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Intelligent transport systems (ITS) — Cooperative intersection signal information and violation warning systems (CIWS) — Performance requirements and test procedures

Systèmes intelligents de transport (ITS) — Systèmes d'avertissement d'information et de violation du signal d'intersection coopérative (CIWS) — Exigences de performance et modes opératoires 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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: Foreword — Supplementary information.

The committee responsible for this document is ISO/TC 204, *Intelligent transport systems*.

Introduction

The main system function of cooperative intersection signal information and violation warning systems (CIWS) is to warn drivers who are about to violate an intersection's traffic signal to stop at the prescribed location. The CIWS is intended to provide a cooperative vehicle and infrastructure system that reduces the likelihood and severity of crashes at signalized intersections by providing the signal phase information and/or by warning the driver that an intersection signal violation is about to occur. The system uses information communicated from the roadside infrastructure to determine if a warning should be given to a driver.

The purpose of implementing CIWS is to reduce violations of traffic signals at signalized intersections to: (a) reduce fatalities, (b) reduce the number and/or severity of injuries, and (c) reduce property damage associated with collisions.

This International Standard addresses CIWS for use in road vehicles approaching signalized intersections.

This International Standard may be used as a system level standard by other standards, which extend the CIWS to a more detailed standard utilizing wireless communication technologies. Issues such as the specific requirements for the function and performance of communication technology or traffic control facilities (including traffic signal controllers) will not be considered in this International Standard.

Intelligent transport systems (ITS) — Cooperative intersection signal information and violation warning systems (CIWS) — Performance requirements and test procedures

1 Scope

This International Standard specifies the concept of operation, system requirements, and test methods for cooperative intersection signal information and violation warning systems (CIWS) at signalized intersections. CIWS are intended to reduce the likelihood of crash injury, damage, and fatality by enhancing the capability of drivers to avoid crash situations at signalized intersections.

The scope of CIWS standardization includes basic functions, functional requirements, performance requirements, information contents, and test methods.

The characteristics of the technologies used to communicate between the signal controller and the vehicles are not addressed by this International Standard nor are the behavioural responses by drivers, the various capabilities of vehicles on the road, or the multitude of combinations of these two characteristics.

2 Normative references

There are no normative references cited in this document.

3 Terms and definitions

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

3.1
stopping distance
distance, X_v, travelled by a vehicle with the speed of v, from the time the driver receives CIWS warning until the vehicle comes to a complete stop

Note 1 to entry: This includes the distance travelled during the driver perception and reaction time.

3.2
speed of vehicle
speed of the subject vehicle, v

3.3
time to arrive at stop line of intersection
TTAI
time needed for a vehicle approaching the intersection at a speed of v to travel the distance, X, from its current location to the stop line

$$TTAI = \frac{X}{v}$$

3.4
traffic signal phase
green, yellow, and red intervals within a cycle that are assigned to an independent traffic movement or combination of movements

3.5
stop line
pavement marking line extending across approach lanes to indicate the point at which a stop is intended or required to be made

3.6
road side equipment
RSE
roadside device that can supply traffic signal information to the approaching subject vehicle and may also support determination of vehicle position and heading

3.7
onboard equipment
OBE
in-vehicle equipment that can provide drivers with information and/or warnings based on the information received from the RSE and the vehicle

3.8
spot communication media
wireless communication system between roadside and vehicles that operates only within such a small zone that the availability of the communication link can serve as a definitive indicator of the vehicle's location in support of the intended application

4 Symbols

d deceleration rate of subject vehicle for stopping on level pavement (m/s^2), assumed for the purpose of designing CIWS (could be specific for the vehicle type, weather conditions, and road gradient)

G duration of green time (s)

G_r remaining green time (s)

t_D total time of information delay (s)

t_{OBE} the time between when the OBE receives information from the RSE and when it displays a warning

$$t_{\mathrm{OBE}} = t_{\mathrm{OBE1}} + t_{\mathrm{OBE2}}$$

where t_{OBE1} includes communication delay and judgement processing in OBE and t_{OBE2} is display delay to driver.

t_{PRT} driver's perception-reaction time (PRT)

t_{RSE} the time between when the RSE receives signal status information and when it broadcasts that information

v approach speed (m/s)

V_{Design} maximum speed of vehicle, assumed for the purpose of designing CIWS (m/s)

X travel distance from the current position of the vehicle to the stop line (m)

X_{AL} location of downloading information from RSE (m)

$$X_{AL} \geq v_{\mathrm{Design}} \cdot t_D + \frac{v_{\mathrm{Design}}^2}{2 \cdot d}$$

NOTE: Location of the RSE is limited by the physical conditions of the road. If the RSE is located upstream than $v_{\text{Design}} \cdot t_D + v^2_{\text{Design}}/(2 \cdot d)$, it can communicate the information in the timing required for warning.

$$t_D = t_{\text{PRT}} + t_{\text{OBE}}$$

X_v stopping distance (m)

$$X_v = v \cdot t_{\text{PRT}} + \frac{v^2}{2 \cdot d}$$

Y duration of yellow time (s)

5 Classification

5.1 System configuration

The system configuration should be in accordance with Figure 1.

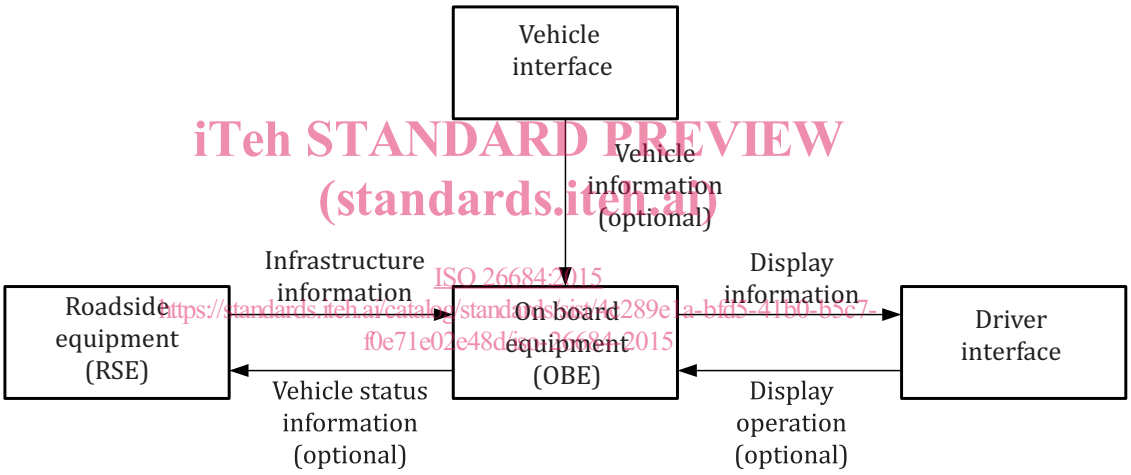

Figure 1 — System configuration

5.2 System configuration

In order to reduce the likelihood of crash injury, damage, and fatality by enhancing the capability of drivers to avoid crash situations at signalized intersections, the CIWS application shall be classified as three types as shown in Table 1. Class I systems are intended to give information about the current phase of the traffic signal for enhancing the driver's awareness of the signal state. Class II systems are intended to provide an in-vehicle warning to the driver of an imminent traffic signal violation for enhancing the opportunity for the driver to avoid the signal violation.

Class III systems address future issues; they are intended to include the function of automatic brake control to reduce red light violations by inattentive drivers.

Table 1 — Classification of CIWS applications

Class	Function	Aims	Driver support	Infrastructure information	Vehicle information	Scope
I	Information	Information provision	Current state of traffic signals	Signal phase: (green/yellow/red) by direction	Direction of travel	Yes
			Timing of signal changes	Signal phase and timing by direction	Direction of travel	Future issue
II	Warning	Avoiding violation	Signal violation warning	Signal phase and timing by direction	Direction of travel, position, speed, *TTAI*	Yes
III	Control	Avoiding violation	Assisted braking or automatic stopping	Signal phase and timing by direction	Direction of travel, position, speed, *TTAI*	Future issue

6 Functional requirements

6.1 CIWS state diagram

CIWS shall, at a minimum, operate according to the state diagrams as shown in Figures 2 and 3.

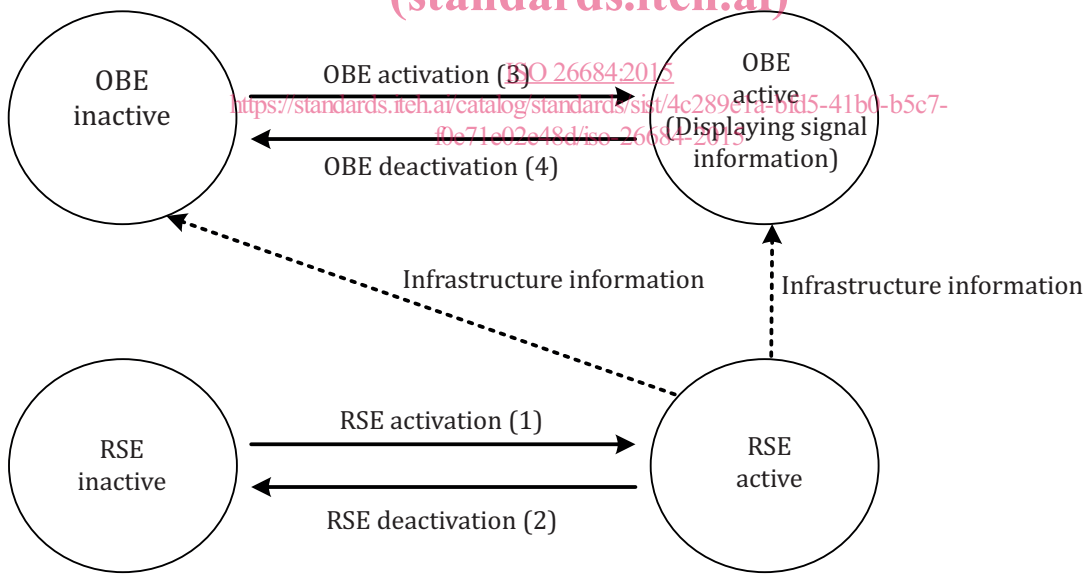

Figure 2 — System state diagram — Class I information

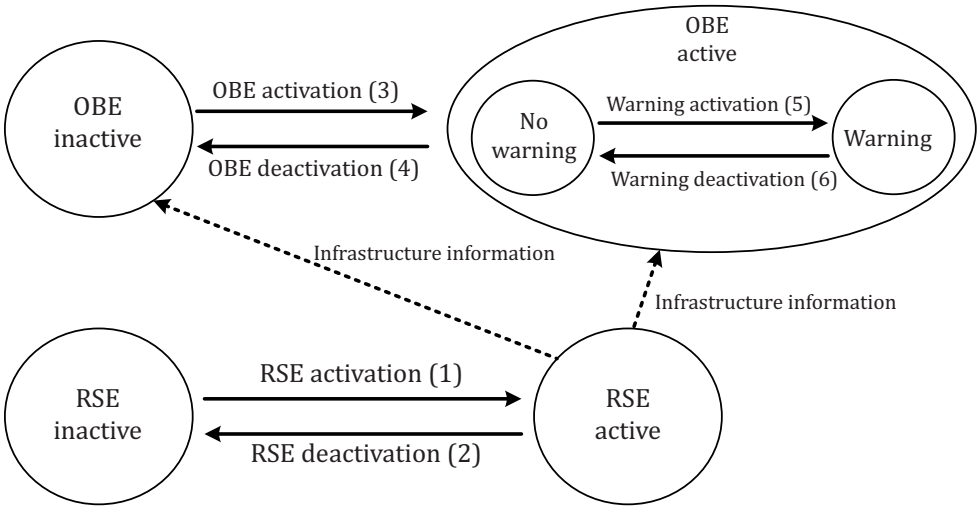

Figure 3 — System state diagram — Class II warning

6.1.1 CIWS states

6.1.1.1 CIWS states

State in which RSE is inactive.

6.1.1.2 RSE active

State in which RSE is active and sends information on signal phase, etc. to OBE.

6.1.1.3 OBE inactive

State in which OBE is inactive.

6.1.1.4 OBE active

State in which the OBE is active, (a) conditions of information provision are met and the system can provide information to driver (Class I) or (b) conditions of warning are met and the system can warn the driver (Class II).

6.1.1.4.1 Warning state

State in which the warning requirements are fulfilled. In this state, a warning shall be issued to human-machine interface (HMI), which might arbitrate priorities relative to other warnings.

6.1.1.4.2 No warning state

State in which the system shall give no warning to the driver because the warning requirements are not met.

6.2 Transition criteria

6.2.1 Criterion (1): RSE activation

When the RSE operator or the automatic system turns RSE on, it becomes active.