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Intelligent transport systems — Low speed following (LSF) systems — Performance requirements and test procedures

Systèmes intelligents de transport — Systèmes suiveurs à basse vitesse (LSF) — Exigences de performance et méthodes d'essai

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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 22178 was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

Introduction

The main system function of low speed following is to control vehicle speed adaptively to a forward vehicle by using information about: (1) ranging to forward vehicles, (2) the motion of the subject (LSF equipped) vehicle and (3) driver commands (see Figure 1 — Functional LSF elements). Based upon the information acquired, the controller (identified as “LSF control strategy” in Figure 1) sends commands to actuators for carrying out its longitudinal control strategy and also sends status information to the driver.

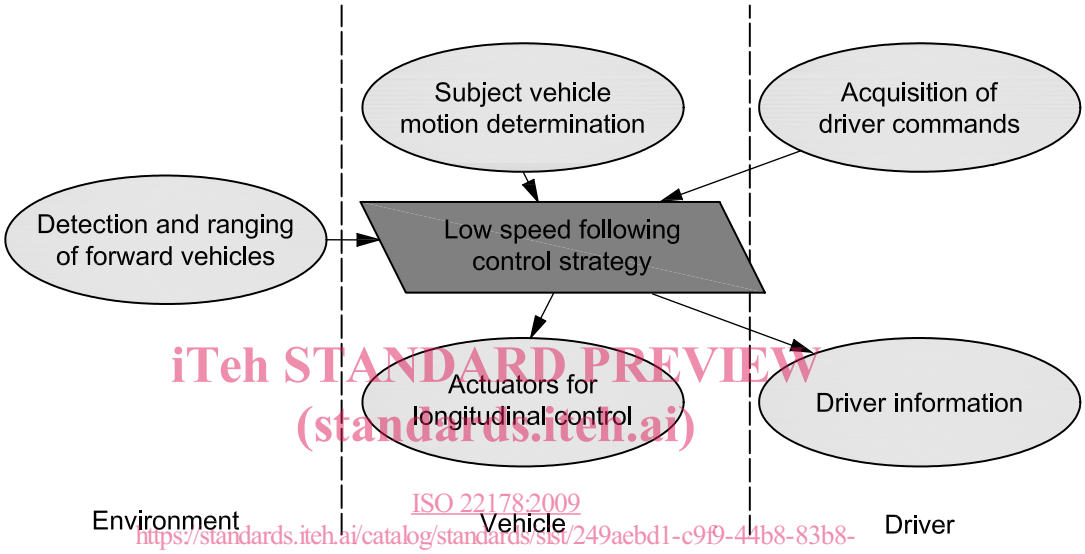


Figure 1 — Functional LSF elements

The goal of LSF is a partial automation of the longitudinal vehicle control to reduce the driver’s workload.

This International Standard may be used as a system level standard by other standards, which extend the LSF to a more detailed standard, e.g. for specific detection and ranging sensor concepts or higher level of functionality. Therefore, issues like specific requirements for the detection and ranging sensor function and performance or communication links for co-operative solutions will not be considered here.

Intelligent transport systems — Low speed following (LSF) systems — Performance requirements and test procedures

1 Scope

This International Standard contains the basic control strategy, minimum functionality requirements, basic driver-interface elements, minimum requirements for diagnostics and reaction to failure, and performance test procedures for low speed following (LSF) systems.

An LSF system is primarily intended to reduce the driver's workload of repeatedly operating the accelerator and the brake pedal under congested traffic in order to keep a proper following distance behind the target vehicle for a relatively long period on roadways where there are no objects like pedestrians and bicyclists who might interrupt motorized traffic flow. An LSF system provides automatic car-following at lower speed by use of a driver interface mechanism and a speed adjustment system. The LSF system does not normally provide speed regulator control.

2 Normative references

The following referenced documents are indispensable for the application 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 2575, *Road vehicles — Symbols for controls, indicators and tell-tales*

3 Terms and definitions [1)]

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

3.1
clearance
distance from the forward vehicle's trailing surface to the subject vehicle's leading surface

3.2
congested traffic
traffic condition where the driver, at lower speed, repeatedly starts, follows a forward vehicle, and stops in order to keep a proper following distance behind the forward vehicle

3.3
cutting out
situation in which the target vehicle changes lanes from behind a preceding vehicle

1) Definitions are in accordance with the Glossary of ISO/TC 204/WG 14.

3.4
forward vehicle
vehicle in front of, and moving in the same direction and travelling on the same roadway as, the subject vehicle

3.5
go operation
driver action to convey to the system the intention of placing the subject vehicle in motion

EXAMPLE Operation of the accelerator pedal and operation of a switch for starting the subject vehicle.

3.6
low speed following
LSF
function that allows the subject vehicle to follow a forward vehicle in low speed ranges such as congested traffic at an appropriate distance by controlling the engine and/or power train and the brakes

3.7
LSF following state
condition where the system controls the clearance to the target vehicle according to the selected time gap

3.8
LSF hold state
condition where the system controls the subject vehicle to be kept stationary

3.9
LSF retargeting state
temporary target-lost period during a transition to the next target vehicle

3.10
maximum operational speed
maximum speed the LSF system can attain while in following control

3.11
minimum operational speed
minimum speed the LSF system can maintain while in following control

3.12
slow moving object
object in front of the subject vehicle that is moving at less than MAX [1,0 m/s, 10 % of the subject vehicle speed] in the direction of the centreline of the subject vehicle

3.13
stationary object
object in front of the subject vehicle that is stationary

3.14
steady state
condition whereby the value of the described parameter does not change with respect to time, distance, etc.

3.15
subject vehicle
vehicle equipped with the LSF system in question and related to the topic of discussion

3.16
target vehicle
vehicle that the subject vehicle follows

3.17
time gap
value calculated from vehicle speed, v, divided by clearance, c

NOTE See Figure 2.

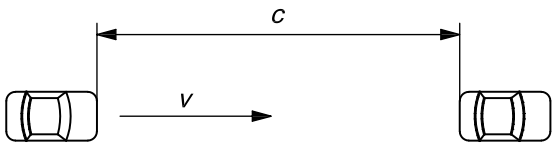


Figure 2 — Time gap

4 Symbols and abbreviated terms

CTT	Coefficient for Test Target (for infrared reflectors) (m^2/sr)
c	clearance, inter vehicle distance (m)
c_{min}	minimum clearance under steady state conditions for all speeds (including hold state) (m)
$c_{min}(v)$	minimum steady state clearance at speed v (m)
d_{max}	distance, maximum detection range on straight roads (m)
d_A	distance between source and projected area A (m)
d_{target_limit}	distance above which the system shall not regard a target vehicle (m)
d_0	distance below which detection of a target vehicle is not required (m)
d_1	distance below which neither distance measurement nor determination of relative speed is required (m)
l	length (of a side of a RADAR test reflector) (m)
R	curve radius (m)
R_{min}	minimum curve radius (m)
RCS	RADAR Cross Section (m^2)
v	true subject vehicle speed over ground (m/s)
v_{circle_start}	vehicle speed as it enters a curve of radius R (m/s)
v_{max}	maximum operational speed (m/s)
v_{min}	minimum operational speed (m/s)
$v_{vehicle\_end}$	vehicle speed at the end of a test (m/s)
$v_{vehicle\_start}$	vehicle speed at the start of a test (m/s)

A	projected (utilized) area (m^2)
A_t	illuminated surface (m^2)
E_t	intensity of irradiation (W/m^2)
I	radiated intensity (W/sr)
I_{ref}	radiated intensity in a given direction (W/sr)
λ	wavelength (m)
τ	gap, time gap between vehicles (s)
τ_{max}	maximum selectable time gap (s)
$\tau_{max(v)}$	maximum possible steady state time gap at a given speed v (s)
τ_{min}	minimum selectable time gap (s)
$\tau_{min(v)}$	minimum steady state time gap at speed v (s)
Φ	radiation source (W)
Φ_{ref}	radiated power (W)
Φ_t	incident radiated power (W)
Ω	solid angle (sr)
Ω_0	solid angle of the source (sr)

5 Classification — types of LSF systems

Two types of LSF systems are addressed in this International Standard.

The type 1 LSF system follows the target vehicle that is recognized when the driver activates the system.

The type 2 LSF system follows the target vehicle that is recognized when the driver activates the system and it retargets the target vehicle automatically until the system is deactivated.

6 Requirements

6.1 Basic control strategy

LSF systems shall, as a minimum, provide the following control strategy and state transitions (see Figure 3).

The following constitutes the fundamental behaviour of LSF systems.

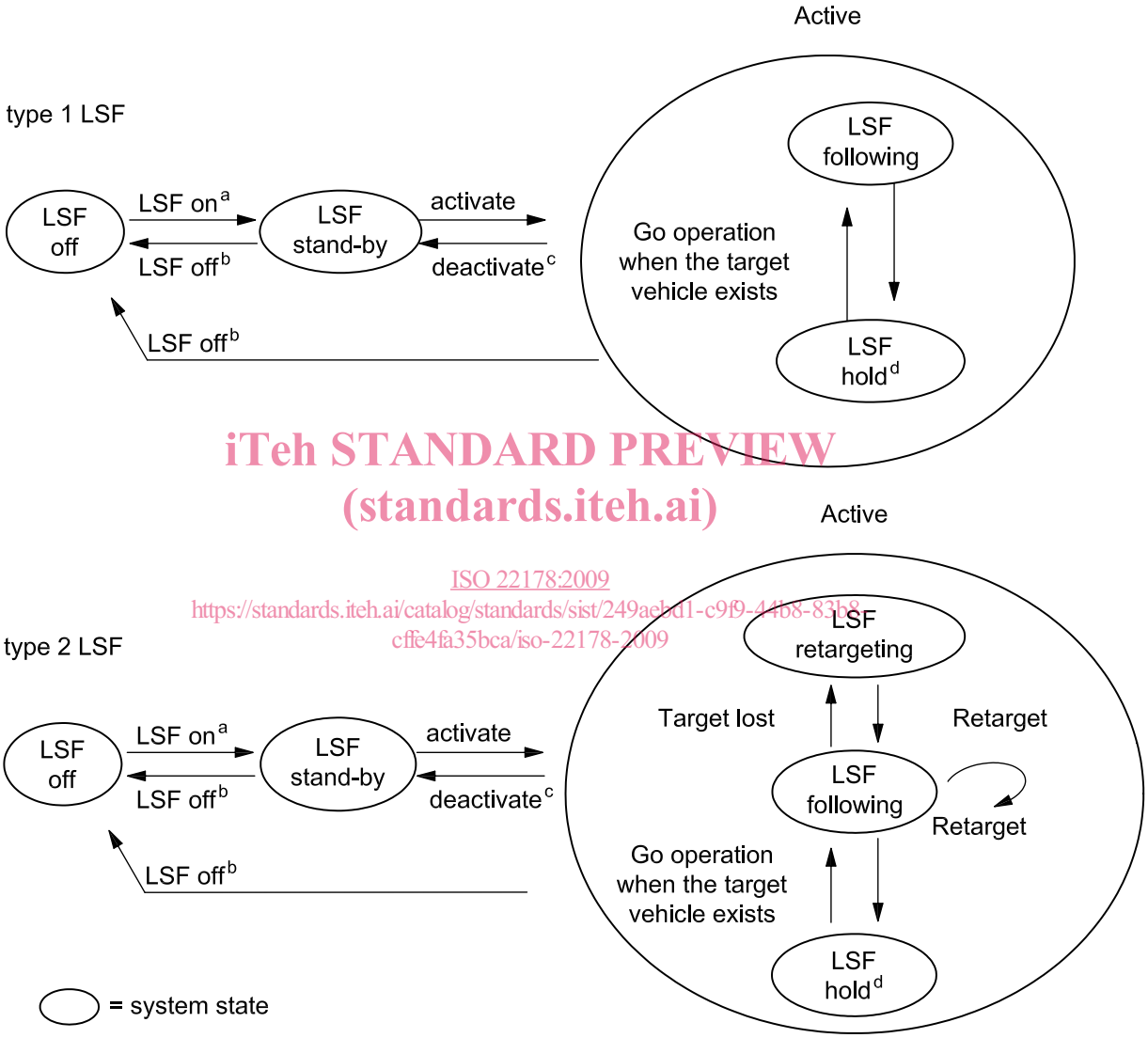
— In the LSF following state, the vehicle speed will be controlled automatically to maintain a clearance to a target vehicle (for car-following capability, see 6.3.2).

— (Type 2 LSF system) In the LSF following state, a new target vehicle will be chosen automatically (for automatic retargeting capability, see 6.3.3).

— (Type 2 LSF system) In the LSF retargeting state, the subject vehicle shall not accelerate (for automatic retargeting capability, see 6.3.3).

— After the subject vehicle has come to a stop, the system shall transfer to the LSF hold or stand-by state (for deactivation conditions, see 6.3.5).

— In the LSF hold state, automatic brake control will be accomplished for keeping the subject vehicle stationary (for hold capability, see 6.3.4).



a The transition is driven after self-diagnostics by manual operation or automatically performed.

b The transition is driven by a manual operation of the on-off switch of the LSF system. Automatic switch-off function can be activated upon detecting any failure.

c The driver's operation to deactivate the system or the conditions specified in 6.3.5.

d Optional state.

Figure 3 — LSF states and transitions

6.2 Applicable target vehicle

6.2.1 General

The LSF system shall regard the forward vehicles that conform to the following conditions from 6.2.2 to 6.2.4 as a target vehicle.

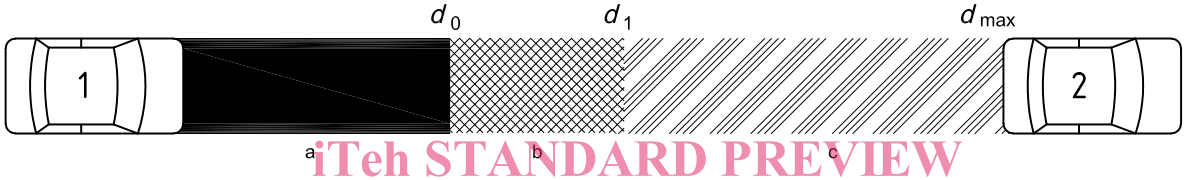
6.2.2 Detection targets

The LSF system shall detect moving vehicles.

The LSF system shall regard a stopped vehicle that was tracked before it stopped as a target vehicle.

It is optional to design LSF systems to regard an object that is already stationary or slow-moving when detected as a target vehicle. When stationary objects or slow-moving objects are not regarded as a target vehicle, the driver shall be informed, as a minimum, by a statement in the vehicle owner's manual.

6.2.3 Detection range on straight roads



Key

1 subject vehicle

2 forward vehicle

a Detection of vehicle not required.

b Detection of vehicle required.

c Detection of vehicle and determination of range.

Figure 4 — Range of detection

If a forward vehicle is present within the distance range of d_1 to d_{max}, the LSF system shall measure the range between the forward and subject vehicles (see Figure 4). Within this range, the forward vehicle shall be detected within a lateral area of at least the subject vehicle width.

$$d_{max} = \tau_{max}(v_{max}) \times v_{max}$$

If a forward vehicle is present within the distance range of d_0 to d_1, the LSF system shall detect the presence of the vehicle but is not required to measure the range to the vehicle nor the relative speed between the forward and subject vehicles. If a forward vehicle is detected within this range and the distance cannot be determined, the system shall inhibit automatic acceleration.

$$d_1 = c_{min}(v_{min})$$

If a forward vehicle is present at a distance less than d_0, the LSF system is not required to detect the presence of the vehicle.

$$d_0 = 2 \text{ m}$$