

D6.5.2 Technical documentation

for the development of an STM ATB

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Author	JW
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Compiled by: JW Signature/E-sign: 463332 ,STMA-71818	Date: December 27 2019
Reviewed by: MP Signature/E-sign: 463332 ,STMA-71820	Date: December 27 2019
Approved by: JH Signature/E-sign: 463332 ,STMA-71847	Date: December 28 2019

Contents

1	Preface	3
1.1	References	4
2	Manufacturing	4
2.1	Production quality	5
2.2	EN50155 requirements concerning manufacturing	5
2.3	Coating and glueing components	5
2.4	Series testing	7
2.5	Assembly of the STM ATB	7
3	Installation	7
3.1	Documentation of the installation	7
3.2	General installation	8
3.3	Connectors and cabling	9
3.3.1	DIO+PS	10
3.3.2	Analogue inputs connectors	13
3.3.3	Profibus connectors	14
3.4	Requirements concerning the antenna + antenna installation	14
3.5	Profibus connection	17
3.6	Coil dependent configuration	17
3.7	Brake percentage configuration	17
3.8	Detection of brake operation by the driver	18
3.9	Switching off in case of defects	18
4	Maintenance manual	18
5	Upgrades	19
6	User manual	20

1 Preface

Text, STMA-40553 - This specification is based on the requirements from the EN50155:2017 standard.

Decision, STMA-40525 - The STM ATBEG shall be documented by at least a data sheet, manufacturing manual and an installation manual.

Decision, STMA-40550 - The manuals shall be written in simplified British English.



External Requirement, STMA-70627 - EC-713-2010 Certification module CB:

The application shall include:



- descriptions and explanations necessary for the understanding of those drawings and schemes and the operation (including conditions for use) and maintenance of the interoperability constituent.
- conditions of integration of the interoperability constituent in its system environment (sub-assembly, assembly, subsystem) and the necessary interface conditions.

1.1 References



Text, STMA-14296 - 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

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](#)

2 Manufacturing

Definition, STMA-40637 - The manufacturing data are all necessary information for the manufacturing and the assembly of the PCBA or electronic equipment. The manufacturing data are delivered only under specific request of the user and are subject to a contractual agreement between supplier and user regarding the confidentiality and the rights of use of those documents.

Requirement, STMA-69577 - The manufacturer is responsible for meeting the EN50155 requirements as included in this chapter.

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-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-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.

2.1 Production quality

Requirement, STMA-40635 -

The generic requirements for PCBA product manufacturing description data and the transfer methodology, IPC-2581 (B), shall be applied. The dossier shall consist of:

Definition, STMA-40645 - 1) bill of materials (PCB, electronic parts, mechanical parts, etc.) with component specifications and sourcing (i.e. manufacturer) information;

Definition, STMA-40643 -

2) manufacturing documents (circuit diagrams, wiring diagrams, etc.);

Definition, STMA-40641 - 3.1) bit stream codes for programmable components - e.g. CPLD, FPGA, etc. With programming

instructions, documentation, references of programming tools, etc.);

Definition, STMA-40658 - 3.2) image files for programmable processors, with programming instructions, documentation, references of programming tools, etc.

Definition, STMA-40642 -

4) drawings, assembly instructions and specifications;

Definition, STMA-40644 -

5) factory testing specifications, test programs (boundary scan programs, where appropriated).

2.2 EN50155 requirements concerning manufacturing

Text, STMA-69181 - No pre-set control adjustments etc. is necessary during manufacturing.

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-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.

2.3 Coating and glueing components

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).

Requirement, STMA-68340 - PCB shall be protected against humidity and salt by using a coating sufficient to withstand EN50155 environmental tests (chapter 12) and compliant to the life time requirements (30 years).

Requirement, STMA-69638 - To withstand shocks and vibrations components indicated in figure  STMA-69637 -

From left to right:

- 2x 3 PTC through hole R300/R310/R320 R301/R311/R321
- 2x 3 opto-isolatoren through hole U300/U301/U302 U303/U304/U305
- 1 condensator through hole C112
- 2x axiale elco through hole C100 C105
- 2x radiale elco through hole C101 C110

Requirement, STMA-71023 - The front panel of the enclosure shall be labelled with the manufacturer's name or trade mark and a serial number.

2.4 Series testing

Decision, STMA-71234 - Each Product shall be tested before delivery, tests shall at least include a functional test including the following functions:

- Antenna selection at start-up; connect the unit with all antenna types (or electrically identical networks) and check if the correct ones are selected.
- Decoding; connect antenna's, feed all possible ATBEG codes and check if correct code is detected.
- ETCS interfacing; connect the STM with an ETCS on-board (or simulator) and check if the STM can operate up to STM state "Data Available".

Decision, STMA-71236 - Each PCB shall be tested before assembly, tests shall at least include (to be specified per type of PCB):

- SAP board: Visual inspection, boundary scan and test of all power supplies (voltage levels)
- AIN board: Visual inspection, test of all power supplies (voltage levels), analogue transfer from input to ADC output, common mode impedance at inputs.
- DIO+PS board: Visual inspection, test of the power supply (output voltage as function of the input voltage between 0 and 154V), common mode impedance at PS and IO interfaces.
- Visual inspection.

2.5 Assembly of the STM ATB

Hardware Design, STMA-69747 - An instruction of the assembly of the STM ATB is given in [M9.2 Manufacturing Manual](#), chapter [STMA-71240 - Assembling](#).

After assembly it shall be checked if the PCB's don't suffer mechanical stress and if all components fit smoothly.

3 Installation

3.1 Documentation of the installation

External Requirement, STMA-40495 - This specification is loosely based on the "Specification for the documentation of railway vehicles" 1st edition, August 2014, from EuroSpec. The following requirements from the EuroSpec shall be fulfilled, the manufacturing manual shall contain (as stated in [STMA-40496](#), [STMA-40498](#) and [STMA-40499](#)):

Definition, STMA-40496 - 4.1.2.3 Arrangement drawings with a parts list for each component; Drawing with parts list to ensure dismantling, repair and assembly of items. The parts list contains all related items (materials) and quantities; Software is also an item (material) on the parts list.

Definition, STMA-40498 - 4.1.2.7 Drawing of systems (electrical, pneumatic, hydraulic and control-circuit diagrams); Electrical, pneumatic, hydraulic and control-circuit diagrams necessary to explain the function and operation of the particular systems.

Definition, STMA-40499 - 4.1.2.8 Drawings and description of the vehicle and its components; Schematic circuit diagrams, network diagrams, connection diagrams and wiring diagram to show the physical relationship of all the components, as well as the information needed to hardwire the circuit.

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

3.2 General installation

Text, STMA-64086 - The STM ATBEG has been designed to be a line-side replaceable unit, requiring no additional configuration and/ or calibration.

Decision, STMA-40563 - For the analogue input signals a shielded sub-D15 connector shall be used:

- Capable of hosting the resistors as mentioned in [STMA-40566](#) and [STMA-40561](#).
- A metal shielding making electrical contact (around) with the front panel of the STM ATB.

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-40560 - The STM ATB shall be installed in an environment with an ambient temperature which is always between -25 °C to +70 °C or during maximum 10 minutes between +70 °C to +85 °C.

Requirement, STMA-69084 - The STM ATB shall be installed in an environment with an ambient temperature which is in average below +40°C.

Requirement, STMA-69085 - The STM ATB shall be installed in an environment with a humidity which is always between (and including) 5% and 100%.

Requirement, STMA-69086 - The STM ATB shall be installed in an environment in which the temperature deviates with less than 3°C/s for temperature variations up to 40°C. Larger variations shall take more than 10 minutes.

Requirement, STMA-64095 - The STM ATB shall be installed in a way that the front panel is visible.

Requirement, STMA-64073 - No more than one STM ATB shall be connected to a single ERTMS/ETCS on-board.

Requirement, STMA-40557 - The configuration table as defined in [D4.1 Interface Requirements Specification \(IRS\)](#), [STMA-8277 - DMI configuration table according to . Description Values NID_STM of the STM 1 \(...\)](#) shall be loaded in the ETCS on-board (DMI) to enable displaying the correct icons at the correct place when ordered by the STM ATB.

Requirement, STMA-41918 - At installation it shall be decided (per cabin) to use sounds via parallel wiring **OR** via Profibus. (both is not allowed for the same cabin).

If parallel wiring is chosen, a sound module shall be installed ([STMA-4901](#)).

If the sounds are communicated via Profibus the sounds shall be defined in the DMI configuration table.


Requirement, STMA-40599 - The system integrator shall be responsible for the compliance of the system to EN45545-2 (see chapter 4.6 in case of refurbishment) and EN45545-5.

Decision, STMA-71263 - The environment shall be compliant with Pollution degree PD3A to table EN50124-1 A.3

Decision, STMA-40586 - Unused digital inputs shall be connected like if the input is false.

Decision, STMA-40577 - Unused analogue inputs shall be shortened (short circuit between + and - of the concerning input).

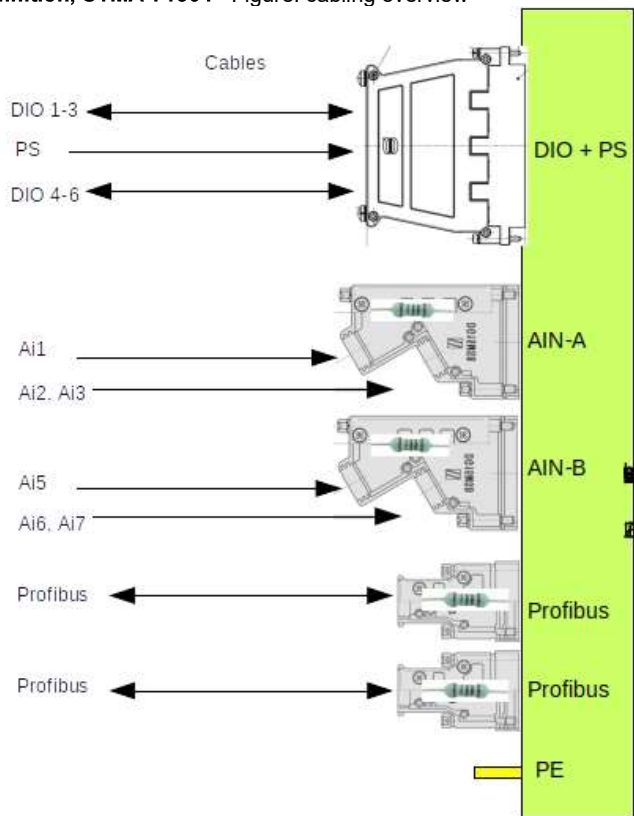
3.3 Connectors and cabling

Hardware Design, STMA-71305 - The cable connection, is the interface of the STM-ATM to the train. All connectors are positioned at the front panel of the module. In total 5 connectors can be plugged into the module (see  STMA-71304):

- X1: DIO+PS Board DIN41612-F-48
- X2, X3: AIN Board 2x SubD-15
- X4, X5: SAP Board 2x SubD-9 (Profibus)

Besides these connectors, an earth (PE) stud is applied.

Definition, STMA-71304 - Figure: cabling overview



The bundling of the cables in this figure are an example:

- In case the analogue brake pipe pressure signal (Ai3/Ai7) is not used subD-15 connectors with a single cable exit may be used.
- Coil connections Ai1 and Ai2, and Ai5 and Ai6 may be combined in a single cable as those are used for coils at different front-ends of the locomotive/trainset.
- DIO and PS cables may be combined if sufficient isolation is provided

Text, STMA-71311 - Based on EN50355 the following standards apply:

Decision, STMA-71306 - DIO and power supply cables shall be compliant with EN50264.

Decision, STMA-71310 - Analogue signal cables shall be compliant with EN50306.

Decision, STMA-71309 - EN50343 is applicable concerning installation of cabling.

Definition, STMA-71308 - Wire/Signal voltage and current rating

Signal	I _{max} [A]	U _{max} [V]	I _{peak} [A]	U _{peak} [V]	I cable [A]	U _{cable} [V]
PWR	0.5	160/800	42	255	11.2	600/3500
DI	0.05	160/800	42	380	5.44	600/3500
DO	0.2	160/800	42	2000	5.44	600/3500

I_{max} is the continuous maximal current in normal operation

U_{max} is the continuous maximal voltage in normal operation, the second value is isolation to PE.

I_{peak} is a surge maximal current according to the surge behavior

U_{peak} is a surge maximal voltage according to the surge behavior

Decision, STMA-71307 - The connectors and cables shall meet the following requirements/withstand the tests:

- Temperature: -25 to +70°C ambient (+85 °C for 10 minutes)
- Vibration & shocks
 - 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.
- Dust & moisture: 5 ? 100%
- Salt and mist: ST3 (pollution degree PD3A)

3.3.1 DIO+PS

Requirement, STMA-69718 - The DIO+PS connector (DIN41612-F-48P) shell shall be connected to PE.

Requirement, STMA-69688 - The STM ATB shall be connected according to the connector definitions in:

Definition, STMA-19190 - The digital inputs are defined as specified in the table below (if the inputs are not connected the input value shall be defined in the same way for all inputs, i.e. all inputs which are not connected shall be either all "high" or all "low")

input	signal	description
DIn_1A	BHA	Brake Handle Applied
DIn_2A	BSO	Brake Sufficiently Operated
DIn_3A	SIA	Spare Input Asserted
DIn_1B	BHN	Brake Handle Not applied
DIn_2B	BSN	Brake Not Sufficiently operated
DIn_3B	SIN	Spare Input Not Asserted

Definition, STMA-28699 - The digital outputs are defined as specified in the table below

output	signal	description

DOut_1A	rembel	Acoustic signal, overspeed
DOut_2A	gong	Acoustic signal, cab signal change
DOut_3A	Spare Out	Spare Output
DOut_1B	WhiteLamp	White indicator, brake operated
DOut_2B	RedLamp	Red indicator, brake commanded by ATB
DOut_3B	BlueLamp	Blue indicator, monitoring active

Definition, STMA-8323 - (table)

For the power supply and digital I/O signals a front connector type DIN41612-F-48P is defined.

DIO Front connector

Pin	I/O	Pin name	Description
2d		PE	Shield
4d	I	DIn_1B	Digital input
6d		DIn_B-PWR	External power supply for input circuit
8d		PE	
10d	O	DOut_1B	Digital output
12d		DOut_B-GND	Digital out ground
14d		PE	
16d	I	Supply +	Power input
18d	I	Supply -	Power input
20d		PE	
22d	I	DIn_1A	Digital input
24d		DIn_A-PWR	External power supply for input circuit
26d		PE	
28d	O	DOut_1A	Digital output
30d		DOut_A-GND	Digital out ground
32d		PE	
2b		PE	
4b	I	DIn_2B	Digital input
6b		DIn_B-GND	Digital in ground
8b		PE	
10b	O	DOut_2B	Digital output
12b		DOut_B-GND	Digital out ground
14b		PE	

16b	I	Supply +	Power positive input
18b	I	Supply -	Power negative/return input
20b		PE	
22b	I	DIn_2A	Digital input
24b		DIn_A-GND	Digital in ground
26b		PE	
28b	O	DOut_2A	Digital output
30b		DOut_A-GND	Digital out ground
32b		PE	
2z		PE	
4z	I	DIn_3B	Digital input
6z		Di4-6 GND	Digital in ground
8z		PE	
10z	O	DOut_3B	Digital output
12z		DOut_B GND	Digital out ground
14z		PE	
16z	I	Supply +	Power input
18z	I	Supply -	Power input
20z		PE	
22z	I	DIn_3A	Digital input
24z		DIn_A-GND	Digital in ground
26z		PE	
28z	O	DOut_3A	Digital output
30z		DOut_A-GND	Digital out ground
32z		PE	

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.

Decision, STMA-69909 - The digital inputs are used anti-valent, i.e. at least one of the inputs shall be off (not powered). In case an input is not used, it shall not be powered.

i.e. maximum 50% of the digital inputs shall be powered (transients lasting maximum a few seconds excluded).

note: the maximum is used to calculate the maximum continuous power dissipation in the STM ATB

3.3.2 Analogue inputs connectors

Text, STMA-21189 - For the analogue input signals front connectors of type SubD-15 female and SubD-15 male, are defined ( STMA-8241 and  STMA-8276).

Requirement, STMA-69732 - Cable shields of the analogue signal cables shall be connected to the connector shells.

Definition, STMA-8241 - (table)

AD-A Front connector, SubD-15-F

Pin	I/O	Pin name	Description
1	I	<i>Rconfig_A</i>	Configuration resistor input
15	I	<i>Aln_1A+</i>	Coil input
7	I	<i>Aln_1A-</i>	Coil input
14	I	<i>Rg_1A+</i>	Coil gain resistor
6	I	<i>Rg_1A-</i>	Coil gain resistor
13		<i>Aln_A_GND</i>	
5	I	<i>Aln_2A+</i>	Coil input
12	I	<i>Aln_2A-</i>	Coil input
4	I	<i>Rg_2A+</i>	Coil gain resistor
11	I	<i>Rg_2A-</i>	Coil gain resistor
3		<i>Aln_A_GND</i>	
10	I	<i>Aln_3A+</i>	brake pipe pressure input
2	I	<i>Aln_3A-</i>	brake pipe pressure input
9	I	<i>Aln_A_GND</i>	
8	I	<i>Rconfig_A_ret</i>	Configuration resistor return
Sh		<i>PE</i>	Shield

Definition, STMA-8276 - (table)

AD-B Front connector, SubD-15-M

Pin	I/O	Pin name	Description
8	I	<i>Rconfig_B</i>	Configuration resistor input
9	I	<i>Aln_1B+</i>	Coil input
2	I	<i>Aln_1B-</i>	Coil input
10	I	<i>Rg_1B+</i>	Coil gain resistor
3	I	<i>Rg_1B-</i>	Coil gain resistor
11		<i>Aln_B_GND</i>	

4	I	<i>Aln_2B+</i>	Coil input
12	I	<i>Aln_2B-</i>	Coil input
5	I	<i>Rg_2B+</i>	Coil gain resistor
13	I	<i>Rg_2B-</i>	Coil gain resistor
6		<i>Aln_B_GND</i>	
14	I	<i>Aln_3B+</i>	brake pipe pressure input
7	I	<i>Aln_3B-</i>	brake pipe pressure input
15	I	<i>Aln_B_GND</i>	
1	I	<i>Rconfig_B_ret</i>	Configuration resistor return
Sh		<i>PE</i>	Shield

3.3.3 Profibus connectors

Text, STMA-71243 - The STM ATB is equipped with a male and a female Profibus connector (internally connected for daisy chaining).

Decision, STMA-40596 - The Profibus shall be connected according to [STMA-8172](#) Pins identified as "not used", "DGND" and "VP" shall not be connected to a wire of the bus cable.

Definition, STMA-8172 - table

Profibus connector pinning (Sub-D9)

Pin	Name	Description
1	not used	
2	not used	
3	RxD/TxD?P	Data line plus (B)
4	not used	
5	DGND	Data ground
6	VP	+5V supply for bus termination
7	not used	
8	RxD/TxD-N	Data line minus (A)
9	not used	

3.4 Requirements concerning the antenna + antenna installation

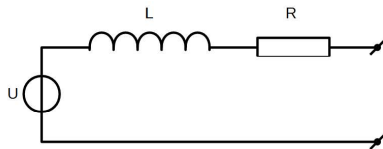
Requirement, STMA-40593 - The antennas shall be installed according to the installation requirements provided by the antenna supplier.

Text, STMA-71246 - Antennas types compatible with the STM ATB are listed in [STMA-7001 - Specification of ATBEG antenna's in use, including coupling. Antenna type self i...](#)

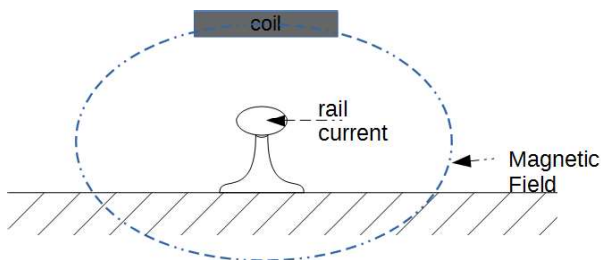
Definition, STMA-7001 - Specification of ATBEG antenna's in use, including coupling.

Antenna type	self inductance L in H	resistance R in ohm	output voltage U / rail current (mV/A @75Hz)	output voltage U / di/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.

Requirement, STMA-40587 - The left and right antenna at the same end (front or rear) of the train shall use separated connectors.

Decision, STMA-71259 - All coils used in combination with one single STM ATB shall be of the same type.

Decision, STMA-71258 - Coils shall be installed for each of the (two) cabs which can be used.

i.e. if the STM ATB is installed in combination with an ETCS on-board responsible for one cabin and driving direction then coils shall be installed for only that cabin. If the ETCS on-board is responsible for both cabins then coils shall be installed for both cabins.

Requirement, STMA-40578 - At installation, a 560 Ohm resistor shall be installed in parallel with the ATBEG coils.

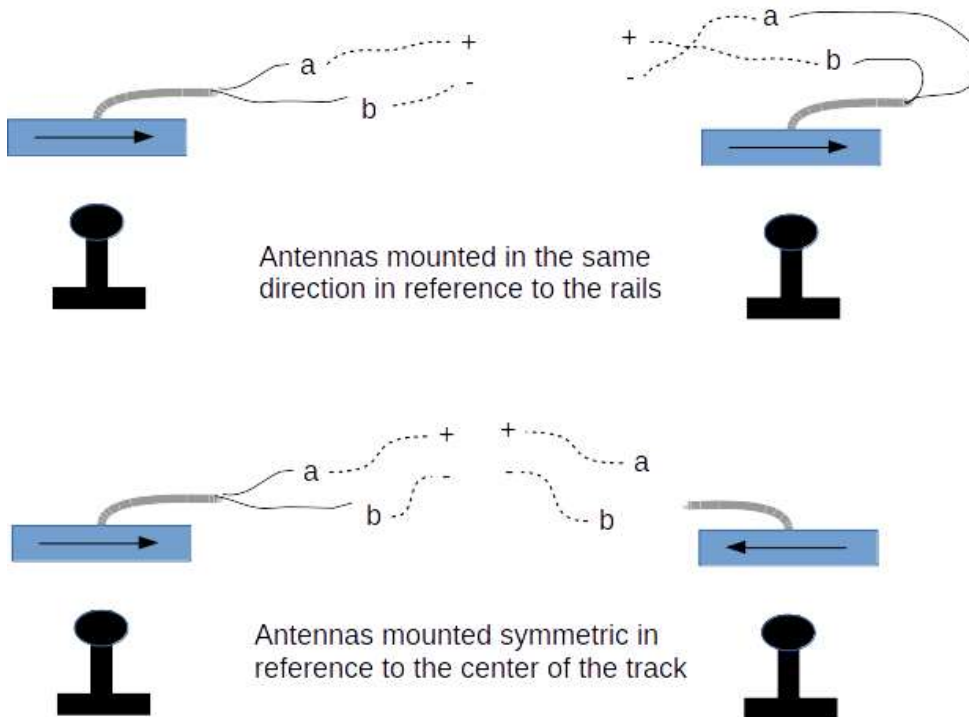
Requirement, STMA-40572 - The coil signals shall be connected according to the indications in figure STMA-14777. Which wire is "a" and "b" is arbitrary, as long as it's the same wire in the left and the right coil.

Requirement, STMA-14776 - Orientation of the antenna's and connection of the wiring (STMA-14777)

If the antenna's are mounted symmetric in reference to the center of the track then the wires of the left and right antenna shall be connected equally to the + and - input at the connector (STMA-8241 and STMA-8276)

If the connections are mounted in the same direction in reference to the concerning rail then the wires of the left and right antenna shall be connected inverse to the + and - input at the connector (STMA-8241 and STMA-8276)

Definition, STMA-14777 - Figure: possible orientations and connection schemes of the antenna's corresponding to one cabin.



Requirement, STMA-40589 - The antenna + antenna installation shall not cause more than $\pm 10\%$ tolerance (quasi constant) in the amplitude of the antenna signal due to horizontal displacements (taking into account a smallest curve (radius) of 350 m).

Decision, STMA-40583 -

The tolerance in the antenna signal due to antenna installation differences within one train type (e.g. due to wheel diameter differences) shall not be more than a factor 1.2 compared to the nominal value.

note: this is a sufficient tolerance for all train types in order not having to perform a series test concerning decoding after installation. Further it leaves enough room for other variations (compared to the requirement of a factor 1.5 concerning the decoder).

Requirement, STMA-40585 -

The antenna + antenna installation shall not cause more than $\pm 5\%$ variation in amplitude, with an ATBEG code frequency, in the antenna signal due to antenna movement (with respect to the rail, other than in the driving direction).

Requirement, STMA-40576 -

ATBEG currents floating through the front axle shall not cause more than 10 % of the signal level in the antenna, compared to the signal level caused by the same current floating through the rails underneath the antennas.

note: the current can intermittent float through the first or through other axles, this way generating code due to variations in wheel-rail contact.

Requirement, STMA-40579 -

The antenna + antenna installation shall not generate a 72-78 Hz signal, higher than 5 % of the high level of the ATBEG current through the rails, due to EM sources inside the rolling stock (e.g. motor cabling etc.).

Decision, STMA-40573 - Correct mounting of all connections to the coils and the mounting of the connectors containing the coil signals at the STM ATB shall be checked independent from the installation engineer who did the installation.

3.5 Profibus connection

Requirement, STMA-40594 - The length of the Profibus shall not exceed 200 m per segment.

Requirement, STMA-40588 - For the Profibus a cable type A (EN50164) shall be used (and RS485 compliant twisted shielded copper).

Requirement, STMA-40590 - Maximum 32 stations (devices) may be connected to the Profibus.

Requirement, STMA-40584 - Only one bus shall be connected at the STM ATB.

3.6 Coil dependent configuration

Text, STMA-40574 - Different antennas may be used, however requirements concerning the connection of the antennas differ per type.

Decision, STMA-40566 - Between connection Rg_1A- and Rg_1A+ (schematic-AIN-Board-R1.12.pdf) a resistor shall be installed to calibrate the amplification of the antenna signal (value, see ¶ STMA-71251).

note: x and y are the far most pins in the sub-D15 connector to detect a badly mounted connector with the highest probability.

Definition, STMA-71251 - Divider R dependent on the antenna type.

Antenna:	Divider R
Alstom Bar:	1740 Ohm
Alstom V:	14000 Ohm
PW-170:	5620 Ohm
PW-225:	11300 Ohm
Fase-3:	1740 Ohm

3.7 Brake percentage configuration

Requirement, STMA-40561 - Between connection Rconfig_A and Rconfig_ret_A (and within a shielded connector) a resistor shall be installed to configure the brake delay time. The brake delay time is (as a function of the value of the resistor, see ¶ STMA-17205).

The resistors shall have a tolerance of max. 1% (taking temperature into account) and be of the same type.

Definition, STMA-17205 - Table: ConfiguredBrakingPercentage as a function of U_config_filtered.

R (E96 series)	2,048	1,00	min range (Volt)	max range (Volt)	Braking %
	nominal input voltage (Volt)	input voltage (Volt)			
4,53	1,68	1,62	1,74	36	
3,01	1,54	1,48	1,60	46	
2	1,37	1,31	1,43	54	
1,5	1,23	1,17	1,29	55	
1,13	1,09	1,03	1,15	65	
0,845	0,94	0,88	1,00	72	
0,634	0,79	0,73	0,85	91	
0,464	0,65	0,59	0,71	113	
0,332	0,51	0,45	0,57	119	
0,221	0,37	0,31	0,43	160	

84% and 100% are not supported, these values are only relevant for trains > 500m which always drive above 100km/h. These locomotive shall either be allowed to driver 130km/h. When driving alone (113%) or reduce speed when hauling long trains.

3.8 Detection of brake operation by the driver

Decision, STMA-40580 -

There are a number of possibilities to detect brake operation by the driver:

- Brake handle position detection (BHA) for (brake handle) position controlled brake systems.
- Brake handle position detection plus digital feed back from the braking system (BSO).
- Brake handle position detection plus analogue feed back from the braking system (brake pipe pressure).
- Only digital feed back from the braking system: slow response, can lead to not fulfilling the reaction time requirement for the driver.
- Only analogue feed back from the braking system: slow response, can lead to not fulfilling the reaction time requirement for the driver.

The engineer of the STM ATB shall select and implement one of the above options.

Decision, STMA-71275 - In case the digital inputs are used:

the voltage level for the digital inputs can vary from 24Vdc to 110Vdc (according to EN50155)

Decision, STMA-40556 -

In case an analogue brake pipe pressure measurement is used for detection of brake operation then a pressure sensor with 4-20 mA output shall be used where 5.6 mA equals to 1 bar (0 bar environmental) and 13.6 mA equals to 6 bar (5 bar environmental).

This sensor shall be connected between connection x and y.

The accuracy of the sensor shall be +/- 0.1 bar (= +/-0.16 mA).

Requirement, STMA-40565 - Brake operation detection information shall be provided redundantly to the STM ATB.

The chance that both signals fail within 5 s shall be less than $1 \cdot 10^{-11}/h$.

Requirement, STMA-41867 - The driver shall only operate the BD button if the brakes are manually operated

3.9 Switching off in case of defects

Requirement, STMA-63917 - A switch shall be installed to deactivate the STM ATB and in parallel inform the ETCS on-board equipment to ignore the absence of the STM ATB at the profibus.

The latter shall be provided to ETCS according to "national system isolation" in ERA subset-119.


4 Maintenance manual

Definition, STMA-40500 - 4.3.2.5 Maintenance description file; Trouble shooting (fault diagnosis and isolation) manual or facilities for all reasonably foreseeable situations, this includes functional and schematic diagrams of the systems or IT-based fault finding systems, cause and effect diagrams. The manuals shall give the link to the relevant corrective maintenance task.

Requirement, STMA-40616 - Defect STM ATB modules or defect components of an STM ATB which are not repaired shall be disposed according to WEEE, Waste of Electrical and Electronic Equipment, Directives 2002/96/EG, 2012/19/EU.

Decision, STMA-40617 - If any of the connections from the STM ATB is changed (connected or disconnected) then the STM ATB shall be restarted before using the system.

note: preferably connections are only changed while the system is turned off (is not powered).

Requirement, STMA-42769 - If the LEDs at the front indicate a fault state then the STM ATB shall be exchanged according to table  STMA-36942.

No repairs shall be performed on-board.

Definition, STMA-36942 - LED status:

The nine IDs defined below shall be used as separate states.

Each module which wants to control the LEDs can set a state. Which one prevails depends on the priority given in the table below.

Severity Level	LED A	LED C	meaning
9	Green	Green	no fault
8	Green	Orange	non-specific fault
7	Green	Red	single power supply defect; exchange unit
6	Orange	Green	coils not detected or missing
5	Orange	Orange	no brake detection possible
4	Orange	Red	EB unavailable
3	Red	Green	ETCS related fault
2	Red	Orange	over / under temperature
1	Red	Red	exchange unit

Text, STMA-69103 - The STM ATBEG does not require preventive maintenance.

Requirement, STMA-69104 - As the STM ATBEG is a "line replaceable unit" repairs shall be done outside the trains.

Decision, STMA-64087 - Repairs and software or hardware updates shall be done by the OEM in accordance processes described in the manufacturing manual.

5 Upgrades

Decision, STMA-69544 - At least the following items shall have an individual version number:

- The complete assembly
- Each populated PCB
- Each unpopulated PCB
- The functional processor software
- The profibus processor software
- The FPGA bitstream

note: upgrading netX51 software shall lead to a new version number of the populated SAP board.

Decision, STMA-69545 - Each version number shall consist of a unique identifier for the responsible entity, and a number identifying the specific version.

Decision, STMA-69532 - If a new version of the FPGA bitstream is loaded, then

- This new bitstream shall include a function to communicate the (new) version number from the diagnostic channel to the Functional Processor (at start-up).
- If the communication function to receive the bitstream version number from the diagnostic channel is not yet

implemented, then the FP software shall be upgraded to read the number and pass it to the JRU

Decision, STMA-69546 - If a new version of the Profibus processor is loaded, then

- This new Profibus processor software shall include a function to communicate the (new) version number to the Functional Processor in the response on the configuration data provided by the functional processor at start up
- If the communication function to receive the functional processor software version number is not yet implemented, then the FP software shall be upgraded to read the number and pass it to the JRU

Text, STMA-69547 - Up to the first upgrade of the FPGA bitstream and/or Profibus Processor SW, the FP will communicate the concerning initial (preset) version numbers to the JRU.

Requirement, STMA-69659 - In case of upgrades the back plane pinning shall not be changed.

Requirement, STMA-69910 - The power supply input shall be protected against short circuits. The protection shall be sufficient to avoid a defect in the TVS in case of reverse connection of the power supply.

6 User manual

Decision, STMA-40625 - If the ATBEG function is switched off (e.g. due to a failure blocking further operation), then the user of the STM ATB shall take measures to guarantee a sufficient safety level.

Decision, STMA-40626 - If the "white lamp" remains lit while the driver doesn't operate the train, the driver shall not trust the ATBEG function any longer, and take the train out of service according to the normal procedure concerning defect ATB systems (limit the speed to 80 km/h and take the train out of service at the next main station (or replace the STM ATB)).