

M9.3 Installation Manual

for STM ATB

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Compiled by: JW Signature/E-sign: 783954 ,STMA-81110	Date: 2023/02/21 20:18
Reviewed by: WD Signature/E-sign: 783954 ,STMA-81105	Date: 2023/02/22 10:48
Approved by: BVB Signature/E-sign: 783954 ,STMA-81124	Date: 2023/02/22 12:26

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1 Introduction

Text, STMA-65624 - This document is the installation manual for STM ATB. It provides instructions and guidance for the installation design and safe construction and installation work.

1.1 What is an STM ATB

Text, STMA-65625 - An STM ATB is a train protection system providing ATB functionality in cooperation with an ETCS system. When integrated with an onboard ETCS system, the combination of STM ATB and the ETCS onboard system ensures all ATB-EG and ATB-Vv functionalities on ATB-EG equipped lines. The specific characteristics of the embodiment "STM" is explained below.

An STM (a "Specific Transmission Module") is an embodiment of a (national) automatic train protection (ATP) or automatic train control (ATC) system, with the feature of being manageable by an ETCS on-board system. I.e. the ETCS on-board system is master over the STM and can activate and deactivate it. This way transitions between different national ATP/ATC areas, and between national ATP/ATC areas and ETCS areas can be managed in a harmonized way. It allows ETCS equipped trains to operate on conventional (non ETCS) lines.

To optimize the overall configuration, a standard has been developed for the interface between ETCS and the STMs. This interface not only allows the ETCS system to switch on/off the specific ATP/ATC functionality, but also to share generic ATP/ATC facilities provided by the ETCS on-board system:

- Train specific parameters: Parameters entered during "Data Entry" and fixed parameters are sent by ETCS to the STMs
- Speed and distance measurement (odometry): Speed and distance information is sent by ETCS to the STMs
- Driver Machine Interface (DMI): information sent by an STM to ETCS will be presented at the ETCS DMI and inputs given by the driver will be passed by ETCS to the addressed STM.
- Control of traction and brakes (Traction Cut Off and Service/Emergency Brake Commands): Commands to cut of traction or to initiate braking sent by the STM will be passed to the traction and/or braking systems by the ETCS system.
- Cabin selection and driving direction: information concerning the currently selected cabin and the driving direction is sent by ETCS to the STMs.
- Juridical data and diagnostic data storage: The ETCS on-board will take care of storing juridical data and diagnostic data sent by the STM to the ETCS on-board.


The standardized interface specifications and the way ETCS and STMs should cooperate is defined in ERA ERTMS

specifications, specifically in subsets-035/056/057/058/059.

Sharing facilities allows the design of lean STMs which only provide the specific national functionality, mostly analyzing trackside data sent by the national wayside systems and performing the specified protection/control functions.

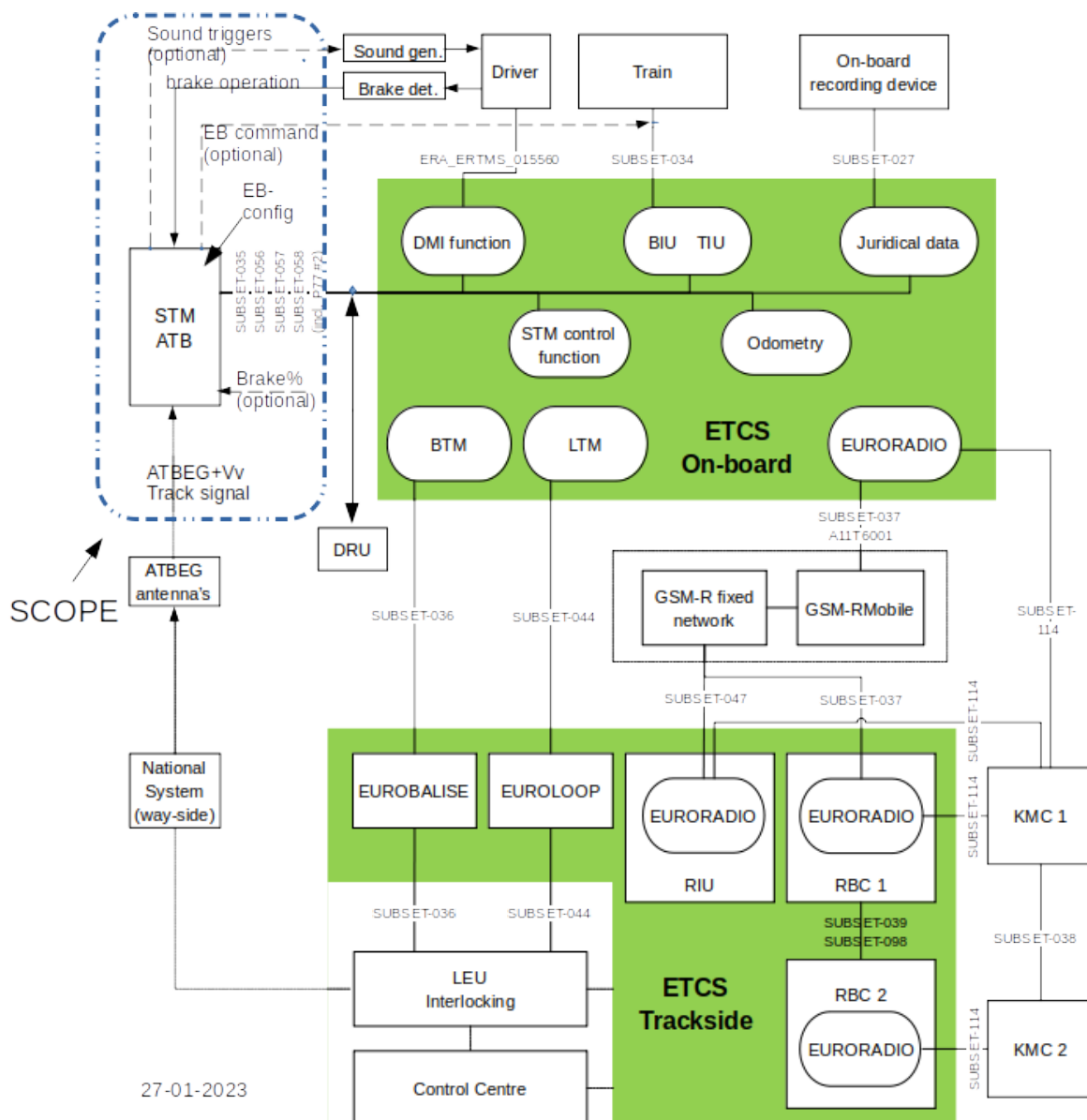
The use of the ETCS facilities is not mandatory for an STM (only the control of switching on/off is), therefore not all STMs are lean systems.

1.2 Scope

Text, STMA-65620 - Figure  **STMA-4891** is taken from the ETCS specifications (subset-035 STM FFFIS Specific Transmission Module). It shows the ETCS reference architecture and the integration of STM ATB with the ETCS onboard system. The scope for this installation manual is marked.

Definition, STMA-4891 - (figure)

STM ATB system scope



Text, STMA-73302 - Not included in the STM ATB delivery scope:

- SubD-9 connectors for the Profibus cable (one cable plus optionally one termination if no cable to the next node is

connected)¹⁾, ²⁾, plus profibus cabling.

- SubD-15 connectors for the analogue input connector cables (one male, one female per STM ATB unit²⁾).
- Digital IO (DIO) plus Power Supply (PS) connector cable (per STM unit, 1 DIN41612-F-48P connector cable is required).
- ATBEG antennas plus antenna cabling.
- Earthing cable.
- Mounting rack.




¹⁾ The brand and type of the subD connectors are prescribed to fit correctly at the STM ATB and to comply with the configuration as used in EM-tests.

²⁾ The type of Ain connector cable assembly is dependent on the type of ATBEG antenna used in the specific application. An application shall use ATBEG antennas of the same type. Mixed use of ATBEG antenna types within a single application is not allowed. When replacing a defective ATBEG antenna with another type ATBEG antenna, all antennas must be of the same type and the corresponding type of Ain connector cable assembly shall be used.

1.3 HQSE guidance note



Definition, STMA-67784 -

In this document the following graphical elements are used to emphasize HQSE relevance.



	DANGER Denotes a danger with a high <u>HQSE</u> content which must always be avoided.
	WARNING Denotes a risk with medium <u>HQSE</u> content which always requires attention as indicated.
	REMARK Denotes a situation with no or only minor <u>HQSE</u> content which is best served by attention as indicated.

1.4 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](#)

1.5 Audience

Text, STMA-67777 - This STM ATB installation manual is intended to be used by technical staff qualified and responsible for the engineering and installation of onboard train protection systems.

The staff qualification demands are to be determined by the system integrator, in accordance with the regulatory and statutory requirements.

2 General requirements

2.1 Organizational requirements

STMA-68350 - The installation design based on the requirements in this manual shall be made by the system integrator in compliance with EU Directives 2016/797/EU and 2016/798/EU.

Proper waste management shall be implemented in accordance with the prevailing statutory requirements including, but not limited to WEEE Directive 2012/19/EU.

The ECM or workshop management provides its staff with appropriate workshop instructions and tools, and oversees the adherence and proper use thereof.

2.2 Health and Safety requirements

Definition, STMA-67774 - All parts of this STM ATB installation procedure may only be executed if all prevailing health and safety requirements are met. These health and safety requirements include, but are not limited to:

- proper staff training and qualification for the tasks to be performed;
- appropriate HQSE measures, based on a project specific risk inventory;
- proper use of personal protective equipment.

The ECM or workshop management provides its staff with appropriate instructions and oversees the adherence thereof.

2.3 Material handling

Text, STMA-77741 - The following storage conditions for STM ATB shall be taken into account:

Storage temperature:

- STM ATB nominal storage temperature is between 10°C and 25°C.
- The ambient temperature shall not change more than 3°C / hour.

Humidity:

- STM ATB shall be stored in dry storage conditions; the humidity may vary between 5 % and 95% (non condensing).

2.4 Application conditions

STMA-74441 - The application conditions as defined in [STMA-7238 - D4.6 Exported constraints](#) shall be checked, as those are relevant for RIS compliance of the STM ATB in combination with the ETCS onboard, during operation in level NTC.

3 Installation design

Text, STMA-67775 - This chapter describes the requirements for onboard installation design of STM ATB.

3.1 General requirements

3.1.1 TSI and RIS conformity

STMA-67787 - The STM ATB shall be installed in combination with an ETCS onboard system.

Text, STMA-77889 - To facilitate temporary use without a full ETCS onboard system, another system together with which all parts of the RIS and ATBVv requirements which are complied with, may be used (as described in [STMA-21895 - In this chapter exported constraints concerning the ETCS on-board are defined. T...](#)). At any place in this document where "onboard ETCS system" is written, this may be replaced by such a limited system.

STMA-72024 - The STM ATB shall be integrated with an onboard ETCS system using a fully compliant STM-ETCS interface

according to TSI CCS (2016/919/EU) BL3R2 requirement specifications:
subset-035, subset-056, subset-057, subset-058 and subset-059;

STMA-72025 - The integration of STM ATB with the ETCS onboard system in the vehicle shall be subject to a NoBo/AsBo assessment and certification procedure according to TSI CCS and the procedures for assessment of conformity (2010/713/EU) ;

STMA-72027 - The integration of the onboard system shall, concerning the ATB requirements, be subject to a DeBo assessment according to Regeling Indienststelling Spoorvoertuigen.

STMA-76576 - A documented HQSE risk analysis in the installation design phase is required to identify the installation risks. Such risk analysis shall be carried out in the installation design phase, prior to the commencement of the works. The risks associated with the installation works shall be identified. Appropriate measures shall be defined and implemented to ensure safety and health of staff and prevention of damage to equipment, tools and railway vehicle.

STMA-76578 - All installation materials, including the cable assemblies and cable connectors used to interface with STM ATB shall comply with fire protection requirements as defined in EN 45545-2 and EN 45545-5 (published in 2013, amended in 2015). Detailed requirements for the classification of the operational environment are described in Chapter 2.17 of D4.5.

3.1.2 Documentation

Definition, STMA-72049 - The installation design for each train/locomotive series should be based on:

- representative electrical drawings for the particular train/locomotive series;
- representative mechanical drawings for the particular train/locomotive series;
- representative manufacturer documentation for the particular train/locomotive series.

The suitability of the input documentation shall be verified.

STMA-68959 - STM ATB software and hardware revision information shall be documented in the vehicle specific configuration data at (re)installation. The source information is contained in the SVD ([STMA-77990 - M9.7 System Version Description \(SVD\)](#)), which is delivered with the STM ATB unit.

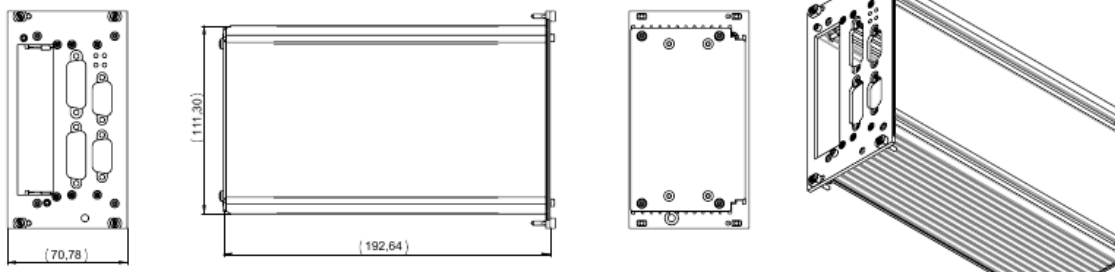
The installation design shall include a check of the version information of the installation and commissioning documentation, referred to in the SVD.

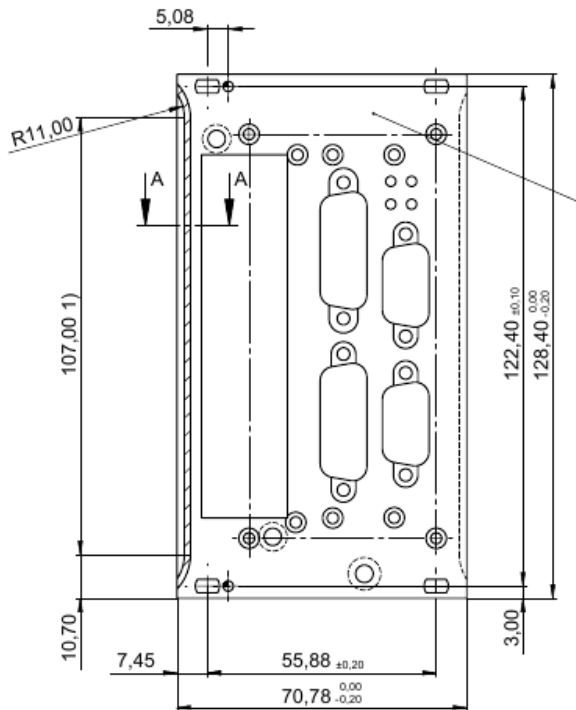
3.2 Mechanical design and location

3.2.1 Mechanical characteristics

Definition, STMA-67785 - The system has the following mechanical characteristics:

- The size of STM ATB is 220 (l) x 72 (w) x 132 (h) mm.
- The weight is approximately 1.2 kg







3.2.2 Cabinet/Rack

Text, STMA-77687 - The detailed mechanical installation is vehicle specific and shall therefore be described in the vehicle specific design. The description shall at least include a description and a figure explaining every step in the mounting of the unit:



- Detailed description of the location where the STM ATB shall be mounted.
- Place the unit in the rack.
- A description of the means and tools to fix the unit in the rack.

STMA-68351 - General requirements

The STM ATB shall be mounted:

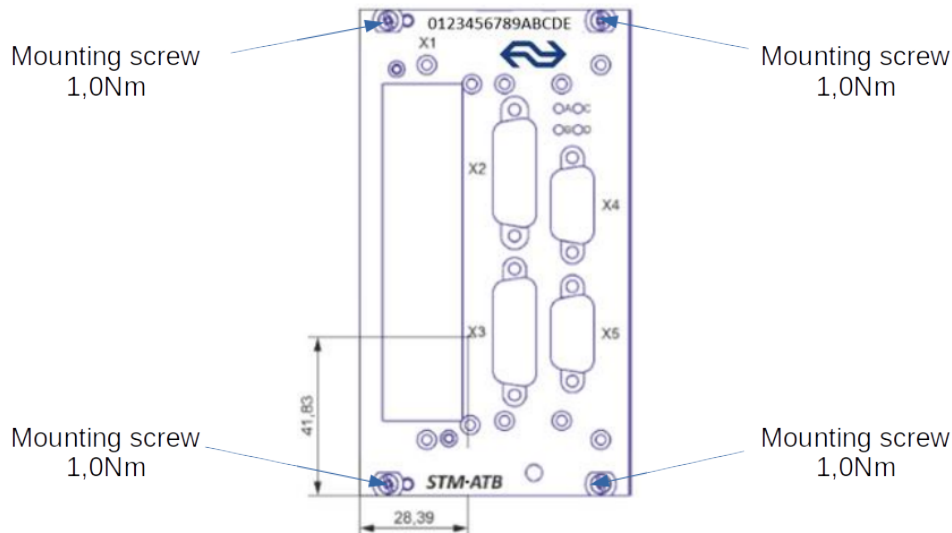
- in a protective cabinet, equipped with a suitable mounting rack, to ensure sufficiently robust mechanical mounting and resistance against shocks and vibrations;
- the orientation of the unit shall be as shown in figure  STMA-68369, unless an additional temperature analysis is done and the environmental temperature conditions are adapted according to the results;
- with 4 stainless steel mounting screws, type M3, one in each of the 4 mounting holes in the front cover, allowing a firm mounting of the STM ATB to the mounting rack; in such a way that the unit is protected against physical damage;
The screws must be tightened with a torque of 1.0Nm (see example in  STMA-80413 - figure: mounting the unit ())
- in such a way that the cables can be mounted / dismantled without damaging the cables or connectors;
- in such way that the cabinet door (if applicable) can be closed/opened without damaging the mounted cables or connectors;
- in compliance with maintenance and inspection requirements (see Ch. 3.2.5).

STMA-68345 - The cabinet and/or mounting rack shall comply with the following requirements:

- have sufficient mounting space for the STM ATB and its cables;
- provide additional space for ventilation (see  STMA-80403 - Temperature/ventilation) to comply with temperature requirements ( STMA-80412 - The environment of the STM ATB shall provide an STM ATB enclosure temperature);
- provide water leak holes, to let out condensation;
- provide ample room for all interfaces and cabling:

- in particular, the cabinet design shall take into account the minimum bending radius of the cabling;
- the distance between the front cover of the STM ATB and the (closed) cabinet door (if applicable) shall be sufficient for the depth of the cable connector plus space for the cabling.
- Include a means (e.g. a lockable door) to prevent unauthorized access.

Definition, STMA-80413 - figure: mounting the unit (**T** [STMA-74438 - Installation 5. Place the STM ATB in the 19" rack](#) (see); [6. Hand fasten the STM...](#))



3.2.3 Temperature/ventilation

Text, STMA-80410 - As for all electronic devices the failure rate and expected life time of the STM ATB are to a great extent influenced by the environmental temperature (rule of thumb: a factor 2 per 10 degrees Celcius). Therefore it is important to select an on-board location where the average temperature is as low as possible (but above the vapor point). In addition maximum limits apply. The maximum limits for temperature depend on the ventilation (speed and direction) around the STM ATB unit. Therefore the limits below apply for the temperature of the outside of the STM ATB enclosure.

STMA-80412 -

The environment of the STM ATB shall provide an STM ATB enclosure temperature :

- not exceeding the ranges -25°C to $+60^{\circ}\text{C}$ continuous (taking into account between 0W and 12W dissipation of the STM ATB)
note: the enclosure temperature shall be as low as possible , as the lifetime increases and the failure rate decreases when the average temperature is lowered ("non-condensing").
note: improvements to increase the temperature range to $+70^{\circ}\text{C}$ are investigated.
- not exceeding temperature changes of $\pm 3^{\circ}\text{C/s}$, with a maximum variation of 40°C/hr ;

STMA-80411 -

The STM ATB (installation cabinet) shall not be placed at a location with direct exposure to sunlight or solar radiation;

3.2.4 EMI

STMA-80408 - The STM ATB shall be placed at a location where the EM-limits given in [STMA-8548 - D4.5 Environmental Requirement Specification \(ERS\)](#) are met, especially:

- [STMA-8556 - Power supply](#)
- [STMA-8652 - Conducted immunity](#)
- [STMA-8675 - ESD](#)
- [STMA-8676 - Radiated immunity](#)

STMA-80409 - The STM ATB shall be placed at a location where all other equipment is immune for the emission of the STM ATB: [STMA-8653 - Emission](#)

Text, STMA-68346 -

It is advised to place the STM ATB:

- in close vicinity of the EVC to limit the length of the Profibus cable (Profibus standard defines a maximum length of 200m; a shorter Profibus cable results in a lower the bit-fault rate, the more stable the communication will be);
- in a way EMI is minimized on the equipment and on the cabling.

3.2.5 Maintenance

STMA-80405 -

The STM ATB shall be placed in a way the LED indicators at the front panel are easily visible
i.e.:

- After opening the cover (e.g. door) of the cabinet the LED's shall be visible from a position in front of the cabinet.
- The LED's shall be visible without removing or replacing cabling.

Text, STMA-80406 -

The STM ATB does not require preventive maintenance (except for a periodic test in the case the parallel EB command outputs are used to reduce the response time of the EB).

In case of faults which require a repair, the STM ATB unit shall always be exchanged. The frequency of exchanging shall be in the order of 1/10 years (or lower).

If, in case of defects, exchange by mobile maintenance personnel is foreseen (e.g. at a station or yard), it is advised to install the STM ATB at an maintenance friendly location where it can be accessed and (dis)mounted without special (climbing) tools and without removing other equipment.

Text, STMA-80407 - As it is possible to retrieve additional information via the Profibus is it useful if the Profibus is accessible at the STM ATB or at another location at the Profibus.

3.3 Electrical design

STMA-72018 - The electrical design shall be captured in:

- a block diagram showing all electrical connections from STM ATB to the adjacent equipment and interfaces and allowing identification of these connections;
- wiring diagrams of the cabling used, including cable and connector identification and references to cable and connector specifications (including pinning);
- cable routing diagrams based on the physical layout of the cabinet;
- an update of the existing vehicle type specific electrical drawings.






The design shall also include the provision of:

- bill of materials;
- hard- and software configuration data of STM ATB and the cable assemblies used;
- quality assurance requirements/compliance evidence (design verification reports, article inspection checklists, installation test protocols, integration test protocols, commissioning test protocols).

STMA-68344 - The STM ATB shall be electrically connected to:

- ETCS onboard system (Profibus interface);
- ATB antennas;
- Brake-handle (BHA and/or BSO and/or a 4-20 mA brake pipe pressure sensor via vehicle interface);
- CAB audio unit in drivers cabin (optional);
- EB-command circuits (optional);
- Vehicle earth and ground, using a flexible copper braid bond (200 x 14 x 1.5 mm);
- Two onboard power supply connections, both individually protected with an own over-current protection commonly supplied via one multi signal circuit breaker.

Text, STMA-68355 -

The pin numbering of the STM ATB connectors is shown in Figure  STMA-68369 and the pin occupation is listed in  STMA-77973 - Appendix: X1,  STMA-77974 - Appendix: X2,  STMA-77971 - Appendix: X3 and  STMA-77972 - Appendix: X4/X5

STMA-68951 - The wiring to be used shall be compliant with normative requirements with respect to electrical safety and environmental aspects.

3.3.1 Profibus interface


STMA-68349 -

The Profibus in the vehicle shall be:

- designed according to EN 50170;
 - only prescribed Sub-D09 connectors should be used;
- include the following connectivity:
 - data line (A);
 - data line (B);
- exclude power supply lines, because external power supplied to the STM ATB Profibus connectors will lead to a failure during startup tests of the STM ATB.

Text, STMA-68353 - The Profibus connection is made via connectors X4 and X5 as described in 3.4.5 - Assemble Profibus connectors and cabling (X4 / X5)

3.3.2 ATB antenna (ATBEG coils) interface

Hardware Design, STMA-68347 - Five types of ATB antennas are currently in use ( STMA-45025). Each type of antenna has its own electro-magnetic characteristics and each type of antenna shall be installed according to vehicle supplier installation guidelines. This results in antenna-specific signal levels.

For retrofit installations, the existing ATB antennas and antenna cables can be re-used.

The existing cables shall be connected to the STM ATB using an ATB antenna type specific cable assembly (3.4.4 - Sub-D15 connectors X2 and X3), which adapts the signal levels from various antenna types.

STMA-68940 - The installation design staff shall determine the type of ATB antenna installed in the train/locomotive and the corresponding cable set in advance.

The total cable resistance between the antennas and the STM ATB unit shall not exceed 50 ohms. If this value is exceeded, additional tests shall be performed to prove that the antennas

are always correctly recognized by the STM ATB (taking tolerances into account).

If the antennas are recognized then the STM ATB will function as intended.

Text, STMA-72016 - The STM ATB requires the 75 Hz input signals to be in phase, therefore the polarity of the antennas is important for the correct operation. If the polarity is inverted, valid ATBEG code will not be recognized by the STM ATB, thus normal operation is not possible.


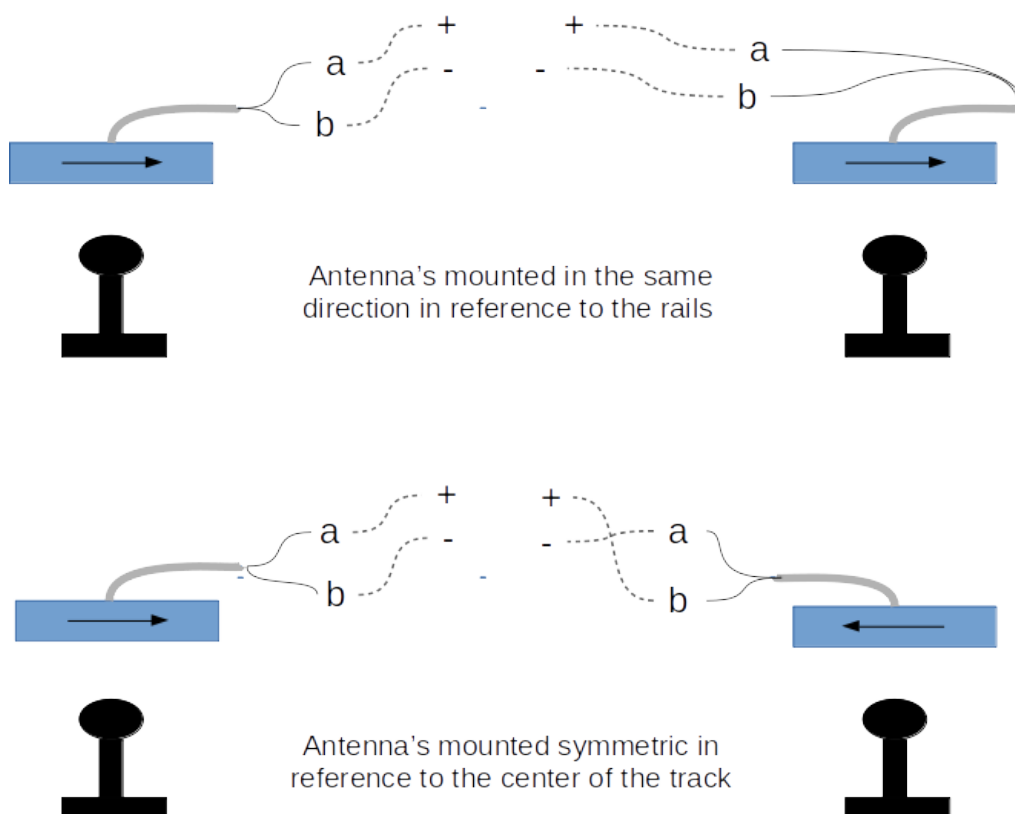
Text, STMA-68360 - The two ATB antennas under each cabin can be mounted in different orientations (see  **STMA-14777** -

Figure: possible orientations and connection schemes of the antenna's correspond... which will result in a 180° phase

difference of the antenna input signals:

- polarized in the same direction in reference to the rails (in phase);
- polarized symmetric in reference to the center of the track (out of phase).

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



Definition, STMA-72028 - Table: STM ATB pinning ATB antenna AIN

STM ATB connector	cable	pin		
		nr.	name	description
X2	D	15	<u>AIn_1A+</u>	ATB antenna cabin A right hand side seen from forward direction cabin A
		7	<u>AIn_1A-</u>	ATB antenna cabin A right hand side seen from forward direction cabin A
	E	5	<u>AIn_2A+</u>	ATB antenna cabin B left hand side seen from forward direction cabin B
		12	<u>AIn_2A-</u>	ATB antenna cabin B left hand side seen from forward direction cabin B
X3	F	9	<u>AIn_1B+</u>	ATB antenna cabin B right hand side seen from forward direction cabin B
		2	<u>AIn_1B-</u>	ATB antenna cabin B right hand side seen from forward direction cabin B
	G	4	<u>AIn_2B+</u>	ATB antenna cabin A left hand side seen from forward direction cabin A
		12	<u>AIn_2B-</u>	ATB antenna cabin A left hand side seen from forward direction cabin A

STMA-72030 -

The STM ATB requires that the a and b poles of each antenna always to be connected according to Table [STM-72028](#) and figure [STM-14777](#).

The correct connection of the antennas is proven if the STM ATB is able to decode ATB track signals provided with the ATB test generator / ATB test-loop ("lusplank"), see [STM-72034 - Table: STM ATB test protocol Cab A testing measured check result LED indicators....](#)

Requirement, STMA-75518 - The correct mounting of all ATB antenna's, the electrical 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.

Text, STMA-80433 - The antenna connections shall be made via connectors X2 and X3 as described in [3.4.4 - Sub-D15 connectors X2 and X3](#).

3.3.3 Inputs for detection of brake operation

Requirement, STMA-14987 - The train shall provide brake handle supplied information ([STM-10889](#))

STMA-73212 - Inputs used for detection of brake operation.

Information concerning brake operation by the driver can be obtained via digital inputs and/or an analogue pressure signal.

One of the following options shall be chosen:

- In case the train is equipped with a position dependent brake handle control including a contact which is switched at a brake handle position equivalent with at least 0.31m/s² deceleration (at flat track), or lead to 0.4 bar brake pipe pressure decrease: connect the BHA/BHN signal, with the contact switched at the indicated brake handle position.
A position dependent brake handle control implies that the brake power requested by the driver is equivalent with the brake handle position.
- In case the train is equipped with a time dependent brake handle control including a contact which is switched if the brake handle is operated, and a digital feed-back from the braking system that the brakes are operated sufficiently to reach at least 0.31m/s² deceleration (at flat track), or lead to 0.4 bar brake pipe pressure decrease in case of freight trains: connect the BHA/BHN to the contact which is switched if the brake handle is operated, and connect the BSO/BSN inputs to the digital feed-back giving the information that the brakes are sufficiently operated.
A time dependent brake handle control implies that the brake power requested by the driver is equivalent with the time the brake handle is operated.
- In case the train is equipped with a brake handle control without a contact which is switched if the brake handle is operated, and with a digital feed-back from the braking system that the brakes are operated sufficiently to reach at least 0.31m/s² deceleration (at flat track), or lead to 0.4 bar brake pipe pressure decrease in case of freight trains: connect the BSO/BSN inputs to the digital feed-back giving the information that the brakes are sufficiently operated.
note: if the delay in the feed-back signal exceeds 300ms, this option will lead to an unacceptable decrease of the available driver reaction time. In concerning cases the option shall not be used.
- In case the train is equipped with a time dependent brake handle control including a contact which is switched if the brake handle is operated, and a analogue feed-back from the braking system providing the brake pipe pressure (or an equivalent signal controlling the brake pipe pressure): connect the BHA/BHN to the contact which is switched if the brake handle is operated, and connect the analogue brake pipe pressure signal.
- In case the train is equipped with a brake handle control without a contact which is switched if the brake handle is operated, and a analogue feed-back from the braking system providing the brake pipe pressure (or an equivalent signal controlling the brake pipe pressure): connect the analogue brake pipe pressure signal.
note: if the time between brake operation and the reduction of the brake pipe pressure to 4.8 bar, exceeds 300ms, this option will lead to an unacceptable decrease of the available driver reaction time. In concerning cases the option shall not be used.

Definition, STMA-19190 - The digital inputs are defined as specified in the table below

input	signal	description
DIn_1A	BHA	Brake Handle Applied
DIn_2A	BSO	Brake Sufficiently Operated
DIn_3A	EB_A	Indication if direct EB is used (high active, i.e. high if the EB is connected, low if the EB is not connected)
DIn_1B	BHN	Brake Handle Not applied
DIn_2B	BSN	Brake Not Sufficiently operated
DIn_3B	EB_B	Indication if direct EB is used (low active, i.e. low if the EB is connected, high if the EB is not connected)

Text, STMA-77908 - Electrotechnical specification of the digital inputs

Two groups of three digital inputs with a common ground are implemented. The nominal voltage may vary between 24Vdc and 110Vdc, taking into account tolerances according to the applicable standards. The switching voltage is 8Vdc +/- 2Vdc.

The digital inputs can be used in two different ways, either per three digital inputs an additional power supply can be used (inputs DIn_A-PWR and DIn_B-PWR) to increase the input resistance of the digital input, see figure [STMA-39079 - Over-voltage protection plus input filter](#).

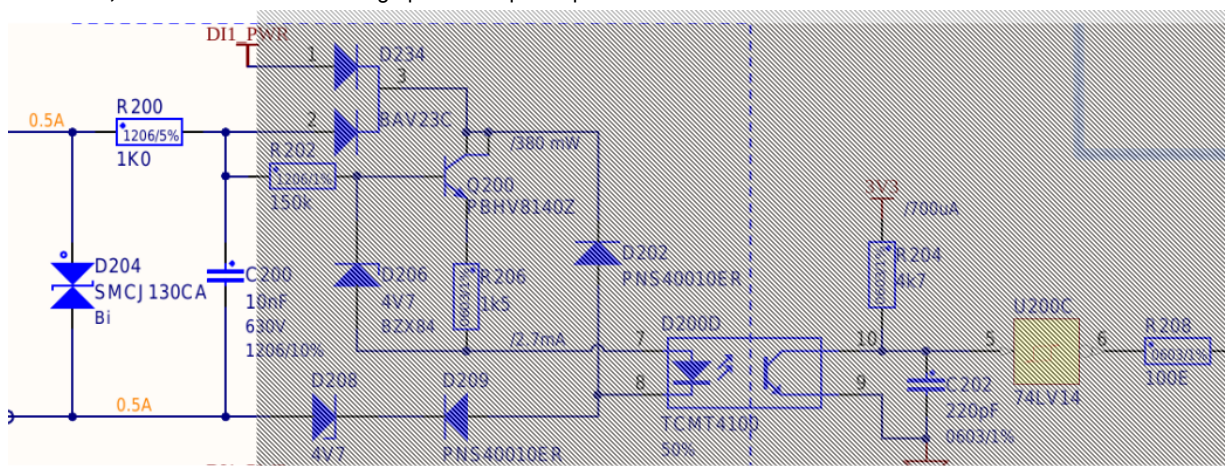
Without additional power supply the input current will be app. 2.7mA (4.7V/1.5k, [STMA-39079 - Over-voltage protection plus input filter](#)). With additional power supply the input impedance increases to at least 150k.

STMA-80445 - The selected connector (and in-circuit switching elements) shall be fit for low currents (i.e. not prone to contact isolation).

The lowest expected input current in case externally powered inputs are used, is (24VDC-4.7VDC - 1.4VDC)@150kOhm, thus app. 0.12mA.

The lowest expected input current if no external power supply (DIn_PWR, [STMA-39079 - Over-voltage protection plus input filter](#)) is used is 2.7mA (current floating through R206, [STMA-39079 - Over-voltage protection plus input filter](#)).

Definition, STMA-39079 - Over-voltage protection plus input filter



Text, STMA-77909 - Electrotechnical specification of the analogue brake pipe pressure inputs:

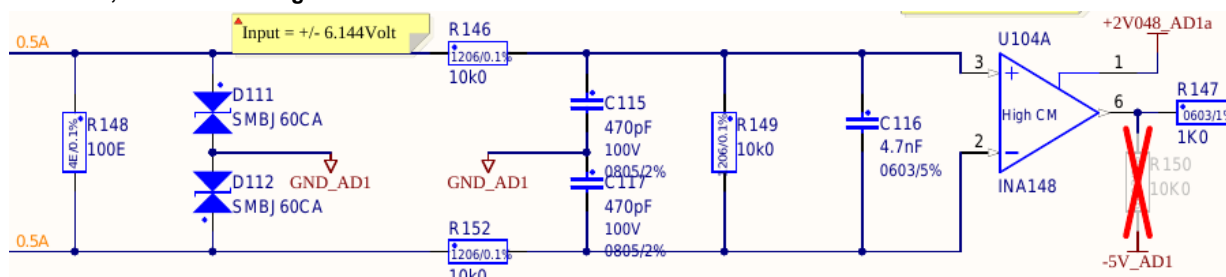
The analogue brake pipe pressure inputs are designed to operate with a 2 or 3 wire 4-20mA pressure sensor with an absolute reference (vacuum). The power supply for the sensor shall be implemented outside the STM ATB. The input resistance for the redundant circuits is app. 100 Ohm (see [STMA-39133 - Figure scheme Buffer](#).)

Definition, STMA-4898 -

The current level for the analogue inputs for pressure measurement shall be 4-20mA (resolution 0.01mA, 1.6mA/bar), @ <= 200 ohm

5,6mA shall be 1 bar = environmental pressure,
 13,6mA shall be 6 bar (= 5 bar + environmental pressure)
 below 4,6 bar: brake applied
 above 4,6 bar: brake not applied
 below 3,6mA: failure or not connected
 above 21mA: failure

Definition, STMA-39133 - Figure scheme Buffer:



Text, STMA-80436 - The digital signals for determining brake operation shall (as far as used) be connected via connector X1, as described in [3.4.3 - Assemble DIN 41612 counter connector X1 with the cables A, B and C](#) . Unused BHA/BHN and BSO/BSN inputs may be "not connected".

Text, STMA-80437 - The analogue signals for determining brake operation shall (as far as used) be connected via connector X2 and X3 as described in [3.4.4 - Sub-D15 connectors X2 and X3](#) . Unused "brake pipe pressure" inputs may be "not connected".

3.3.4 Inputs for configuration of the direct EB command

Text, STMA-80435 - The STM ATB is equipped with two EB outputs via which a contact in the (ETCS) brake loop can be opened. This functionality can be used to lower the response time after an EB command (compared to only commanding the EB via the Profibus). To know if EB delay time (T_EB_MAXDELAY) can be ignored because of parallel commanding of the EB, input information to indicate if a parallel EB command is used, shall be provided to the STM ATB.

For this input information the inputs Din_3A and Din_3B are used. The inputs shall be connected (also if no direct EB command is used) according to [STMA-19190 - The digital inputs are defined as specified in the table below input signal desc...](#) in [3.3.3 - Inputs for detection of brake operation](#).

The signals shall be connected via connector X1, as described in [3.4.3 - Assemble DIN 41612 counter connector X1 with the cables A, B and C](#) .

3.3.5 Inputs for the configuration of the braking percentage

Text, STMA-80439 - The STM ATB shall be informed about the braking percentage by the ETCS on-board. As a fall-back for the cases the ETCS on-board doesn't provide this information, the information is provided by a resistor in connectors X2 and X3 as described in [3.4.4 - Sub-D15 connectors X2 and X3](#)

If, in the target configuration, the braking percentage is always provided by the ETCS on-board, then the configuration resistor doesn't have to be placed.

The information from the configuration resistor will only be used in case no "braking percentage" is received from the ETCS on-board.

3.3.6 Outputs to control sound signals

Text, STMA-77897 - The digital outputs are implemented as contacts which are switched to a pole common to a group of three outputs (DOut_A-Common for DOut_1A, DOut_2A, DOut_3A and DOut_B-Common for DOut_1B, DOut_2B, DOut_3B). Each common can be connected to the plus or to the minus.

STMA-73213 - Digital outputs

The digital outputs have been added to allow for an external sound generator. This sound generator shall play the required sounds as defined in [STMA-8277 - DMI configuration table according to](#) . The values in the table are mandatory as... in case the transmission of the signals via profibus to the DMI takes too long (see [STMA-2760](#)).

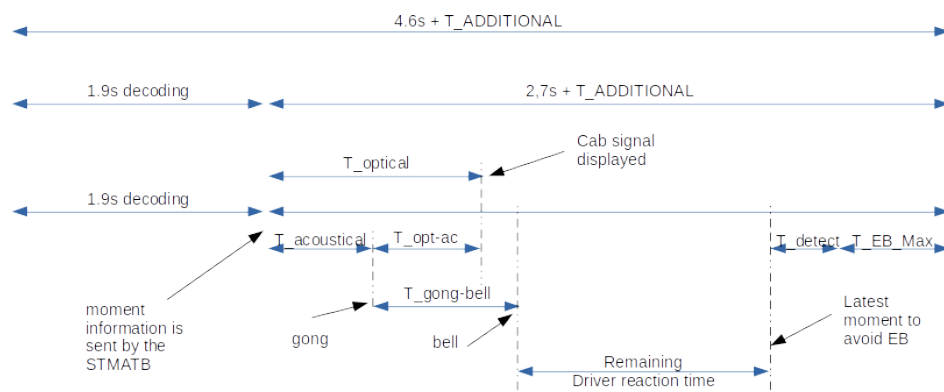
The concerning signals are the "gong" and "bel" as defined in [STMA-8277 - DMI configuration table according to](#) . The values in the table are mandatory as...

The Gong and Bel shall be connected at Dout 2A and Dout 1A (table [STMA-28699](#)). For pinning, see [STMA-8323 - \(table\)](#) For the power supply and digital I/O signals a front connector type DIN4...

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	EB_A	Emergency Brake (Active high)
DOut_1B	Yellow4	Yellow cab signal
DOut_2B	Code	coded signal to communicate the guarded speed (= Cab Signal)
DOut_3B	EB_B	Emergency Brake (Active high)

Requirement, STMA-2760 - Figure: explanation of time delays



- T_ADDITIONAL: additional time because of faster braking system (compared to UIC models at which the signal distance is based)
- T_Optical: time between the moment packet STM-35 is put at the Profibus and the moment the cab signal is displayed
- T_acoustical: Delay in commanding the acoustical signals (external delay in case an external sound generator is used)
If the acoustical information from the profibus is used, then this information is contained in the same message as the optical information
- T_opt-ac: time between gong and the moment the cab signal is displayed (maximum value: 300ms)
- T_gong-bell: time between gong and bell; 500ms (300ms acc. to the RIS plus 200ms spread in communication time)
- T_detect: time between the moment the driver operates the brake and the moment the information is available in the STMATB (BHA, BSO, BP)
- T_EB_Max: time between the moment packet STM-128 is put at the Profibus and the moment the EB is commanded (T_EB_MAXDELAY)

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Definition, STMA-75531 - If the digital outputs are used to control a sound device in the cabin, then the ".wav" files in the DMI configuration table shall be empty (i.e. no sound shall be played if the concerning command via profibus, packet STM-46 is received).

*) STM ATB is equipped with redundant SMPS units.

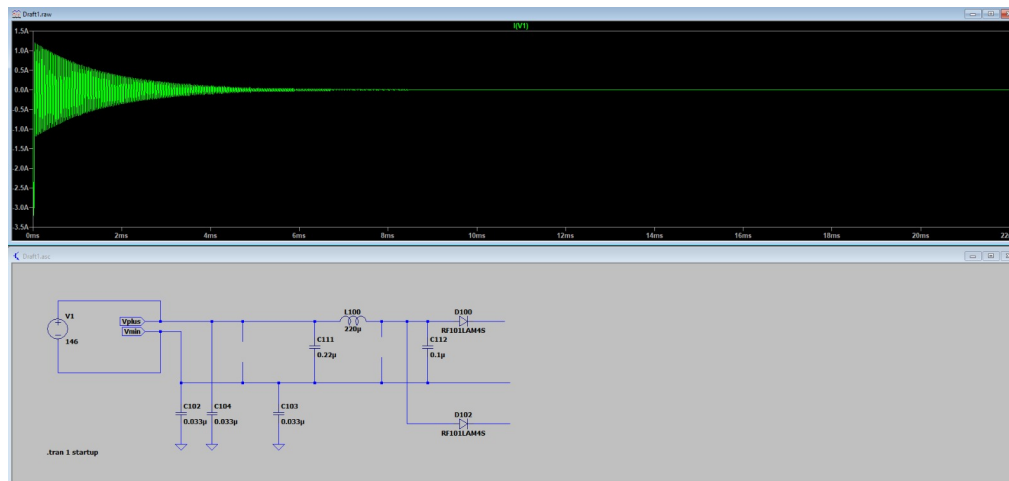
Requirement, STMA-5115 -

The train shall provide means to power off/deactivate the STM ATB and inform the ETCS system that the STM ATB shall be ignored. Usage of this function shall be logged.

note: the signal can be provided as "national system isolation" signal acc. to subset-119 to the ETCS on-board.

Definition, STMA-80414 -

Figure: Simulated switch on current at 146VDC with not activated power supply module (GAIA_MGDD20W) (with power supply the oscillation will be damped, compared to the behaviour below).



Text, STMA-80443 - The two power supply circuits shall (as far as used) be connected via connector X1, as described in [3.4.3 - Assemble DIN 41612 counter connector X1 with the cables A, B and C](#).

3.3.9 Earthing and grounding

STMA-72019 -

- The STM ATB enclosure shall be earthed by connecting the M4 screw on the front plate to PE with a flexible copper braid bond (200 x 14 x 1.5 mm).
- The earthing of the cables between the STM ATB and the vehicle interface shall be connected only via the connection of the cable jacket with the PE pins in each connector and the earthing of the STM ATB enclosure.
- For AC currents the STM ATB cable shielding shall be connected to PE at both ends of the cabling.
Measures to prevent too high DC currents shall be taken, normally the PE circuits in the vehicle will have a sufficiently low impedance to achieve this without further measures.

3.4 Cabling manufacturing and testing

Text, STMA-72017 -

The STM ATB electrical connections require a prefabricated cable set consisting of 5 cables as defined in this chapter

The connector X1 provides for the digital in/outputs with the cables A and C and the power supply with cable B. Connector is type DIN41612-F-48P.

The connectors X2 (Sub-DB15 pins) (with cables D and E) and X3 (DB15) (with cables F and G) provide for the analog in/outputs. The gender of X2 and X3 is different (M/F).

For each ATB antenna type (5 variants), a specific set of cables D, E, F and G is required, as gain compensation resistors are mounted inside the connectors X2 and X3.

- with 1 cable: J (Profibus) or termination

STMA-69226 - The cable manufacturer shall choose the appropriate cables in accordance with:

- All cables and connector materials in accordance with EN45545-2 requirements for the specific onboard application
- Profibus cables in accordance with EN50170 and EN50264
- DIO, PS and AIN cables in accordance with EN 50264
- For analogue input signals (subD-15 connectors) shielded twisted pair cabling shall be used;
(one twisted pair per analogue signal)
- For the battery referenced signals (DIO + power supply connector) a sufficient diameter (for the current protection) shall be used.
- Voltage and current rated for the application;
- temperature -25 ° C to +70 ° C ambient and up to 85 ° C during 10 minutes maximum.

STMA-68372 - The cabling shall be RoHS and REACH compliant.

Text, STMA-77961 - Vehicle specific issues:

- number of Profibus connections to the STM ATB
- type of ATB antennas used in the vehicle;
- brake system used in the vehicle;
- number of cabins controlled from the unit, e.g. if two or four antennas are connected;
- cable length and curvature.

STMA-69227 -

Cable connector types, see [13 - Appendix : Cable connector parts](#)

The recommendations of the connector supplier shall be taken into account.

3.4.2 Preparations

Text, STMA-69214 -

1. Check that the required length of each cable (A-J) has been determined, see Table [STMA-69215](#);

Definition, STMA-69215 - Table: cutting length of the STM ATB cables

The length of the cables is to be determined vehicle dependent, i.e. tbd.

code	tag	maximum number active wires	cutting length [m]
A	STM-ATB DIO4-6	12	tbd
B	STM-ATB Supply	6	tbd
C	STM-ATB DIO1-3	12	tbd
D	STM-ATB AIN 1	6	tbd
E	STM-ATB AIN 2, 3	9	tbd
F	STM-ATB AIN 5	6	tbd
G	STM-ATB AIN 6, 7	9	tbd
H	STM-ATB PROFIBUS 1	2 (if connected to Profibus)	tbd
J	STM-ATB PROFIBUS 2		tbd

Text, STMA-69222 -

2. Check that the vehicle specific resistors to be built into the counter connectors X2, X3 and (if applicable) X4 or X5 have been determined and supplied:
 - antenna resistors, see **T** [STMA-69220 - The following resistors are necessary in X2 and X3; connectors for the analog in...](#)
 - Profibus resistors, see **I** [STMA-69218 - * termination resistors \(3\) to build into the termination for connector X4 or X5...](#)

Text, STMA-69219 - 3. Check that all components to be assembled and tools are present:

- see Table in [13 - Appendix : Cable connector parts](#)

3.4.3 Assemble DIN 41612 counter connector X1 with the cables A, B and C**Text, STMA-69217 -**

1. Cut and strip the cables A, B and C according the specification of the connector supplier:
 - If (a) cable(s) is/are provided with more cores than active (A and C: 12, B: 6):
 - Cut any unused cores and isolate each of them with a protective cover;
 - Label the cables;
2. Connect the cores used for the specific application (train type) to the non-PE pins on the STM ATB counter connector X1 according to Table **I** [STMA-69210](#):
 - Using the crimp contacts;
 - perform a visual inspection and a mild pulling test on each contact assembled;
3. Connect the cable jacket to the PE pins on the on the STM ATB counter connector X1 according to Table **I** [STMA-69210](#) :
 - perform a visual inspection and a mild pulling test on each contact assembled;
4. Assemble the counter connector in the housing and hand fasten all connector housing screws:
 - ensure that the counter connector is placed correctly in the housing;
5. Secure all cable entries into the counter connector housing with the crimp flanges and ferrules;
6. Close the unused cable entries of the connector housing with the blanking pieces and hand fasten all blanking piece housing screws;
7. Perform a visual inspection and a mild pulling test on each cable assembled;
8. Counter connector X1 with cables A, B and C is ready for testing;

Definition, STMA-69210 - Table: cable cores and pinning counter connector X1

The cable shall be labeled at both ends as ("STMATB-X1")

If the individual wires are labeled, the labels shall be according to the pin number of the connector.

The colours are to be decided by the manufacturer

The train interface is determined by the system integrator

cable	core		counter connector X1				train interface	
	colour	label	pinning					
C	jacket	PE	32z				tbd	
	jacket	PE	32b				tbd	
	jacket	PE	32d				tbd	
	tbd	tbd	30z				tbd	
	tbd	tbd	30b		32	○	○	tbd
	tbd	tbd	30d				tbd	
	tbd	tbd	28z				tbd	
	tbd	tbd	28b		30	○	○	tbd
	tbd	tbd	28d				tbd	
	jacket	PE	26z		28	○	○	tbd
	jacket	PE	26b				tbd	
	jacket	PE	26d				tbd	
	tbd	tbd	24z		26	○	○	tbd
	tbd	tbd	24b				tbd	
	tbd	tbd	24d				tbd	
	tbd	tbd	22z		24	○	○	tbd
	tbd	tbd	22b				tbd	
	tbd	tbd	22d				tbd	
B	jacket	PE	20z	22	○	○	tbd	
	jacket	PE	20b			tbd		
	jacket	PE	20d			tbd		
	tbd	tbd	18z	20	○	○	tbd	
	tbd	tbd	18b			tbd		
	tbd	tbd	18d			tbd		
	tbd	tbd	16z	18	○	○	tbd	
	tbd	tbd	16b			tbd		
	tbd	tbd	16d	16	○	○	tbd	
	jacket	PE	14z	14	○	○	tbd	
	jacket	PE	14b			tbd		
	jacket	PE	14d			tbd		
A	tbd	tbd	12z	12	○	○	tbd	
	tbd	tbd	12b			tbd		
	tbd	tbd	12d			tbd		
	tbd	tbd	10z			tbd		
	tbd	tbd	10b	10	○	○	tbd	
	tbd	tbd	10d			tbd		
	jacket	PE	8z	8	○	○	tbd	
	jacket	PE	8b			tbd		
	jacket	PE	8d			tbd		
	tbd	tbd	6z	6	○	○	tbd	
	tbd	tbd	6b			tbd		
	tbd	tbd	6d			tbd		
	tbd	tbd	4z	4	○	○	tbd	
	tbd	tbd	4b			tbd		
	tbd	tbd	4d			tbd		
	jacket	PE	2z	2	○	○	tbd	
	jacket	PE	2b			tbd		
	jacket	PE	2d			tbd		

3.4.4 Sub-D15 connectors X2 and X3

Text, STMA-80417 - Connectors X2 and X3 are used to connect the analog input signals. Apart from the four ATB-antenna signals there are two optional "brake pressure" signals and two configuration signals.

The ATB-antenna signals shall be terminated with an 560 ohm resistor, preferably in the connector.

To correct the differences in gain for the different ATB-antenna types, a specific "gain resistor" (in fact an attenuation resistor) shall be installed for each individual antenna. The value of this attenuation resistor, which is dependent on the ATB-antenna type, is given in [STMA-69223 - Table: ATB antenna specific resistors to be built into counter connectors X2 and...](#)

The configuration signals are used to provide the braking percentage in case this is not sent by the ETCS system. The signal

can be generated inside the connector by means of the configuration resistor. The value of this resistor is given in [STMA-17205 - Table: ConfiguredBrakingPercentage as a function of U_config_filtered. R \[kΩ\] \(E...](#)

Text, STMA-69220 -

The following resistors are necessary in X2 and X3; connectors for the analog inputs

- gain resistors (4):
 - 4 ATB antennas installed (general, dual-directional vehicle): 4 x 560 Ω
 - only 2 ATB antennas installed (single directional rail vehicle or in case both cabins will be equipped with an ETCS onboard installation): 2 x 560 Ω for the installed ATB antennas and 2 x open circuit for ATB antennas that are not installed;
- Antenna specific resistors, see table [STMA-69223 - Table: ATB antenna specific resistors to be built into counter connectors X2 and...](#)
- configuration resistors (2) depending on the brake system installed in the vehicle for which the STM ATB cabling is ordered, see [STMA-17205 - Table: ConfiguredBrakingPercentage as a function of U_config_filtered. R \[kΩ\] \(E...](#)

note: the termination resistors (560 Ω) may also be placed outside the connector somewhere between the antenna and the STM ATB. The cabling part between the STM ATB and the termination resistors is monitored by the STM ATB internal monitoring function using 145Hz and 2133Hz test signals (the frequencies are too high to result in a current through the coils). The vulnerability for EM disturbances at the cable will increase when placing the termination resistors further from the STM ATB, however this is not expected to be critical.

The total termination resistor seen from the STM ATB shall be 560 Ω. Therefore, if the resistor is placed on distance from the STM ATB, the value of the resistor shall be lowered with the cable impedance. Thus termination resistor plus resistance of the cabling between STM ATB and termination resistor shall be 560 Ω in total.

Definition, STMA-69223 -

Table: ATB antenna specific resistors to be built into counter connectors X2 and X3

ATB antenna	antenna gain resistor [Ω]
Alstom Bar	1740
Alstom V	14000
PW-170	5620
PW-225	11300
Fase 3	1740
No antenna	220

Definition, STMA-17205 -

Table: ConfiguredBrakingPercentage as a function of U_config_filtered.

R [kΩ] (E96 series)	nominal input voltage [V]	nominal voltage @ ADC [V]	min range [V]	max range [V]	Braking %
4,53	3,36	1,31	1,25	1,37	36
3,01	3,07	1,03	0,97	1,09	46
2	2,73	0,68	0,62	0,74	54
1,5	2,46	0,41	0,35	0,47	55
1,13	2,17	0,12	0,06	0,18	65
0,845	1,88	-0,17	-0,23	-0,11	72
0,634	1,59	-0,46	-0,52	-0,40	91
0,464	1,30	-0,75	-0,81	-0,69	113
0,332	1,02	-1,03	-1,09	-0,97	119
0,221	0,74	-1,31	-1,37	-1,25	160




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

3.4.4.1 Assemble sub-D15 counter connector X2 with the cables D and E

Text, STMA-69212 -

- Cut and strip the cables D and E and their wires according to the specification of the connector supplier :
 - If (a) cable(s) is/are provided with more cores than active (D: 6, E: 9):
 - Cut any unused cores and isolate each of them with a protective cover;
 - Label the cables;
- Connect the cores used for the specific application (train type) to the pins on the STM ATB counter connector X2 according to Table [STMA-69198](#):
 - using the crimp contacts;
 - perform a visual inspection and a mild pulling test on each contact assembled;
- Insert the specified resistors according to Table [STMA-69213](#):
(alternatives, e.g. placing the resistors on a PCB inside the connector housing, is also acceptable as long as the resistors are inside the shielded area).
 - cut the resistor wires to the length required to fit into the counter connector X2 housing;
 - strip the resistor wires, turn them around the resistor pins and solder them to the pins;
 - guide the resistor wires along the resistor in the same direction;
 - shrink a shrink sleeve with inner melt around the resistor assembly for protection;
 - perform a visual inspection and a mild pulling test on each contact assembled;

Definition, STMA-69213 - Table 7: resistors to be installed in counter connector X2


resistor type	resistance	resistor wiring	between pins
antenna resistors (termination)	560 Ohm		7-15 5-12
gain resistors	⚠ STMA-69223 - Table: ATB antenna specific resistors to be built into counter connectors X2 and...		6-14 4-11
configuration resistors	⚠ STMA-17205 - Table: ConfiguredBrakingPercentage as a function of U_config_filtered. R [kΩ] (E...		1-8

Text, STMA-69211 -

4. Connect the cable jacket to the PE shield on the on the STM ATB counter connector X2
5. perform a visual inspection and a mild pulling test on the contact assembled;

Text, STMA-69200 -

6. Assemble the counter connector in the housing and hand fasten all connector housing screws;

	REMARK There is very little room between cable D and the upper connector housing screw of cable E. Take care not to damage the cable.
---	---

Text, STMA-69201 -

7. Secure all cable entries into the counter connector housing with the cable clamps and ferrules;
8. perform a visual inspection and a mild pulling test on each cable assembled;
9. Counter connector X2 with cables D and E is ready for testing.

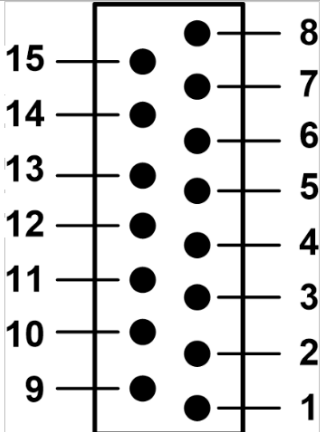
Definition, STMA-69198 - Table: cable cores and pinning counter connector X2

The cable shall be labeled at both ends as ("STMATB-X2")

If the individual wires are labeled, the labels shall be according to the pin number of the connector.



The colours are to be decided by the manufacturer

The train interface is determined by the system integrator

cable	core		counter connector X2				train interface
	colour	label	resistor	pinning			
D	tbd	tbd	config to 1	8		tbd	
	tbd	tbd	antenna to 7	15		tbd	
	tbd	tbd	antenna to 15	7		tbd	
	tbd	tbd	gain to 6	14		tbd	
	tbd	tbd	gain to 14	6		tbd	
	tbd	tbd		13		tbd	
E	tbd	tbd	antenna to 12	5		tbd	
	tbd	tbd	antenna to 5	12		tbd	
	tbd	tbd	gain to 11	4		tbd	
	tbd	tbd	gain to 4	11		tbd	
	tbd	tbd		3		tbd	
	tbd	tbd		10		tbd	
	tbd	tbd		2		tbd	
	tbd	tbd		9		tbd	
	tbd	tbd	config to 8	1		tbd	
	jacket	PE		Sh		tbd	




3.4.4.2 Assemble sub-D15 counter connector X3 with the cables F and G:

Text, STMA-69206 -

- Cut and strip the cables F and G and their wires according to the specification of the connector supplier:
 - If (a) cable(s) is/are provided with more cores than active (F: 6, G: 9):
 - Cut any unused cores and isolate each of them with a protective cover;
 - Label the cables;
- Connect the cores used for the specific application (train type) to the pins on the STM ATB counter connector according to Table  STMA-69205:
 - using the crimp contacts;
 - perform a visual inspection and a mild pulling test on each contact assembled;
- Insert the specified resistors according to Table  STMA-69207:
 (alternatives, e.g. placing the resistors on a PCB inside the connector housing, is also acceptable as long as the resistors are inside the shielded area).
 - cut the resistor wires to the length required to fit into the counter connector X3 housing;
 - strip the resistor wires, turn them around the resistor pins and solder them to the pins;
 - guide the resistor wires along the resistor in the same direction;
 - shrink a shrink sleeve with inner melt around the resistor assembly for protection;
 - perform a visual inspection and a mild pulling test on each contact assembled;


Definition, STMA-69207 - Table 9: Resistors to be installed in counter connector X3

resistor type	resistance	resistor wiring	between pins
antenna resistors (termina	560 Ohm		

antenna resistors (termination)	560 Ohm		2-9 4-12
gain resistors	⚠ STMA-69223 - Table: ATB antenna specific resistors to be built into counter connectors X2 and...		3-10 5-13
configuration resistors	⚠ STMA-17205 - Table: ConfiguredBrakingPercentage as a function of U_config_filtered. R [kΩ] (E...		1-8

Text, STMA-69204 -

- Connect the cable jacket to the PE shield on the on the STM ATB counter connector;
- perform a visual inspection and a mild pulling test on the contact assembled;
- Assemble the counter connector in the housing and hand fasten all connector housing screws:

	REMARK There is very little room between cable F and the upper connector housing screw of cable G. Take care not to damage the cable.
---	---

- Secure all cable entries into the counter connector housing with the cable clamps and ferrules;
- Perform a visual inspection and a mild pulling test on each cable assembled;
- Counter connector X3 with cables F and G is ready for testing.

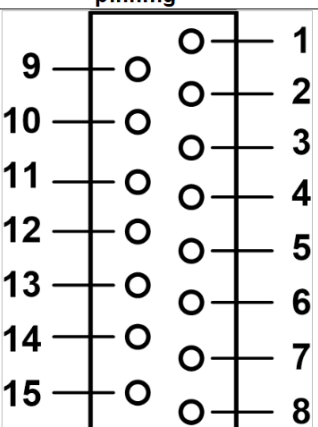
Definition, STMA-69205 - Table 10: cable cores and pinning counter connector X3

The cable shall be labeled at both ends as ("STMATB-X3")

If the individual wires are labeled, the labels shall be according to the pin number of the connector.

The colours are to be decided by the manufacturer

The train interface is determined by the system integrator

cable	core		counter connector X3				train interface
	colour	label	resistor		pinning		
F	tbd	tbd	config to 8	1		1	tbd
	tbd	tbd	antenna to 2	9		2	tbd
	tbd	tbd	antenna to 9	2		3	tbd
	tbd	tbd	gain to 3	10		4	tbd
	tbd	tbd	gain to 10	3		5	tbd
	tbd	tbd		11		6	tbd
G	tbd	tbd	antenna to 12	4		7	tbd
	tbd	tbd	antenna to 4	12		8	tbd
	tbd	tbd	gain to 13	5			tbd
	tbd	tbd	gain to 5	13			tbd
	tbd	tbd		6			tbd
	tbd	tbd		14			tbd
	tbd	tbd		7			tbd
	tbd	tbd		15			tbd
	tbd	tbd	config to 1	8			tbd
		jacket	PE			Sh	

3.4.5 Assemble Profibus connectors and cabling (X4 / X5)

Text, STMA-77925 - The STM ATB is equipped with two Profibus connectors, one male (X4) and one female (X5).

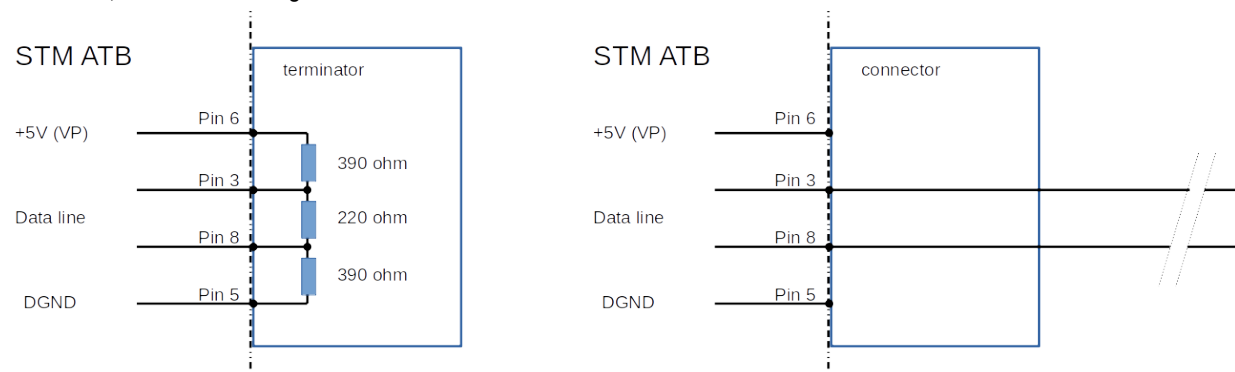
One or both of the SubD-09 connectors X4 and X5 shall be used as a cable connector, connecting to the two wire profibus. In case the Profibus topology is a star network, or if the STM ATB is the last system in the daisy chain/linear network then at one of the connectors a termination has to be placed. Below both options are described.

If the STM ATB is removed (and not immediately replaced) for whatever reason, the two cables or the one cable and the termination can be connected to restore the network. The latter is the reason to use a male and female connector.

Definition, STMA-69218 -

- termination resistors (3) to build into the termination for connector X4 or X5 if only one Profibus connection to the STM ATB is to be established and the other STM ATB Profibus connector (X5 or X4) is spare: $2 \times 390 \Omega + 1 \times 220 \Omega$.

Definition, STMA-77911 - Figure: Profibus termination and connector



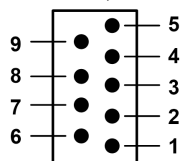
3.4.5.1 Profibus connector plus cable to connect to the Profibus

Text, STMA-69190 -

1. Cut and strip the cable H and its wires according Table [STMA-69215](#) :
 - If the cable is provided with more cores than active (2):
 - Cut any unused cores and isolate each of them with a protective cover;
 - Label the cable and the cores according to Table [STMA-69191](#);
2. Connect the cores used for the specific application (train type) to the pins on the subD-09 STM ATB counter connector X4 according to Table [STMA-69191](#) and do the same with the subD-09 connector (m/f as specified by the customer) on the train interface side:
 - using the crimp contacts;
 - perform a visual inspection and a mild pulling test on each contact assembled;
3. Assemble the counter connector in the housing and hand fasten all connector housing screws;
4. Secure the cable entry into the counter connector housing with the cable clamp and ferrules;
5. Perform a visual inspection and a mild pulling test on both sides of the cable;
6. The Profibus connector (either Counter connector X4 with cable H or Counter connector X5 with cable J) is ready for testing.

7. Repeat steps 1 to 6 if two Profibus cables shall be connected.

Definition, STMA-69191 - Table: cable cores and pinning counter connector X4 if connected to Profibus



cable	core		counter connector X4/X5 when used to connect to the Profibus
	colour	label	pinning
J	-	spare	1
	-	spare	2
	red	data line (B)	3
	-	spare	4
	-	spare	5
	-	spare	6
	-	spare	7
	green	data line (A)	8
	-	spare	9

3.4.5.2 Profibus connector as termination

Text, STMA-69530 -

- Insert the specified resistors according to [STMA-77911 - Figure: Profibus termination and connector](#) and [STMA-69526 - Table: cable cores and pinning counter if termination](#). The termination can be put...
 - cut the resistor wires to the length required to fit into the counter connector X4 housing;
 - strip the resistor wires, turn them around the resistor pins and solder them to the pins;
 - guide the resistor wires along the resistor in the same direction;
 - shrink a shrink sleeve with inner melt around the resistor assembly for protection;
 - perform a visual inspection and a mild pulling test on each contact assembled
- Assemble the counter connector in the housing and hand fasten all connector housing screws;
- Close the unused cable entry of the connector housing with the blanking pieces and hand fasten all blanking piece housing screws;
- Perform a visual inspection;
- The termination, (either Counter connector X4 or Counter connector X5) is ready for testing as termination.

Definition, STMA-69526 - Table: cable cores and pinning counter if termination

The termination can be put in a second connector placed at the unused port (either X4 or X5)

function	termination X4/X5	
	resistor	pinning

	-	1
	-	2
data line (B)	220 Ω to 8 390 Ω to 6	3
	-	4
GND	390 Ω to 8	5
5 V DC (Vp)	390 Ω to 3	6
	-	7
data line (A)	220 Ω to 3 390 Ω to 5	8
	-	9

3.5 Installation design verification

STMA-68367 - The installation design of the STM ATB in the train/locomotive as laid down in the electrical and mechanical drawings and installation work instructions shall be subject to a review ("4-eyes principle") against the requirements in this manual. The review shall be performed by a competent engineer and the outcome of the review shall be documented using a design verification checklist at requirement level.

4 Installation

Text, STMA-77689 - The STM ATB shall be mounted according to an approved installation design resulting from the requirements in chapter [3 - Installation design](#), in compliance with the relevant norms for onboard electronic equipment. Specific considerations are described in this chapter.

4.1 Installation of peripherals

Text, STMA-77907 - The peripherals to be installed are:

- ATBEG antennas (coils)
- Brake detection circuits
- Optionally (a) sound module in the cabin(s)
- Optionally direct access to the ETCS (emergency) brake loop
- Power supply
- Earthing point


The concerning connections are described in paragraph [STMA-68309 - Electrical design](#). Before installing the unit the concerning signals shall be made available at a location where the prepared STM ATB cable sets can be connected.



In case the STM ATB is replacing an existing ATBEG system, all peripherals necessary will be available, however potentially some adaptations might be necessary.

In addition a PE, close enough to the installation location of the STM ATB to allow the connection with the PE connector pin at the STM ATB enclosure with a 200mm long copper braid bond shall be made available.

In case of installation in a vehicle not yet equipped with ATBEG the peripherals shall be added to the vehicle design:

- ATBEG antennas (coils): all currently available ATBEG antennas might be used (see [STMA-69223 - Table: ATB antenna specific resistors to be built into counter connectors X2 and...](#)). The antennas shall be installed according to the installation requirements from the concerning supplier. The total cable resistance between the antenna and the STMATB

shall not exceed the value specified in  **STMA-68940** - The installation design staff shall determine the type of ATB antenna installed...

- Brake detection circuits: based on the criteria listed in  **STMA-73212** - Inputs used for detection of brake operation. Information concerning brake operation... a concept for detection of brake operation shall be selected and the concerning digital and or analogue signals shall be made available:
 - BHA/BNH: an antivalent input signal depending on the chosen concept indicating:
 - that the brake handle position is equivalent with at least 0.31m/s² deceleration (at flat track) or lead to 0.4 bar brake pipe pressure decrease, **or**
 - that the brake handle is operated (used in case of time dependent brake handle control)
 - BSO/BSN: a digital feed back from the braking system indicating that based on a safe control parameter the brakes have been operated sufficiently to reach at least 0.31m/s² deceleration (at flat track), or lead to 0.4 bar brake pipe pressure decrease.
 - An analogue signal representing the brake pipe pressure.
- Optionally, a sound module providing a "gong" and a "bel" (sounds defined in the DMI configuration table:  **STMA-8277** - DMI configuration table according to . The values in the table are mandatory as...) which can be switched with the digital outputs as described in paragraph 3.3.6 - Outputs to control sound signals.
- Optionally, an interface to the ETCS brake loop as described in 3.3.7 - EB command outputs.
- EB config: an antivalent input signal indicating if the EB command outputs are used.
- A power supply as defined in paragraph 3.3.8 - Power supply requirements.
- A PE, close enough to the installation location of the STM ATB to allow the connection with the PE connector pin at the STM ATB enclosure with a 200mm long copper braid bond, as defined in 3.3.9 - Earthing and grounding.

4.2 Installation considerations for installing the unit

Text, STMA-74446 - The following installation considerations shall be taken into account when installing an STM ATBEG in to a railway vehicle.

Text, STMA-74435 - Pre-conditions.

2. Check that the following pre-conditions are met:

- Authorised installation drawings and work instructions are available (in correct revision);
- Correct installation materials (STM ATB, mounting kit, earthing kit, correct cable set to match with antenna type (see annex B) and cables of sufficient length) are available;
- Required tooling is available;
- The 19" signalling cabinet (or equivalent) with sufficient space for the STM ATB is mounted firmly in place and electrically connected to vehicle PE;
- An ETCS onboard system is installed or is going to be installed in accordance with the onboard ETCS installation design and in working order;
- The ATB digital and analog input/output interface are wired and tested in accordance with the onboard design;
- Power supply interface is available in accordance with the onboard design. The STM ATBEG should be fed through a monitored switch that can turn the power to the STM ATBEG on and off. The operation of the switch shall be logged in a JRJ.

Text, STMA-74436 - Wiring check.

3. Check on wiring

- Check which type of ATB antennas are installed on the train/locomotive and that a matching cabling set is provided;
- Check that the cable length is appropriate for connecting the STM ATB with the Profibus, ATB input/output and power supply interfaces:
- Check whether both Profibus connectors will be used:


- If not, whether connector X4 with cable H or connector X5 with cable J will be used;
- Check cable routes for accessibility and (future) maintenance;
- Cables are long enough to be connected and fastened to all interfaces without strain, but not longer than necessary;
- Sufficient fixes for fastening the cables are available;
- All parts of the cabling set have been tested and valid quality assurance certificates are provided;
- If any cabling set quality assurance certificate is missing, perform connectivity tests on the entire cabling set.

Text, STMA-74434 - Power off check

4. Check that the STM ATB overload protection devices are switched “off”:

- If the circuit breakers are switched “on”, switch it “off”;

Text, STMA-74438 - Installation

- Place the STM ATB in the 19” rack (see  STMA-68345);
- Hand fasten the STM ATB with 4 M2.5 bolts (max. 1 Nm torque);
- Establish an ground connection between the M4 screw on the front plate of the STM ATB housing and PE with a flexible copper braid bond (200 x 14 x 1.5 mm);

Text, STMA-74439 - Connecting the STM ATBEG

8. The sequence and way of securing the cabling is vehicle specific and shall therefore be described in the vehicle specific design, choose a convenient sequence for connecting all cables based on the spatial limitations in the CCS cubicle. Check which sequence for connecting the 8 (or 9) cables STM ATB cables (A/B/C/D/E/F/G/H/J) has been specified in the design.

Text, STMA-74437 - Secure cabling

9. Connect all STM ATB cables (8 or 9, according to the design) in the sequence established in step 8:

- 9 cables if both Profibus connectors are used and 8 if only one Profibus connector is used;
- If only one Profibus connector (X4 or X5) is used, cover the spare connector (X5 or X4) with a termination;
- Fasten each cable where appropriate with cable fasteners so that the connectors fit onto the STM ATB and that the connections with the interfaces on the opposite side can be made without straining the cables, allowing for easy (de)installation of STM ATB;
- Connect each cable on the opposite side of STM ATB according to the vehicle specific design.
- Connect each cable connector to the corresponding connector on the STM ATB and fasten the connector hand-tight as the design requires with the screws/bolts provided by the supplier;


Text, STMA-74440 - Safety check on cabling

10. Check that all STM ATB connections are physically sound and safe:

- perform both a visual check and mechanical locking of all interfaces;
- check that the CCS cabinet door closes without putting strain on any cable;

Text, STMA-68364 - HQSE procedures.

Check that all HQSE procedures for safe work on the train/locomotive have been fulfilled.

	<p>DANGER Non-compliance with HQSE procedures for safe work on railways in general and electrical applications therein in particular pose a serious risk to health and life.</p>
---	---

11. Switch on the power supply to the onboard power supply;

12. After turning on the power supply to the onboard network, switch the STM ATB overload protection device to “on”;

13. After the ETCS on-board provides all relevant ETCS and train data the STM will request Cold Stand-by.

Text, STMA-76372 -

14. Check the status of the STM ATB:

- All four status LEDs (A, B, C and D) on the STM ATB front panel shall show continuous green;
- the STM ATB shall be selectable on the DMI in the control cabin:
 - consult the applicable ETCS manual for further details;

Text, STMA-76371 -

15. Only in case one or more of the LED indicators do not show green and/or the STM ATB is not selectable in the control cabin:

- check the probable cause for the incorrect indication in [STMA-63492 - M9.4 Maintenance Manual](#) Chapter [STMA-75451 - Diagnostics](#)
- ensure that all HQSE procedures (step 1) have been fulfilled once more;
- switch the STM ATB overload protection device "off";
- correct the fault.

Text, STMA-76370 -

16. Report the STM ATB installation:

- successful and ready for testing once the status LEDs all show green and the STM ATB is selectable on the DMI in the control cabin;
- include the hard- and software versions in the installation protocol;
- failed if the status LEDs do not all show green and/or the STM ATB is not selectable on the DMI
- Check that the STM ATB supplied has correct software version installed, using startup information recorded in JRU at startup:
- Compare the software versions installed with the actual version in the Safety Case.

5 Functional tests / commissioning

Text, STMA-69274 -

Before installation each cable shall be tested concerning the correct connections and isolation.

Text, STMA-77970 - After installation and before putting the vehicle into operation on ATBEG tracks the vehicle with the integrated STM ATB shall be commissioned. The tests to prove the correct installation of the STM ATB are described in this chapter.

Text, STMA-77914 - The functional tests shall prove that all connections have correctly been installed, i.e.:

- Power supply: proven by switching on the unit
- PE: visual check
- The antennas: check that ATBEG code can be found using an ATB test loop ("lusplank")
- Detection of brake operation
- The optional external sound device
- The optional opening of the ETCS EB loop

Text, STMA-75666 - Test acc. to [11 - Appendix: STM ATB test protocol](#)

1. Commissioning Test Preparation:

Check that installation of the STM ATB is completed and checked:

- the LED indicators on the front panel of the STM ATB all show green and the STM ATB is selectable on the DMI in the active cabin;
- in case one or more of the LED indicators does not show green and/or the STM ATB is not selectable on the DMI

in the active cabin: abandon the test, check [STMA-63492 - M9.4 Maintenance Manual](#) chapter

[STMA-75451 - Diagnostics](#) for the possible cause and initiate appropriate actions (repair of connections / replacement);

2. Check that the ATB test levels (75Hz current, and 300Hz-1200Hz noise) on the test track meets the test requirements, i.e. < 100mA each.
3. Place an ATB test loop ("Lusplank") perpendicular to the track centered under both ATB antennas on one cabin side of the train/locomotive
4. Connect an ATB test generator (ATB codegenerator) to the ATB test loop and switch it on;
 - select 180 pulses/minute and an output level equivalent to 0.5A / 75 Hz;
5. Ensure that a colleague is present in the active cabin to:
 -
 - carry out a Start of Mission;
 - register the visible and audible ATB signals (including those on the DMI)
6. Increase the 75 Hz current in steps (minimum time 3s) of the equivalent of 0.5 A until the STM ATB recognizes the ATB code;
7. Record and document
 - the current at which the STM ATB recognizes the ATB code;
 - the visible and audible ATB signals (including those on the DMI) at that current:
 - in particular the speed limit (80 km/h or otherwise) signaled at that current;
8. Operate the brakes and check if the white lamp appears.

If an external sound device is used:

9. Switch BD mode on and off and check if the gong sounds
10. Drive above 45km/h or simulate a speed above 45km/h and check if the rembel sounds

If the parallel EB commands via digital outputs are connected:

11. Test inputs Di_3A/B using the JRU information and test outputs Do_3A/B using a DRU

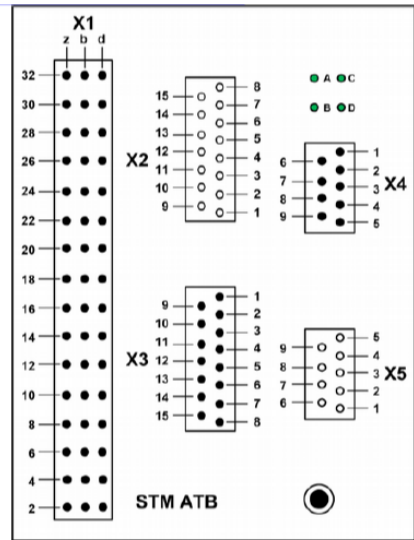
Finalize:

12. Repeat the entire test on the other cabin side of the train/locomotive ;
13. Report the all test results acc. to [12 - Appendix: STM ATB commissioning protocol](#)
14. Combine the test results with required results. The STM ATB is ready for service if all check results are OK. In this case only, the security certificate for the train/locomotive may be issues in accordance with the Specific Application Safety Case - Physical Implementation Portion (SASC-PIP).

Appendices

6 Appendix: STM ATB connectivity checklist

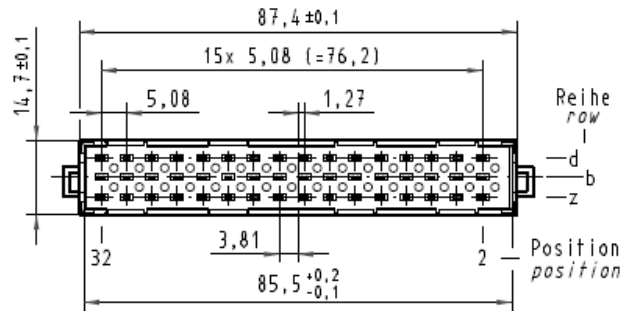
Definition, STMA-68369 - Figure: STM ATB pin numbering



7 Appendix: X1

Definition, STMA-76726 - figure:

Connector X1 pinout (DIO+PS Front connector, DIN41612)



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-Common	Digital out common
14d		PE	

16d	I	<i>Supply1 +</i>	Power input (supply 1)
18d	I	<i>Supply -</i>	Power input
20d		<i>PE</i>	
22d	I	<i>DIn_1A</i>	Digital input
24d		<i>DIn_A-PWR</i>	External power supply for input circuit
26d		<i>PE</i>	
28d	O	<i>DOut_1A</i>	Digital output
30d		<i>DOut_A-Common</i>	Digital out Common
32d		<i>PE</i>	
2b		<i>PE</i>	
4b	I	<i>DIn_2B</i>	Digital input
6b		<i>DIn_B-GND</i>	Digital in ground
8b		<i>PE</i>	
10b	O	<i>DOut_2B</i>	Digital output
12b		<i>DOut_B-Common</i>	Digital out common
14b		<i>PE</i>	
16b	I	<i>Supply2 +</i>	Power positive input (supply 2)
18b	I	<i>Supply -</i>	Power negative/return input
20b		<i>PE</i>	
22b	I	<i>DIn_2A</i>	Digital input
24b		<i>DIn_A-GND</i>	Digital in ground
26b		<i>PE</i>	
28b	O	<i>DOut_2A</i>	Digital output
30b		<i>DOut_A-common</i>	Digital out common
32b		<i>PE</i>	
2z		<i>PE</i>	
4z	I	<i>DIn_3B</i>	Digital input
6z		<i>Di4-6 GND</i>	Digital in ground
8z		<i>PE</i>	
10z	O	<i>DOut_3B</i>	Digital output
12z		<i>DOut_B-Common</i>	Digital out common
14z		<i>PE</i>	
16z	I	<i>Supply2 +</i>	Power input (supply 2)

18z	I	<i>Supply -</i>	Power input
20z		<i>PE</i>	
22z	I	<i>DIn_3A</i>	Digital input
24z		<i>DIn_A-GND</i>	Digital in ground
26z		<i>PE</i>	
28z	O	<i>DOut_3A</i>	Digital output
30z		<i>DOut_A-Common</i>	Digital out common
32z		<i>PE</i>	

GND: common minus for the group of inputs (or outputs)

Common: common plus or minus for the group of outputs

8 Appendix: X2

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>AIn_1A+</i>	Coil input
7	I	<i>AIn_1A-</i>	Coil input
14	I	<i>Rg_1A+</i>	Coil gain resistor
6	I	<i>Rg_1A-</i>	Coil gain resistor
13		<i>AIn_A_GND</i>	
5	I	<i>AIn_2A+</i>	Coil input
12	I	<i>AIn_2A-</i>	Coil input
4	I	<i>Rg_2A+</i>	Coil gain resistor
11	I	<i>Rg_2A-</i>	Coil gain resistor
3		<i>AIn_A_GND</i>	
10	I	<i>AIn_3A+</i>	brake pipe pressure input
2	I	<i>AIn_3A-</i>	brake pipe pressure input
9	I	<i>AIn_A_GND</i>	
8	I	<i>Rconfig_A_ret</i>	Configuration resistor return
Sh		<i>PE</i>	Shield

Definition, STMA-76728 - AD-A front connector further specification of the coil inputs

Inputs 15-7: coil cabin A right hand side in driving direction A; Inputs 14-6: Coil gain resistor Cabin A right hand side

Inputs 5-12: coil cabin B left hand side in driving direction B; inputs 4-11: Coil gain resistor Cabin B left hand side

9 Appendix: X3

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

Definition, STMA-76727 - AD-B front connector further specification of the coil inputs

Inputs 9-2: coil cabin B right hand side in driving direction B; Inputs 10-3: Coil gain resistor Cabin B right hand side

Inputs 4-12: coil cabin A left hand side in driving direction A; inputs 5-13: Coil gain resistor Cabin A left hand side

10 Appendix: X4/X5

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	

11 Appendix: STM ATB test protocol

Definition, STMA-72034 - Table: STM ATB test protocol Cab A

testing	measured	check	result
LED indicators STM ATB		all green	
STM ATB selectable on cabin DMI		Selectable	
75 Hz level		< 100mA	
noise level		< 100mA	
Install the ATB test loop (Iusplank)			
Inject ATB code 180, 0.5A		Cab signal Yellow	
Inject ATB code 180, 1A		Cab signal Yellow or Yellow8	
Inject ATB code 180, 1.5A		Cab signal Yellow or Yellow8	
Inject ATB code 180, 2A		Cab signal Yellow or Yellow8	
Inject ATB code 180, 2.5A		Cab signal Yellow or Yellow8	
Inject ATB code 180, 3A		Cab signal Yellow or Yellow8	
Inject ATB code 180, 3.5A		Cab signal Yellow or Yellow8	
Inject ATB code 180, 4A		Cab signal Yellow8	
Inject ATB code 180, 4.5A		Cab signal Yellow8	
Inject ATB code 180, 5A		Cab signal Yellow8	
Inject ATB code 180, 5.5A		Cab signal Yellow8	
Inject ATB code 180, 6A		Cab signal Yellow8	
Inject ATB code 180, 6.5A		Cab signal Yellow8	
Inject ATB code 180, 7A		Cab signal Yellow8	
Inject ATB code 180, 7.5A		Cab signal Yellow8	
Inject ATB code 180, 8A (leave on)		Cab signal Yellow8	
Operate the brake		white lamp indicator shall be on	
Release the brake		white lamp indicator shall be off	
remove the ATB test loop		Yellow	
the steps below are only necessary in case an external sound device is installed			
Operate the BD button during > 2s		Blue Lamp and Gong	
Operate the attention button during >2s		Yellow and Gong	
Increase speed or simulate speed >45km/h, brake if the rembel sounds		rembel shall sound	

The following steps are only necessary in case parallel commanding of the EB via digital outputs is used			
set the EB config inputs to indicate the parallel EB is used.		Check in JRU data that the input signals are correctly recognized.	
Connect a DRU and command Do_3A high (closed)		Check that the brakes are applied (due to opening of the brake loop)	
Connect a DRU and command Do_3B high (closed)		Check that the brakes are applied (due to opening of the brake loop)	

Definition, STMA-77913 - Table: STM ATB test protocol Cab B

testing	measured	check	result
LED indicators STM ATB		all green	
STM ATB selectable on cabin DMI		Selectable	
75 Hz level		< 100mA	
noise level		< 100mA	
Install the ATB test loop (lusplank)			
Inject ATB code 180, 0.5A		Cab signal Yellow	
Inject ATB code 180, 1A		Cab signal Yellow or Yellow8	
Inject ATB code 180, 1.5A		Cab signal Yellow or Yellow8	
Inject ATB code 180, 2A		Cab signal Yellow or Yellow8	
Inject ATB code 180, 2.5A		Cab signal Yellow or Yellow8	
Inject ATB code 180, 3A		Cab signal Yellow or Yellow8	
Inject ATB code 180, 3.5A		Cab signal Yellow or Yellow8	
Inject ATB code 180, 4A		Cab signal Yellow8	
Inject ATB code 180, 4.5A		Cab signal Yellow8	
Inject ATB code 180, 5A		Cab signal Yellow8	
Inject ATB code 180, 5.5A		Cab signal Yellow8	
Inject ATB code 180, 6A		Cab signal Yellow8	
Inject ATB code 180, 6.5A		Cab signal Yellow8	
Inject ATB code 180, 7A		Cab signal Yellow8	
Inject ATB code 180, 7.5A		Cab signal Yellow8	
Inject ATB code 180, 8A (leave on)		Cab signal Yellow8	
Operate the brake		white lamp indicator shall be on	
Release the brake		white lamp indicator shall be off	
remove the ATB test loop		Yellow	
the steps below are only necessary in case an external sound device is installed			

Operate the BD button during > 2s		Blue Lamp and Gong	
Operate the attention button during >2s		Yellow and Gong	
Increase speed or simulate speed >45km/h, brake if the rembel sounds		rembel shall sound	

12 Appendix: STM ATB commissioning protocol

Definition, STMA-72036 - Commissioning protocol

The commissioning report shall consists of:

- all logged data: e.g. versions and serial numbers
- anomalies from the described proces
- test results as logged in the test protocols

13 Appendix : Cable connector parts

Definition, STMA-69310 -

Connector parts					
code	type	number	description	Manufacturer (example)	Order code (example)
X1	Connector	1	DIN 41612 Type F female	Harting	09 06 248 3201 222
	Hood	1	DIN-Power shell housing D 20 metall emv	Harting	09 06 848 0551
	Cable entries (cable type dependant)	2	Crimp flange, 9 mm	Harting	61 03 000 0072
		2	Crimp ferrule, 14 mm	Harting	61 03 000 0061
		1	Crimp flange, 5 mm	Harting	61 03 000 0066
		1	Crimp ferrule, 8 mm	Harting	61 03 000 0051
		4	Crimp flange insert	Harting	09 06 800 9952
		5	Blanking piece	Harting	61 03 000 0042
	Connector female crimp FC contacts	34	Copper alloy, conductor: 0.5...1.5 for FC 3	Harting	09 06 000 7482
	Alternative screw cable entries	?	DIN-Power cable clamp D20 zinc die cast	Harting	09 06 800 9955
		?	Blinding piece D20 zinc die cast	Harting	09 06 800 9951
X2	Pin connector	1	SubD-15 crimp pin	Inotec	DC15P-G
	hood	1	D-Sub full metal hood with screw locking, M3 screw	Inotec	DG15 MSB-91
	Cable entries	?	Cable clamp	Inotec	DKS100
		?	ferrule	Inotec	CH-x/x (*)

	Crimp contacts	?	Crimp contacts, pin, AWG 24-20	Inotec	DCC2P4
X3	Socket connector	1	SubD-15 crimp socket	Inotec	DC15S-G
	hood	1	D-Sub full metal hood with screw locking, M3 screw	Inotec	DG15 MSB-91
	Cable entries	?	Cable clamp	Inotec	DKS100
		?	ferrule	tbd	tbd
	Crimp contacts	?	Crimp contacts, socket, AWG 24-21	Inotec	DCC2S4
X4	Pin connector	1	SubD-09 crimp pin	Inotec	DC09P-G
	hood	1	D-Sub full metal hood with screw locking, M3 screw	Inotec	DG09 MSX-91
	Cable entries	?	Cable clamp	Inotec	DKS100
		?	ferrule	tbd	tbd
	Crimp contacts	?	Crimp contacts, pin, AWG 24-20	Inotec	DCC2P4
X5	Socket connector	1	SubD-09 crimp socket	Inotec	DC09S-G
	hood	1	D-Sub full metal hood with screw locking, M3 screw	Inotec	DG09 MSX-91
	Cable entries	?	Cable clamp	Inotec	DKS100
		?	ferrule	tbd	tbd
	Crimp contacts	?	Crimp contacts, socket, AWG 24-21	Inotec	DCC2S4