

STM ATB Product Realisation

Generic Requirements Trainborne Hardware

SPID-000803

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Revision control

Version	Date	Author	
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1 Introduction

A train borne subsystem “STM-ATB” according to Directives 2012/88/EU (TSI-CCS), 2015/014/EU (Set of specifications # 2) and “Regeling van de Minister van Infrastructuur en Milieu, van 5 maart 2012, nr. IENM/BSK-2012/28591, houdende vaststelling van regels met betrekking tot de indienststelling van spoorvoertuigen op hoofdspoorweginfrastructuur” (RIS) is to be developed.

Figure 1 shows the ETCS reference architecture as specified in SUBSET-026-2. In blue the scope of the development is outlined.

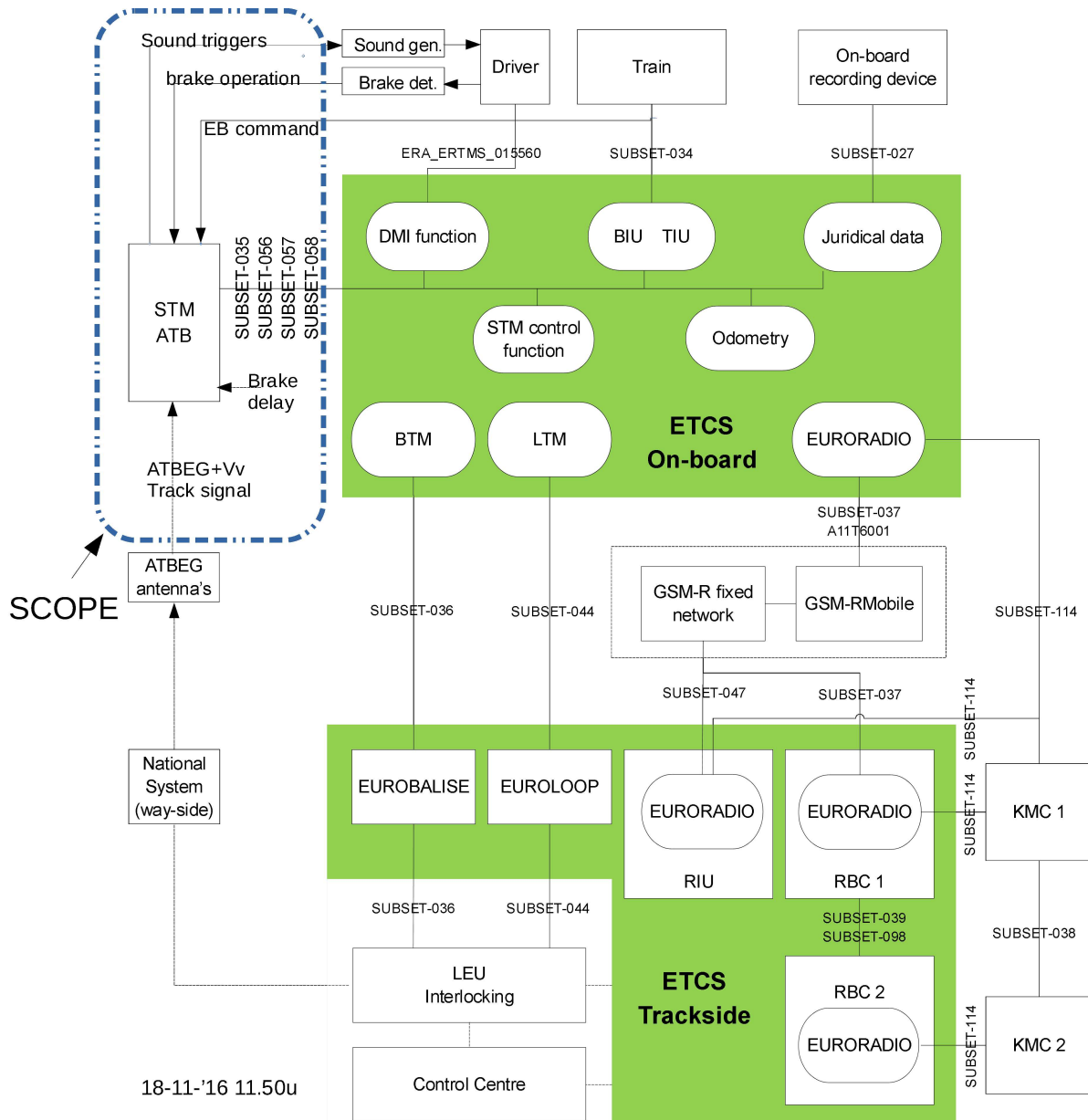


Figure 1 ETCS reference architecture, in blue the scope of the ATB equipment

In short the subsystem is characterized as a SIL-3 system whose main functionality and top-level requirements are described by:

- Directives 2012/88/EU (TSI-CCS)

- Directive 2015/014/EU (Set of specifications # 2) and
- Wet van 23 april 2003, houdende nieuwe algemene regels over de aanleg, het beheer, de toegankelijkheid en het gebruik van spoorwegen alsmede over het verkeer over spoorwegen (Spoorwegwet)
- Regeling indienststelling spoorvoertuigen (RIS)
- ATBVv RL-MH-070006813 Systeembeschrijving v11.0 (SPID-000717)

The subsystem shall be interoperable with ETCS train borne systems according to RIS and in accordance to ERA Set of specifications # 2.

Functionality as required for ATBVv, a recent addition to ATBEG, will be integrated. For this purpose the frequencies 1145Hz, 1445Hz, 1744,5Hz, 2353Hz and 2670,5Hz (RIS Bijlage 1 tabel 1 ad. 10) will be used.

Functionality for ATBNG is not supported.

The hardware and software is to be developed according to EN 50126, EN 50128 and EN 50129.

This document describes the for the environmental conditions applicable standards.

2 Applicable environmental standards

The mentioned standards are mandatory based on TSI's or national legislation.

The equipment shall be in compliance with the following standards:

- EN50155: Railway applications
Electronic equipment used on rolling stock
Juli 2007
- EN50121: Railway applications
Electromagnetic compatibility
Maart 2015
- EN50124: Railway applications
Insulation coordination
Mei 2001 / Mei 2010
- EN60664: Insulation coordination for equipment within low-voltage systems
Edition 1.1
Augustus 2007
- EN50153: personal safety against electric shock.
Mei 2014
- EN45545: Brandbescherming op voertuigen (guideline can be found in CEN/TS 45545-2 and CLC/TS 45545-5). Maart 2013
- WEEE, Waste of Electrical and Electronic Equipment, Directives 2002/96/EG, 2012/19/EU
- RoHS, Restriction of Hazardous Substances 2002/95/EG 2011/65/EU

Notes:

- a) IEC60571, EN50125: Electronic equipment on rolling stock: relevant considerations are covered by the more strict EN50155.
- b) EN50238 is informative.

- c) Most recent versions of the mentioned standards shall be used. The supplier shall advise the customer if a deviation is noticed.

2.1 EN50155

In this chapter the requirements given in EN50155 are further specified.

This chapter details the requirements from EN50155 and their relationship with the STM equipment. The entire norm is applicable, except where otherwise stated. The numbering used in this document correlates with that of EN50155.

EN50155 H4 Environmental service conditions of operation

The STM equipment shall meet the requirements in this section as written, with the following additional comments.

- Subsection 4.1.1: The STM equipment must be able to function to an altitude of 1000m. (EN50125-1 Class A2)
- Subsection 4.1.2: The STM equipment shall be developed for the temperature ranges described by class T1
- Subsection 4.1.4: The STM equipment shall be able to resist condensed moisture resulting from increases or decreases in temperature ($dT/dt < 3^{\circ}\text{C/s}$).

EN50155 H5 Electrical service conditions

The STM equipment shall meet the requirements in this section as written, with the following additional comments.

- It is assumed that the power supply provided to the STM equipment will meet the requirements of EN50155. To be able to cope with exceptions additional requirements will be included in this document. The following points remain relevant to the STM equipment.

The STM shall be fully operable at any of the following battery voltages on the vehicle.

Nominal	Variation
24V	According to EN 50155 Interruption class S2 (10 ms)
48V	
60V	
72V	
110V	

Table 2 Battery voltages and requirements

- Subsection 5.1.1.1: This paragraph is applicable since not every rolling stock has a voltage stabilizing device.

- Subsection 5.1.1.2: Class S2.
Interruptions may not cause any equipment failure. Moreover, the interruptions shall not cause the status of the STM equipment to become undefined. As soon as supply voltage returns to tolerated levels, the STM equipment must recover full function.
- Subsection 5.1. 2: Switching from auxiliary power supply to battery power supply shall take place within the following boundaries:
 - minimum voltage = 0,5Un (for a period of 100ms)
 - maximum voltage = 1,4Un
- Subsection 5.1.3:
Both classes apply, class C1 and class C2
- Subsection 5.3: The STM equipment can be installed in vehicles with one battery pole connected to the vehicle body and in vehicles without a battery pole connected to the vehicle body.

EN50155 H6 Reliability, maintainability and expected useful life

The STM equipment shall meet the requirements in this section.

- Subsection 6.1.1: MTBF is minimally 500.000 hours.
- Subsection 6.1.2: The procedure to verify the MTBF is to be agreed.
- Subsection 6.2: The system lifetime shall be designed for a lifetime of 30 years
- Subsection 6.4: Communication shall be possible with an external computer.

EN50155 H7 Design

The STM equipment shall meet the requirements in this section as written, with the following additional comments.

- Subsection 7: The system requires no GTO-drive and no Firing pulses.
- Subsection 7.2.2: Fuses or similar protections can be used only in consultation with the client.
- Subsection 7.2.3 and 7.2.5: See EN50155 section 5.3.
- Subsection 7.4.3: The use of a watchdog shall be underpinned with safety and availability analysis.

EN50155 H8 Components

The STM equipment shall meet the requirements in this section as written.

EN50155 H9 Construction

The STM equipment shall meet the requirements in this section as written, with the following additional comments.

- Subsection 9.1.4: Not relevant for the STM equipment.
No IC sockets. (except in the case of the development prototype)
- Subsection 9.2.5: Select on test (SOT) components may not be used.
- Section 9.4: Not relevant for the STM equipment, as inside the STM ATB no cables shall be used.
- Subsection 9.8.1: PCB's shall have unique identification numbers.

- Subsection 9.8.4: In principle, the use of batteries shall be avoided in the STM equipment. If use of batteries is unavoidable, then customer approval of the type and mounting of the same is required.

EN50155 H10 Personnel safety

The STM equipment shall meet the requirements in this section as written, with the following additional comments.

- Section 10.3: No voltage above 50V may be reachable outside the STM ATB.

EN50155 H11 Documentation

The STM equipment shall meet the requirements given in the EN50126 and EN50129.

EN50155 H12 Testing

The STM equipment shall be tested in conformity with tests listed in EN50155, section 12.2, table 2. This requirement entails that the STM equipment can undergo the tests listed in table 1.

See next page.

	Test STM equipment	Type	Routine
1	Visual inspection	*	*
2	Performance test	*	*
3	Cooling test	*	-
4	Dry heat test	*	-
5	Damp heat test, cyclic	*	-
6	Supply overvoltages	*	-
7	Surges, electrostatic discharge tests and transient burst susceptibility test	*	-
8	Radio interference test	*	-
9	Insulation test	*	*
10	Salt mist test	*	-
11	Vibration, shock and bump test	*	-
12	Water tightness test	-	-
13	Equipment stress screening (Burn in test)	*	-
14	Low temperature storage test	-	-

Table 1, List of tests to be executed

Note: *= Test is required.

- = Test is not to be executed.

With respect to these tests the following comments:

- Subsection 12.2.6 The analogue inputs shall be able to withstand supply-overvoltages. All inputs shall have been tested in accordance with figure 2. If the choice has been made that $U_N = 110V$, the duration shall be determined by the appropriate figure and correlating table, with exception of the serie resistor which shall be 100Ω . The test voltage shall be applied in differential mode at the inputs.
- Subsection 12.2.10: Salt mist test required according to class ST4.
- Subsection 12.2.11:
EN61373: Category 1, Class B.
For table 1, 2 and 3: In all three directions use the maximum value

2.2 EN50121

This chapter details the requirements from EN50121-3-2 and their relationship with the STM equipment.

The entire norm is applicable, except where otherwise stated. The numbering used in this document correlates with that of EN50121.

Moreover, for EMC immunity the presence of cabling between the coaches and the presence of broadcasting systems including GSM-R/GSM/GPS/porto phone must be accounted for.

EN50121-3-2 : H7 Emission tests and limits

The STM equipment must meet the emissions requirements as written in this chapter. Typically, a good design which adopts standard requirements pertaining to high-frequency disruptions will also satisfy these requirements.

Table 1 : Emission – Auxilliary AC or DC power ports :

The requirements are applicable for all power in- and out-outs of the STM equipment. Damping may be expected from casing and cabling shield.

Table 2 : Emission – Battery power supply (input and output) :

The requirements are applicable for all in- and out-outs of the STM equipment. Damping may be expected from casing and cabling shield.

Table 3 : Emission – Enclosure port :

There requirements are applicable for the STM equipment. Damping may be expected from casing and cabling shield.

EN50121-3-2 : H8 Immunity tests and limits

The STM equipment must meet the emissions requirements as written in this chapter. Typically, a design with the capacity to function well in proximity of switching power will also meet these requirements. The use of a protective case, protected cables and EMC-resistant entries contributes in part to the satisfaction of these requirements. The method of testing and test set-up is described in EN61000.

Table 4 : Immunity – Process measurement and control ports :

There requirements are applicable for all power in- and out-outs of the STM equipment. Damping may be expected from casing and cabling shield.

Table 5 : Immunity – Process measurement and control ports :

There requirements are applicable for all in- and out-outs of the STM equipment. Damping may be expected from casing and cabling shield.

Table 6 : Immunity – Enclosure port :

The requirements for radio frequency interruption and the electromagnetic field produced by mobile phones are applicable for the whole STM equipment. The choice of connectors, cables and casing largely determine the signal transfer and damping. The STM equipment represents a significant portion of this. For such reason, these requirements are placed directly upon the STM equipment.

6.2	Radio-frequency electromagnetic field from digital communication devices	30V/m* (rms carrier voltage) 800-1000MHz @30V/m 1400-2 000MHz @30V/m 2000-2700 MHz @5V/m 5100-6000MHz @3V/m 1 kHz, 80 % AM	EN 61000-4-3
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* The RLN00024 as released by ProRail requires 30V/m instead of 20V/m bij 900MHz, measured in conformance with ENV50204.

2.3 EN50124

This norm has two parts. At last check, these parts were known as 50124-1:2001+A2:2005+C1:2010 and 50124-2:2001+C1:2010. This chapter details the requirements from EN50124-1 concerning un-

isolated conductors and the consequences for the STM equipment. The entire norm is applicable to the STM equipment, except where otherwise stated.

It is supposed that the supplier can develop a print PCB which:

- Complies to the required life-expectancy;
- Complies to the reliability expectations;
- Can successfully withstand the testing in conformity with EN50155.

The supplier shall deliver the required evidence.

The numbering used in this document correlates with that of EN50124.

Guidance Values:

- Minimum clearances in air (in mm) based on the rated impulse voltage (annex A.3)

PD3A schrijft bij $U_{ni} = 0,8kV$ een minimum clearances voor van 1,60mm.

- Minimum creepage distances (in mm) based on rated insulation voltage U_{Nm} up to 1000V for printed wiring material and associated components (annex A.5)

- Minimum creepage distances (in mm) for low values of rated insulation voltage U_{Nm} for materials

For $U_{nm}=150V$ the nearest value available in the table is 160V, the following distances are applicable:

PD3A		
Material Group		
I	II	III
3,2	4,0	5,0

2.4 IEC60664

The last known version of IEC 60664 is composed of five parts, known as IEC60664-1:2007, IEC 60664-2-x:2011/2002, 60664-3:2003+A1:2010, 60664-4:2006, and 60664-5:2007.

Up to and including a frequency of 30kHz, the IEC 60664-1:2007 is applicable for the isolation coordination low-voltage systems.

Above 30kHz, the IEC 60664-4 is applicable for low-voltage coordination systems.

The entire norm (IEC 60664-1 t/m 5) is applicable to the STM equipment , except where otherwise stated. The comments in this section can be used in the design and realization of the STM equipment.

It is supposed that the supplier can develop a PCB which:

- Complies to the required life-expectancy;
- Complies to the reliability expectations;
- Can successfully withstand the testing in conformity with EN50155.

The supplier shall be able to demonstrate that the print meets the requirements outlined in the IEC 60664. Parts 2-5 may be modified where it is an advantage to the design to do so. The design supposes a multi-layer printed circuit board with SMD components. The distance between PCB tracks used in this document will be less than the indicated value of the IEC 60664, such that additional proofs and testing shall be required. The numbering used in this document correlates with that of the IEC 60664.

Within 60664-1 a number of classifications will be introduced in certain areas which influence the isolation coordination as it is to be applied.

Overvoltage category:

Overvoltage category I

Rated impulse voltage:

Rated impulse voltage $U_{ni} = 800 \text{ V}$.

Pollution degree:

Pollution degree 3

Material groups:

To be motivated by supplier

Field conditions

At certain distances, a distinction between homogeneous and inhomogeneous e-field conditions is made.

To be motivated by supplier.

Distances $\leq 2\text{mm}$

For the isolation coordination of systems with distances $\leq 2\text{mm}$ see the IEC6066-5. This includes the additions to 60664-1. Additional classifications are included in this norm which influence applicable isolation distances. These are:

Water absorption

To be motivated by supplier.

Critical relative humidity

To be motivated by supplier.

- Minimum clearances for insulation coordination (Table 2)

Bij $U_{ni} = 0,8\text{kV}$ en Pollution degree 3 is applicable to the minimum clearances:

minimum clearances in air in mm up to 2000m above sea level	
Inhomogeneous field	Inhomogeneous field
0,8	0,8

Minimum clearance 0,8 mm

- Minimum creepage distances for equipment subject to long-term stresses (Table 4)

Creepage distances in mm		
Pollution degree 3		
Material group		
I	II	III
2	2,2	2,5

Creepage distance I = 2, II = 2,2 III = 2,5

2.5 EN50153

The most recent version of EN 50153 was published in 2014. The entire norm is applicable with the exception of the following points.

In table 1 varying voltage classifications are shown.

Table 1 – Voltage bands

Band	Nominal voltage U_n	
	AC V	DC V
I	$U \leq 25$	$U \leq 60$
II	$25 < U \leq 50$	$60 < U \leq 120$
III	$50 < U \leq 1\,000$	$120 < U \leq 1\,500$
IV	$U > 1\,000$	$U > 1\,500$

For STM band I and II are applicable.

2.6 EN45545

The most recent version of EN 45545-2 and EN 45545-5 were published in 2013. The entire norm is applicable with the exception of the points as mentioned in the following subsections.

2.6.1 EN45545-2

In EN 45545-1 the operation category is given:

5.2.3 Vehicles operating on infrastructure not subject to the Directive

A running time for Operation Category 1 vehicles in the event of fire is not specified as these vehicles may be stopped with minimum delay and evacuation started.

The running time for Operation Category 2 vehicles in the event of fire shall be 4 min.

The running time for Operation Category 3 vehicles in the event of fire shall be 15 min.

The running time for Operation Category 4 vehicles in the event of fire shall be 4 min.

NOTE The difference between OC2 and OC4 is the infrastructure, see Annex B.

Table 1 — Running time requirements for operational categories

Operation Category	Running time	Minimum average speed infrastructure subject to the Directive	Minimum average speed infrastructure not subject to the Directive
OC 1	Vehicles may stop with minimum delay	Not applicable. See 5.2.1, Note 2	No requirement
OC 2	4 min	80 km/h	No requirement
OC 3	15 min	80 km/h	No requirement
OC 4	4 min	No requirement	No requirement

OC3 is applicable.

Table 1 — Hazard level classification

Operation category	Design category			
	N: Standard vehicles	A: Vehicles forming part of an automatic train having no emergency trained staff on board	D: Double decked vehicle	S: Sleeping and couchette vehicles
1	HL1	HL1	HL1	HL2
2	HL2	HL2	HL2	HL2
3	HL2	HL2	HL2	HL3
4	HL3	HL3	HL3	HL3

HL2 is applicable.

4.3 Grouping rules

Rule 3 is applicable, Tabel 2: EL9 and EL10, R24/R25 and R26

2.6.2 EN45545-5

5.1 Overload protection

“Where neither pole of the power supply is bonded to earth, the overload protection shall be on both poles of the supply line (e. g. trolley buses).”

It is not acceptable to employ “unprotected parts.”

5.3 Electrical arc protection devices

Arc protection is not applicable.

2.7 WEEE

The STM equipment shall be in compliance with 2002/96/EG, 2012/19/EU.

2.8 RoHS

The STM equipment shall be in compliance with 2002/95/EG 2011/65/EU

3 Additional environmental conditions

The STM equipment shall not be installed in a location where it is exposed to direct solar radiation unless the concerning equipment can withstand 1120W/m² (EN50125, paragraph 4.9, class R2) in combination with the highest environmental temperature.

Standards that are needed for producing STM hardware

EN50155, EN50121-3-2, EN50124, IEC60664, EN50153, EN45545, (EN50238 informative) , EN61373, EN50126, EN50128. Found in the EN50155 norm for PCB's, do not know if the following are applicable EN60249-2-15, EN60297, 61000-4-4, EN61249, EN62326, EN123000, EN123200, EN123300, EN123400, EN123500.