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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

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Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

English Version

Railway applications - Driver's cab - Part 7: Design of displays for tram vehicles

Applications ferroviaires - Cabine de conduite - Partie
7 : Conception des affichages pour tramways

Bahnanwendungen - Führerraum - Teil 7:
Displaygestaltung für Straßenbahnfahrzeuge

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 256.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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European foreword

This document (prEN 16186-7:2024) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

EN 16186 *Railway applications — Driver’s cab* consists of the following parts:

- *Part 1: Anthropometric data and visibility;*
- *Part 2: Integration of displays, controls and indicators;*
- *Part 3: Design of displays;*
- *Part 4: Layout and access;*
- *Part 5: External visibility for tram vehicles;*
- *Part 6: Integration of displays, controls and indicators for tram vehicles¹;*
- *Part 7: Design of displays for tram vehicles²;*
- *Part 8: Tram vehicle layout and access.*

NOTE Part 1 to 4 above-mentioned standards are only applicable for heavy rail vehicles.

¹ Under development.

² This document, under development.

Introduction

The requirements of this standard, which interface with vehicle functions, have been elaborated with the commitment to respect the standards specifying these functions and in addition to respect the state of the art of other rolling stock functions.

The reasons for defining the information are as follows:

- achieving harmonized and coherent presentation of information;
- defining Driver-Machine Interface ergonomics that is compatible with agreed interoperable specifications;
- to reduce the risk of incorrect operation by a driver working with different tram vehicles fitted with displays;
- facilitating tram vehicle operation with unified ergonomics, hence reducing the cost of driver training.

Information designed according to this standard is deemed to fulfil the following basic principles:

- be clear, correct and necessary;
- indicate its priority, whether by positioning, size, colour, sounds, sound levels, etc.;
- minimize confusion of the driver;
- prevent unnecessary distraction of the drivers' attention while performing their normal duties.

If a requirement contains an option, the choice of this option is purely up to the applicant.

NOTE 1 The term “option” is to be understood as a possibility that is usually expressed by the word “can”.

NOTE 2 In the context of this document, “tram vehicles” also means “tram-trains”.

1 Scope

This document is applicable to vehicles operating on tram networks.

This document specifies all necessary design rules and associated assessment criteria as well as guidance concerning the design of information and the corresponding user interfaces of driver's cabs of tram vehicles.

It considers the tasks the driver has to carry out and human factors. This document specifies how information is arranged and displayed.

All assessments based on the normative requirements of this document are applicable mainly to:

- symbols provided by Annex A;
- arrangement of screen areas conform with Figure 1 (generic organization of information);
- colours, fonts;
- audible information.

This document is applicable to the following aspects:

- legibility and intelligibility of displayed information: general rules concerning the layout of information on the displays, including character size and spacing;
- definition of harmonized colours, symbols, etc.;
- definition of harmonized principles for the command interface (by physical or touchscreen buttons): size, symbols, reaction time, way to give feedback to the driver, etc.;
- general arrangements (dialogue structures, sequences, layout philosophy, colour philosophy), symbols, audible information, data entry arrangements.

NOTE If this document deals with how information can be given for operation and in degraded situations, it does not define operating rules and degraded situations.

This document does not request any safety requirement related with displayed information.

This document specifies minimum requirements and does not prevent more complex solutions.

Requirements describing the functions using the display are out of 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.

FprEN 16186-6:2023, *Railway applications - Driver's cab - Part 6: Integration of displays, controls and indicators for tram vehicles*

EN 894-2:1997+A1:2008, *Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 2: Displays*

EN ISO 9241-307:2008, *Ergonomics of human-system interaction — Part 307: Analysis and compliance test methods for electronic visual displays (ISO 9241-307:2008)*

ISO 2575:2021, *Road vehicles — Symbols for controls, indicators and tell-tales*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 16186-5 and FprEN 16186-6 and the following apply.

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

activated

put into a functional state following a validated input

3.2

authentication

process checking the identity of the user, device or any other element of the system or integrity of the stored, transmitted or retrieved/exposed data

Note 1 to entry: This may be a pre-requisite to access the system.

3.3

authorisation

process granting the access rights to a user, program or process, or an event or status of the system putting the system itself in hold condition which can be exited only by the action of authorized staff

3.4

brightness

attribute of a visual sensation according to which an area appears to emit more or less light

Note 1 to entry: The use of this term is not restricted to primary light sources.

[SOURCE: ISO 9241-302:2008 [1], definition 3.3.9, modified (Note added)]

3.5

button

operating element for interaction with the display (hard key, soft key, sensitive area)

3.5.1

enabled

put into a state where the function related to the button can be activated by pressing the button

3.5.2

pressed

put into a state where the action on the button is ongoing

3.6

cell

basic unit to define the shape of DMI objects and the proportions of areas

Note 1 to entry: Depending on the resolution of the screen, a cell consists of one or more pixels.

3.7

Closed Circuit Television

CCTV

television allowing the transmission of images over a relatively short distance intended for a particular group of users

[SOURCE: IEC 60050-723-01-19 [2], modified “generally by cable” removed]

3.8

display

hardware device or system that shows text and/or graphic information to the user

Note 1 to entry: The display optionally contains hard keys.

3.9

command

action executed by the personnel on the human-machine interface

3.10

consistency

maintenance of interface design choices (codes, naming, formats, procedures, etc.) in similar contexts

Note 1 to entry: see BASTIEN J.M.C., SCAPIN D.L. *A validation of ergonomic criteria for the evaluation of human-computer interfaces*. Int. J. Hum. Comput. Interact. 1992, 4 pp. 183–196 [3].

3.11

Operational Aided System Display

OASD

display that allows the driver to enter operational related information and to get real time information (tram vehicle number, route information, driver ID, track status, electronic timetable, messages, ...)

3.12

error

discrepancy between a computed, observed or measured value or condition and the true, specified or theoretically correct value or condition

Note 1 to entry: An error can be caused by a faulty item, e.g. a computing error made by faulty computer equipment.

Note 2 to entry: A human error can be seen as a human action or inaction that can produce an unintended result.

[SOURCE: EN 50129:2018 [4], 3.1.13]

3.13

event

occurrence of a state at a defined precondition and time requesting attention, e.g. alarm, authentication, authorisation, fault, warning

[SOURCE: EN 15380-4:2013 [5], 3.12, modified (“requesting attention, e.g. alarm, authentication, authorisation, fault, warning” added)]

3.14

failure

⟨Of an item⟩ loss of ability to perform as required

[SOURCE: EN 50129:2018 [4], 192-03-01, modified (the Notes 1, 2 and 3 to entry have been omitted)]

3.15**fault**

(in a system) state of an item characterized by inability to perform a required function, excluding the inability during preventive maintenance or other planned actions

Note 1 to entry: a fault is often the result of a failure of the item itself, but can exist without prior failure (e.g. in case of a design fault).

Note 2 to entry: the fault is a state characterized by inability to perform a required function.

[SOURCE: IEC 60050-821:2017 [6], 821-11-20, modified – The definition “abnormal condition that could lead to an error in a system” has been changed. The note 1 to entry has been changed and the note 2 to entry has been added.]

3.16**grid array**

area consisting of cells which results in a visual appearance of information in certain proportions

Note 1 to entry: Form and shape of the information on the screen in this standard is based on a graphical screen with a total grid array of 1024×768 rectangular cells. This ratio forms the basis for all object proportions independent of resolution and size of the screen.

3.17**hard key**

physical key with permanent marking and not part of the screen area

Note 1 to entry: This permanent marking may be alpha and/or numeric and/or a symbol.

3.18**input field**

highlighted screen area for entering data

3.19**label**

symbol or text indication on close to an indicator or a button

EXAMPLE Soft key label

3.20**luminance**

physical measurement of the stimulus which produces the sensation of brightness, in terms of the luminous intensity in a given direction (usually towards the observer), per unit area, of an emitting, transmitting or reflecting surface, expressed in candelas per square metre (cd/m^2)

Note 1 to entry: It is the luminous intensity of the light emitted or reflected in a given direction from an element of the surface divided by the area of the element projected in the same direction.

[SOURCE: ISO 11064-6:2005 [7], 3.9, modified: (cd/m^2) added, notes 2 and 3 removed.]

3.21**remedy**

help and/or explanatory information related to a technical fault

3.22**RGB**

colour scheme defined in EN 61966-2-1 [8]

3.23

screen

visual result of software, implemented on a display that is devoted to interact with the user

Note 1 to entry: A screen is a set of information made of a background, windows and symbols. This information may be for example speed, distance, pressure, temperature, electric current, real time video images, which may allow or request drivers to input data through a user interface

3.24

screen area

part of display providing the screens

3.25

sensitive area

enabled area on a touchscreen on which a physical action is possible in order to give input to the display

3.26

soft key

context-dependent key consisting of a combination of a hard key and an associated screen label (text or symbol)

Note 1 to entry: This key is for multifunctional use.

3.27

status

existent or potential state of the system or actual state at a given time t

Note 1 to entry: A status may be:

- a) ON/active/up;
- b) OFF/inactive/down;
- c) excluded;
- d) faulty.

3.28

symbol

pictorial representation (with optional digits and letters) used for displaying information

Note 1 to entry: a pictogram is a specific type of symbol

3.29

technical and diagnostic display

TDD

device that provides information and recommendations with regard to tram vehicle and/or vehicle status, diagnostics, failure management and dedicated functions of the vehicle or the entire train

3.30

basic screen

screen at the root of the screen hierarchy easily accessible

Note 1 to entry: Depending on the situation, the basic screen can be different (at standstill, while running, etc.).

3.31**technical specification**

document describing specific parameters and/or product requirements, which have to be agreed by contracting parties

3.32**text**

alphanumeric information

3.33**title**

text explaining the purpose of the window or screen

3.34**Train Control and Monitoring System****TCMS**

means of controlling and monitoring functions of the train internally, whether by software or hardware, and of providing information to the driver of the status of equipment on-board the train

3.35**mission**

train running number and start and end of train run, assuming the train composition is not changed

3.36**troubleshooting**

process of structured and intentional activities in order to cope with a technical problem with support of the diagnostic system

3.37**window**

separate visual area of the screen which displays information output and may allow input

Note 1 to entry: Usually it has a rectangular shape.

4 Symbols and abbreviations**Table 1 — Abbreviations**

ACK	Acknowledgment
CCTV	Closed Circuit Television
DAC	Driver Activity Control
HSCB	High Speed Circuit Breaker
PAD	Passenger Alarm Device
PAS	Passenger Alarm System
TCMS	Train Control and Monitoring System
TDD	Technical and Diagnostic Display
WSP	Wheel Slide Protection

5 Characteristics of displays and visible or audible information

5.1 General

5.1.1 General guidelines

5.1.1.1 Robustness

Any protection against mechanical damage should not adversely affect the visibility of any displayed information.

5.1.1.2 Consistency of display application

An application Information that requires an action from the driver, shall be presented only once. Existing data shall be consistently available for all displays where relevant. Each piece of information (e.g. time) should be only shown on one display. In case a piece of information is shown on more than one display (or other devices), the delay between the visualization of the information on the displays shall not exceed 1 s.

5.1.1.3 Design principles

All displays and displayed applications should be designed according to consistent principles and therefore have a common approach for the user interface.

The following principles govern graphical user interface design:

- symbols should be used consistently with their meaning (same information = same symbol);
- all driving related displayed information should be located in the preferred field of vision (see FprEN 16186-6:2023, Figure A.2);
- visual information requiring immediate action shall be prominently displayed;
- high priority visual information shall be accompanied by an alerting tone. The number of sounds should be minimized (see 5.1.3.5);

NOTE 1 High priority information is information that requires immediate action by the driver.

- each window should have an explicit title;
- numerical values should be displayed using standard units and SI standard prefixes (e.g.: voltage in V, mV, kV etc.);
- when two symbols (e.g. a needle and a figure) represent the same piece of information on a screen, the same colour shall be used for both unless they physically overlap;

NOTE 2 The symbols in Annex A follow these general rules. Further information related with the symbols is provided in Annex A.

5.1.1.4 Principles for the provision of information

The information provided should be adapted to the phase of driving and the state of the train. The principle of “just enough” at the right time should drive the design of the screens.

TDD displaying safety information shall be developed with the appropriate safety level, if the information is not already displayed outside the TDD.

Mandatory information for operations should be displayed on the TDD basic screen, such as:

- door status and selected side (left, right, both);

- brake;
- power supply;
- main alarms (passenger alarm (emergency handle), fire and smoke detection) and other notifications (PRM request, interphony request, call for aid);
- obstacle detection;
- driving mode (forward, reverse, coupling, washing, speed limiter, cruise control);
- train composition (single or multiple unit), and/or coupled or un-coupled status. This information should be displayed only when status is not nominal (for rescue coupling for instance, or when multiple units are used exceptionally). In case there are more than two units, the total number of units should be displayed as well, for example inside the multiple units pictogram;
- suspensions status;
- speed;
- time and date;
- head and rear lights status, direction indicators (also called trafficators);
- battery charge level information (when tram is running on batteries, supercapacitor or other autonomous systems): Pictogram and/or charge level value (in percent).

The TDD basic screen shall be accessible easily from any screen.

For tram-trains, the following additional information shall be displayed while driving:

- traction/dynamic brake force;
- front light selection states (dimmed headlight, full headlight ...).

The TDD should automatically switch to the appropriate TDD basic screen when new specific conditions are met (stopping, running, etc.).

Other non-mandatory information can be available by navigating through submenus, such as:

- driver area and comfort: Interior lighting, HVAC mode, temperature, etc.;
- passenger area and comfort: Interior lighting, HVAC mode, temperature, etc.;
- external lights;
- trip information (current destination, current station, next station, name of the line, punctuality/delay);
- CCTV, driver announce, passenger alarm system;
- lubrication system;
- sanding system;
- Selected Driving mode (Normal, Driving, Coupling, Washing...);

- low voltage information: Pictogram and/or voltage value, displayed at least when reaching a critical value (i.e. below a certain threshold);
- power supply (pantograph, ground level, ground power collector, roof power collector) position status;
- circuit breaker;
- power convertor;
- motor block;
- status of parking brake, brake test, status of brake test, result of the “Ready to go” test;
- other alarms (if raised).

If a system is available for continuously monitoring an element, an interface shall be provided to indicate the failure of this element to the driver if the failure impacts operations, for example for:

- exterior lights (e.g. the head, marker, tail, stop, fog, day and warning lights);
- wipers;
- direction indicators (also called trafficators).

5.1.1.5 Suppression of information

Information that does not affect the driving task should be suppressed unless specifically selected.

5.1.2 Display performance requirements and principles of presenting information

5.1.2.1 General

All information should be organized into functional groups that contain related items of information. Such relationships should be based on logical or functional considerations:

a) Critical information

Critical information, such as alarms, should be displayed in dedicated locations. In general, the character size and colour of a particular item of information should depend on the importance of that information.

Other information should be limited in order not to overload or to distract the driver.

b) Audible information

Audible information may be used for prompting the user that input is required but, in general, audible information should be reserved for feedback or critical information.

c) Menus

If a menu structure is provided to locate different functions, the menu should:

- facilitate a selection of quick and easy options relevant for the operational task;
- provide a selection facility which allows the choice of a desired option accurately and unambiguously.

d) Feedback and response times

Visual, audio or tactile feedback should be provided at all times.

The response time of the system to an input should be rapid enough not to be perceived as a delay in the workflow.

If the response time of the system is by design longer than 600 ms for a function, and if there is no other feedback from the system, then an information should be displayed (e.g. “Wait” pictogram in Table A.2 or text). If there is still no feedback from the system after a reasonable amount of time, the waiting information should disappear and the function should be ready for use again.

5.1.2.2 Time to change screens

Notwithstanding the processing time of the application, the maximum time to change screens should not exceed 1 s.

5.1.2.3 Display response time

The time between the reception of new data and the update of the screen display image should not exceed 200 ms.

5.1.2.4 Degradation of displays

The system shall provide feedback to enable detection of malfunction that will have an impact on the reliability of the information displayed (e.g. frozen image displayed on the screen). The time information (in s) displayed on the different screens may be used as a means to detect failures.

5.1.2.5 No reverse impact of a display failure

The failure of one display shall not impair the function of any other display.

5.1.2.6 Design of screen area

The screen area shall meet the requirements of pixel failure type 2 and shall be designed in accordance with EN ISO 9241-307:2008, Table 63.

5.1.2.7 Data consistency

If displays are connected by data communication, data shall be available in a consistent way for all displays.

5.1.3 Principles for warnings

5.1.3.1 Content of warnings

The content of warnings should include information on:

- a) titles of the warnings, their form, what they indicate and what response they require;
- b) the levels of priority;
- c) any coding systems that are employed.

Audible warning signals inside the cab should be distinctive and have loudness and sound qualities, according to their functions, urgency and importance. This principle applies for all applications in the cab.

Visual warnings inside the cab should be distinctive and have light intensities, according to their functions, urgency and importance. This principle applies for all applications in the cab.

5.1.3.2 Priority levels

If different levels of priority are used, e.g. high, medium, low, warnings shall be displayed accordingly.

Each level of priority shall be defined.

If different levels of audible signals are used (e.g. High, medium or low), they should be sounded accordingly.

EXAMPLE For example, four different sounds can be created, each associated with conditions which lead to specific actions required from the driver:

- conditions that require the train to be stopped immediately;
- conditions that require the train to be stopped at the next station;
- conditions that require action but not the requirement to stop the train;
- conditions that allow traction.

5.1.3.3 Warning design

The design of warnings should be consistent:

- a) The same type of event occurring should always provide the same type of warning.
- b) A specific type of warning should always require specific response(s).

5.1.3.4 Numbers of visual warnings

The average rate of warnings displayed in normal operation conditions should be less than one in 10 min. When driving, only 2 types of warnings are allowed to be displayed, one for immediate stop and one for stopping at the next station. Other warnings can be available at standstill.

For tram-trains, EN 16186-3:2022, 5.1.4.4 applies.

5.1.3.5 Principles for audible signals

Audible signals should meet all the following requirements:

- as far as practicable, be consistent in their meaning;
- be distinguishable from each other;
- be audible from all applicable driving positions and in all driving conditions;
- not cause drivers audible discomfort when sounding;
- use the selected language, if language selection is provided.

At least two different audible signals should be provided, one which requires immediate stop and one which requires stopping at the next safe place.

At most seven different audible signals should be provided. For tram-trains, the number of audible signals can be higher.

The same signal can be associated with several events if also associated with a pictogram.

NOTE Either a noise or a recorded/synthesized voice is acceptable.

More information on audible signals are available in A.3.

5.1.4 Languages

5.1.4.1 Language selection

If the information can be displayed or sounded in different languages, the possibility to select a language shall be provided.

5.1.4.2 Simultaneous language selection

As an option, the selection of a language in one display may change the language in all displays accordingly.

5.1.5 Tram-trains

For tram-trains running on heavy rail networks, EN 16186-3:2022 applies.

5.2 Design of information

5.2.1 General

5.2.1.1 General design of displayed information

EN 894-2:1997+A1:2008, 4.2.1 shall apply.

5.2.1.2 Common user interface

The same type of display should be used in a cab for all displays. For example displays with touchscreen and displays without touchscreen should not be mixed in a cab.

This could not apply to existing systems, e.g. integrations of new displays in existing driver's cab.

5.2.1.3 Prioritization of information

Prioritization of displayed information can be achieved by adopting the following rules:

- when running in driving mode, the sum of information such as symbols, pictograms, text messages and physical values (e.g. voltage and pressure) displayed simultaneously on a single display should be as low as possible;
- status of equipment not in nominal state and having an impact on the driver's tasks should be displayed;
- if an information is already available on the driver's desk, it has lower priority to appear on a display.

5.2.1.4 Display of indicators

Any indicator should be displayed for at least 2 s, except when a user action leads to deletion of the indicator.

5.2.1.5 Audible and/or visual warnings

When a system and/or function intervenes with a driver's task, an audible and/or visual warning shall be given by the display.

5.2.1.6 Use of information

The use of symbols, standardized text messages and audible information shall comply with Annex A and the requirements of this standard.

5.2.2 Screen organization and dimensions

5.2.2.1 Organization of screen information

The screen shall be organized as shown in Figure 1.

Use of optional areas and size of all areas in Figure 1 shall depend on the specific requirements of the applications using the display. Touchscreen buttons, if any, can be placed on the entire screen. If hard keys are used, Annex B should apply. TDD information should be structured according to Annex C.

For tram-trains, EN 16186-3:2022, Annex E, Annex F and Annex H apply.