

D4.5 Environmental Requirement Specification (ERS)

for the development of an STM ATB

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STM ATB: D4.5 Environmental Requirement Specification (ERS)

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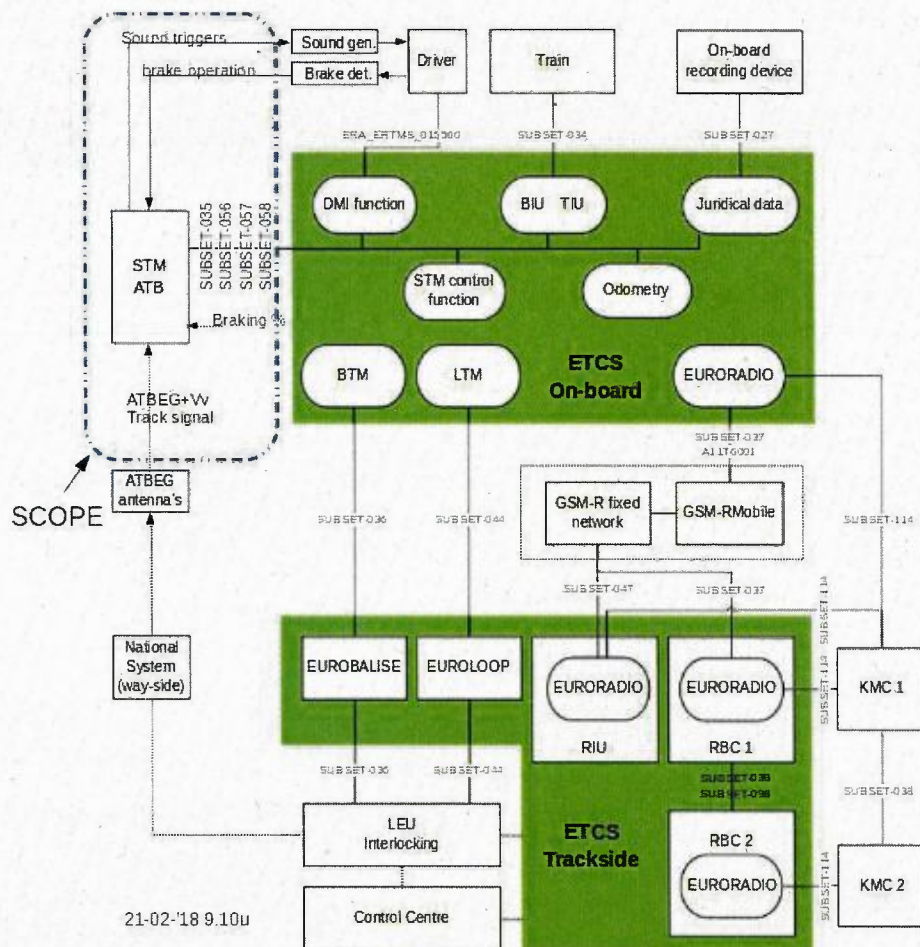
1 Preface

Text, STMA-21880 - A train-borne subsystem "STM ATB" is to be developed. The "STM ATB" is part of the ETCS system, which is depicted in figure 1 STMA-4891. The scope of the development is outlined in the blue dash-dotted line.

Definition, STMA-4891 - (figure)
STM ATB system scope

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Text, STMA-21881 - In short the subsystem is characterized as an STM whose main functionality and top-level requirements are described in the SRS STM ATB [D4.3 System Requirements Specification (SRS)]. This document describes the applicable environmental standards and the resulting requirements from these standards.

Text that has a red typeface is applicable to only a selection of the submodules within the STM ATB.

1.1 Reference documents

Text, STMA-21877 -

Reference documents

All the documents references used in this document can be found in the document P6.1 Bibliography available in the Polarion folder Processes

Abbreviations, definitions and terminology

An overview of the abbreviations, definitions and terminology used in this document can be found in document

P6.2 List of abbreviations, definitions and terms available in the Polarion folder Processes

Requirement identification

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The STM ATB project makes use of an automated requirement management system. In this system each requirement has been identified as a work item. Each work item has been automatically assigned with a unique ID, with the format "STMA-<number>". As a result requirement ID's are not in logical order. An overview of all the used STMA-numbers is given in document [P6.3 Requirement Overview](#) available in the Polarion folder [Processes](#)

Requirement, STMA-28794 - Required legal standards and norms applicable to the STM ATB project and product are listed in document [D3.0 Legal framework standards and norms](#)

2 Environmental requirements

2.1 Applicable standards

Text, STMA-21878 - The mentioned standards are mandatory based on TSIs (a.o. referring to EN50129:2003) or national legislation.

The equipment shall be in compliance with the following standards (see EN50129: 2003, annex B4):

Requirement, STMA-8383 - EN50155: Railway applications Electronic equipment used on rolling stock, July 2007 including corrigendum May 2010.

Text, STMA-16106 - Note: compliance with EN50155:2007/C1:2010 covers the compliance with EC Directive 2008/57/EC within its scope, according to Annex ZZ

Requirement, STMA-8384 - EN50121: Railway applications Electromagnetic compatibility, March 2015.

Requirement, STMA-8385 - EN50124-1/2: Railway applications Insulation coordination May 2001 / May 2010.

Requirement, STMA-16100 - EN50125-1: Railway applications Environmental conditions for equipment. Rolling stock and on-board equipment.

Requirement, STMA-16107 - EN61373: Railway applications Rolling stock equipment Shock and vibration tests, September 2010 including corrigenda October 2010, January 2012, March 2012.

Requirement, STMA-8386 - EN60664-1/5: Insulation coordination for equipment within low-voltage systems Edition 1.1 August 2007

Requirement, STMA-8387 - EN50153: personal safety against electric shock, May 2014.

Requirement, STMA-8389 - EN45545-1/2/5: Railway applications Fire protection on railway vehicles (guideline can be found in CEN/TS 45545-2 and CLC/TS 45545-5). March 2013 including corrigendum November 2015.

Requirement, STMA-8390 - WEEE, Waste of Electrical and Electronic Equipment, Directives 2002/96/EG, 2012/19/EU

Requirement, STMA-8391 - RoHS, Restriction of Hazardous Substances, 2002/95/EG 2011/65/EU

Requirement, STMA-16121 - REACH, Registration, Evaluation, Authorisation and Restriction of Chemicals, 2006/1907/EU.

Text, STMA-22072 - Notes:

Text, STMA-8632 - IEC60571, EN50125: Electronic equipment on rolling stock: relevant considerations are covered by the more strict requirements in EN50155.

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2.2 Scope

Text, STMA-21875 - In this chapter the requirements based on the norms mentioned in the previous chapter are further specified. The requirements apply for the complete STM ATB.

Unless specified otherwise the requirements apply for the HW modules:

- Enclosure.
- Backplane Board.
- SAP Board: Processor Board including the Profibus connection.
- DIO+PS Board: the Power Supply plus Digital IO Board.
- AIN Board: the Analogue Input board.

If a requirements only applies to a part of the components then this will be indicated using red coloured text.

Requirement, STMA-8398 - 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.

2.3 Environmental service conditions of operation

Text, STMA-21876 - References below are made to EN50155 unless stated that a reference is made to the EN50125.

Requirement, STMA-8401 - EN50155, Subsection 4.1.1: The STM ATB shall be able to function to an altitude of 1800 m. (EN50125-1, 4.2 Class AX > 1400 m).

note: according to a remark in EN50129 altitudes above 1800 m are unlikely for railway vehicles, so 1800 m has been chosen as the maximum altitude.

Text, STMA-8645 - EN50125-3 (track side equipment, gives an indication for on-board equipment) H4.2.2: The typical variation of pressure caused by train entering tunnel is: $P = 5 \text{ kPa}$

The associated rate of change of pressure is: $\Delta P / \Delta t = 0.5 \text{ to } 1 \text{ kPa/s}$

note: probably not relevant as the enclosure is not air-tight.

Requirement, STMA-8402 - EN50155, Subsection 4.1.2: The STM ATB shall be developed for the temperature ranges described by class T3 (EN50155:2010, 4.1.2 and EN50125-1:2014, 4.3):

i.e. The STM ATB shall sustain operation and storage for ambient temperatures around the STM ATB from -25°C to $+70^\circ\text{C}$ and the STM ATB shall sustain an ambient overtemperature of $+15^\circ\text{C}$ (i.e. up to $+85^\circ\text{C}$) for 10 minutes.

Requirement, STMA-8660 -

The Backplane Board, SAP Board, DIO+PS Board and AIN Board shall sustain operation and storage for ambient temperatures around the PCBs from -25°C to $+85^\circ\text{C}$ and

the Backplane Board, SAP Board, DIO+PS Board and AIN Board shall sustain an over temperature of $+15^\circ\text{C}$ (i.e. up to $+100^\circ\text{C}$) for 10 minutes.

Requirement, STMA-8656 - EN50125-1 Subsection 4.3 A reference temperature of 40°C ($25^\circ\text{C} + \text{cubicle } \Delta T$) is to be considered as being the permanent temperature of the air surrounding the STM ATB for analysing the effects

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on the material ageing during the lifetime.

Requirement, STMA-8661 -

A reference temperature of 55 C is to be considered as being the permanent temperature of the air surrounding the SAP Board, DIO+PS Board and AIN Board for analysing the effects on the material ageing during the lifetime.

Requirement, STMA-8646 - EN50125-1 Subsection 4.4: Humidity surrounding the STM ATB (and inside the enclosure) can vary between 5 % and 100 %.

Requirement, STMA-8648 - EN50125-1 Subsection 4.4: The environmental temperature (environmental to the STM ATB) can vary with +/- 3K/s (maximum variation 40K) and shall be able to resist the resulting condensed moisture (EN50155, Subsection 4.1.4).

Requirement, STMA-8621 - EN50155, Subsections 12.2.3-4: The STM ATB shall be able to withstand "Cooling" and "dry heat" tests for the temperature class specified in:  **STMA-8402**

Requirement, STMA-8545 - EN50125-1 Subsection 4.9: The STM ATB shall not be installed in a location where it is exposed to direct solar radiation.

Requirement, STMA-8551 - EN50155, Subsection 4.1.3/12.2.11: The STM ATB shall be able to withstand shocks and vibrations according to EN61373: Category 1, Class B, while being fully operating (thus connected), i.e.

- Vibrations, in all directions: 5.72 m/s² at 5-150 Hz (according to EN61373:2010 figure 3).
- Shocks, in all directions: 50 m/s² during 30 ms.

As the orientation at which the STM ATB will be installed is unknown, the maximum value applies in any direction. The unit shall remain operational during the test and no damage shall occur.

Details as specified in EN61373

2.4 Power supply

Text, STMA-21879 - Power Supply requirements only apply to the DIO+PS Board. The function of the DIO+PS Board is to transfer the input power to 12 Vdc and to condition the digital I/O.

Requirement, STMA-8407 - EN50155, Subsection 5.1.1.1, 5.1.2, 5.1.3, 5.2: The STM ATB shall be fully functional at nominal supply voltages from 24 Vdc to 110 Vdc

Requirement, STMA-16108 - EN50155, Subsection 5.1.1.1, 5.1.3: The STM ATB shall be fully functional at $0.6 \cdot U_n$ (= 14.4 V When the system is powered with a 24 V power supply (minimum acceptable power supply)) during 100 ms.

Requirement, STMA-16109 - EN50155, Subsection 5.1.1.1: The STM ATB shall be fully functional at $1.4 \cdot U_n$ (= 154 V @ 110 V) during 100 ms

and

voltage fluctuations lying between $1.25 U_n$ and $1.4 U_n$ and not exceeding 1 s shall not cause damage: equipment may not be fully functioning during these fluctuations.

Requirement, STMA-8620 - EN50155, Subsection 12.2.2: The STM ATB shall remain fully functional during "Performance testing" at 14.4 Vdc, 24 Vdc, 72 Vdc, 110 Vdc and 154 Vdc power supply (i.e. the nominal voltages

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and the lower and higher limits).

Testing shall include software driven tests to check all circuits.

note: For routine tests one supply voltage between 14.4 Vdc and 154 Vdc shall be chosen.

Requirement, STMA-8448 - EN50155, Subsection 12.2.6: Supply and digital input overvoltage.

All digital inputs and the Power Supply shall be able to withstand 154 Vdc ($=1,4 U_n$ when $U_n = 110V$) for at least 1 s.

Requirement, STMA-8584 - EN50155, Subsection 7.2.5: The STM ATB shall not be damaged by (repetitive) dropping of the supply voltage below 14.4 Vdc

and

the STM ATB will block its outputs in case its safety function cannot be guaranteed.

Text, STMA-8409 - EN50155, Subsection 5.1.1.2: STM ATB shall be categorized as Class S1: no interruptions.

Therefore, no additional requirements for voltage interruptions.

Requirement, STMA-8553 - EN50155, Subsection 5.1.1.4 (STMA-8407) : The STM ATB shall be able to sustain a ripple at the DC power supply of 15 % of the nominal voltage (110 Vdc, 72 Vdc or 24 Vdc).

2.5 Reliability, maintainability and expected useful life

Text, STMA-8416 - EN50155, Subsection 6.1.1: The reliability and availability are specified in STMA-7122 - D4.3 System Requirements Specification (SRS).

Text, STMA-8417 - EN50155, Subsection 6.1.2: The reliability requirements are covered by EN50126.

Requirement, STMA-8418 - EN50155, Subsection 6.2: The STM ATB shall be designed for a lifetime of 30 years (30 years is the remaining life expectancy of the ATB EG/ Vv system).

Components with a shorter life time shall be identified and documented in the hardware documentation.

Requirement, STMA-8565 - EN50155, Subsection 6.3: in STMA-2643 it is specified that no preventive maintenance shall be necessary.

Requirement, STMA-8568 - EN50155, Subsection 6.4.1: in STMA-8567 it is specified that the complete STM ATB is the smallest "Line Replaceable Unit".

Requirement, STMA-8569 - EN50155, Subsection 6.5 The STM ATB shall provide a visual status indication at the front of the system.

(only applies to the SAP Board).

2.6 Design

Requirement, STMA-8572 - EN50155, Subsection 7.1.1: The HW design process shall comply with EN ISO 9001 requirements.

Requirement, STMA-8573 - EN50155, Subsection 7.1.2: The HW design process shall comply with EN50126/EN50129 requirements.

Requirement, STMA-8574 - EN50155, Subsection 7.2.1: The STM ATB shall provide galvanic isolation between the Power Supply and the other system interfaces. The isolation requirements are listed in STMA-8474 - Isolation (doesn't apply to individual HW modules).

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Requirement, STMA-8575 - EN50155, Subsection 7.2.1: The STM ATB shall provide galvanic isolation between the digital inputs plus one group of 3 digital outputs (output 1-3) and the other system interfaces (doesn't apply to individual HW modules).

Requirement, STMA-8576 - EN50155, Subsection 7.2.1: The STM ATB shall provide galvanic isolation between one group of 3 digital outputs (output 4-6) and the other system interfaces (doesn't apply to individual HW modules).

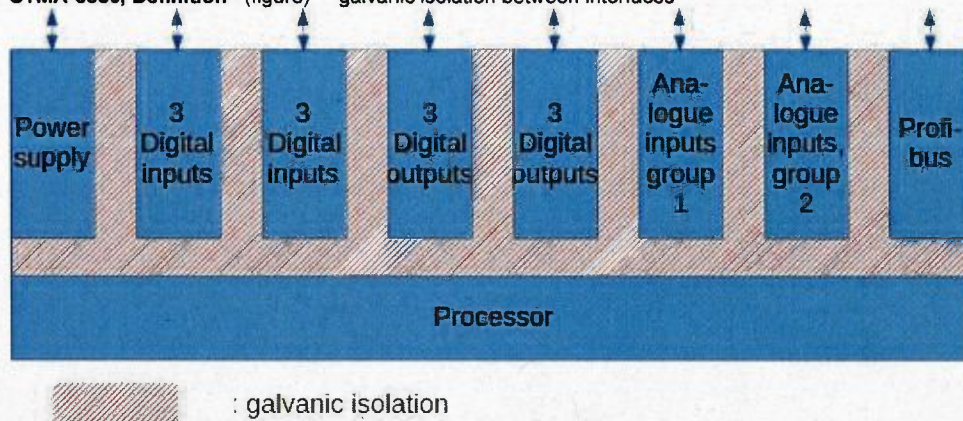
Requirement, STMA-8577 - EN50155, Subsection 7.2.1: The STM ATB shall provide galvanic isolation between one group of analogue inputs (input A1, A2, A3 and Rconfig) and the other system interfaces (doesn't apply to individual HW modules).

Requirement, STMA-8581 - EN50155, Subsection 7.2.1: The STM ATB shall provide galvanic isolation between one group of analogue inputs (input A5, A6, A7 and Rconfig) and the other system interfaces (doesn't apply to individual HW modules).

Requirement, STMA-8578 - EN50155, Subsection 7.2.1: The STM ATB shall provide galvanic isolation between the Profibus and the other system interfaces (doesn't apply to individual HW modules).

Requirement, STMA-8579 - EN50155, Subsection 7.2.1: The STM ATB shall provide galvanic isolation between the processor and all system interfaces (doesn't apply to individual HW modules).

STMA-8580, Definition - (figure) galvanic isolation between interfaces



Requirement, STMA-8423 - EN50155, Subsection 7.2.2: Fuses or other destructive protections shall not be used.

Requirement, STMA-8582 - EN50155, Subsection 7.2.2: Current limiting protection in regulated Power Supply units will be foreseen in the STM ATB to prevent the use of fuses.

Requirement, STMA-8424 - EN50155, Subsection 7.2.1: Digital outputs shall be provided as floating (potential free) contacts. (only applicable for the DIO+PS Board).

Requirement, STMA-8586 - EN50155, Subsection 7.2.6: The selection of the Power Supply connector shall make it impossible to reverse the polarity of the Power Supply (only applicable for the DIO+PS Board).

Requirement, STMA-7117 - EN50155 9.6.1 Printed board types: Traces on inner layers in the PCB shall not be used for plug connection.

Note: Inner layers make it difficult to measure connector signals.

2.7 Components

Requirement, STMA-8427 - EN50155, Subsection 8.1/8.2: The developer of the STM ATB hardware shall provide specifications for all components, defining at least:

- reference number (referring to the circuit diagrams)
- temperature range
- life time
- reliability/availability
- performance/accuracy
- derating (if applicable)
- key components (long lead times, single supplier, etc.)

Requirement, STMA-8589 - EN50155, Subsection 8.1: The developer of the STM ATB hardware shall deliver a list of "single source components", and underpin why those cannot be avoided.

Requirement, STMA-8590 - EN50155, Subsection 8.2: The components used for the STM ATB shall be fit to achieve the required system specifications (e.g. temperature, life time, performance, reliability,.....).

Requirement, STMA-8659 - The developer of the STM ATB hardware shall describe per component:

- The function of the component.
- Considerations at the selection of the component.
- Effect of failure for all failure modes as defined in EN50129, annex C (table C1,...,C16)
(taking into account that all failure modes can be intermittent).

2.8 Construction

Requirement, STMA-8429 - EN50155, Subsection 9.1.1: It shall be possible to lay the STM ATB on a flat surface on any of its faces without causing mechanical damage to any component.

Requirement, STMA-8593 - EN50155, Subsection 9.1.3: The STM ATB shall fit in a 3U high rack. (only applicable for the enclosure).

Requirement, STMA-8594 - EN50155, subsection 9.2.1: The STM ATB shall be installed in a way the front side LEDs are visible.
(doesn't apply to individual HW modules).

Requirement, STMA-16114 - EN50155, Subsection 9.2.1: The front side LEDs and front side connectors shall be labeled with a unique identifier. (only applicable for the enclosure).

Requirement, STMA-8596 - EN50155, subsection 9.2.3: Connections to components shall be made such that no mechanical or thermal stress exceeds the limits specified for the component.

Bending of component leads shall not cause damage or permanent stress to the component body/lead junction.

Requirement, STMA-8597 - EN50155, subsection 9.2.4: no pre-set control adjustments etc. shall be necessary during the operation life cycle.

Requirement, STMA-8431 - EN50155, Subsection 9.2.5: Select on test (SOT) components shall not be used.

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Requirement, STMA-8598 - EN50155, Subsection 9.3.1: Soldered connections shall be made only to components specially designed for that purpose.

Flexible/stranded conductors and metallic braiding designed for flexing shall not be soldered but fitted with crimped tags and strain relieved before the electrical connections.

Silver or gold plated wires or components shall not be soldered, unless the plating is thin enough to avoid any adverse effect on the joints.

Soldered wires and components shall as far as possible be capable of disconnection without disturbing other connections.

Solder fluxes shall be non-corrosive.

Text, STMA-8599 - EN50155, Subsections 9.3.2, 9.3.3 and 9.3.4 are not applicable as only soldered connections are used (except connector-connector connections at the Backplane).

Requirement, STMA-8432 - EN50155, Section 9.4-5: No cables/wires shall be used inside the STM ATB.

Requirement, STMA-8600 - EN50155, Section 9.6.1: The following types of printed board may be used:

- rigid single or double-sided;
- rigid multilayer.

Signal tracks on inner layers shall not be used for direct connection to the vehicle wiring.

All the holes used for soldered connections shall be plated through, with pads on both sides.

Other types may be used with prior approval of the user.

Requirement, STMA-16115 - EN50155, Section 9.6.2: Printed boards shall be procured and manufactured according to the provisions of the relevant Specification from the list below:

- EN 123000 (Generic Specification - Printed boards);
- EN 123200 (Sectional Specification - Single and double sided printed boards with plain holes);
- EN 123300 (Sectional Specification - Multilayer printed boards);

Requirement, STMA-16116 - EN50155, Section 9.6.3: Board layout shall be carried out according to EN 62326, with due regard to the service conditions of the EN50155 standard.

Requirement, STMA-16117 - EN50155, Section 9.6.4: The base material shall be an epoxide woven glass fabric laminated sheet of defined flammability (vertical burning test) for rigid printed boards and for use in the fabrication of multilayer printed boards, according to EN 61249-2-7, EN 61249-2-10 and EN 62326, as appropriate.

Other materials may be used providing they meet or exceed the performance of base material specified above.

Requirement, STMA-8433 - EN50155, Section 9.8.1: PCBs shall have unique identifiers embedded in artwork (visible copper, silk screen) that identify the board type and its revision.

SAP Board identifier: STM-ATB-SAP-xxx

AIN Board identifier: STM-ATB-AIN-xxx

DIO+PS Board identifier: STM-ATB-DIO-xxx

Backplane Board identifier: STM-ATB-BP-xxx

where xxx is a revision number to be agreed with the user.

Requirement, STMA-8604 - EN50155, Section 9.9: The enclosure shall meet the requirements applicable for IP43 (only applicable for the enclosure).

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Requirement, STMA-8605 - EN50155, Section 9.10: No forced cooling shall be used within the STM ATB.

Requirement, STMA-8606 - EN50155, Section 9.11: All materials shall be dimensionally stable, non-hygroscopic, resistant to fungal growth and either non ignitable or resistant to flame propagation (the latter is covered by EN45545)

and

no material shall be on the RoHS list, Directive 2002/95/EG and Directive 2011/65/EU

and

no material shall be on the REACH list, EC regulation 2006/1907/EU.

2.9 Personnel safety

Text, STMA-8436 - EN50155, Sections 10.1 and 10.2: Functional safety requirements are set in (SRS).


Text, STMA-21890 - EN50153 defines requirements to guarantee human safety when using and maintaining the equipment.

for the STM ATB, a device operating maximum in band II (110 Vdc supply and interfaces) those requirements shall be met by the concept of the enclosure:

Requirement, STMA-9362 - The STM ATB shall cover parts potentially carrying unsafe voltages in a way they can't be reached. .

2.10 Documentation

Requirement, STMA-8439 - The STM ATB documentation shall meet the requirements given in the EN50126 and EN50129.

Requirement, STMA-8609 - EN50155, Section 11.1: In addition to  **STMA-8439** the following hardware documentation shall be provided by the designer:

System Description:

- Block diagram.
- System interface description.
- System functionality description.

Hardware Description Document:

- Electrical block diagram.
- Electrical schematic diagrams.
- Functional block description.
- Board layout, component placement.

Technical Construction File:

- Board manufacturing files (Gerbers).
- Board drill file.
- Board layer stack-up.

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- Physical locations of Test Points.
- Bill Of Materials.
- List of special components (long-lead, single supplier, etc.).
- List of limited life components.
- Labeling files.
- Assembly instructions.
- Firmware programming instructions.
- Storage precautions.

Hardware Validation Specification:

- Description of Test Points and other test interfaces.
- Specification of Test Cases (conditions, stimuli, expected results, etc.).
- Specification of test tools / test software.

Hardware Validation Report:

- Test report of validation tests.

Requirement, STMA-8612 - EN50155, Subsection 11.3.1: All "electrical schematics" and "PCB designs" shall bear an appropriate drawing number, date, version/release and title indicating the particular item shown and the type of drawing.

All "electrical schematics" shall include the ERTMS program logo and the license conditions (to be agreed with the user).

Requirement, STMA-8613 - EN50155, Subsection 11.3.1: All graphical symbols used in "electrical schematics" and "PCB designs" shall comply with IEC 60617.

Requirement, STMA-8616 - EN50155, Subsection 11.3.4: The following documentation shall be provided for PCB designs:

- PCB overlay.
- Bill-of-Materials: complete specification of all components.
- Gerbers .
(e.g. Silkscreen top and bottom, Solder mask top and bottom, All metal layers, Paste mask top and bottom, Component map (X-Y coordinates), Assembly drawing top and bottom, Drill file, Drill legend, FAB outline (dimensions, special features), net list, board layer stack up information).

An ODB++ archive containing all information for manufacture shall be provided as well.

Requirement, STMA-8617 - EN50155, Subsections 11.3.7: Drawings defining the cabling from the external connectors to the environment shall be provided.

Requirement, STMA-8618 - EN50155, Subsection 11.3.8: A mechanical drawing of the enclosure plus mounting of the PCBs shall be provided by the designer.

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2.11 Conducted immunity

Text, STMA-21892 - Subsection 12.2.7-8.1: Immunity for conducted and radiated interference, the requirements apply to the STM ATB with mounted connectors and cabling for Power Supply, 6x digital input, 6x digital output, 6x analogue input (only coil signals and pressure signal, the configuration input is not external to the STM ATB) and 2x Profibus cable.

Requirement, STMA-8789 - According to EN50129 E9.5:
surge immunity shall be tested higher / higher limit than the boundary values of the real operation conditions.

2.11.1 Surges at analogue inputs

Text, STMA-21886 - The requirements in this section are only applicable to AIN.

Requirement, STMA-8622 - Subsection 12.2.7: Surges at the analogue inputs:

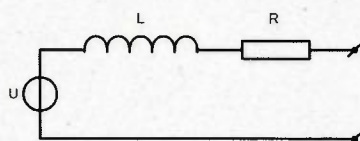
The analogue inputs shall be able to withstand a peak voltage, external impedance (coil) and time as defined below:

Note: The peak voltage shall be calculated using the information given in STMA-7001 and STMA-7002 and STMA-7003. The peak voltage shall be calculated for all antenna types.

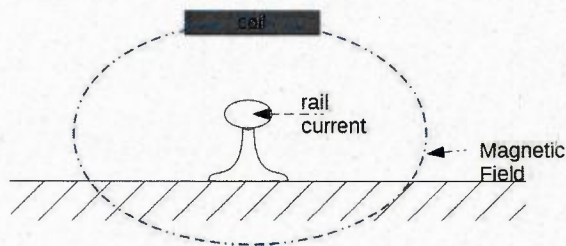
Definition, STMA-7001 - Specification of ATBEG antenna's in use, including coupling.

Antenna type	self inductance L in H	resistance R in ohm	output voltage U / rail current (mV/A @75Hz)	output voltage U / dl/dt (mV/(kA/s))
Alstom bar	1.4	45	21.3	31
Alstom V	1.4	44	4.7	6
PW170-0	4.7	270	22.3	33
PW225-30	4.55	270	14.0	21
fase 3	10.85	250	123	185

(currents and voltages in RMS values, preliminary values based on field measurements)



Thevenin equivalent scheme of the ATBEG antenna's with U, L and R as defined in the table above.



EM coupling of an antenna with the rail current.

Text, STMA-21887 - Rail current peaks to be taken into account

Short circuits in the infrastructure can cause high current peaks depending on the self inductance between the short circuit and the sub station, and depending on the capability of switching the current off:

Requirement, STMA-7002 - The following two short circuit currents have to be taken into account, i.e. the input circuits shall not be damaged in case of a rail current as defined below, independent of the type of antenna used:

- A current raising with a time constant $\tau = 5\text{ms}$, initial di/dt : 20MA/s , end value: 100kA cut-off after 15ms , with a $di/dt = -40\text{MA/s}$.
- A current raising with a time constant $\tau = 25\text{ms}$, initial di/dt : 2MA/s , end value: 50kA cut-off after 50ms , with a $di/dt = -6\text{MA/s}$.

Definition, STMA-7003 -

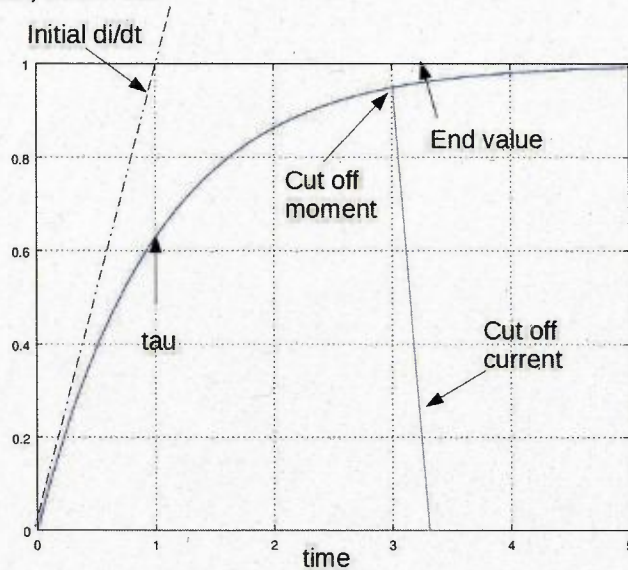



figure 4

Rail current pulses to be taken into account (values given in requirement  STMA-7002)

Text, STMA-21884 - In addition concerning the analogue inputs:

Requirement, STMA-8624 - The immunity of the STM ATB (+ connectors) of analogue inputs (+ cables, excluding the configuration input) and the Profibus interface for fast transients and common mode radio frequencies shall be

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tested according to EN50121-3-2:2015, table 4.1, 5.1 and 5.2.

2.11.2 Surges at digital I/O plus Power Supply

Text, STMA-21885 - The requirements in this section are only applicable to the DIO+PS Board.

Requirement, STMA-8623 - The immunity of the STM ATB (+ connectors) digital I/O and Power Supply (+ cables) for surges, fast transients and common mode radio frequencies shall be tested according to EN50121-3-2:2015, table 4.

Requirement, STMA-36375 - The electrical environment where the STM ATB will be installed in is class 3 or lower, (i.e. class 0, 1 or 2) as described in EN61000-4-5:2014, annex C3. As a result, the test level as defined in EN61000-4-5:2014 table 1 shall be equal to 3.

Taking into account the (possible) non-linear current-voltage characteristics of the equipment under test, as specified in chapter 8.3, EN61000-4-5:2014 and remarked in table 4.3, EN50121-3-2:2015, the open-circuit test voltages for the STM ATB shall be:

- 0.5 kV line-to-line.
- 1 kV line-to-line.
- 0.5 kV line-to-ground.
- 1 kV line-to-ground.
- 2 kV line-to-ground.

2.11.3 Surges at the Profibus interface

Text, STMA-21888 - The requirements in this section are only applicable to the SAP Board.

Requirement, STMA-9325 - The immunity of the STM ATB (+ connectors) profibus interface (+ cables) for surges, fast transients and common mode radio frequencies shall be tested according to EN50121-3-2:2015, table 5.

2.12 ESD

Requirement, STMA-8625 - The STM ATB enclosure and reachable connectors (+pins) shall be able to withstand ESD (electrostatic discharge) according to EN50121-3-2:2015, table 6.3.

2.13 Radiated immunity

Requirement, STMA-8626 -

All external STM ATB interfaces (+ mounted connectors) shall be able to withstand radiated interference according to EN50121-3-2:2015, table 6.1-2. Taking into account 30 V/m(rms) for the frequency range 800 MHz-1000 MHz (6.2).

2.14 Emission

Text, STMA-22075 - EN50155, Subsection 12.2.8.2: emission ,

The requirements in this paragraph apply to the STM ATB with mounted connectors and cabling for Power Supply, 6x digital input, 6x digital output, 6x analogue input (only coil signals and pressure signal, the configuration input is not external to the STM ATB) and 2x Profibus cable.

Requirement, STMA-8459 - The emission from the STM ATB (including mounted connectors) via the Power Supply (cabling) shall not exceed limits as specified in EN50121-3-2:2015, table 1 and 2. (doesn't apply to individual HW modules).

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Requirement, STMA-8461 - The emission from the STM ATB (including mounted connectors) via all analogue, digital and serial I/O shall not exceed limits as specified in EN50121-3-2:2015, table 2.

Requirement, STMA-8463 - The emission from the STM ATB (including mounted connectors) as a system shall not exceed the limits as specified in EN50121-3-2:2015, table 3.

2.15 Corrosion

Requirement, STMA-8449 - EN50155, Subsection 12.2.10:

The STM ATB (and its components) shall be able to withstand a "salt mist test" as specified in subsection 12.2.10 according to class ST3.

Text, STMA-16122 - The STM ATB will be installed "indoor" (☒ **STMA-40560**). As a train could be out of use for an undefined time, long time condensation is possible as the train could cool down for a long time. In addition the air could be salty (near sea side).

2.15.1 PCB coating

Text, STMA-21891 - The STM ATB prototype PCBs will not be coated therefore this section is not relevant for the STM ATB prototype components.

Final version: t.b.d. (EN60664-3)

Requirement, STMA-8601 - EN50155, Section 9.7: All printed board assemblies shall be protected on both sides with a protective transparent coating. The coating shall not have any adverse reaction with any other materials or components used.

(this requirement doesn't apply for prototypes).

2.16 Isolation

Text, STMA-21893 - Insulation requirements translate into clearance and creepage distances for different circumstances. For simplicity one set of values is used for all STM ATB (components).

EN50129, annex C5:

10) Where safety is reliant on clearance and creepage distances, the minimum clearance and creepage distances shall be defined according to the application requirements (including material, technology, implementation, environmental and operating conditions, failure conditions and temporary overvoltages). EN 50124-1 or IEC 60664 shall be used to determine minimum requirements based on re-inforced insulation. These requirements shall be accepted or further strengthened or complemented by the Railway Authority.

In comparison to the EN50124-1, this standard results in less severe requirements. Therefore the clearance and creepage distances resulting from the EN50124-1 G2.3 are taken into account:

Requirement, STMA-8641 - Isolated sections are defined in: ☐ STMA-8580, the insulation between the isolated sections shall fulfill requirements based on the following criteria:

Text, STMA-8635 - The minimum rated isolation voltage (U_{Nm}) for each of the sections shall be 0.15kV

Note: Based on a 110 Vdc power supply, EN50124-1 Table D.1.

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Text, STMA-8636 - As the enclosure is connected to earth and other interfaces cannot be reached, the isolation is "functional" as defined in EN50124-1, figure G.1.

Text, STMA-8637 - The STM ATB will be installed "indoor" (☑ **STMA-40560**). As a train could be out of use for an undefined time, long time condensation is possible as the train could cool down for a long time. In addition the air could be salty (near sea side). Therefore requirements applying for pollution degree PD3A shall be met (EN50124-1, annex E, table A.4).

Text, STMA-8638 - According to EN50124-1, A.1, the minimum "rated impulse voltage U_{Ni} shall be:

- OV2 for the processor part of the system; no overvoltage to be expected, having a safety function, i.e.
 $U_{Ni} = 1.5 \text{ kV}$.
- OV3, based on the lower safety requirements. An insulation problem will in none of the electrical circuits cause a safety failure as all the inputs are protected at an application level, i.e.
 $U_{Ni} = 2.5 \text{ kV}$.

Requirement, STMA-8639 - The clearance within the STM ATB shall be not smaller than 1.6 mm.

Note: Pollution degree PD3A and $U_{Ni} = 1.5 \text{ kV}/2.5 \text{ kV}$, results in a minimum clearance in air of at least 1.6 mm according to table EN50124-1 A.3.

Requirement, STMA-7116 - In addition to the clearance mentioned in ☑ **STMA-8639**, the metal PCB guides of the enclosure shall be taken into account. These are 2.0 mm deep.

Text, STMA-9464 - Traces on the inner layers do not need to be strictly placed on an insulation distance of 1.6 mm, because there can be a higher breakdown voltage between the traces.

Requirement, STMA-20748 - Minimum creepage distances (in mm) for printed wiring material and associated components shall be sufficient for the rated insulation voltage. The table below shows the required creepage distances for PD1 and PD2 as an example (EN50124-1, A.5).

pollution degree	PD1	PD2
creepage distance in mm (U_{Nm} up to 50 V)	0.025	0.040
creepage distance in mm (U_{Nm} up to 160 V)	0.25	0.40

Requirement, STMA-20749 - The material group for the used materials depends on the designers choice. Taking into account pollution degree PD3A and rated insulation voltage U_{Nm} of 160 V, the minimum creepage distance for material other than "printed wiring material" shall, depending on the material group, be (in mm): (EN50124-1, A.6).

material group	I	II	III
creepage distance in mm	3.2	4.0	5.0

2.17 Fire protection

Text, STMA-8527 - The most recent version of EN 45545-2 and EN 45545-5 were published in 2013 and amended in 2015.

2.17.1 EN45545-2

Requirement, STMA-8530 - Operation Category 3 (according to EN 45545-1, Annex B) is applicable.

Note: It should be possible to use rolling stock in tunnels longer than 5 km in length.


Requirement, STMA-8531 - Hazard Level 2 (EN45545-2, table 1) is applicable.

Note: Sleeping and couchette vehicles do not require an STM ATB. Based on Operation Category 3, Hazard Level 2 applies in all other cases.

Requirement, STMA-9316 - Rule 3 (EN45545-2, 4.3.3) is applicable for the STM ATB.

Note: The STM ATB should be able to be part of a larger electric configuration, such as a 19 inch rack. Therefore, it is considered a grouped product. The combustible mass is larger than 500 g.

Requirement, STMA-8533 - The STM ATB shall be compliant with requirement 22 from EN45545-2.

Text, STMA-9296 - Requirement 22 is applicable, since  **STMA-40560** states that the equipment will be installed inside the vehicle and the exposed area will be smaller than 0.20 m².

Requirement, STMA-9302 - EN45545-2 4.8 R22: The oxygen content according to T01 EN ISO 4589-2 IO test shall have a minimum value of 28 %.

Requirement, STMA-9303 - EN45545-2 4.8 R22: The D_s value of T10.03 EN ISO 5659-2 (25 kW m⁻²) shall be lower than 300.

Requirement, STMA-9304 - EN45545-2 4.8 R22: The CIT_{NLP} value of T12 NF X 70-100-1 and -2 (600 degrees Celsius) shall be lower than 0.9.

2.17.2 EN45545-5

Text, STMA-8535 - 5.1 Overload protection

Requirement, STMA-9312 - Both poles of the Power Supply of the STM ATB shall be connected to an external overload protection device.

Text, STMA-8536 - Rolling stock auxiliary power supplies can be floating with respect to earth. Quote from the EN45545-5: "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)." Therefore, both poles should be able to be interrupt with the use of an overload protection device.

2.18 RoHS

Requirement, STMA-8543 - The STM ATB shall be in compliance with 2002/95/EG and 2011/65/EU.

2.19 WEEE

STMA-21923, Definition - The Waste Electrical and Electronic Equipment directive 2012/19/EU of 4 July 2012 exempts rolling stock, being a "means of transport for persons or goods, excluding electric two-wheel vehicles which are not type-approved", Article 2, Paragraph 4, point (d). This paragraph becomes into effect on 15 August 2018. According to Article 2, Paragraph 3, point (b) "equipment which is specifically designed and installed as part of another type of equipment that is excluded from or does not fall within the scope of this Directive, which can fulfil its function only if it is part of that equipment" is exempt from this directive. An STM ATB is part of another type of equipment (ETCS onboard), and is therefore exempt from the requirements from the WEEE.

3 Tests

3.1 EN50155 Chapter 12 Testing

STMA-8441, Definition - Type tests are defined as

Tests which have to be performed on one instance of each hardware design, manufacturing procedure and manufacturing site (EN50155, Subsection 12.1.1.).

Note: software updates are not considered to be new instances.

STMA-8619, Definition - Routine tests shall be performed on every instance of the product (EN50155, Subsection 12.1.2).

Requirement, STMA-8443 - (table)

Tests according to EN50155 chapter 12, shall be performed as specified in this table:

	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	*	-

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12	Water tightness test	-	-
13	Equipment stress screening	-	-
14	Low temperature storage test	-	-

Note:

"12" = Test is required.,

"- " = Test is not required.

Text, STMA-16142 - Mandatory routine tests are imported from EN50155. Mandatory type tests as well, but the following items are added:

Damp heat test is applicable because cyclic condensation can occur on rolling stock that is out of service for a longer period of time. Radio interference test are deemed necessary as a type change could change the immunity of the STM ATB. The salt mist is necessary because rolling stock can be out of service for a longer time, this could occur near the sea.

Text, STMA-21889 - EN50155 Subsection 12.2.9 Isolation tests

Requirement, STMA-8627 - EN50155, Subsection 12.2.9: The "isolation" tests shall be performed at the complete STM ATB module with mounted connectors and external cabling.

Requirement, STMA-8628 - EN50155 Subsection 12.2.9.1: An insulation measurement shall be done using a voltage of 500 Vdc between all interfaces and the enclosure (mass) while logging the current per interface, before and after the voltage withstand test.

Requirement, STMA-8629 - EN50155, subsection 12.2.9.2: A voltage withstand test shall be done, using a 50 Hz, 1000 V rms between all interfaces and the enclosure (mass) during 60 s. The STM ATB shall not be damaged and no disruptive discharge or flashover shall occur.

note: shields of shielded cables are on the same potential as the enclosure and are therefore excluded from this test.

Text, STMA-9379 - Tests will be performed at the STM ATB as a complete system. In case a test is not successful further testing might be done to find which of the components causes the problem.