INTERNATIONAL STANDARD

ISO 17387

First edition
2008-05-01

Intelligent transport systems — Lane change decision aid systems (LCDAS) — Performance requirements and test procedures

Systèmes intelligents de transport — Systèmes d'aide à la décision de changement de voie — Exigences de performances et méthodes d'essai

Reference number
ISO 17387:2008(E)

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Published in Switzerland

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Foreword

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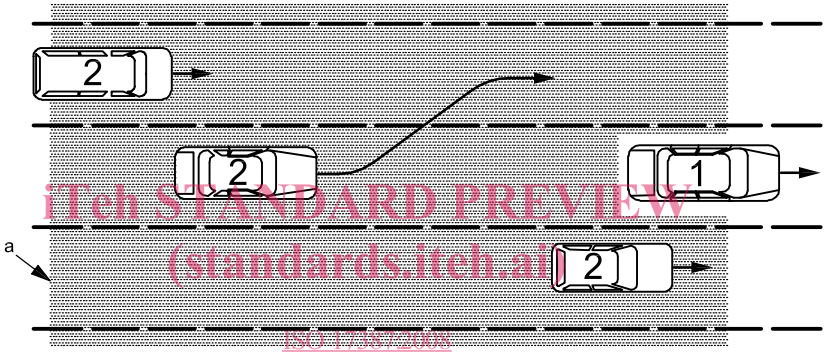
Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 17387 was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

Introduction

Lane Change Decision Aid Systems (LCDAS) warn the driver against collisions that may occur due to a lane change manoeuvre. LCDAS are intended to supplement the vehicle's interior and exterior rear-view mirrors, not eliminate the need for such mirrors. LCDAS are intended to detect vehicles to the rear and sides of the subject vehicle (see Figure 1). When the subject vehicle driver indicates the desire to make a lane change, the system evaluates the situation and warns the driver if a lane change is not recommended. LCDAS are not meant to encourage aggressive driving. The absence of a warning will not guarantee that the driver can safely make a lane change manoeuvre. The system will not take any automatic action to prevent possible collisions. Responsibility for the safe operation of the vehicle remains with the driver.

NOTE Many figures in this document show vehicles on roadways with lane markings. This is not meant to imply that lane marking recognition or lane detection is required for an LCDAS. The lane markings are drawn for reference only.



Key

1 subject vehicle

2 target vehicles

[a] The shaded area illustrates the concept of one possible system. The actual requirements are given in Clause 4.

Figure 1 — LCDAS concept

Intelligent transport systems — Lane change decision aid systems (LCDAS) — Performance requirements and test procedures

1 Scope

This International Standard specifies system requirements and test methods for Lane Change Decision Aid Systems (LCDAS). LCDAS are fundamentally intended to warn the driver of the subject vehicle against potential collisions with vehicles to the side and/or to the rear of the subject vehicle, and moving in the same direction as the subject vehicle during lane change manoeuvres. This standardization addresses LCDAS for use on forward moving cars, vans and straight trucks in highway situations.

This standardization does not address LCDAS for use on motorcycles or articulated vehicles such as tractor/trailer combinations and articulated buses.

2 Terms and definitions

For the purpose of this document, the following terms and definitions apply.

NOTE The figures illustrating the coverage zone definitions show the zone concept only. The actual requirements are given in 4.2.

2.1
subject vehicle
vehicle equipped with the system in question and related to the topic of discussion

2.2
LCDAS target vehicle
any vehicle that is closing in on the subject vehicle from behind, or any vehicle that is located in one of the adjacent zones

NOTE An LCDAS target vehicle is referred to as “target vehicle” in this document.

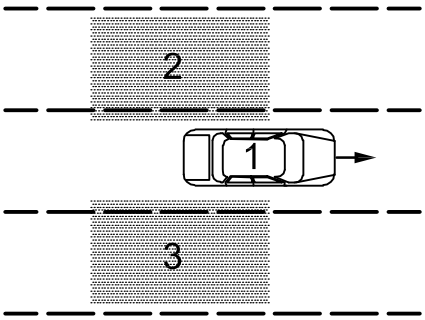
2.3
coverage zone
entire area to be monitored by an LCDAS, a system’s coverage zone consisting of a specific subset of the following zones: left adjacent zone, right adjacent zone, left rear zone and right rear zone

NOTE A target vehicle located within the coverage zone will thus be detected by the system.

2.4
adjacent zones
zones to the left and right of the subject vehicle

See Figure 2.

NOTE The adjacent zones are intended to cover the lanes adjacent to the subject vehicle. However, the position and size of the adjacent zones are defined with respect to the subject vehicle, and are independent of any lane markings.



Key

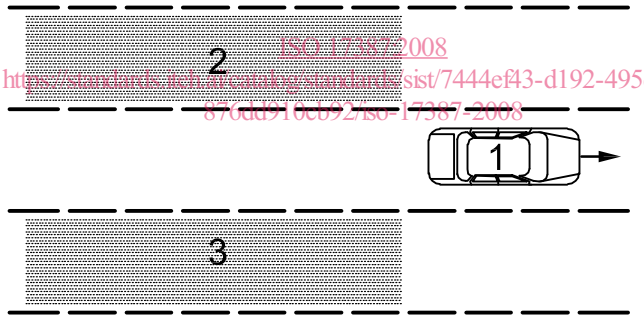
1 subject vehicle
2 left adjacent zone
3 right adjacent zone

Figure 2 — Adjacent zones

2.5
rear zones
zones that are behind and to the sides of the subject vehicle

See Figure 3.

NOTE The rear zones are intended to cover the lanes adjacent to the subject vehicle. However, the position and size of the rear zones are defined with respect to the subject vehicle, and are independent of any lane markings.



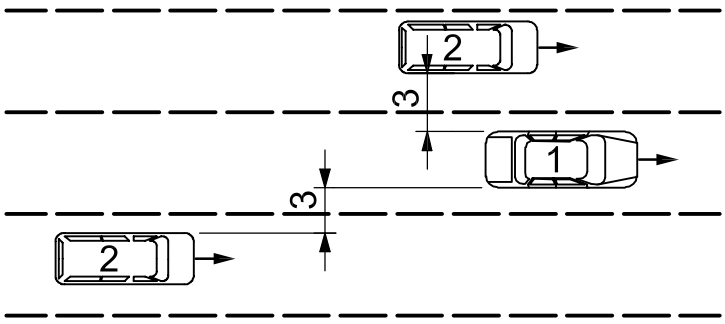
Key

1 subject vehicle
2 left rear zone
3 right rear zone

Figure 3 — Zones

2.6
lateral clearance
〈of a target vehicle〉 lateral distance between the side of the subject vehicle and the near side of a target vehicle

See Figure 4.



Key

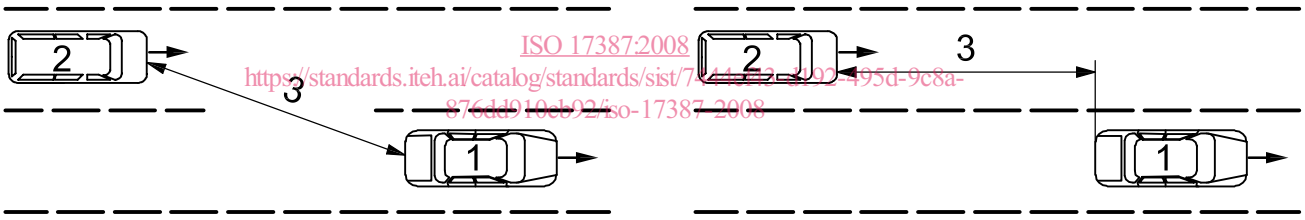
1 subject vehicle
2 target vehicle
3 lateral clearance

Figure 4 — Lateral clearance

2.7
rear clearance
⟨of a target vehicle⟩ distance between the rear of the subject vehicle and the front of the target vehicle as measured along a straight line, or optionally, as estimated along the target vehicle's estimated path

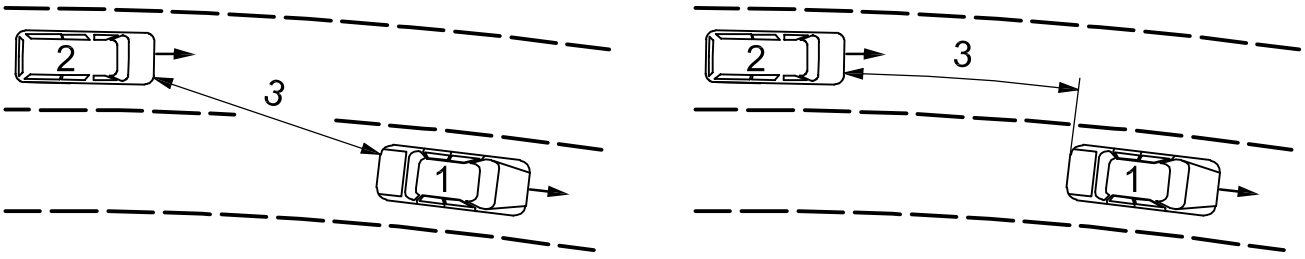
See Figures 5 a) to 5 d).

NOTE This definition applies to target vehicles in the rear zones only.



a) On a straight road measured along a straight line

b) On a straight road estimated along target vehicle path



c) On a curved road measured along a straight line

d) On a curved road estimated along target vehicle path

Key

1 subject vehicle
2 target vehicle
3 rear clearance

Figure 5 — Examples of rear clearance

2.8
closing speed
⟨of a target vehicle⟩ difference between the target vehicle's speed and the subject vehicle's speed

NOTE This definition applies to target vehicles in the rear zones only. A positive closing speed indicates that the target vehicle is closing in on the subject vehicle from the rear.

2.9
time to collision
estimated time that it would take a target vehicle to collide with the subject vehicle if the subject vehicle were in the target vehicle's path and the target vehicle's current closing speed remained constant

NOTE Time to collision can be estimated by dividing a target vehicle's rear clearance by its closing speed. This definition applies to target vehicles in the rear zones only.

2.10
overtaking speed
⟨of the subject vehicle⟩ difference between the subject vehicle's speed and the target vehicle's speed when the subject vehicle is overtaking the target vehicle

NOTE A positive overtaking speed indicates that the subject vehicle is moving faster than the target vehicle.

2.11
blind spot warning function
function that detects the presence of target vehicles in one or more of the adjacent zones and warns the subject vehicle driver in accordance with the requirements given in Clause 4

2.12
closing vehicle warning function
function that detects closing vehicles in one or more of the rear zones and warns the driver in accordance with the requirements given in Clause 4

2.13
lane change warning function
function that includes the blind spot warning function and the closing vehicle warning function

2.14
roadway radius of curvature
horizontal radius of curvature of the road on which the subject vehicle is travelling

3 Classification

3.1 Coverage zone classification

3.1.1 General

LCDAS are classified by the minimum required coverage as shown in Table 1; for example, a Type I system shall provide coverage of at least the left and right adjacent zones.

Table 1 — Coverage zone classification

Type	Left adjacent zone coverage	Right adjacent zone coverage	Left rear zone coverage	Right rear zone coverage	Function
I	X	X			Blind spot warning
II			X	X	Closing vehicle warning
III	X	X	X	X	Lane change warning

3.1.2 Type I systems

Type I systems provide the blind spot warning function only. These systems are intended to warn the subject vehicle driver of target vehicles in the adjacent zones. These systems are not required to provide warnings of target vehicles that are approaching the subject vehicle from the rear. The subject vehicle driver shall be made aware of the limitations of this type of system, at least in the owner's manual. In particular, the owner's manual shall include the following statement: "This system provides support only within a limited area beside the vehicle. The system may not provide adequate warning for vehicles approaching from the rear."

3.1.3 Type II systems

Type II systems provide the closing vehicle warning function only. These systems are intended to warn the subject vehicle driver of target vehicles that are approaching the subject vehicle from the rear. Because these systems are not required to provide warnings of target vehicles located adjacent to the subject vehicle, Type II systems are recommended for use on vehicles that have side mirrors with a horizontal field of view of at least 45° on both sides of the vehicle. If these systems are used on other vehicles, the owner's manual shall include the following statement: "The driver must turn and look into the adjacent area before attempting a lane change." The subject vehicle driver shall be made aware of the limitations of this type of system, at least in the owner's manual. In particular, the owner's manual shall include the following statement: "This system provides no support for the areas adjacent to the subject vehicle. This system may not provide adequate warning for very fast moving vehicles approaching from the rear."

3.1.4 Type III systems

Type III systems provide the blind spot warning function and the closing vehicle warning function. These systems are intended to warn the subject vehicle driver of target vehicles in the adjacent zones and target vehicles which are approaching the subject vehicle from the rear. The subject vehicle driver shall be made aware of the limitations of this type of system, at least in the owner's manual. In particular, the owner's manual shall include the following statement: "This system may not provide adequate warning for very fast moving vehicles approaching from the rear."

3.2 Target vehicle closing speed classification

3.2.1 General

LCDAS of Types II and III are classified by the maximum target vehicle closing speed and the minimum roadway radius of curvature as shown in Table 2. A system may belong to more than one of the types listed in Table 2. For example, a highly capable system may meet or exceed the minimum requirements defined individually for Types A, B and C.

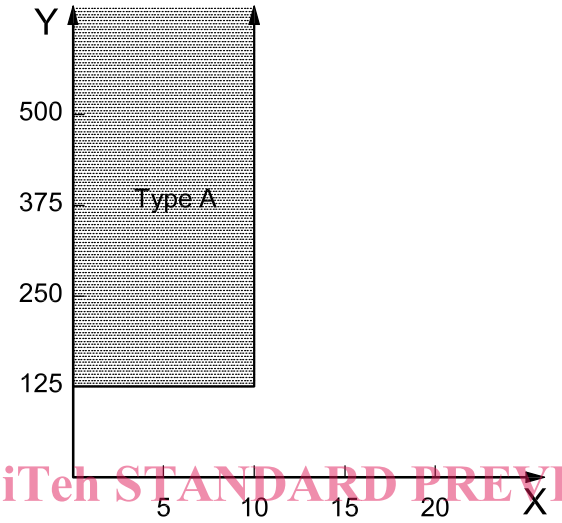
Table 2 — Target vehicle closing speed classification

Type	Maximum target vehicle closing speed m/s	Minimum roadway radius of curvature m
A	10	125
B	15	250
C	20	500

NOTE The maximum target vehicle closing speed has a direct effect on the required sensor range and/or acquisition time. A higher closing speed will require a longer sensor range and/or a shorter acquisition time in order to detect the target vehicle quickly enough to give the subject vehicle driver adequate warning. In addition, there is a relationship between the maximum target vehicle closing speed and the roadway radius of curvature. For a given curve radius and a typical subject vehicle speed, the closing speed of a target vehicle is limited by driving dynamics parameters.

3.2.2 Type A systems

Figure 6 shows the minimum required region of performance with regard to roadway radius of curvature and target vehicle closing speed for a Type A system. These systems may be capable of operating on curved roads with smaller radii. The subject vehicle driver shall be made aware of the limitations of the system, at least in the owner's manual. In particular, the owner's manual shall include the following statement: "This system may not provide adequate warning on curves tighter than X metres radius" where X is replaced by the tightest curve radius for which the system is designed but not more than 125 m.



Key

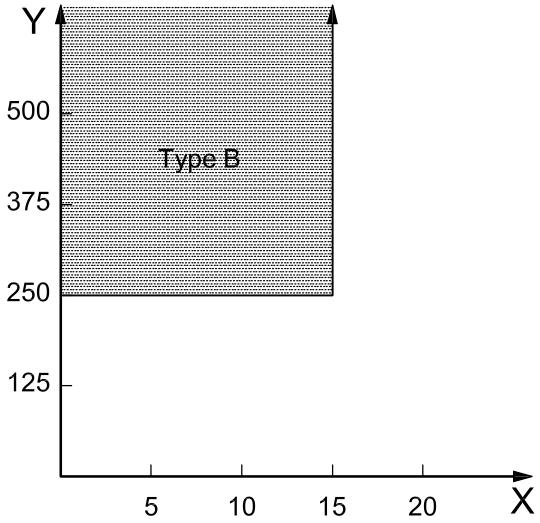
X target vehicle closing speed, m/s

Y roadway radius of curvature, m

Figure 6 — Type A system minimum region of performance

3.2.3 Type B systems

Figure 7 shows the minimum required region of performance with regard to roadway radius of curvature and target vehicle closing speed for a Type B system. These systems may be capable of operating on curved roads with smaller radii. The subject vehicle driver shall be made aware of the limitations of the system, at least in the owner's manual. In particular, the owner's manual shall include the following statement: "This system may not provide adequate warning on curves tighter than X metres radius" where X is replaced by the tightest curve radius for which the system is designed but not more than 250 m.



Key

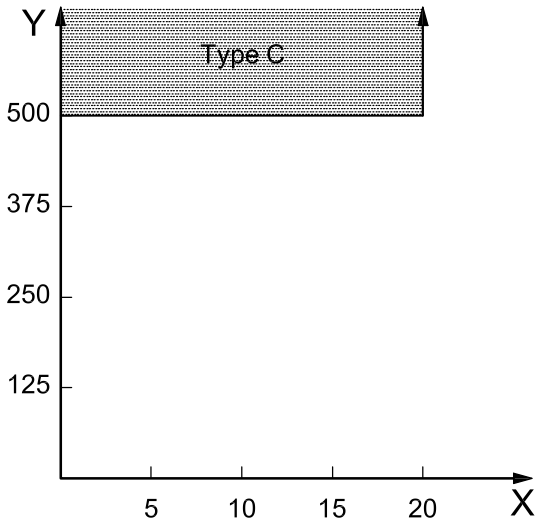
X target vehicle closing speed, m/s

Y roadway radius of curvature, m

Figure 7 — Type B system minimum region of performance

3.2.4 Type C systems

Figure 8 shows the minimum required region of performance with regard to roadway radius of curvature and target vehicle closing speed for a Type C system. These systems may be capable of operating on curved roads with smaller radii. The subject vehicle driver shall be made aware of the limitations of the system, at least in the owner's manual. In particular, the owner's manual shall include the following statement: "This system may not provide adequate warning on curves tighter than X metres radius" where X is replaced by the tightest curve radius for which the system is designed but not more than 500 m.



Key

X target vehicle closing speed, m/s

Y roadway radius of curvature, m

Figure 8 — Type C system minimum region of performance

4 Functional requirements

4.1 LCDAS state diagram

4.1.1 General

LCDAS shall at a minimum operate according to the state diagram in Figure 9.

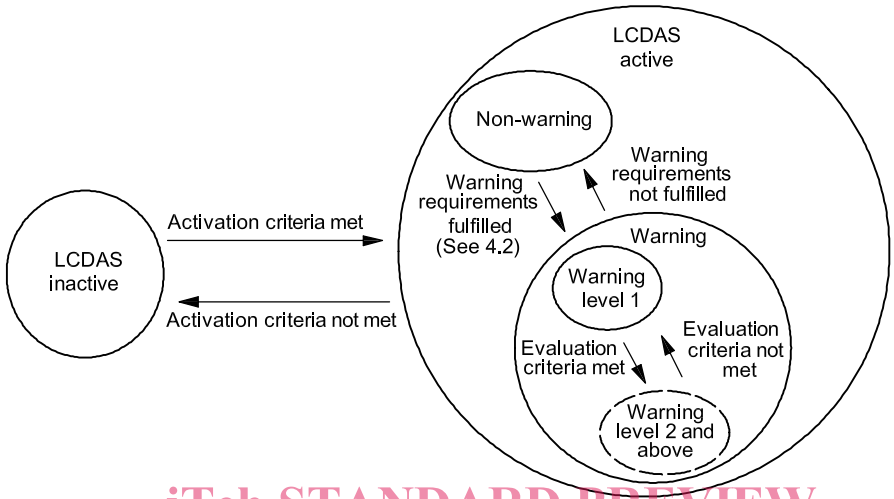


Figure 9 — LCDAS state diagram

4.1.2 LCDAS inactive state

In the LCDAS inactive state the system shall give no warnings to the driver. This state may be a power off state or a ready state. In a ready state the system may detect target vehicles, but shall not issue warnings because the activation criteria are not met.

4.1.3 Activation criteria

4.1.3.1 General

When activated, the LCDAS shall transition from the LCDAS inactive state to the LCDAS active state. Several activation criteria may be used at the same time. Potential activation criteria include but are not limited to the following.

4.1.3.2 Continuous activation

The system may be active continuously (whenever the subject vehicle's ignition is on).

4.1.3.3 Manual switch activation

The system may be activated manually, e.g. by a toggle switch, a tip switch or a menu-based user interface.

4.1.3.4 Turn signal activation

The system may be activated based on the subject vehicle turn signal status. For instance, if the left turn signal is on, the system may be activated on the left side of the subject vehicle, while remaining inactive on the right side of the subject vehicle.

4.1.3.5 Subject vehicle speed activation

The system may be activated based on the subject vehicle speed. If this is the case, then when the subject vehicle speed is greater than or equal to a certain threshold speed the system will transition to the LCDAS active state. The threshold speed shall be no more than 16,7 m/s (60 km/h).

4.1.4 LCDAS active state

4.1.4.1 General

In the LCDAS active state the system shall detect target vehicles.

4.1.4.2 Non-warning state

In the non-warning state the system is active, but the warning requirements are not fulfilled.

4.1.4.3 Warning state

4.1.4.3.1 General

In the warning state the system is active and the warning requirements are fulfilled.

4.1.4.3.2 Warning level 1 state

In the warning level 1 state the warning requirements are fulfilled but no evaluation criteria are met. The warning given to the driver in this state shall be a cautionary warning, which is less urgent than the warnings given in warning level 2 and any subsequent warning levels.

4.1.4.3.3 Evaluation criteria

4.1.4.3.3.1 General

Evaluation criteria are certain parameters that an LCDAS may monitor. Evaluation criteria should be useful in determining the driver's intention for changing the lane of travel. If one or more of these evaluation criteria are met, then the system may transition from the warning level 1 state to warning level 2 and above. Several evaluation criteria may be used at the same time. Potential evaluation criteria include but are not limited to the following.

4.1.4.3.3.2 Turn signal evaluation

The system may evaluate the subject vehicle turn signal status. For instance, if the left turn signal is on, the system may transition to warning level 2 or higher on the left side of the subject vehicle, while not affecting the right side of the subject vehicle.

4.1.4.3.3.3 Subject vehicle steering input evaluation

The system may evaluate the steering input by the subject vehicle driver. If, for instance, the system determines that the driver is initiating a lane change to the left, the system may transition to warning level 2 or higher on the left side of the subject vehicle, while not affecting the right side of the subject vehicle.

4.1.4.3.3.4 Subject vehicle lane position evaluation

The system may evaluate the subject vehicle's position and/or lateral motion within its lane. If, for instance, the system determines that the subject vehicle is moving toward or into the lane to the left, the system may transition to warning level 2 or higher on the left side of the subject vehicle, while not affecting the right side of the subject vehicle.