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Intelligent transport systems — Emergency electronic brake light systems (EEBL) — Performance requirements and test procedures

Systèmes de transport intelligents — Systèmes de diffusion de l'information d'un freinage d'urgence (EEBL) — Exigences de performance et procédures d'essai

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

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

Emergency Electronic Brake Light systems (EEBL) alert the driver against the danger caused by the emergency braking of a forward vehicle (FV) on the upcoming road. EEBL generates an emergency brake message based on vehicle emergency brake and transmit. The system periodically broadcasts the message to nearby vehicles through vehicle to vehicle (V2V) wireless communication. If the system equipped on an FV detects the emergency braking of its own vehicle, the system generates the emergency braking flag, and sends the message including emergency braking flag. When the system equipped on the subject vehicle (SV) receives the message containing the emergency braking flag, the system judges whether an alert needs to be issued. If the location of the FV is within the specified region of interest (ROI) of the SV, the system provides an alert to the driver to prompt appropriate deceleration for driver safety. The scope of EEBL does not include automated intervention features or means for controlling the vehicle to match a desired speed.

A significant benefit of cooperative safety systems such as EEBL is the significant reduction of the potential risk of collision when a driver cannot see the brake light of an FV that is braking hard. For example, when there is an interfering vehicle between the emergency braking vehicle (FV) and the SV, the driver in the SV can still be alerted through vehicle to vehicle (V2V) wireless communication while on-board sensor-based systems cannot even detect the existence of the FV.

Intelligent transport systems — Emergency electronic brake light systems (EEBL) — Performance requirements and test procedures

1 Scope

This document contains the basic alert strategy, minimum functionality requirements, basic driver interface elements, minimum requirements for diagnostics and reaction to failure, and performance test procedures for Emergency Electronic Brake Light systems (EEBL).

EEBL alerts the driver against danger caused by the emergency braking of an FV on the upcoming road, so that the driver may reduce the speed. The system does not include the means to control the vehicle to meet the desired speed. The responsibility for safe operation of the vehicle always remains with the driver.

The scope of this document does not include performance requirements and test procedures of the wireless communication device used for EEBL. The requirements of communication devices are defined in other standards, e.g. the IEEE series listed in the Bibliography[6][7][8]. The test procedure in this document is designed for third party testing of the product while the test procedure can also be used for other stakeholders such as manufacturers or consumer unions.

The document applies to light duty vehicles and heavy vehicles. These systems are not intended for off-road use.

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
Emergency Electronic Brake Light system
EEBL
system consisting of *EEBL-T* (3.1.1) and *EEBL-R* (3.1.2)

3.1.1
Emergency Electronic Brake Light – Transmitting system
EEBL-T
system capable of detecting the emergency braking of the vehicle where the system is equipped, and capable of transmitting a message including emergency brake flag and other information, e.g. location, speed, to nearby vehicles

3.1.2
Emergency Electronic Brake Light – Receiving system
EEBL-R
system capable of receiving a message including emergency brake flag from *forward vehicles (FVs)* (3.3), and capable of alerting the driver of emergency braking of an FV on the same road and traveling in the same direction as the *SV* (3.2)

3.2
subject vehicle
SV
receiving vehicle
vehicle equipped with the *EEBL-R* (3.1.2) system

Note 1 to entry: The subject vehicle is located behind and traveling in the same direction as the *forward vehicle (FV)* (3.3).

3.3
forward vehicle
FV
transmitting vehicle
vehicle equipped with the *EEBL-T* (3.1.1) system

Note 1 to entry: The *forward vehicle (FV)* (3.3) is located ahead of the *subject vehicle (SV)* (3.2) within the *region of interest (ROI)* (3.9) of the SV.

3.4
interfering vehicle
IV
vehicle which is located in between the *subject vehicle (SV)* (3.2) and *forward vehicle (FV)* (3.3) to interfere with the line-of-sight between the SV and FV

Note 1 to entry: During the test, the IV does not generate a message including emergency brake flag nor issue an emergency brake alert to the driver, so the IV will not influence the *EEBL* (3.1) operation of the *FV* (3.3) and SV.

3.5
subject vehicle speed
longitudinal component of the *subject vehicle (SV)* (3.2) velocity

3.6
visibility
distance at which the illuminance of a non-diffusive beam of white light with the colour temperature of 2700K is decreased to 5 % of its original light source illuminance

3.7
host lane
lane in which the *subject vehicle (SV)* (3.2) is located

3.8
adjacent lane
lane of travel sharing one lane boundary with the host lane and having the same direction of travel as the host lane

3.9
region of interest
ROI
area in which a *subject vehicle (SV)* (3.2) receives the emergency brake flag from the *forward vehicle (FV)* (3.3)

4 Symbols and abbreviated terms

a_{d}	The deceleration of the FV
$a_{d\_Current}$	Absolute value of the deceleration of the FV
$a_{d\_Threshold}$	Threshold amount of deceleration of the FV to judge the emergency braking
EEBL	Emergency Electronic Brake Light system
EEBL-T	Emergency Electronic Brake Light -Transmitting system
EEBL-R	Emergency Electronic Brake Light - Receiving system
FSRA	Full Speed Range ACC
FV	Forward Vehicle
FVCWS	Forward Vehicle Collision Warning System
GNSS	Global Navigation Satellite System
HMI	Human Machine Interface
IV	Interfering Vehicle
PER	Packet Error Rate
ROI	Region of Interest
RSE	Road Side Equipment
SV	Subject Vehicle
V_1	A pre-set speed of vehicle for test
V2I	Vehicle to Infrastructure communication
V2V	Vehicle to Vehicle communication
V_{max}	Maximum operational speed value

5 Specifications and requirements

5.1 Basic functions

The purpose of the EEBL is to provide alerts that will assist drivers in avoiding or reducing the severity of rear end crashes caused by emergency braking of an FV.

EEBL has following functions.

— EEBL-T detects and judges the emergency braking of an FV, and broadcasts a message including the emergency braking flag. For better understanding, the vehicle that broadcasts the emergency braking flag is denoted as FV in this document.

— EEBL-R receives the message including the emergency braking flag, judges whether the alert shall be issued, and provides the alert to the driver. For better understanding, the vehicle whose driver is alerted is denoted as SV in this document.

— The EEBL requires both of these functions, EEBL-T and EEBL-R, on separate vehicles. The implementations can be different for different manufacturers on their respective vehicles.

The alert should be issued as soon as the SV receives the emergency braking message flag from an FV within its ROI and has evaluated it to be relevant. EEBL provides an alert only and does not perform vehicle control to mitigate the crash.

EEBL may suppress or delay the alert when the SV is applying an automatic braking or alert(s) commanded by another system in the vehicle, e.g. FVCWS or FSRA.

The basic components of EEBL can include radio communication transmitter/receiver and antenna, GNSS receiver and antenna, processing device and HMI device. The processing device can be a separate control unit or it can be combined with another control unit.

5.2 Necessary functions

Vehicles equipped with EEBL-T shall be equipped to fulfil the following functions:

— monitor vehicle deceleration, vehicle position, vehicle speed and vehicle heading direction;

— detect emergency braking in accordance with deceleration threshold value;

— broadcast the message including emergency braking flag to nearby vehicles.

Vehicles equipped with EEBL-R shall be equipped to fulfil the following functions:

— receive the message including emergency braking flag;

— judge the position and heading of the FV with respect to the SV;

— provide alerts to driver in accordance with the EEBL function and requirements.

5.3 Basic operation principle

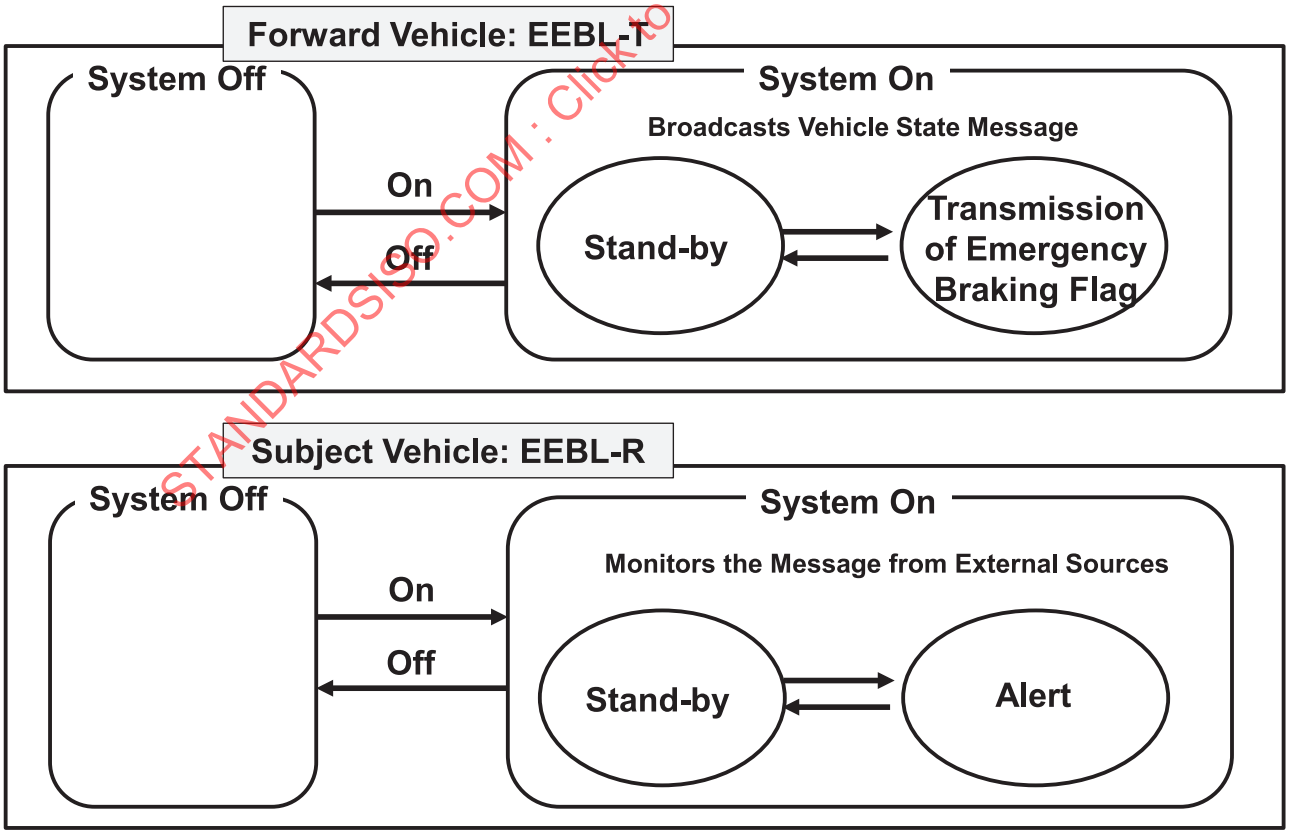


Figure 1 — EEBL states and transitions

5.3.1 State functional descriptions

5.3.1.1 State transition conditions

Conditions for EEBL transitions from system Off state to system On state:

a) For EEBL vehicles equipped with on/off control, both the vehicle ignition and the on/off control are on.

b) For EEBL vehicles not equipped with on/off control, the vehicle ignition is on.

c) The transition from EEBL Off to EEBL On may be performed by the driver or automatically.

d) The transition from EEBL Off to EEBL On shall only occur if no EEBL system failures have been detected.

Conditions for EEBL transitions from system On state to system Off state:

a) For EEBL vehicles equipped with on/off control, either the vehicle ignition or the on/off control are off.

b) For EEBL vehicles not equipped with on/off control, the vehicle ignition is off.

c) If the system is in on state, and a system failure occurs.

The system may be fitted with an on/off control that can be operated by the driver at all times.

EEBL shall as a minimum, provide the following operations and state transitions. The following constitutes the fundamental behaviour of EEBL. The alert criteria are described in 5.4.

— The EEBL-T system of an FV generates the message including the emergency braking flag as long as the vehicle braking exceeds the threshold value ($a_{\text{d\_Threshold}}$), and returns back to the stand-by state after the vehicle braking no longer exceeds the threshold value. The system broadcasts the message including the emergency braking flag to nearby vehicles through V2V wireless communication within 100 ms of detecting the emergency brake.

— When the EEBL-R system of an SV is in the stand-by state, the system monitors messages from external wireless communication sources. If a message including the emergency braking flag is received, the system judges the alert criteria to determine whether the alert should be issued. If the system judges to alert, the system transitions to the alert state, and the EEBL-R starts alert(s) immediately.

— When the EEBL-R system of an SV is in the alert state, the system provides alert(s) to the driver for a minimum 2 s, and maximum of the duration that the FV emergency braking flag is received, and then returns back to the stand-by state.

One of several stages or phases of system operation.

— EEBL off state: The state that EEBL is off. This state has one of the following three causes: the driver has selected the off condition, the ignition is off, or the EEBL is in failure. The failure of EEBL means that the system cannot function as it is described in the user manual due to the failure of the system or the failure of the sub-component of the EEBL. The cause of failure can be, e.g. system malfunction, communication fail, failure during self- diagnosis process.

— EEBL system on state: For EEBL-T equipped on a FV, this state is either stand-by or broadcast state. For EEBL-R equipped on an SV, this state is either stand-by or alert state. Vehicles equipped with EEBL-T periodically broadcast and the vehicles equipped with the EEBL-R receive status messages.

— EEBL system stand-by state: For EEBL-T equipped on a FV, the system monitors the vehicle deceleration. For EEBL-R equipped on an SV, the system is ready to receive the message including the emergency braking flag.

— EEBL-T transmission of emergency braking state: The system generates the emergency braking flag, and sends the message including emergency braking flag to nearby vehicles using wireless communication module. The EEBL-T starts broadcasting the message including emergency braking flag if the amount of deceleration of the vehicle exceeds the threshold value.

— EEBL-R alert state: The system starts alert(s) or is operating the alert(s). The EEBL-R starts alert(s) if the message including emergency brake flag is received, and the system judged that the alert criteria are all met.

5.3.2 Operational limits

The maximum operational speed value (for SV) of Vmax shall be greater than or equal to 27,8 m/s.

The system shall not operate when the speed of SV or FV is less than 2,8 m/s.

The operational limits of EEBL shall be indicated in an owner's manual and/or caution label.

5.4 Alert functionality

5.4.1 General

EEBL shall provide an alert for emergency braking of an FV in the forward path of the SV. The EEBL alert is provided in accordance with the following functions.

5.4.2 Generating the message including emergency braking flag for broadcasting

EEBL-T monitors the deceleration of the vehicle. If the deceleration, $a_{\text{d\_Current}}$ is greater than or equal to the absolute value of the threshold value, the EEBL-T generates the message including emergency braking flag. The message is broadcast through the wireless communication module of EEBL-T to nearby vehicles. The threshold value, $a_{\text{d\_Threshold}}$, is 4,0 m/s^2.

If $a_{\text{d\_Current}} \geq a_{\text{d\_Threshold}}$, FV broadcasts the message including emergency braking flag.

5.4.3 Judging to issue the alert

When the EEBL-R in an SV receives the message including emergency braking flag, and the FV is within the ROI, the EEBL-R starts the alert. The judgement whether the location of the FV is inside of the ROI of the SV's EEBL-R is based on the GNSS location of the SV and FV.

Dimensions in metres

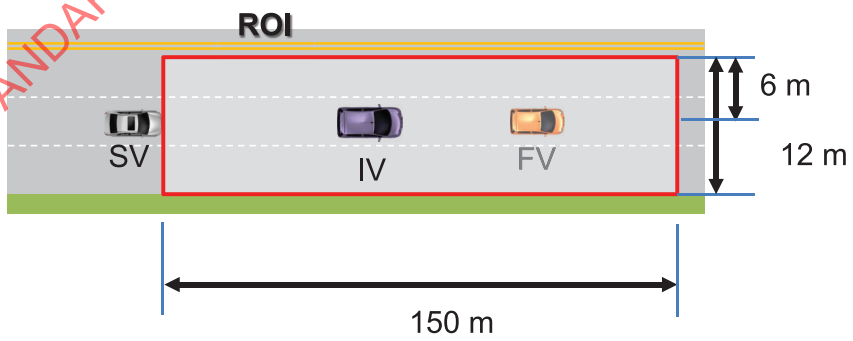


Figure 2 — Minimum region of interest (ROI) for EEBL

The minimum area of the ROI is described in Figure 2. The ROI in the longitudinal direction shall be greater than or equal to 150 m measured from the tip of the front bumper of the SV. The ROI in the lateral direction shall be greater than or equal to 6 m to both left and right sides, measured from the center of the SV

Longitudinal distance of ROI ≥ 150 m

Lateral distance of ROI ≥ 6 m (each left and right)

If the following criteria are all met, the alert shall be issued.

— The location of the FV is inside of the ROI of the SV.

— Both the FV and SV are traveling in the same direction on the same roadway.

— The EEBL-R is in System On state, and the gear selection is in forward or neutral position (all gear positions except reverse and park).

It is permitted to have a larger ROI but the minimum value in both longitudinal and lateral directions shall be at least 150 m and 12 m, respectively. If the road is curved, the longitudinal distance is measured along the centerline of the road.

The method to judge whether the FV is in the location to cause a possible danger to SV depends upon the manufacturer of EEBL-R.

If the manufacturer of EEBL-R can judge that the emergency brake of FV in ROI will not result in danger for the SV (e.g. FV in adjacent lane), the EEBL-R is allowed not to provide an alert to the driver.

5.5 Alerting element requirements

5.5.1 EEBL-R output

When the alert criteria mentioned in 5.4.3 are all met, EEBL-R of the SV shall provide an emergency brake alert to the driver.

5.5.2 Alert modality

When the system transitions to the EEBL-R alert state, the driver shall be alerted by an audible, haptic or visual element.

While the alert is designed and provided, the following related standards may be used for reference.

— ISO/TR 12204:2012

— ISO/TS 16951:2004

Drivers shall be informed of the conditions that result in EEBL-R activation and deactivation and of the limitations of the system performance by the vehicle owner's manual.

If EEBL-R is not available due to a failure, the driver shall be informed, and the description of the notice shall be stated in the vehicle owner's manual.

An alert should be selected such that it can easily be distinguished from warnings unrelated to forward direction threats (e.g. lateral threat warnings).

5.5.3 Optional functions of EEBL-R

The required deceleration threshold for collision may be adapted based on the detected road condition, environmental conditions, driver conditions or driver behaviour.

The system may suppress additional alerts to avoid repetitive alerts.

The system may suppress alerts when the driver is applying the brake.

The EEBL-R alert may be suppressed or delayed if the SV is detected to be performing a lane change or high dynamic manoeuvring.

The EEBL-R alert may be suppressed or delayed if an automatic warning braking or braking is already activated. The automatic warning braking or braking can be issued by ACC, FVCMS or other automatic braking systems.

It is optional to use V2I communication for EEBL-R. For example, the message including emergency braking flag of the FV can be transferred to an RSE on road infrastructure and redirected to the SV.

If any of these optional functions is included, it shall be described in the vehicle owner's manual.

5.6 Performance requirement of EEBL

5.6.1 Minimum communication range

The minimum communication range between the FV and SV shall be 300 m of roadway.

5.6.2 System delay requirement between FV and SV

Within the communication range required in 5.6.1, the SV shall be able to receive the message including emergency braking flag within 0,3 s for test cases specified in 6.6. This system delay is from the time that the EEBL-T of the FV starts generating emergency braking flag to the time that the EEBL-R of the SV starts the alert.

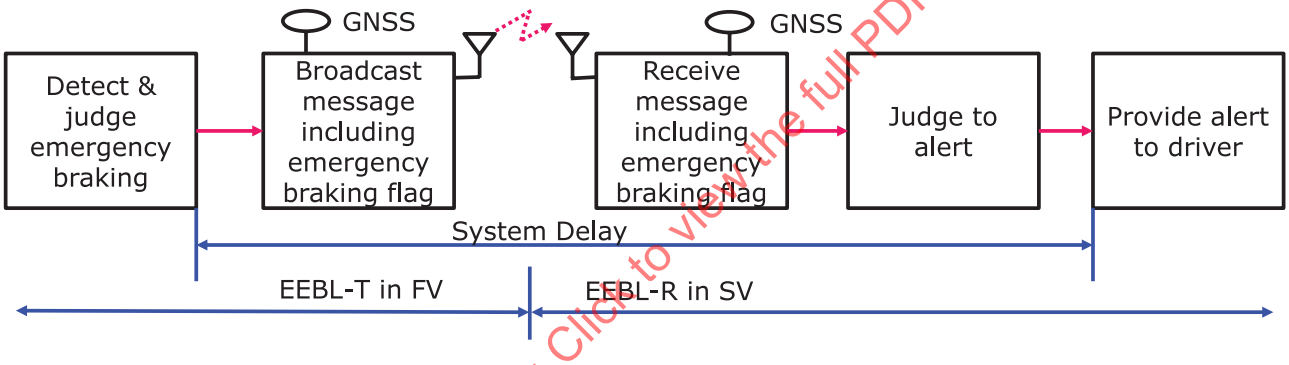


Figure 3 — Definition of system delay

5.7 Driver interface requirements

5.7.1 Alert output specification

All visual, audible, and haptic alerts shall be perceptible by the driver. It is recommended that the visual and audible alert satisfy appropriate human factors. The alert modality requirements for collision alerts are shown in 5.5.2.

5.7.2 Fault indication

If the EEBL is in fault condition, fault indication shall be provided to driver. The indication modality can be visual.

6 Performance evaluation test methods

6.1 Environmental conditions for test

a) The test location shall be on a flat, dry and clean asphalt or concrete surface.

b) The temperature range shall be between −20 °C and 40 °C.

c) The horizontal visibility range shall be greater than 1 000 m.

d) The test shall occur during daylight conditions.

6.2 Test course conditions

— During the test, the test vehicles shall be separated from public traffic.

— A part of a public road can be used as a test course if public traffic can be completely controlled to prevent the public traffic from entering into the test course.

— The test course shall be straight. There should be sufficient length and width to be able to achieve the tests safely.

— The test course shall have open skies.

— The test course shall have lane marking that can separate two vehicles running in two adjacent lanes. The lane marking colour can be white, yellow or blue, and the lane marking can be dashed, solid or double solid. The lane marking can be replaced with traffic cones, adhesive tape or other marking tools which can be clearly visible for test drivers. The lane marking can be in only one side of the lane.

6.3 Test system installation and configuration

The requirements for the test systems installation and configuration for the SV and FV are as follows.

— The EEBL shall be properly installed on test vehicles according to the manual provided by the manufacturer of the EEBL.

— The EEBL shall be in On state from the start to the end of the overall test procedure.

— The EEBL shall be able to provide the required test data to the test authority. The required test data are listed in 6.4.

The test setup required in 6.2 and 6.3 shall be maintained during overall test procedure.

The reference GNSS system for the evaluation of the EEBL shall have ±0,45 m accuracy or better.

6.4 Parameters recoverable from data record

The parameters which shall be recorded and recovered are described as follows.

— The following parameters shall be recorded and shall be recoverable. The data shall be recorded from the start of the test to the end of the test.

  a) The message including emergency braking flag transmission time of FV from GNSS data;

  b) Alert issue time of HMI for SV from GNSS data;

  c) Location of both FV and SV at alert from GNSS data;

  d) Deceleration of FV at the alert start.

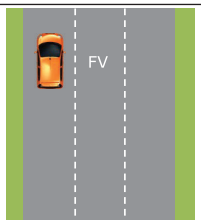
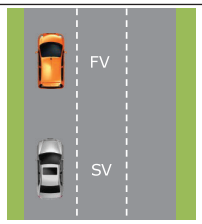
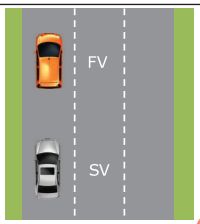
— All alerts that occur during the test shall be recorded. The data shall be recovered by a device other than the EEBL. The precision of the test device shall be noted in the test report.

The recorded time used throughout 6.6 is based on the GNSS time.

6.5 Test cases

There are five test cases for EEBL in this document. The fifth is the basic communication function test and not included in this table.

Table 1 — Test cases

	Test case 1 FV transmission and delay	Test case 2 False positive	Test case 3 True positive	Test case 4 Interfered
Vehicle speed* (V_1)	60 km/h	60 km/h 80 km/h	60 km/h 80 km/h	60 km/h 80 km/h
FV deceleration	2 to 3 m/s^2 and over 5 m/s^2	2 to 3 m/s^2	Over 5 m/s^2	Over 5 m/s^2
IV involved	None	None	None	Yes
Situation description				
NOTE The test vehicle speed indicated has a tolerance of 5 km/h.				

6.6 Test procedure

6.6.1 Test case 1 — FV transmission test and delay measurement

6.6.1.1 General

In this test case, in some cases the FV decelerates slowly and in other cases the FV experiences emergency braking, in which case the transmission function of EEBL-T system is checked. In case of slow deceleration, the deceleration is less than the threshold value, $a_{d\_Threshold}$, in which case the alert shall not be generated. In case of emergency braking, the deceleration is higher than the threshold value, $a_{d\_Threshold}$, in which case the alert shall be generated.

The test course considered in this test case is a straight road.

The test case 1 consists of six-unit tests. The unit test with same speed is repeated three times.

6.6.1.2 Test preparation

1) Prepare the reference GNSS system in order to have required accuracy.

2) Check test vehicle setups for both the FV*** and SV according to 6.3 and 6.4.

3) There are four locations to be marked, illustrated in Figure 4.*

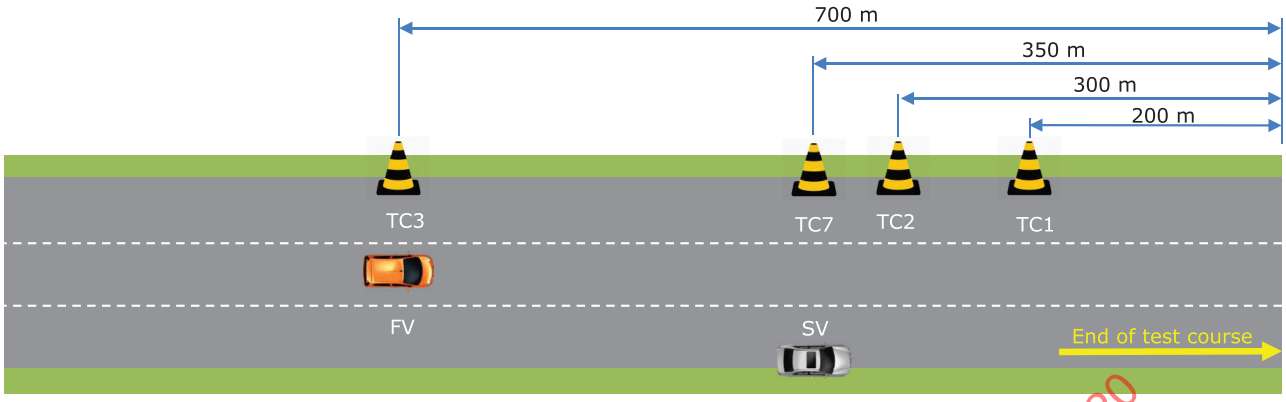


Figure 4 — Start location of test case 1

Table 2 — Location of reference points for test case 1

Location point	Location	Tolerance
TC1	200 m from the end of the test course	±10 m (Longitudinal)
TC2	300 m from the end of the test course	±10 m (Longitudinal)
TC3	700 m from the end of the test course	±10 m (Longitudinal)
TC7	350 m from the end of the test course, 5 m lateral distance from the FV lane	±10 m (Longitudinal) ±1 m (Lateral)

4) The FV shall be located at TC3 position.

5) The SV shall be located at the TC7 position having 5 m lateral distance from the centre of the lane where the FV is located.

NOTE 1 The locations can be marked by traffic cones or other means that can indicate the location.

NOTE 2 The SV described in TC1 can be a functional set of EEBL-R system with data recorder.

NOTE 3 The FV described in TC1 can be a functional set of EEBL-T system with data recorder.

6.6.1.3 Conducting the test

1) The FV starts from location TC3. The location of the vehicle is measured from the front end of the vehicle bumper.

2) The FV accelerates until the vehicle speed reaches V_1. Maintain the speed V_1.

3) The FV decelerates from the TC2 location. The deceleration shall be in a_d. After decelerating for 1,5 ± 0,5 s, stop deceleration and maintain this speed until the FV reaches the TC1 location.

   The a_d for the first 3 tests shall be in the range of 2,0 m/s^2 to 3,0 m/s^2.

4) The SV records the data received from the FV and the FV can record the transmitted data.

5) When the FV reaches the TC1 location, this test is terminated.

6) Repeat the procedure from 1) to 5) three times.

7) Change the a_d to over 5,0 m/s^2 and repeat procedure from 1) to 5) three times so that the overall test will be six times.

6.6.1.4 Test passing criteria

1) For the first three tests, the data recorded in EEBL-R shall not include the emergency braking flag.

2) For the last three tests, the data recorded in EEBL-R shall include the emergency braking flag. From the recorded data, the system delay is calculated based on 5.6.2 and it shall be less than 0,3 s.

If the EEBL-T passes all 6 attempts, EEBL-T passes the test case 1.

6.6.2 Test case 2 — False positive test

6.6.2.1 General

In this test case, the FV located on the same lane decelerates slowly. The deceleration is lower than the threshold value, $a_{\text{d\_Threshold}}$, so the alert can be checked.

The test course considered in this test case is a straight road.

Test case 2 consists of six unit tests. The unit test with the same speed is repeated three times.

There are two test speeds in test case 2. The test speeds are 60 km/h and 80 km/h.

6.6.2.2 Test preparation

1) Prepare the reference GNSS system in order to have required accuracy.

2) Check test vehicle setups for both the FV and SV according to 6.3 and 6.4.

3) There are four locations to be marked, illustrated in Figure 5.

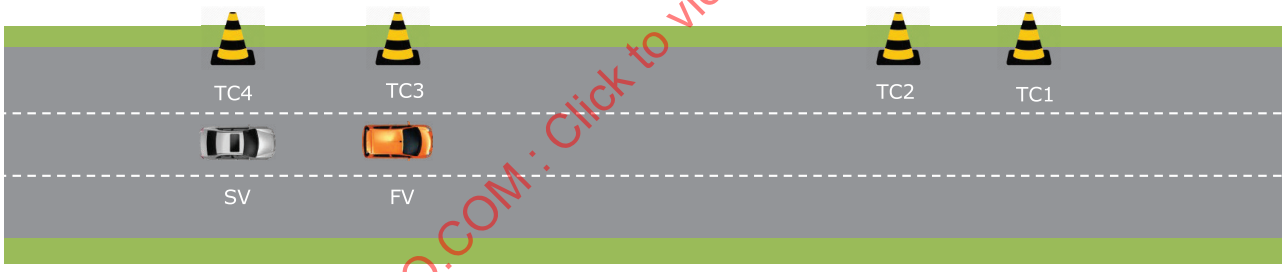


Figure 5 — Start location of test case 2

Table 3 — Location of reference points for test

Location point	Location	Tolerance (Longitudinal)
TC1	200 m from the end of the test course	±10 m
TC2	300 m from the end of the test course	±10 m
TC3	700 m from the end of the test course	±10 m
TC4	850 m from the end of the test course	±10 m

4) The FV shall be located at TC3 position.

5) The SV shall be located at TC4 position with the same lane as the FV.

NOTE The locations can be marked by traffic cones or other means that can indicate the location.

6.6.2.3 Conducting the test

1) Both the FV and SV start acceleration at t_1 ± 1 s from location TC3 and TC4, respectively. The location of the vehicle is measured from the front end of the vehicle bumper.

2) Both the FV and SV accelerate until the vehicle speed reaches V_1. Maintain the speed V_1.

3) The FV decelerates from the TC2 location. The deceleration shall be in the range of 2,0 m/s^2 to 3,0 m/s^2. After decelerating for 1,5 ± 0,5 s, stop deceleration and maintain this speed until the FV reaches the TC1 location.

4) The SV records the alert if one is generated.

5) When the FV reaches the TC1 location, this test is terminated.

6) Repeat the procedure from 1) to 5) three times for one V_1.

7) Change the V_1 and repeat the procedure from 1) to 5) three times so that the overall test will be six times.

6.6.2.4 Test passing criteria

1) If the EEBL-R of SV does not issue the alert, both EEBL-T and EEBL-R pass the unit test.

If the EEBL passes all six attempts, both EEBL-T and EEBL-R pass test case 2.

6.6.3 Test case 3 — True positive test

6.6.3.1 General

In this test case, the FV located in the same lane experiences emergency braking. The deceleration is higher than the threshold value, $a_{\text{d\_Threshold}}$, so the alert shall be issued.

The test course considered in this test case is a straight road.

Test case 3 consists of six unit tests. The unit test with the same speed is repeated three times.

There are two test speeds in test case 3. The test speeds are 60 km/h and 80 km/h.

6.6.3.2 Test preparation

1) Prepare the reference GNSS system in order to have required accuracy.

2) Check test vehicle setups for both the FV and SV according to 6.3 and 6.4.

3) There are four locations to be marked, illustrated in Figure 6.

Figure 6 — Start location of test case 3

Table 4 — Location of reference points for test

Location point	Location	Tolerance (Longitudinal)
TC1	200 m from the end of the test course	±10 m
TC2	300 m from the end of the test course	±10 m
TC3	700 m from the end of the test course	±10 m
TC4	850 m from the end of the test course	±10 m

4) The FV shall be located at the TC3 position.

5) The SV shall be located at the TC4 position with the same lane as the FV.

NOTE The locations can be marked by traffic cones or other means that can indicate the location.

6.6.3.3 Conducting the test

1) Both the FV and SV start acceleration at t_1 ± 1 s from location TC3 and TC4, respectively. The location of the vehicle is measured from the front end of the vehicle bumper.

2) Both the FV and SV accelerate until the vehicle speed reaches V_1. Maintain the speed V_1.

3) The FV decelerates from the TC2 location. The deceleration shall be greater than 5,0 m/s^2. After decelerating for 1,5 ± 0,5 s, stop deceleration and maintain this speed until the FV reaches the TC1 location.

4) The SV records the alert if one is generated.

5) When the FV reaches the TC1 location, this test is terminated.

6) Repeat the procedure from 1) to 5) three times for one V_1.

7) Change the V1 and repeat the procedure from 1) to 5) three times so that the overall test will be six times.

6.6.3.4 Test passing criteria

1) If the EEBL-R of the SV issues the alert, both EEBL-T and EEBL-R pass the unit test.

If the EEBL passes all six attempts, both EEBL-T and EEBL-R pass test case 3.

6.6.4 Test case 4 — Test when there is interfering vehicle (IV)

6.6.4.1 General

In this test case, there is IV between the FV and SV, so the line of sight is not available. The FV located in the same lane in front of the IV experiences emergency braking. The deceleration is higher than the threshold value, $a_{\text{d\_Threshold}}$, so the alert shall be issued.

The test course considered in this test case is a straight road.

Test case 4 consists of six unit tests. The unit test with same speed is repeated three times.

There are two test speeds in test case 4. The test speeds are 60 km/h and 80 km/h.

The IV shall be at least 25 cm wider and 50 cm taller than the FV and the SV to provide effective visual interference with the line of sight.