is split into the classes "base" and "enhanced", which represent a base performance that a driver can expect from all ABLS functions and an enhanced performance.

4.2.2.2 Class "base"

The performance class "base" represents the minimum requirements for ensuring a basic ABLS performance level for all three types (A, B, and C). The class "base" mainly aims to prevent collisions with stationary objects.

The type "class A base" only covers reverse driving and is separated into “object” and “pedestrian” variants reflecting the diversity of state-of-the-art systems in the market. The scope of the “object” variant is to avoid or mitigate collisions with static obstacles such as poles and vehicles. The scope of the “pedestrian” variant is to avoid or mitigate collisions with stationary pedestrians. A combination of these two variants is possible.

4.2.2.3 Class "enhanced"

The performance class "enhanced" provides additional characteristics which lead to an improved collision avoidance performance in other LSM conditions. In addition to the base performance, the class "enhanced" includes an improved collision avoidance performance for moving objects in all movement directions of the LSM system in use, for example (see Table 1).

4.2.3 ABLS classification overview

Based on the types and performance classes of ABLS, different combinations of system characteristics are possible reflecting the range of system use cases. An overview of these use cases is shown in Table 1. More detailed performance requirements are described in Clause 6. The test requirements in 6.6 for the minimal performance of all types and classes are derived from the use cases in Table 1 and the performance requirements in Clause 5.

Different kinds of ABLS systems may be implemented within one vehicle. For example, an ABLS type A1 pedestrian for manual driving and an ABLS type C2 for partially-automated parking may be available within one vehicle.

NOTE The class "enhanced" always includes all performance requirements of the class base.

The vehicle user’s manual (owner’s manual) should include an advisory note that clearly indicates what kind of ABLS system is implemented, including the driver’s responsibility and limitations of the system.

Table 1 — ABLS classification overview

Type	Class	Variant	Objects addressed	Object movement	Moving direction
A1	base	object	objects	stationary	reverse
A1	base	pedestrian	pedestrian	stationary	reverse
A2	enhanced	n.a.	objects+pedestrian	stationary+moving	reverse+forward
B1	base	n.a.	objects+pedestrian	stationary	design specific[a]
B2	enhanced	n.a.	objects+pedestrian	stationary+moving	design specific[a]
C1	base	n.a.	objects+pedestrian	stationary	design specific[a]
C2	enhanced	n.a.	objects+pedestrian	stationary+moving	design specific[a]

[a] Direction of movement depends on the design of the LSM function supported by ABLS.

n.a. = non-applicable

4.3 Principle of operation

4.3.1 General

The OEDR (object and event detection and response) of ABLS contains the following elements for performing the vehicle manoeuvre:

— object detection;

— situation evaluation;

— brake activation.

4.3.2 Object detection

ABLS functions use surround sensors to detect objects around the SV as well as their position and velocity relative to the SV. This document does not endorse or prescribe any sensor technology. Therefore, the sensing technology utilized is not specified.

4.3.3 Situation evaluation

Based on the information provided by object detection, the ABLS function "situation evaluation" evaluates the risk of an imminent collision with the object within the driving path. The situation evaluation also decides whether or not the SV can overrun the object (for example, in the case of a speedbump) without damaging the SV or harming the object. If the object is considered as collision-relevant, the situation evaluation triggers a braking activation.

4.3.4 Braking activation

Based on the results of the situation evaluation, the braking activation executes a deceleration of the SV to avoid the collision. ABLS brakes, bringing the vehicle to a complete standstill, and keeps the vehicle stationary until the driver authorizes the deactivation of the ABLS function or ABLS automatically requests it (see 5.4).

4.4 Information to the driver

The ABLS function warns the driver about a potential collision via an acoustical and/or visual signal prior to the braking intervention to gain the driver's attention. In situations where a prompt braking activation is required, the alert signal may be provided in parallel to the brake activation.

The driver is immediately informed about each ABLS braking activation conducted via a visual and either an acoustical or haptic signal where the brake jerk may be recognized as a haptic signal.

5 Function and performance requirements for ABLS

5.1 General

The ABLS function is intended to avoid or mitigate collisions during LSM, thereby avoiding or mitigating injuries of humans and any kind property damages. Due to technical system limitations it is not achievable to detect all objects under all environmental conditions. It is recommended to include an advisory note in the vehicle operator's handbook (owner's manual) that clearly indicates the system limitation.

5.2 Situations addressed

ABLS shall be active according to the conditions in 4.1 during LSM SAE Level 0 (type A, manual manoeuvring), LSM SAE Level 1 (type B, assisted parking) or LSM SAE Level 2 (type C, partially-automated parking).

Depending on the specific functionality offered by the manufacturer, ABLS addresses different situations. These may include following examples.

Type of parking space:

— parallel parking limited by vehicles or ground markings;

— perpendicular parking limited by vehicles or ground markings;

— garage parking.

Type of manoeuvre:

— entering the parking space (parking in, forward/backward);

— leaving the parking space (parking out, forward/backward).

Driver position (for L2 systems only, e.g. PAPS):

— driver in the driver seat;

— driver outside the vehicle in near range (remote parking).

5.3 Perception requirements

The system shall detect collision relevant objects in or close to the driving path according to the requirements of the different classes in Table 1. Addressed obstacles are:

— stationary pedestrians;

— static objects (e.g. parked vehicle, road signs, walls, pillars);

— slow-moving obstacles up to 1,4 m/s (5 km/h) (e.g. walking pedestrians).

The ABLS function is not required to (but may optionally) address situations with objects such as:

— fast-moving objects above 1,4 m/s (5 km/h) (e.g. moving cyclists, motorbikes, other vehicles);

— objects which are not collision-relevant for specific vehicles (e.g. curb stones, stones, bottles);

NOTE As the relevance of collision depends on the characteristics (e.g. shape, material, height) of the vehicle and the object, this document does not provide a specific definition.

— overhanging objects which have no contact point with the ground in the driving path.

5.4 Vehicle motion control requirements

In situations according to 5.2 and 5.3, the vehicle motion control (VMC) requests a brake activation to bring the vehicle to standstill to avoid or mitigate a collision with the obstacle. ABLS may activate at an earlier point in time that ensures a safety distance to the object at standstill. The definition of the safety distance is left to the discretion of the original equipment manufacturer (OEM).

After the vehicle comes to standstill, the VMC shall continue to hold the brakes to avoid further movement of the vehicle until the driver authorizes the release of the hold (for example, by pushing the accelerator pedal), or until the function releases the standstill automatically in the case that a collision is no longer imminent or when another OEM-defined condition is reached. In case of automatic release, it is recommended to inform the driver. The releasing action such as acceleration by the driver and the information message in case of automatic release are not defined within this document and are left to the manufacturer's discretion.

5.5 Function flow

Based on the information in the previous subclauses, the function flow of the ABLS function is described in Figure 2.

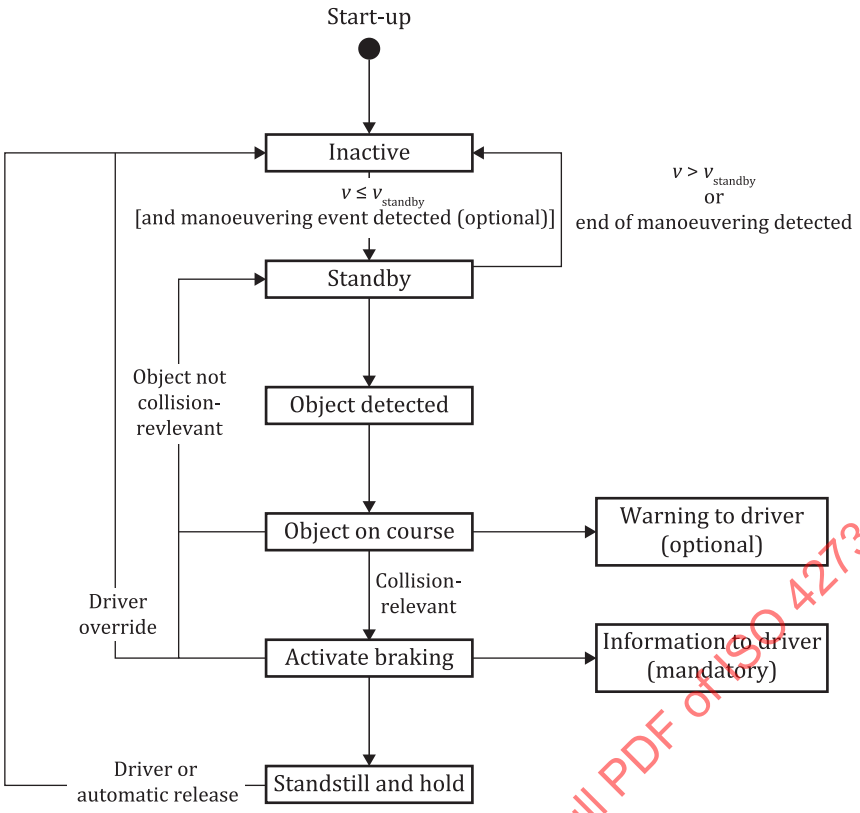


Figure 2 — Function flow of the ABLS function

6 Performance test requirements

6.1 General

This clause specifies the minimum requirements for performance testing of the ABLS function. The performance tests and criteria are separated for the different ABLS types and classes.

6.2 Environmental conditions

The environmental conditions during the tests shall fulfil the following criteria.

— The wind speed does not exceed 5 m/s during testing.

— Temperature during testing is between 5 °C and 30 °C. (The performance test can be conducted below 5 °C or above 30 °C. However, if the system fails, the test is repeated under the conditions specified above to prove conformance.)

— Non-precipitating conditions (not raining, sleeting, snowing, etc.).

— Testing is conducted on a flat, dry, smooth, uniform and paved surface.

— The surface is free of any elements such as drainages or rails and irregularities such as dips or large cracks.

— Any kind of elevated objects (e.g. walls, auxiliary test equipment, and other non-test objects) are removed from the test area in order to eliminate interference caused by their reflections (sonic and/or electromagnetic).

— The minimum illuminance is 2 000 lx.

— Sensors used for object detection are cleaned prior to testing.

6.3 Boundary of parking space

The parking space shall be bounded by parked vehicles (PVs) which are typical high-volume production passenger cars of a similar size to the subject vehicle (SV). Either a real or a surrogate vehicle can be used as the PV.

6.4 Test object

For ABLS performance testing with VRUs and other road users, objects are utilized according to the ISO 19206 series. As an object representing the infrastructural objects, this document applies a pole as defined in ISO 17386.

VRUs shall be represented by a child pedestrian target as defined in ISO 19206-2. As a toddler is one of the most vulnerable objects within low-speed scenarios, particularly due to the high risk of low visibility during parking, a toddler target (TT) with a height of 0,80 m as defined in ISO 19206 series will be used in this document. The reference point for the position is the H-point as defined in ISO19206-2:2018, Annex A, and the outermost point of the respective arm (see Figure 3).

6.5 General test criteria

The criterion “no-contact” is defined, specifying that the distance between any part of the SV and any part of the obstacle is greater than 0 m throughout the test procedure. The test run is rated as passed if "no-contact" occurred during the test manoeuvre. If the distance is 0 m, the test run is rated as failed.

The test run criterion “*n* out of *m*” is defined so that *n* test runs in a continuous sequence of *m* test runs shall be completed with the result “no-contact”. The sequence shall be performed without an interruption in order to maintain the same conditions as far as possible. If the first *n* runs were successful, then the sequence of test runs can be stopped.

It shall be ensured that the stationary obstacles are stable during the testing, so that the obstacle or parts of the obstacle are not moving towards or away from the vehicle, in order to avoid contact between the obstacle and the SV caused by the movement of the obstacle (e.g. “toppling”). Dynamic obstacles like the moving VRU shall not move significantly to any other direction than that intended. If the test run cannot be performed correctly, it shall be repeated.

6.6 Test procedure and criteria

6.6.1 Overview

In this clause, performance test procedures and passing criteria for ABLS are described. The performance test procedures are separated according to the base and enhanced ABLS classification.

As the ABLS function may be activated according to a defined condition as described in 4.1, the necessary procedure for activation shall be carried out before starting the test manoeuvre.

A tolerance of ±0,05 m shall be met for all stationary object positions that are used throughout the test procedures. For moving objects, a tolerance of ±0,1 m is allowed.

6.6.2 Performance test for type A

6.6.2.1 Overview

As type A addresses manually-driven manoeuvres, the test driver is in control of longitudinal and lateral control inputs to the vehicle. It is the driver’s task to maintain the requested velocity and to keep the vehicle on the requested trajectory during the manoeuvre.

The performance test of type A is completed if one of the following conditions is fulfilled.

a) ABLS stops the movement of the vehicle.

b) The SV collides with the obstacle.

During the test procedure, the velocity of the vehicle shall be recorded with a resolution of at least 0,05 m/s.

The driver shall control the velocity and the trajectory. No other activities of the driver shall be necessary. The driver shall not intervene to prevent a collision with the obstacle. An intervention of the driver (e.g. braking) is only allowed if a collision has occurred and the driver is attempting to prevent further damage to the obstacle. If the driver intervenes to prevent a contact at any time before the collision occurred, the test is rated invalid and shall be repeated.

6.6.2.2 Test procedure type A base (A1)

6.6.2.2.1 General

During the manoeuvre, the vehicle is reversing with a straight trajectory towards the obstacle located in the driving path. The obstacles used are stationary.

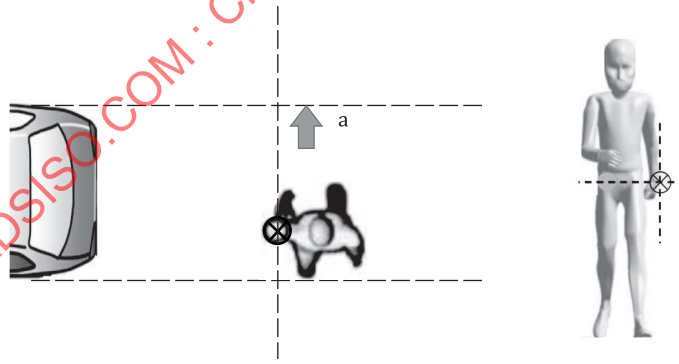
6.6.2.2.2 Stationary pole and pedestrian

For the class "Type A2 object", the obstacle “pole” (see 6.4) is used.

For class “Type A1 pedestrian”, the obstacle "TT" (toddler target; see 6.4) is used.

The obstacle is located in a lateral position x = 25 % and x = 50 % in relation to the SV width within the driving path, as shown in Figure 4. The reference point for the position is the H-point as defined in ISO19206-2:2018, Annex A, and the outermost point of the respective arm. It is left to the tester’s discretion to orientate the object position to the left or right side of the vehicle.

For position 25 %, the gaze of the TT shall be directed to the middle of the driving path (see Figure 3). For position 50 % the gaze is left to the tester’s discretion.

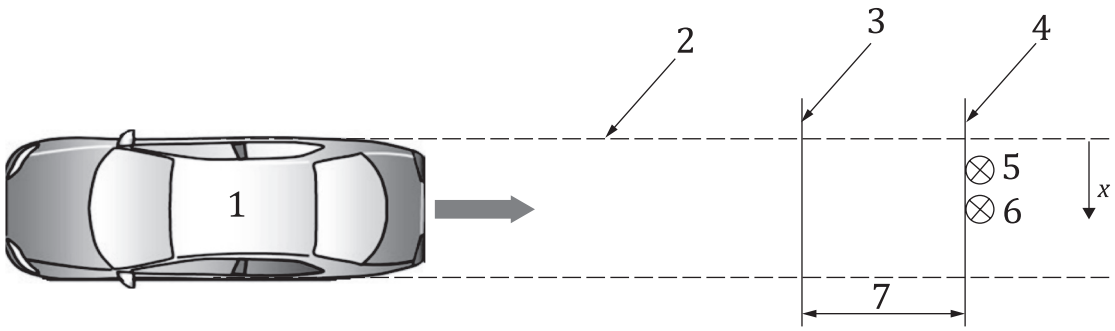


Key

a Direction of gaze.

Figure 3 — Positioning of pedestrian (example position 25 %)

The vehicle shall approach the obstacle with a constant reversing velocity of 1,11 m/s (4 km/h) with a tolerance of +0,28 m/s (+1 km/h). This velocity shall be reached and maintained steady at least 3 m in front of the obstacle (Figure 4: distance 7). The distance used to accelerate and stabilize the velocity before the final phase of 3 m is left to the tester’s discretion.



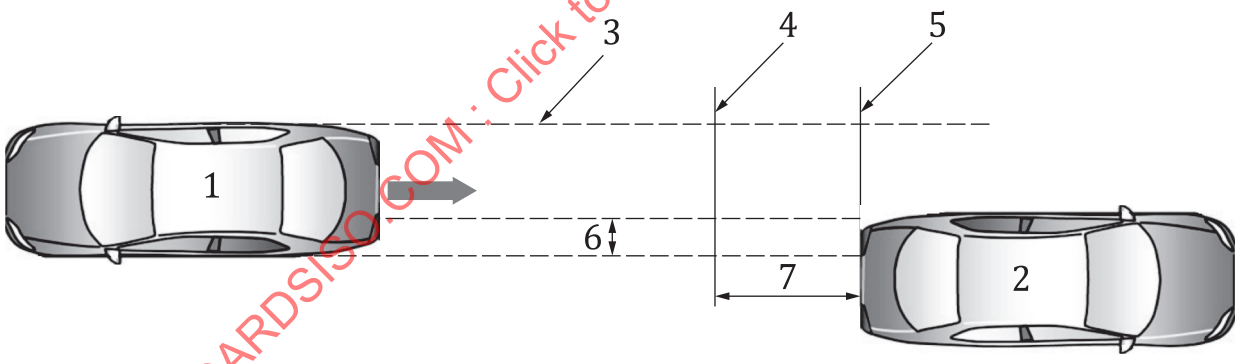
Key

1 SV
2 outline of SV without mirrors
3 position where steady velocity is reached
4 object position
5 object position, x = 25 % in relation to the SV width
6 object position, x = 50 % in relation to the SV width
7 distance (= 3 m) to object/pedestrian from the point where steady velocity is reached

Figure 4 — Definition for backwards driving manoeuvre with object or pedestrian

6.6.2.2.3 Overlapping vehicle

For the class "Type A1 object", a PV test target is used as an obstacle to test the ABLS function. It is positioned with an overlap of 40 cm, as shown in Figure 5, facing with the rear end to the SV. The PV's position with respect to the SV (left or right side) is left to the tester's discretion. All other conditions of the test procedure are used as described in the previous subclauses.



Key

1 SV
2 PV
3 outline of SV without mirrors
4 position where steady velocity is reached
5 rear-end of PV
6 PV-SV overlap (= 0,4 m)
7 distance (= 3 m) to PV from the point where steady velocity is reached

Figure 5 — Definition for backwards driving manoeuvre with PV

Each of the test runs shall be repeated three times with pole and vehicle. Test with pedestrians shall be repeated five times. Overall, the test procedure of ABLS classification A1 consists of the following test runs.

— Type A1 object: pole position 25 % and 50 % of the SV width.

— Type A1 object: vehicle overlap.

— Type A1 pedestrian: TT position 25 % and 50 % of the SV width.

6.6.2.3 Test criteria type A base (A1)

Each test run is rated according to 6.5. Based on the results of the test runs, the overall rating for type A1 is defined according to Table 2. Tests should only be performed for the corresponding class.

Table 2 — Test criteria for type A1

Type	Test specification	Pass criteria
A1 object	Pole 25 %	2 out of 3 passed
A1 object	Pole 50 %	2 out of 3 passed
A1 pedestrian	TT 25 %	4 out of 5 passed
A1 pedestrian	TT 50 %	4 out of 5 passed
A1 object	Vehicle 40 cm	2 out of 3 passed

6.6.2.4 Test procedure type A enhanced (A2)

6.6.2.4.1 General

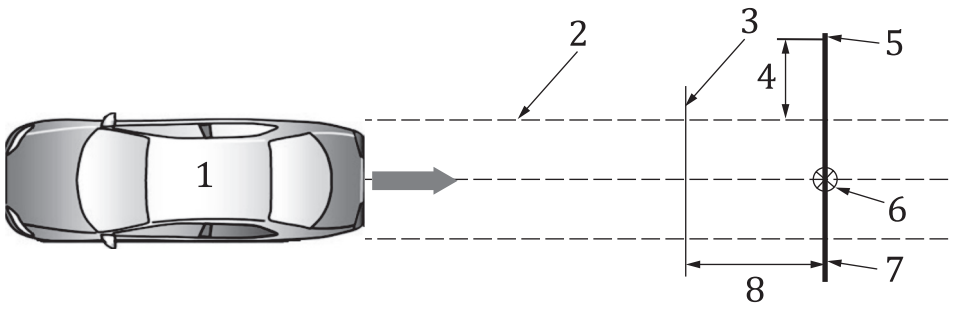
For type A enhanced, additional test procedures are required as the performance requirements are higher compared to type A base. The test procedure A2 includes all of the tests necessary for test procedure A1 and in addition, curve driving, forward manoeuvring and utilization of a dynamic VRU object.

6.6.2.4.2 Dynamic toddler target

For the dynamic TT test procedure, the vehicle is reversing with a straight trajectory towards the object which is moving into the driving path of the vehicle.

The vehicle shall approach the obstacle with a constant reversing velocity of 8 km/h with a tolerance of +0,28 m/s (+1 km/h). This velocity shall be reached and kept steady at least 5 m in front of the obstacle. The acceleration phase is left to the tester's discretion.

The TT is used as the test object. It is moved on an orthogonal trajectory to the SV driving path as shown in Figure 6 with a velocity of 1,4 m/s (5 km/h) with a tolerance of ±0,14 m/s (±0,5 km/h). The starting point on the left or right side of the SV is left to the tester's discretion. The movement shall be synchronized to the movement of the vehicle, so that the intended collision point without ABLS activation is at the middle of the vehicle. The starting point of the object shall be at least 1 m outside the driving path.



Key

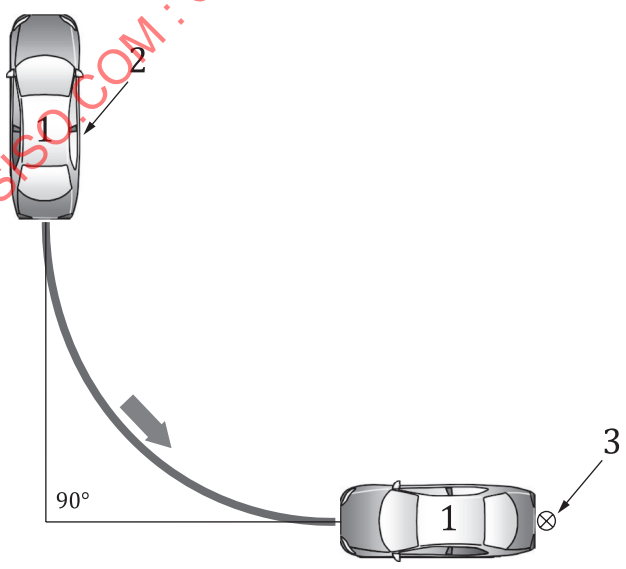
1 SV
2 outline of SV without mirrors
3 position for steady velocity
4 distance to starting point of TT from 2 (= 1 m)
5 starting point of TT
6 position of collision
7 trajectory of TT
8 distance (= 5 m) to object for steady velocity

Figure 6 — Definition of dynamic VRU manoeuvre

6.6.2.4.3 Backward curve driving

For this test procedure the SV approaches the object along a curved trajectory while moving backwards.

The SV starts at an orthogonal position in relation to the SV orientation at the intended collision point as shown in Figure 7. The steering wheel shall be turned to the maximum possible angle and kept in this position. The vehicle shall move backward with a velocity of 0,6 m/s – 0,8 m/s (2 km/h – 3 km/h). The driver shall try to keep the velocity as constant as possible within the limits. The pole is used as a test object. It is positioned so that the collision point would be in the middle of the driving path.



Key

1 SV
2 starting position of SV
3 position of object

Figure 7 — Definition of backward curve manoeuvre

A recommended procedure for performing the preparation of the test is described in Annex A.

The driver shall control the velocity (gas/brake pedal and gear). The steering wheel shall be kept in the position of maximal angle. No other activities of the driver shall be necessary.

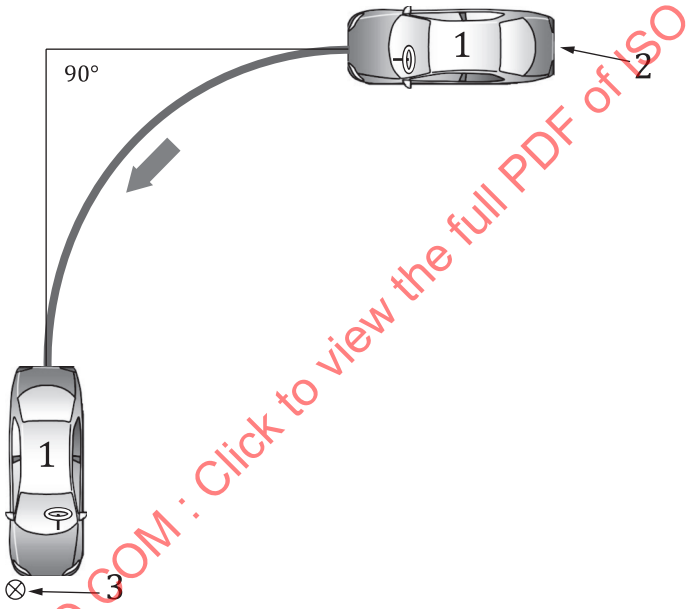
6.6.2.4.4 Forward curve driving

During this manoeuvre, the vehicle approaches the obstacle along a curved trajectory while moving forward.

The SV starts at an orthogonal position in relation to the SV orientation at the intended collision point as shown in Figure 8. The steering wheel shall be turned to the maximum possible angle and kept in this position. The vehicle shall move forward with a velocity of 0,6 m/s – 0,8 m/s (2 km/h – 3 km/h). The driver shall try to keep the velocity as constant as possible within the limits.

The pole is used as the test object. It is positioned so that the intended collision point is at a position of 80 % of the vehicle width (see 6.6.2.2.2 for position definition) on the outside of the curve.

For left-handed and right-handed vehicles, the curve direction shall be adapted, so that the position of the obstacle is on the opposite side to the driver seat (outside of the curve).



Key

1 SV
2 starting position of SV
3 position of object

Figure 8 — Definition of forward curve driving (case of left-hand-side steering wheel vehicle)

A recommended procedure for performing the preparation of the test is described in Annex A.

The driver shall control the velocity (gas/brake pedal and gear). The steering wheel shall be kept in the position of maximal angle. No other activities shall be necessary for the driver.

6.6.2.5 Test criteria type A enhanced (A2)

Each test run is rated according to 6.5. Based on the results of the test runs, the overall rating for type A2 is defined according to Table 3.

Table 3 — Test criteria for type A2

Test specification	Pass criteria
Test result type A1	passed
Dynamic VRU	4 out of 5 passed
Backward curve driving	2 out of 3 passed
Forward curve driving	2 out of 3 passed

6.6.3 Performance test for type B

6.6.3.1 General

The ABLS type B system addresses LSM SAE Level 1, such as assisted parking systems (APS) supporting the driver during parking manoeuvres.

For type B performance testing, the typical standard parking scenarios offered by a specific APS are tested:

— parallel parking space – parking back in manoeuvre;

— perpendicular parking space – parking back in manoeuvre.

The parking space dimensions shall be as defined in ISO 20900:2023, 5.1.

The parking manoeuvres shall be selected according to the parking scenarios of the vehicle. All functions that are offered by the vehicle and are listed in this subclause shall be tested. If the APS is only capable of performing a subset of the above-mentioned manoeuvres, the test procedure shall be reduced to these manoeuvres (e.g. only parallel parking space).

The performance test of type B is completed if one of the following conditions is fulfilled:

a) the APS function completes or aborts the parking manoeuvre indicated via a message to the driver;

b) the SV collides with the obstacle;

c) the APS function does not offer the parking space to the driver after the parking space search;

d) the APS function does not allow the activation of the parking manoeuvre after the parking space search.

Condition c) is only applicable for manoeuvres where the object is placed at the intended position before the SV passes the parking spot to search and identify a suitable parking space.

During the test procedure, the velocity shall be controlled by the driver in the range of 0,83 m/s + 0,28 m/s (3 km/h + 1 km/h). No other activities of the driver shall be necessary. The driver shall not intervene to prevent a collision with the object. An intervention of the driver (e.g. braking) is only allowed if a collision has occurred and the driver is attempting to prevent further damage to the obstacle. If the driver intervenes to prevent contact at any time before the collision occurred, the test is rated invalid and shall be repeated. The velocity shall be recorded with a resolution of at least 0,05 m/s.

6.6.3.2 Test procedure type B base (B1)

For type B base, the same test manoeuvres shall be performed as those described in 6.6.4.1 (type C1 for entering the parking space). Leaving manoeuvres are not addressed as they are not typical manoeuvres for APS systems. For type B1 performance testing, the following scenarios are used:

— entering a parallel parking space with stationary pole and TT;

— entering a perpendicular parking space with stationary pole and TT.

6.6.3.3 Test criteria type B base (B1)

Each test run is rated according to 6.5. Based on the results of the test runs, the overall rating for type B1 is defined according to Table 4.

Table 4 — Test criteria for type B1

Test specification	Pass criteria
Parallel parking pole	2 out of 3 passed
Parallel parking TT	4 out of 5 passed
Perpendicular parking pole	2 out of 3 passed
Perpendicular parking TT	4 out of 5 passed

6.6.3.4 Test procedure type B enhanced (B2)

For type B enhanced, the same test manoeuvres shall be performed as described in 6.6.4.3 (type C1 for entering the parking space). Leaving manoeuvres are not addressed as these are not typical manoeuvres for APS systems. For type B2 performance testing the following scenario is used:

— entering a parallel parking space with dynamic TT.

6.6.3.5 Test criteria type B enhanced (B2)

Each test run is rated according to 6.5. Based on the results of the test runs, the overall rating for type B2 is defined according to Table 5.

Table 5 — Test criteria for type B2

Test specification	Pass criteria
Test result type B1	passed
Parallel parking dynamic TT	4 out of 5 passed

6.6.4 Performance test for type C

As type C addresses LSM SAE Level 2 (e.g. partially-automated parking manoeuvres), longitudinal and lateral movements are controlled by the vehicle.

For type C performance testing, the following parking scenarios are being used:

— parallel parking space – parking manoeuvre;

— perpendicular parking space – parking manoeuvre;

— perpendicular parking space – leaving manoeuvre.

The parking space dimensions shall be as defined in ISO 20900:2023, 5.1.

The parking and leaving manoeuvres shall be selected according to the parking scenarios of the vehicle. All functions that are offered by the vehicle and are listed in this subclause shall be tested.

If the PAPS is only capable of performing a subset of the above-mentioned manoeuvres, the test procedure shall be reduced to these manoeuvres.

The performance test of type C is completed if one of the following conditions is fulfilled:

a) the PAPS function completes or aborts the parking manoeuvre indicated via a message to the driver;

b) the SV collides with the obstacle;

c) the PAPS function does not offer the parking space to the driver after the parking space search;

d) the PAPS function does not allow the activation of the parking/leaving manoeuvre after the parking space search;

e) the PAPS function stopped the movement of the vehicle and does not continue for a time period of 180 s, without any message to the driver. In this case, the test run is rated as not completed and shall be repeated.

Condition c) is only applicable for manoeuvres where the obstacle is placed at the intended position before the SV passes the parking spot to search and identify a suitable parking space.

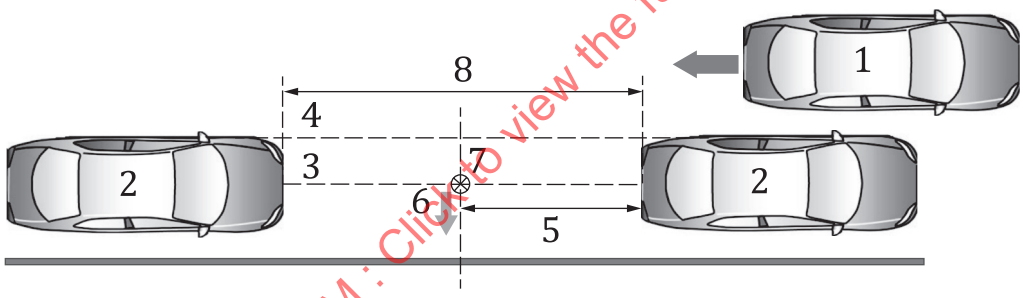
During the test procedure, the velocity of the vehicle shall be recorded with a resolution of at least 0,05 m/s.

After activating the parking manoeuvre, the driver shall not intervene at any time and especially not to prevent a collision with the obstacle. An intervention of the driver (e.g. braking) is only allowed if a collision has occurred and the driver is attempting to prevent further damage to the obstacle. If the driver intervenes to prevent a contact at any time before the collision actually occurs, the test is rated invalid and shall be repeated.

6.6.4.1 Test procedure type C base (C1)

6.6.4.1.1 Parking manoeuvre with stationary obstacle

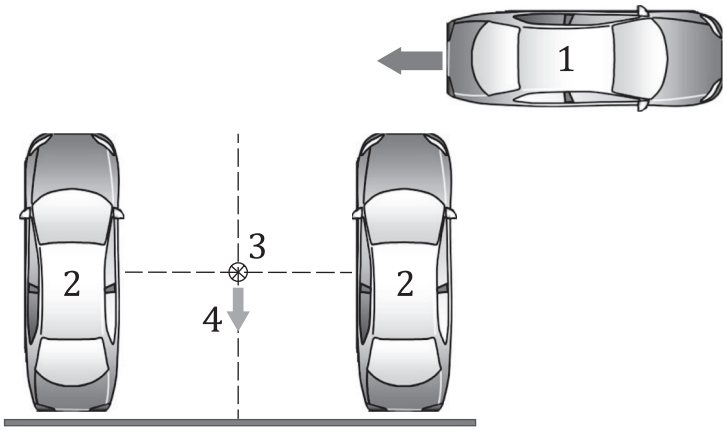
The pole and TT are used as obstacles for these performance tests. The position of both obstacles is in the centre of the parking space as shown in Figure 9 and Figure 10. The pole is put in place before the SV passes by the parking space in search of a parking spot. The TT is placed after passing by the parking space, but before activating the parking manoeuvre.



Key

1 SV
2 PV
3 centre line of PVs
4 left outline of PV without mirrors
5 distance of object to front PV (= ½ length of distance between PVs)
6 gaze of the TT
7 position of object
8 length of parking space according to ISO 20900:2023, 5.1

Figure 9 — Definition of parallel parking manoeuvre C1



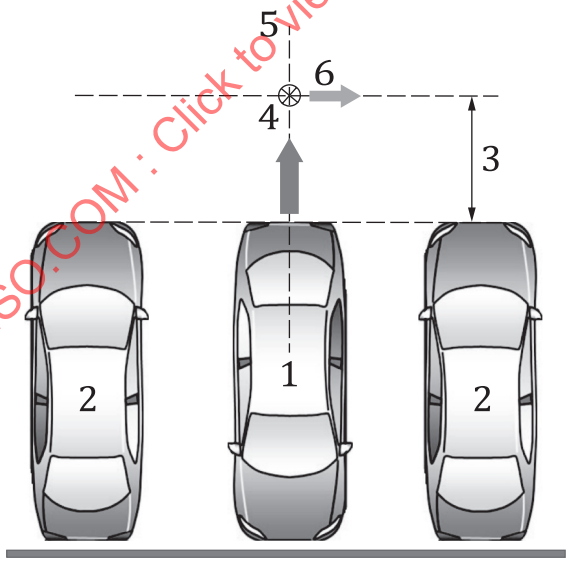
Key

1 SV
2 PV
3 position of object
4 gaze of the TT

Figure 10 — Definition of perpendicular parking manoeuvre C1

6.6.4.1.2 Leaving manoeuvre with stationary obstacle

In addition to the parking manoeuvre, the leaving manoeuvre is tested. The pole and TT are used as obstacles for these performance tests. Both objects shall be positioned at 50 % of the SV and at a distance of 1,5 m behind the PV as shown in Figure 11. The objects shall be positioned before activating the manoeuvre.



Key

1 SV
2 PV
3 distance of object from the front end of the PVs
4 position of object
5 centreline of SV
6 gaze of TT

Figure 11 — Definition of perpendicular leaving manoeuvre C1