

D4.6 Exported constraints

for the development of an STM ATB

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1 Preface



In the current document the "exported constraints" necessary for the STM ATB to comply with the input requirements are defined. The concerning input documents concern:



-  [STMA-10707 - D3.1 Requirements from Regeling Indienststelling Spoorvoertuigen](#)
-  [STMA-6553 - D3.2 ATBv requirements](#)
-  [STMA-10239 - D3.4 Additional User Requirements](#)

In addition the above requirements the ETCS on-board shall comply with the relevant requirements concerning the interface between the STM ATB and the ETCS on-board.




Requirement, STMA-15229 - The ETCS on-board shall be compatible with an STM which is compliant with:

-  [STMA-10814 - D4.7.4 Specific Transmission Module \(SS035 v3.2.0\)](#)
-  [STMA-11331 - D4.7.2 STM FFFIS Safe Time Layer \(SS056 v3.0.0\)](#)
-  [STMA-11326 - D4.7.1 STM FFFIS Safe Link Layer \(SS057 v3.1.0\)](#)
-  [STMA-10810 - D4.7.3 STM FFFIS Application Layer \(SS058 v3.2.0\)](#)
-  [STMA-7262 - D4.7.5 Performance requirements \(SS059 v3.1.0\)](#)



Subsets 56, 57 and 58 completely apply to the STM ATB and ETCS on-board. Subsets 35 and 59 contain requirements which are applicable only to the STM ATB and requirements which are applicable only to the ETCS on-board. In  [STMA-4725 - Requirement concerning ETCS on-board plus ETCS installation](#), and  [STMA-33895 - Requirement concerning the ETCS on-board](#), an overview of requirements assigned from subset 35 and subset 59 to the ETCS on-board is given.


In chapter  [STMA-7239 - ETCS on-board](#) of this document, exported constraints to the ETCS on-board are defined. A part of these requirements, described in paragraph  [STMA-14930 - Generic STM controller functions](#) concern requirements which are also covered by the relevant subsets. The requirements are made more specific but every compliant ETCS system is expected to meet those requirements.


Additional requirements concern:

-  [STMA-14926 - Timing requirements](#); the performance specified in the standards is not, in all cases, sufficient to implement the ATB functions according to the input specifications. Therefore more stringent requirements are defined.
-  [STMA-14927 - Odometer requirements](#); ATBEG is a speed monitoring function. The speed levels communicated by the ATBEG infrastructure depend o.a. on the available braking distance between the signals. The inaccuracy in speed measurement taken into account for those distances is smaller than required from a standardized ETCS on-board. Therefore more strict requirements are defined.
-  [STMA-14928 - DMI requirements](#); The STM ATB will use the "customizable DMI services" as

defined in subset035. Therefore the ETCS on-board shall provide a number of functions to make the integration of STM ATB plus ETCS on-board compliant with the input specifications.



-  **STMA-14929 - ATB isolation**; the ERA specifications (a.o. subset035) describe a method to isolate an STM via a contact at the TIU provided by the ETCS on-board. The train (train borne equipment) shall provide a signal indicating that the specific STM shall be isolated. To comply with input requirements concerning the possibility to switch off the ATBEG equipment (functionality), this optional requirement shall be implemented at the ETCS on-board and in the train borne equipment.
-  **STMA-14931 - RAMS**; RAMS requirements concerning the ATBEG and ATBVv functionality shall be divided between the STM ATB, the ETCS on-board and the train (train borne equipment).

In chapter  **STMA-7242 - Train borne equipment** requirements concerning the train (train borne equipment) are gathered. These requirements concern input information needed for the STM ATB, the EM environment and means to isolate the STM ATB as described in the ERA specifications (a.o. in subset035).



The ATBEG coils (antennas) and their installation are not in the scope of the STM ATB as the prime use of the STM ATB will be for retrofit purposes. In case of retrofitting rolling stock, there will already be ATBEG coils installed. In chapter  **STMA-7243 - ATBEG coils (antennas)** the requirements concerning the coils and their installation, which are necessary for integration with the STM ATB are defined.

2 References



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**

Requirement, STMA-28795 - Required legal standards and norms applicable to the STM ATB project and product are listed in document  **D3.0 Legal framework standards and norms**

3 ETCS on-board

In this chapter exported constraints concerning the ETCS on-board are defined.

The ETCS on-board is expected to be a complete ETCS on-board system. However in case for the specific train, only ATB functionality is required, the ETCS on-board may be replaced by a limited system as long as it's compliant with the requirements in this document and relevant versions of subsets-035/056/057/058/059.

3.1 Generic STM controller functions

Requirement, STMA-2653 -

The ETCS on-board shall take care of the responsibility for guarding the train speed (thus not rely on the STM ATB) if

- the ETCS mode is different from "system national" (SN), or
- the state reported by the STM ATB is different from "data available" (DA).

Note: During the time interval after the ETCS on-board has sent a DA order and the moment the STMATB state changes to DA, the ETCS on-board cannot take this responsibility. However this time will be very short (< 50ms, thus much shorter than the maximum value defined in subset-059).

Requirement, STMA-10382 -

If the ETCS MODE is "SN" and the "override function is activated" then

The ETCS on-board shall still execute EB commands received from the STM ATB as if the override function is not activated.

Requirement, STMA-2686 -

If the STM ATB function (and/or the ETCS on-board) is switched off (i.e. the STM ATB is not responsible) no ATB information shall be shown at the DMI.

Requirement, STMA-2681 -

If the "STM state" of the STM ATB (as reported by the STM) is different from DA, then the ETCS on-board shall not display any ATB information as sent by the STM ATB directly to the DMI. (thus delete the information if the state changes from DA to another state).

Requirement, STMA-2683 -

If the STM ATB reports an "STM state" different from DA, then the ETCS on-board shall ignore (existing) brake commands from the STM ATB, i.e.:

- not brake if an EB command is received.
- release the brake if there is no other reason (from another STM or from ETCS on-board) to command the EB.

Requirement, STMA-2685 -

If

- a cabin is selected and the driver (has) selected level NTC-ATB, and
- The STM state reported by the STM ATB is CS or HS, and
- The SoM procedure according to subset-026v3.6.0 has been completed

then the ETCS on-board shall change the ETCS state to SN and send a DA order to the STM ATB.

Requirement, STMA-2692 -

The response on switching on the ETCS on-board plus STM ATB is a responsibility of the ETCS on-board equipment.

The ETCS on-board shall guarantee a safe response if switched on while driving.

Decision, STMA-80056 - If the STM control function sends packet STM-184 to start specific data entry (not necessary) then the STMATB will reply with STM-179 even if the state is still CO. The ETCS on-board shall accept this.

3.2 Timing requirements

Requirement, STMA-2702 - The minimum reaction time available to the driver shall be 1.7s taking into account the time delays defined below.

note 1: a longer available driver reaction time shall be aspired.

Note 2: Digital outputs may be used for direct communication to a sound generator and/or the EB.

Note 3: The use of digital outputs for communication to a sound module, to meet this requirement shall be discouraged.

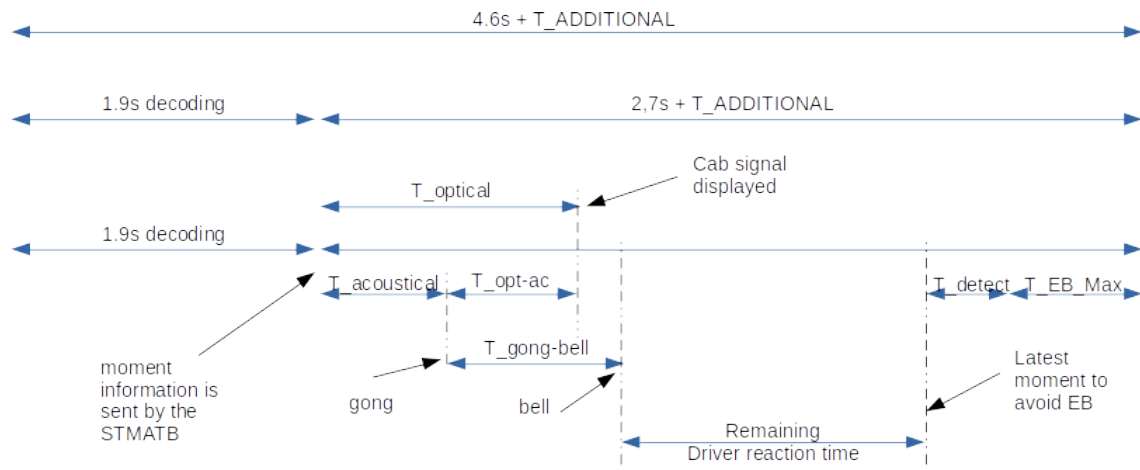
Note 4: The use of digital outputs for commanding the EB, to meet this requirement shall be discouraged.

Note 5 The time delays according to UIC models (see above) are assumed to be:

- $T_{BRAKE_BUILDUP_P} = 3.8s$
- $T_{BRAKE_BUILDUP_G} = 16.4s$

$T_{ADDITIONAL}$ will be calculated as $T_{BRAKE_BUILDUP_x} - T_{BRAKE_EMERGENCY}$
(set to "0" in case the resulting value is negative)

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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Requirement, STMA-10025 - The time difference between communication and processing (up to displaying/sounding) of the optical information and the acoustical information shall not exceed 300ms.
note: in case both are sent via profibus then the information is included in the same message.

Requirement, STMA-2716 -

The difference in communication time between any order to sound the "gong" and any order to sound the "bel" shall not exceed 200ms.

note: A separate sound generator may be used for this purpose, however in that case the maximum difference in communication time shall be 50ms.

note: If the requirement is met in normal cases (>90% of the time), slightly higher differences might be acceptable for the authorities.

Requirement, STMA-5126 - The STMATB will communicate 500ms as "Idle_cycle_timeout" value in the connect request telegrams send to the BIU, and send an idle telegram if no other telegram has been sent during 300ms. To maximize the delay in processing an EB-command in case of a lost BIU connection the sum of the following delays may not exceed 1400ms:

- The time between the last idle or data telegram addressed to the BIU is put on the Profibus by the STMATB and the moment the BIU closes the connection, i.e. puts a disconnect telegram at the Profibus.
- The time between the moment the STMATB closes the connection to the STMctrl function (i.e. puts a disconnect telegram addressed to the STMctrl function at the Profibus) and the moment the EVC provides a safe state, i.e. commands the EB by opening the brake loop.

Note: together with the other delays this will limit the delay in commanding the EB in case of a

connection fault to maximum 2s.

3.3 Odometer requirements

Requirement, STMA-2763 -

The ETCS on-board shall provide a speed value to the STM ATB which is less than 1.2s older than the real speed value, i.e.

The delay in speed measurement plus the maximum delay in the communication including the time between two speed values being sent via the profibus shall be less than 1.2s

Requirement, STMA-5113 -

The difference between the "upper bound of the measured speed" and the "estimated speed" reported by the ETCS on-board shall not exceed 3 km/h + 2 % of the "upper bound of the measured speed".

note: exceeding with more than 2% will lead to a difference between the speed displayed to the driver and the train speed assumed for the speed monitoring function.

3.4 DMI requirements

Requirement, STMA-2694 -

The ETCS on-board shall display ATB icons according to the information in the packets STM-32 and STM-35 in combination with a DMI configuration table according to [STMA-10814 - D4.7.4 Specific Transmission Module \(SS035 v3.2.0\)](#) (provided by the principle: [STMA-8277 - DMI configuration table according to . The values in the table are mandatory as...](#)).

Requirement, STMA-2813 -

The resulting layout shall correspond with the values defined in the DMI configuration table by the customer. (The meaning of the values is defined in ss035 V3.2.0 ch. 13.5).

Therefore compliance with the requirements in CENELEC: CLC/prTR 50459-7: 2007 will depend on the choices made by the customer when filling the DMI configuration table.

Requirement, STMA-14422 -

The ordering of the cab signals (indicatorID = positionID from 1 to 6) shall be such that the ordering of the indicators is from left to right or down-top for increasing indicatorIDs.

Requirement, STMA-2795 - If a packet STM-46 containing the order to trigger the "gong" (one stroke signal) is received from the STM ATB then

The ETCS on-board shall trigger the sound "gong" as specified in the ATB DMI configuration table (gong.wav).

Requirement, STMA-80057 - If a packet STM-46 containing the order to trigger the "gong_bel" (one stroke signal) is received from the STM ATB then

The ETCS on-board shall trigger the sound "gong-bel" as specified in the ATB DMI configuration table (gong_bel.wav).

note: Used instead of the gong in case the bell shall sound, to guarantee the time between gong and bell

independent of a spread in communication times.

Requirement, STMA-2796 - If a packet STM-46 containing the order to trigger the "BD-signal" (stroked signal) is received from the STM ATB then

The ETCS on-board shall trigger the sound "BD-signal" as specified in the ATB DMI configuration table (BD signal.wav).

Requirement, STMA-2797 - If a packet STM-46 containing the order to trigger the "losbel" (stroked signal) is received from the STM ATB then

The ETCS on-board shall trigger the sound "losbel" as specified in the ATB DMI configuration table (losbel.wav).

Requirement, STMA-2798 - If a packet STM-46 containing the order to start the "bel" (continuous signal) is received from the STM ATB then

The ETCS on-board shall start the sound "bel" as specified in the ATB DMI configuration table (bel.wav).

Requirement, STMA-2799 - If a packet STM-46 containing the order to stop the "bel" (continuous signal) is received from the STM ATB then

The ETCS on-board shall stop the sound "bel" as specified in the ATB DMI configuration table (bel.wav)

Requirement, STMA-15230 - If a packet STM-46 containing the order to trigger the "bel damping" (one stroke signal) is received from the STM ATB then

The ETCS on-board shall trigger the sound "bel-damping" as specified in the ATB DMI configuration table (bel-damping.wav).

Requirement, STMA-2794 -

One pixel as defined in the DMI configuration table shall be displayed with a size of at least 0.32x0.32mm.

note: using a 10" screen with a resolution of 480x640 pixels leads to a size of 0.32x0.32mm per pixel.

Requirement, STMA-2806 -

The minimum size of an icon to be used for cab signals shall be 40x50 pixels (W x H)

Requirement, STMA-2812 -

The minimum font size to be used on the indicators for the cab signals shall be 30 pixels

The STM ATB can send diagnostic information via a JRU message.

3.5 ATB isolation

Requirement, STMA-5116 -

The ETCS on-board shall isolate the STM ATB according to subset035, v3.2.0, paragraph 4.2.1.1, if this is indicated by the "national system isolation" signal provided by the train according to subset119.

Requirement, STMA-10869 -

Once the STM ATB is isolated, the ETCS on-board shall enter level ATB if ordered by track-side, however without any speed nor distance monitoring.

Requirement, STMA-10848 -

If the STM ATB is isolated then the ETCS on-board or Train borne equipment shall report the isolation of the STM ATB to the juridical recorder and indicate the state to the driver (remark: the ETCS on-board shall not display the information sent by the STM ATB to the DMI)

Requirement, STMA-22545 - If the STM ATB is isolated then the train shall switch off the power supply of the STM ATB

3.6 RAMS

Requirement, STMA-10897 - The ETCS on-board failure rate concerning failures leading to unsafe (*) false ATB information at the DMI shall be $< 1.3 \cdot 10^{-5}/\text{hour}$.

() unsafe is defined as displaying a higher allowed speed than communicated by the STM ATB*

Decision, STMA-80298 - The ETCS on-board failure rate concerning the configuration data communicated to the STMATB shall be $< 1 \cdot 10^{-9}/\text{h}$

note: it is decided to assign this failure budget to the ETCS on-board as the ETCS on-board (as SIL4 system) shall comply to the requirement for safety critical functions anyway.

Decision, STMA-80297 - The ETCS on-board failure rate concerning not commanding the EB if an EB command was given by the STMATB or if the connection between STM controller and STMATB is lost shall be $< 2.7 \cdot 10^{-7}/\text{h}$

note: it is decided to assign this failure budget to the ETCS on-board as the ETCS on-board (as SIL4 system) shall comply to the requirement for safety critical functions anyway.

Requirement, STMA-16884 - The unavailability fraction of the ATBEG function due to ETCS on-board failures shall be less than $60 \cdot 10^{-5}/\text{hour}$

3.7 Profibus safety levels

Requirement, STMA-17352 - The minimum safety level implemented for the connection between the STM ATB and the STM controller function shall be SL2

Requirement, STMA-17349 - The minimum safety level implemented (and communicated in packet STM-2) for the connection between the STM ATB and the BIU function shall be SL2

Requirement, STMA-17350 - The minimum safety level implemented (and communicated in packet STM-2) for the connection between the STM ATB and the DMI function (DMI channels) shall be SL0

Requirement, STMA-17347 - The minimum safety level implemented (and communicated in packet STM-2) for the connection between the STM ATB and the TIU function shall be SL2


Requirement, STMA-17348 - The minimum safety level implemented (and communicated in packet STM-2) for the connection between the STM ATB and the JRU function shall be SL0

4 Train borne equipment

Definition, STMA-10889 -

Brake handle applied information can consist of:



- Digital information from a brake handle contact (switch)
- Digital feed back from the braking system that the brakes are applied
- Analogue feed back from the brake pipe pressure sensor.

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

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.

The EB may be directly connected to the STMATB EB command outputs ( STMA-28699 - The digital outputs are defined as specified in the table below output signal de...). If those outputs are connected this shall be indicated via the digital inputs( STMA-19190 - The digital inputs are defined as specified in the table below input signal desc...).

Because the digital inputs are antivalent, also not connecting the EB command outputs shall be indicated via the digital inputs.


Decision, STMA-80060 - Via the digital inputs "EB config" it shall be indicated if the EB command is connected to the EB brake loops.

The inputs shall be set according to  STMA-19190 - The digital inputs are defined as specified in the table below input signal desc... in document  STMA-7149 - D4.1 Interface Requirements Specification (IRS).

5 ATBEG coils (antennas)

Requirement, STMA-14994 - The train borne equipment shall include ATBEG coils mounted above the center of each rail (left and right) at each front-end (cabin side) of the train. The coils shall be mounted in front of the first axle (seen in the concerning driving direction), according to the installation requirements of the supplier of the ATBEG coils.

Requirement, STMA-35032 -

The maximum deviation of the ATBEG antenna signal due to EM-interference other than via the track current and due to antenna movements shall be limited to +/- 10% ( STMA-40585). This shall at least take into account:

- Movement of the antenna




- EM sources different from the current through the rails (e.g. motor cabling)
- EM field due to currents in the wheels at the first axle

Requirement, STMA-7250 - In case of a constant 75Hz current through the rails, the variation in the signal level due to antenna movements (vertical + horizontal) shall be less than +/- 5% compared to the average 75Hz level

Requirement, STMA-7251 - In case of an equal 75Hz current through the left and right rail the signal difference between the left and right coil signal shall be less than 10%

Requirement, STMA-7252 - EM sources in the train shall not cause a 75 Hz signal level at the STM ATB coil signal inputs higher than 10 % of the signal caused by a 4.7A@75Hz current through the rail.

Requirement, STMA-7261 - The coil signal caused by the current floating through the wheels at the first axle of the train, shall not exceed 10% of the signal caused by the same current floating through the rail.

Requirement, STMA-15037 - The sum of the disturbances mentioned in  STMA-7250,  STMA-7252 and  STMA-7261 shall not exceed 15% of the average 75 Hz signal level.

Requirement, STMA-14951 - The risk on having intermittent interruptions of the connection to (or inside) the ATB coils (antenna's) , simultaneously in the left and right coil circuit shall be less than $1 \cdot 10^9$ /hour.

Requirement, STMA-9955 - Antenna's shall not saturate due to traction return currents up to 8000A/rail.
note: based on the RIS 4000A/rail should be sufficient, however the maximum current has been increased without updating the RIS.




6 Operational constraints

Decision, STMA-80481 - "level NTC ATB" may only be selected at standstill while the selected driving direction is "neutral".

7 Usage of packet 44

[CHAPTER 6 IS TO BE REMOVED WHEN THIS DOCUMENT IS USED IN MARKET TENDERS].

Three different variants of a packet 44 are defined, containing the following information:

- ATBEG maximum speed levels ( STMA-13935 - The data block (MSB first) in a packet 44 (= M_DATA(k) in packet STM-45, see sub...)
- Distance to a signal at danger for ATBVv braking curve monitoring ( STMA-13937 - The data block (MSB first) in a packet 44 (= M_DATA(k) in packet STM-45, see sub...)
- Maximum speed on ATB lines depending on braking performance ("remtabellen":  STMA-34496 - The data block (MSB first) in a packet 44 (= M_DATA(k) in packet STM-45, see sub...)

Requirement, STMA-15658 - If ATBEG maximum speed levels are communicated, then either all speeds shall be equal or higher compared to the default speed levels, or all speeds shall be equal or lower compared to the default speed levels

note: this is necessary to calculate the distance over which the speed levels are valid in a safe manner, as for higher speeds the communicated "maximum safe distance" and for lower speeds the "minimum safe distance" is used. The changed speeds will not be used partially to avoid too complex solutions (although it could).

Requirement, STMA-15685 - If distances to the signal at danger are communicated to the STM ATB (ATBVv function) then:

- 3 m shall be used for "immediate braking"
- the distances to be communicated shall be [4m,...,2000m] in steps of 1m

Decision, STMA-29828 - One message shall not contain more than 5 packets type STM-45