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Railway applications — Classification system for railway vehicles

Part 5: System Breakdown Structure (SBS)

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National foreword

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A list of organizations represented on this committee can be obtained on request to its secretary.

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Foreword

This document (EN 15380-5:2014) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2015 and conflicting national standards shall be withdrawn at the latest by March 2015.

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

This series of European Standards EN 15380 “*Railway applications — Classification system for railway vehicles*” consists of the following parts:

— *Part 1: General principles*

— *Part 2: Product groups*

— *Part 3: Designation of train-set positions and installation sites*

— *Part 4: Function groups*

— *Part 5: System Breakdown Structure (SBS)*

NOTE EN 15380–2 refers to Product Breakdown Structure (PBS). EN 15380–4 refers to Functional Breakdown Structure (FBS).

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Introduction

The System Breakdown Structure (SBS) provides the means of defining a railway vehicle in manageable and recognizable main systems and subsystems.

In addition to main systems and subsystems this document includes transverse elements, which result from the architectural design.

The SBS can be used to link functions according to EN 15380-4 to main systems and subsystems. The SBS is also used to associate subsystems with products. Examples of products or product groups are given in EN 15380-2.

The relationships of functions to the SBS and to the products depend on the architectural design of the railway vehicles.

As a result of the architectural design there will be different associations of products to subsystems. These different associations can be compared and evaluated. In addition the SBS provides a common stable structure “black box approach” for optimization of the train architecture.

The SBS with the other breakdown structures can be used at different stages of the vehicles life cycle. The SBS provides a common structure to be used by various stakeholders, e.g. authorities, operators, maintainers, integrators and suppliers.

The System Breakdown Structure according to EN 15380-5 (SBS), the Product Breakdown Structure according to EN 15380-2 (PBS) and the Functional Breakdown Structure according to EN 15380-4 (FBS) complement each other. These structures describe different views of railway vehicles.

1 Scope

This European Standard defines the System Breakdown Structure for railway vehicles and their principal associated attributes.

This European Standard may also be applied to specific railway vehicles like track machines and snow ploughs. However, while the systems that are common with general railway vehicles are included, the systems which are specific to their work processes are not included in this European Standard. They need to be added for these individual projects.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 50343, *Railway applications — Rolling stock — Rules for installation of cabling*

EN 81346-1:2009, *Industrial systems, installations and equipment and industrial products — Structuring principles and reference designations — Part 1: Basic rules*

3 Terms and definitions

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

3.1
object
entity treated in a process of development, implementation, usage and disposal

[SOURCE: EN 81346-1:2009, 3.1, modified — Notes 1 and 2 to entry have been omitted]

3.2
system
set of interrelated objects considered in a defined context as a whole and separated from their environment

Note 1 to entry A *system* is generally defined with a view to achieve a given objective, e.g. by performing a definite function.

Note 2 to entry Examples of a system: A drive system, a water supply system, a stereo system, a computer.

Note 3 to entry The *system* is considered to be separated from the environment and from the other external *systems* by an imaginary surface, which cuts the links between them and the *system*.

Note 4 to entry The term *system* should be qualified when it is not clear from the context to what it refers, e.g. control system, colorimetric system, system of units, transmission system.

Note 5 to entry When a *system* is part of another *system*, it may be considered as an *object* as defined in this standard.

[SOURCE: EN 81346-1:2009, 3.2, modified — Note 2 to entry has been changed]

3.3
structure
organization of relations among *objects* of a *system* describing constituency relations (consists-of/ is-a-part-of)

[SOURCE: EN 81346-1:2009, definition 3.9]

3.4
product
intended or accomplished result of labour, or of a natural or artificial process

Note 1 to entry In the context of this standard the term refers to the industrial *process* (assembly, construction, installation, etc.) through which an *object* is realized.

[SOURCE: EN 81346-1:2009, 3.6, modified — NOTE 1 to entry has been added]

3.5
product-oriented structure
based on the way a system is implemented, constructed or delivered using semi-finished or finished components

Note 1 to entry A product-oriented structure shows the subdivision of the system into constituent objects with respect to the product aspect without taking into account possible function and/or location aspects of these objects.

Note 2 to entry Documents in which the information on a system is organized in accordance with a product-oriented structure highlight the physical arrangements of the components of that system.

3.6
requirement
necessary condition or ability to constrain the solutions of a task or an aim

Note 1 to entry A requirement describes for example, performance characteristics, operational conditions and quality attributes, expressed as measurable and testable technical parameters or indicators.

Note 2 to entry Requirements are usually summarized in a specification.

Note 3 to entry Beside requirements allocated to functions, additional requirements are allocated to other features (e.g. design, manufacturing).

3.6.1
system requirement
requirement on a system, subsystem or device

Note 1 to entry Requirement on a system, subsystem or device regarding the requested technical compatibility, reliability, availability, maintainability, environmental impact/conditions (recyclables, emissions, EMC, climate, vibration), LCC, performance, quality, documentation, realtime behaviour, physical limits (dimension, weight), electrical interface (plugs, voltage, physical layer), or mechanical interface (fixing points, fixing method).

3.7
system breakdown structure (SBS)
hierarchical structure summarising a set of systems

3.8
system level
level of group systems

Note 1 to entry Assignment to the appropriate level is described in the rules.

3.9
1st level system (main system)
main system that provides the key characteristics of the railway vehicle like functions, performance

Note 1 to entry A railway vehicle is built up of main systems.

3.10
2nd level system (subsystem)
system that provides the key characteristics of a main system

Note 1 to entry A main system is built up of subsystems.

3.11
transverse element
element that is common to a number of main systems or subsystems

Note 1 to entry For more information see 5.4.

3.12
attribute
key characteristic usually defining performance parameters or boundary conditions applicable to consist and system levels

Note 1 to entry For more information see Annex A (informative).

3.13
boundary condition
non-influenceable condition which has to be taken into account as a given parameter

3.14
consist
single vehicle or a group of vehicles that are not separated during normal operation; train set and rake of coaches are synonyms

EXAMPLE The vehicles of a consist are permanently connected in a workshop. These consists may form a train using for instance automatic couplers, which may be performed during operation.

[SOURCE: EN 50463-4:2012, 3.1.2, modified — Note 1 to entry omitted and example has been added]

4 Symbols and abbreviations

FBS Functional Breakdown Structure

SBS System Breakdown Structure

PBS Product Breakdown Structure

FRS Functional Requirement Specification

5 System Breakdown Structure (SBS)

5.1 General remarks

The hierarchy of the SBS serves as a guideline when creating system structures. Systems realize functions at a high technical level as hardware and software within hierarchically structured units. Although the units interact at the functional level, they may be spatially separate from one another.

Expanding the systems and subsystems is possible within the scope of this standard. Whether it is necessary to make use of this option will depend on the specific application being considered.

Changes of the existing set of main systems and subsystems as defined in this standard shall not be permitted.

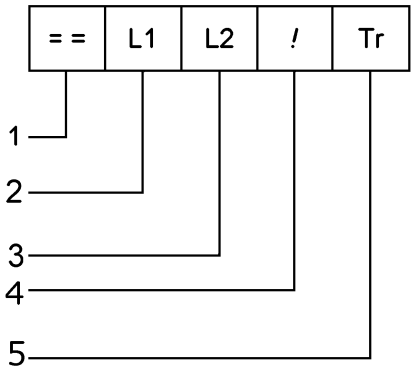
In the case the design solution requires transverse elements (see 3.11) the specific system breakdown structure comprises the system breakdown structure according to EN 15380-5 (SBS) expanded by the transverse elements.

5.2 Classification used for system levels

System levels are identified by using letters of the alphabet only, as set out in Table 1 and Table 2. The use of the letters I and O, as well as special characters and separators, is not permitted.

The 1st level systems and 2nd level systems and transverse elements are coded in their respective levels using a single letter. If transverse elements are applicable for each system, several lines with related transverse elements can be added in the following way, e.g. = = GA/V,GA/S, where GA is the identifier for SBS and V, S are the identifiers for the transverse element contained in 5.4, Table 3. If no transverse element is used the identification in this example is = = GA.

The classification systems can be used either in whole or in part. As a minimum, it is recommended to use it with both level 1 and level 2.



Key

1 sign „system“ according to EN 81346-1 (Rule 16)

2 1st level system according to 5.3.1

3 2nd level system according to 5.3.2

4 separator between system and transverse element

5 level 1 transverse element according to 5.4

Figure 1 — Precept of system level identification

5.3 Code letters

5.3.1 Letters used to identify 1st level systems

The first level systems are specified using the letters as listed in Table 1.

Table 1 — 1st level systems

Ident of 1st level systems	1st level systems
B	Car body
C	Doors/Loading
D	Guidance
E	Interiors
F	Lighting
G	Energy supply
H	Propulsion and braking
J	Information and communication
K	Train control
L	Coupling and interconnection

5.3.2 Letters used to identify 1st and 2nd level systems

The main system and subsystem levels are specified using the letters as shown in Table 2.

Table 2 — 1st and 2nd level systems

Level		System	Example / explanation
L1	L2		
B	A	Car body	Including Front/Rear Module if applicable
B	B	Car body shell	
B	C	Crash energy absorption	
B	D	Aerodynamic System	including components supporting aerodynamics
B	E	Windows	
B	F	Windscreens	
C	A	Doors/Loading	
C	B	Exterior doors	
C	C	Interior doors	
C	D	Loading system	
D	A	Guidance	
D	B	Running gear	
D	C	Running gear connection	
D	D	Running gear auxiliary components	
E	A	Interiors	
E	B	Floors and stairways, vestibules	

E	C	Compartments	Including partitions
E	D	Toilet/Sanitary system	
E	E	Catering / Galley	
E	F	HVAC	Heating, Ventilation and Air Conditioning
E	G	Driver's cab	
F	A	Lighting	
F	B	Interior lighting	
F	C	Exterior lighting	
G	A	Energy supply	
G	B	Main energy	
G	C	Auxiliary energy	
G	D	Energy storage system	
H	A	Propulsion and braking	
H	B	Propulsion	
H	C	Braking	
J	A	Information and communication	
J	B	On-board train communication	
J	C	On-board train information	Passenger Information System (PIS)
J	D	Train external communication	Radio communication
J	E	Ticketing system	Fare selection, sale and validation of tickets or passes
K	A	Train control	
K	B	Train Control and Monitoring System (TCMS)	Including Onboard Driver Data Recording System (ODDRS)
K	C	Automatic Train Control (ATC)	Including Automatic Train Operation (ATO) and Automatic Train Protection (ATP)
L	A	Coupling and interconnection	
L	B	Consist coupling	
L	C	Vehicle coupling	
L	D	Gangway	

5.4 Transverse elements

Transverse elements are subsystems which belong to or interface to several main systems or subsystems.

The objective of transverse elements is to avoid repetition of subsystems, and to optimize concepts and solutions vehicle wide.

A transverse element is applicable when:

— a design solution cannot be, or is not, attached to one main system or subsystem of the SBS, and is for application across or within multiple systems or subsystems

— individual systems or subsystems are to be designed with the possibility of achieving common concepts and solutions.

Transverse elements will be treated like subsystems for the purpose of:

— defining the design of transverse elements;

— selection of the PBS elements of the transverse elements;

— defining integration and interfaces to other subsystems.

Table 3 — Listing of potential transverse elements (not exhaustive)

Tr [a]	**Transverse elements**	**Explanation**
Z	Cooling	
Y	Cabling and harnesses	HV (High Voltage), MV (Medium Voltage), LV (Low Voltage) including trays, ducts, conduits, etc. according to EN 50343
X	Diagnostics	diagnostic concept
W	Piping	fluids (liquids and gases)
V	Fire safety	passive and active protection provisions
U	Displays	visualization concept, e.g. Human Machine Interface (HMI), Driver Machine Interface (DMI)
T	Labelling	emergency signs, product, assembly and maintenance information, vehicle marking (e.g. classification, serial number)
S	Locking	locks, electrical protection for safety and maintenance
R	Panels and cases	cabinets, boxes, cubicles, etc.
Q	Fixings	
[a] Ident of transverse elements		

Annex A
(informative)

Attributes

The objective of attributes is to indicate the type and applicability of specific conditions or performance parameters.

Attributes are quantified by requirements and allow the sorting of requirements.

The attributes support the development of requirements for the design of systems and the quantification of the associated requirements.

NOTE Attributes are not systems or subsystems.

Requirements may need to be broken down to system requirements to ensure that the overall performance of consist is met by the collective performance of the systems, subsystems and associated products.

Table A.1 — Examples for attributes

Attribute	**Comment**
Reliability, Availability, Maintainability (RAM)	performance parameter
Safety	performance parameter (includes crash and fire safety)
Security	performance parameter (IT security)
Health protection	performance parameter (protection of workers)
Life Cycle Cost (LCC)	performance parameter (also including Integrated Logistic Support – ILS)
Visibility and Audibility	performance parameter, awareness of vehicle presence, e.g. warning horn, exterior lighting
Physical limits	boundary condition (vehicle key dimensions)
Electromagnetic compatibility (EMC)	boundary condition
Weight	performance parameter / boundary condition
Acoustics and Vibration	performance parameter / boundary condition
Environmental condition	boundary condition (e.g. temperature, weather)
Environmental protection	performance parameter (e.g. recyclability, sustainability, banned substances)
Thermodynamics	performance parameter
Aerodynamics	performance parameter
Vehicle dynamics and gauging	performance parameter / boundary condition
Industrial design (interior and exterior aesthetics) and ergonomics	performance parameter (e.g. customer comfort)
Operating performance	performance parameter / boundary conditions (route and operating profile)

Attribute	**Comment**
Structural mechanics	performance parameter
Rescue and recovery	performance parameter
Power distribution and management	performance parameter
Energy consumption	performance parameter
External Command and Control and signalling	boundary condition
Operational conditions	performance parameter / boundary condition (like operator's specific requirements, regulations and normative requirements)
Maintenance provisions	boundary condition (including cleaning provisions)

Annex B
(informative)

Connections of FBS, SBS and PBS (Example)

This informative annex is intended to provide simplified examples of the relationship between the several parts of the EN 15380 series. It is up to the user to define the linkage between Part 5 and Part 2. The following simplified examples may give the user an idea of several methods to implement this matter.

Table B.1 — Example of associating functions and products for the subsystem EF "HVAC"

EN 15380–4 (FBS)				EN 15380–5 (SBS)				EN 15380–2 (PBS)		
	1st Level function		**2nd Level function**		**Main systems**		**Sub-systems**		**Sub Product Groups**	**Products**
C	Provide appropriate conditions to passenger, train crew and payload	CE	Provide proper climate	E	Interiors	EF	HVAC			
								LA	Air conditioning	
								LB	Intake/evacuation of air	
										Air filter
								LC	Treatment	
										Exchanger
										Ventilator
										Heater
										Compressor
								LD	Distribution	
								LE	Regulation	
										Electronic regulator

Table B.2 — Example of associating functions and products for the subsystem HB "propulsion"

EN 15380–4 (FBS)				EN 15380–5 (SBS)				EN 15380–2 (PBS)
	1st Level function		**2nd Level function**		**Main systems**		**Subsystems**	**Products**
				K	Train Control	KB	Train Control and Monitoring System	to be determined by Train control engineer
						KC	Automatic Train control	to be determined by Train control engineer
				G	Energy supply	GB	Main energy	to be determined by Energy supply engineer
						GC	Auxiliary energy	to be determined by Energy supply engineer
						GD	Energy storage system	to be determined by Energy supply engineer
G	Accelerate, maintain speed, brake and stop	GB	Provide acceleration *	H	Propulsion and Braking	HB	Propulsion	
								FD Traction motor
								FD Traction-brake resistor
								FD Voltage selection device
								GB-GF Various elements e. g: GC Driving and brake controls
								HB-HF Various elements e. g: HE Cooling unit for power and drive systems
								MB Sanding Equipment

NOTE See Table B.3 for additional sub functions

Table B.2 shows a (simplified) second example not using the column "Sub Product Groups" as given in EN 15380-2. It is up to the user to define whether the full coding of EN 15380-2 should be applied as shown in the examples above.

When EN 15380-2 and EN 15380-5 are being used together, the two levels of EN 15380-5 should be applied. Where level three or more needs to be developed then elements of EN 15380-2 should be used.

The example in Table B.2 shows how the system under development “Propulsion” is linked between FBS, SBS and PBS.

In principle the system “Propulsion” is linked to the first level function “Accelerate, maintain speed, brake and stop”. The principle function of the system “Propulsion” is to “Provide acceleration” (main function, 2nd level function). Therefore, stopping/braking sub functions are not applied for this example (see Table B.3).

The list of associated sub functions (see Table B.3) is a useful checklist when writing the requirements specification. This list (the list is not exhaustive) is useful as a reminder to the author:

a) it shows the relationship between sub functions and main functions.

b) it highlights the contribution of other principle functions and main systems (in this example to K Train Control and G Energy supply) which will/may have to be managed as assumptions in the initial phase of development due to those principle functions and main systems being outside the scope of the system under development.

Table B.3 — List of sub functions focused on the main function GB “Provide acceleration” of the function G “Accelerate, maintain speed, brake and stop” (extract of EN 15380-4)

Sub functions: GB Provide acceleration
Configure propulsion system
Configure propulsion system according to operational modes/ limits
Configure propulsion system according to internal status
Apply power limits
Acquire propulsion demand
Acquire propulsion demand from the driver
Acquire propulsion demand from the ATO
Acquire propulsion demand from internal speed control
Acquire demand for dynamic brake force from brake control [a]
Acquire traction cut-off [a]
Manage traction system within mode
Control motor speed and torque
Control the torque transmission (gear)
Isolate traction elements
Cut-off traction on demand [a]
Provide demand for energy supply
Control wheel slipping
Generate tractive effort
Convert electrical energy into traction force and vice versa
[a] Stopping/braking sub-function not applicable

Annex C
(informative)

Rules to define the system level

The following rules have been used to define the system levels and should be applied in case of any future expansion of the standard:

Rule 1:

The first level of the SBS is a list of the main systems which provide the key characteristics of the railway vehicle.

Rule 2:

In the process of creating the first level of the SBS the FBS has been used for guidance and completeness.

Rule 3:

A main system supports one or more level 2 functions of the FBS.

Rule 4:

All main systems should cover all level 1 and 2 functions of the FBS.

Rule 5:

A subsystem (level 2) provides the key characteristics of the related main system.

Rule 6:

A main system is built out of a combination of the related subsystems.

Rule 7:

A subsystem can be built out of a combination of products (hardware and software).

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[2] EN 15380-2, *Railway applications — Designation system for railway vehicles — Part 2: Product groups*

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