[4.3] SRS STM-ATB

for the development of an STM-ATB

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Document History

version	date	author	remark
1	5-12-2016	JW	initial version for external communication

CONTENT

1 Requirement sources

In this document requirements assigned to the STM ATBEG are gathered. The sources of the requirements are:

- The „RIS“ („regeling indienststelling spoorvoertuigen), d.d. 9-9-'16. The RIS requirements concern the complete ATBEG function. In an ETCS + STM ATBEG configuration, parts of these requirements are assigned to the ETCS on-board and parts are assigned to the STM ATBEG
- The „systeembeschrijving ATBVv, v11“. (SID-717) These requirements concern the complete ATBVv function. In an ETCS + STM ATBEG configuration, parts of these requirements are assigned to the ETCS on-board and parts are assigned to the STM ATBEG
- A few additional user requirements concerning performance, availability and flexibility for future updates

STMA-3306 - In addition to the requirements listed in this SRS, the STM ATB shall comply with the following requirements:

- HW and environmental: ERTMS programma document SID-803
- ERA specifications concerning cooperation and interfacing with ETCS on-board equipment: subset035 v310, subset056 v300, subset057 v300, subset058 v310 and subset059 v300
- Interoperability directive: EC2008-57
  EN50126:1999, EN50128:2001, EN50129:2003 ammended 2010, EN50159:2010

2 System interfaces

The STM shall interface with an ETCS on-board system and some additional peripherals such as ATBEG antenna's, a sound generator, circuits providing brake (sufficiently) applied information and a EB feed-back.

2.1 Parallel interfaces (digital I/O and track signal)

The STM shall:

- receive and decode the ATBEG track signal and determine the current maximum ATBEG speed.
- detect brake operation by the driver
  Antivalent Inputs shall be provided for:
  - brake handle operation satisfying the criterion for a configurable time: "BrakeHandleApplied"
    note: this input can be used in case of trains having a time controlled brake handle were a short command is enough to set the required braking force
  - detection of sufficient brake power: BrakesOperatedSufficiently
    note: this input can be used in case of trains with a position controlled brake handle and for trains with a time controlled brake handle to get a feed back for (e.g.) the brake pipe pressure.
- detect EB commands given by ETCS to the braking system, an Antivalent Input shall be provided for:
  - ETCS EB command

DETERMINE ATBEG AND ATBVv TRACK SIGNAL

If the STM ATB state is different from "inactive" then the STM ATB shall determine the ATBEG track signal according to "9. ATBEG decoding" and the ATBVv track signal according to "10. ATBVv decoding"
This requirement is detailed in the chapters concerning the STM states "preparing" and "responsible"

DETERMINE BRAKE OPERATION BY THE DRIVER

STMA-2761 -
The STM ATB shall determine if the driver is operating the brakes enough to avoid an emergency brake (EB) command due to overspeed:
If the antivalent inputs "BrakeHandleApplied" both indicate that the driver is applying the brake (i.e. "BrakeHandleApplied" = true) or
the anitivalent inputs "BrakeHandleApplied" both became true less than 3s ago, or
the antivalent inputs "BrakesOperatedSufficiently" both indicate that the brakes are operated (i.e. BrakesOperatedSufficiently" = true)
then the STM ATB shall set "DriverOperatesBrakes" true
else the STM ATB shall set "DriverOperatesBrakes" false

STMA-3301 -
If the antivalent inputs "BrakeHandleApplied" provide contradictionary information then
the STM ATB shall take measures to ensure safety

STMA-3304 -
If the antivalent inputs "BrakesOperatedSufficiently" provide contradictionary information then
the STM ATB shall take measures to ensure safety

DETERMINE EB COMMANDED BY ETCS ON-BOARD

STMA-3303 -
The STM ATB shall determine if the ETCS on-board is commanding the brakes, to check if an EB command sent by the STM ATB has had effect:
If the antivalent inputs "ETCS EB commands" both indicate that the EB is commanded by the ETCS on-board
then ETCScommandsEB shall be set "on"
else ETCScommandsEB shall be set "off"

STMA-3305 -
If the antivalent inputs "ETCS EB commands" provide contradictionary information then
the STM ATB shall take measures to ensure safety

SENT ACOUSTICAL INFORMATION

STMA-2764 - SOUNDS via parallel wiring
The STM shall provide the following sound information using digital outputs (galvanically isolated contacts):
- "gong": close for 50ms
- "bell" and "zoemer": closed as long as the signals shall be given

2.2 Profibus

The STM ATB shall communicate with the ETCS on-board equipment via a profibus connection.

STMA-2177 - Interfacing between the STM ATBEG and the ETCS on-board system shall comply with ERA requirements ss035, v3.0.0; ss056, v3.0.0; ss057 v3.0.0; ss058 v3.1.0 and ss059, v3.0.0

INFORMATION to be received from the ETCS on-board

The STM ATB will receive the following configuration data from the ETCS on-board:

- maximum train speed
- train length
- braking percentage of the train
- the brake type of the train (R,P or G)
- the brake build up time
- Adhesion information (slippery, yes/no) *(considered as configuration data as it configures the Vv braking curve)*
- the traction cut-off time
- ATBEG code speeds plus validity in distance (if the information is available via packet-44)
- The delay in commanding the emergency brake (shall be less than 200ms)
- The maximum odometer cycle and delay in producing an odometer value (sum shall be less than 800ms)

The STM ATB will receive the following state information from the ETCS on-board:"

- the selected cabin
- the selected driving direction in relation to the selected cabin
- The ETCS mode and level
- The availability of the emergency brake

The STM ATB will receive the following dynamic information from the ETCS on-board:

- speed information: "estimated speed", "maximum safe speed", "minimum safe speed"

The STM ATB will receive the following DMI information from the ETCS on-board:

- Button Events: message if an ATB button is pushed by the driver.

CURRENT TRAIN SPEED

The current train speed to be used by the STM ATB can not always be the nominal speed as received from the ETCS on-board. If the difference between "maximum safe speed" and "nominal speed" is too big, that would be unsafe

STMA-2766 -

The STM shall use the received speed information to calculate the "current train speed" which is regarded for the ATB function to be correct:

The "current train speed" shall be the maximum of the "estimated speed" and the "maximum safe speed" minus 3km/h

STMA-2190 -

If the ETCS on-board sents data (configuration data like maximum speeds, status data like selected cabin, and current train speed information), the STM ATB shall update the information accordingly.

MAXIMUM SPEED PER ATBEG CODE

STMA-2249 -

The guarded speed shall depend on the ATBEG code,

The STM ATB shall (re)calculate the guarded speed per ATBEG code if:

- a new value for the maximum train speed is received.
- a new value for the braking percentage or brake type is received
- a packet STM-45 containing new speed levels is received.

STMA-2867 -
Speed levels shall be adaptable using packet STM-45
default values are (parameterizable by the user):

STMA-2250 - code96: 140km/h (range 140, 160km/h)

STMA-2251 - code120: 130km/h

STMA-2252 - code147: 80 km/h (range 10, 80, 100, 160km/h)

STMA-2253 - code180: 80 km/h

STMA-2254 - code220: 60km/h

STMA-2255 - noCode: 40km/h

STMA-2809 -
The speed levels shall be limited to the maximum train speed as received from the ETCS on-board, and the maximum safe speed on an ATBEG line according to the braking percentage as received from the ETCS on-board.

STMA-2865 -
If the braking percentage as received from the ETCS on-board is lower than "LowBrakingPercentage" then the lowest speed level (in case of "no code") shall be limited to 30km/h.

STMA-2866 -
The parameter "LowBrakingPercentage" shall be configurable by the user

CAB SIGNAL PER ATBEG CODE

Which cab signal is coupled to which ATBEG code is determined by the speeds coupled to the ATBEG codes

STMA-3283 - If the guarded speed coupled to any of the ATBEG codes changes then
The STM ATB shall (re)calculate the color and text (speed indication) per cab signal.

STMA-2810 -
Codes corresponding to the same guarded speed shall be coupled to the same cab signal

STMA-2805 -
The position for the indicators coupled to the cab signals shall be such that the ordering at the screen is from left to right for speed levels from low to high.

ATBVv BRAKING CURVE DECELERATION AND BRAKE BUILD UP TIME

STMA-3286 - The STM ATB shall (re)calculate the maximum deceleration (a) and brake build up time (t_a) to be used in the ATBVv braking curve calculation every time one of the following parameters is received while the other parameters are already known:

- train length
- brake percentage of the train
- the brake type
- brake build up time
- Adhesion information
- traction cut of time

The calculation method shall be comparable with the methods used for ATBNG and ETCS

BUTTON OPERATION BY THE DRIVER

STMA-3288 - If a message is received that a button is pushed (operated) by the driver then
The STM ATB shall set the status of the button to "operated" and store the time of operation

STMA-3289 - If a message is received that a button is released (not operated) by the driver then
The STM ATB shall set the status of the button to "not operated"

RESPOND ON PERFORMANCE DATA

STMA-3291 - If a message is received specifying the delay in commanding the EB by the ETCS system then
the STM ATB shall store the data and take measures to ensure safety

STMA-3292 - If a message is received specifying the delay in measuring and sending the current train speed then
the STM ATB shall store the data and take measures to ensure safety

STORING STATUS INFORMATION

STMA-3294 - The following information shall be stored when received from the ETCS on-board:

- the selected cabin
- the selected driving direction in relation to the selected cabin
- the ETCS mode and level
- the availability of the EB

INFORMATION to be sent to the ETCS on-board

BRAKE COMMAND to be sent to the ETCS on-board

STMA-2205 -

If the status of the EB changes to "commanded" then the STM ATBEG shall sent an EB command to the ETCS on-board

STMA-2206 -

If the status of the EB is "commanded" and
the input "ETCS EB command" doesn't indicate that the ETCS on-board commands the brake (i.e. ETCScommandsEB = false) then
The STM ATBEG shall sent an EB command to the ETCS on-board once per second

STMA-2208 -

If the status of the EB changes to "not commanded" then
the STM ATBEG shall sent an EB release command to the ETCS on-board

DMI INFORMATION to be sent to the ETCS on-board

The ERA ETCS specification (subset035 paragraph 13.5) offers the possibility to define a customisable DMI. The STM ATB will use this possibility

STMA-2187 -

DMI information shall be coded according according to STMA-2719

STMA-2719 -

The configuration shall be captured in a "DMI configuration table" defining a customisable DMI according to (ss035, v300, 13.5.1.2 "recapping table"), specifying:

- Per indicator (identified with an IndicatorID) the icons, icon positions and text formats on the icons
- Per button (identified with a buttonID)button positions and text formats on the buttons
- Per sounds (identified with a soundID) a .wav file (gong.wav, BD signal.wav, losbel.wav, bel.wav, zoemer.wav)

For both "soft key technology" and "touch screen technology"

STMA-2813 -

The resulting layout as specified using the DMI configuration table shall comply with the requirements in CENELEC: CLC/prTR 505497 as far as this doesn't conflict with ETCS indicators used in level STM ATB.

STMA-2226 -

The STM ATBEG shall sent the DMI information to be sent to the ETCS on-board in a format according to the "DMI configuration table" (STMA-2719).

STMA-2713 -

If the guarded speed changes the "gong" shall be triggered and the new cab signal shall be sent (STMA-2240 and STMA-2842)

The gong shall be triggered (sent packet STM-46 to trigger the "gong" and close the digital output "gong") at the same moment the packet STM-35 including the corresponding cab signal change is sent, with a tolerance of +/- 20ms.

INDICATORS

INDICATORS TO BE DISPLAYED

cab signals, maximum 6 cab signals, possible values:

- yellow_off,
- yellow_on
- green_off,
- green_on

"brakes operated by the driver" (WhiteLamp) information, possible values (if displayed):

- "on"
- "off"

ATBEG status indicator, possible values (in the order of priority)

- if the ATBEG state is intervention: "status intervention" with text ATB
- if the ATBVv state is intervention: "status intervention" with text Vv
- if the ATBVv state is "overridden": "status_bd/overridden" with text" STS
- if the ATBEG state is "out of ATB area": "status_bd/overridden" with text BD
- in other cases: "status_active" with text ATB

Cab signals

STMA-2233 - For the different cab signals fixed positions shall be used, i.e.:

• The “indicator_ID” as sent by the STM will always be equal to the “indicator position_ID”

STMA-2234 - The maximum speed corresponding to the cab signals shall be sent to the ETCS on-board (in decakm/h (=10km/h)) together with the cab signal information, according to the DMI configuration table.

STMA-2806 -

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

STMA-2812 -

The minimum font size to be used on the indicators for the cab signals shall be 40

STMA-2231 -

If a cab signal corresponds to the highest allowed speed (lowest of the maximum ATBEG speed and the maximum train speed)

then

if the status of a cab signal is "on" then the STM ATB shall set the color of the indicator to "green_on"
if the status of a cab signal is "off" then the STM ATB shall set the color of the indicator to "green_off

i.e.:

The cab signal icons "green_off" and "green_on" shall be used for the concerning cab signal

STMA-2232 -

If a cab signal doesn't correspond to the highest allowed speed (lowest of the maximum ATBEG speed and the maximum train speed)
then
if the status of a cab signal is "on" then the STM ATB shall set the color of the indicator to "yellow_on"
if the status of a cab signal is "off" then the STM ATB shall set the color of the indicator to "yellow_off
i.e.:
The cab signal icons "yellow_off" and "yellow_on" shall be used for the concerning cab signal

STMA-3271 -

If the status of a cab signal is "not displayed" then the indicator for the cab signal shall not be displayed

Brakes operated indicator (white lamp)

STMA-3268 -

The current color of the indicator showing if the driver is operating the brakes shall be determined as follows

If WhiteLamp = on then the color of the indicator shall be white

if WhiteLamp = off then the color of the indicator shall be grey
if WhiteLamp = not displayed then the indicator shall not be displayed

ATBEG state indicator

STMA-3269 -

The current color and text for the ATBEG state indicator at the DMI shall be determined as follows:

If StateIndicator = ATBEG_Intervention then the color shall be red and the text shall be "ATB"

If StateIndicator = ATBVv_Intervention then the color shall be red and the text shall be "Vv"

If StateIndicator = ATBVv_overridden then the color shall be blue and the text shall be "VRIJ"

If StateIndicator = ATBEG_BD then the color shall be blue and the text shall be "BD"

If StateIndicator = ATBEG_Active then the color shall be grey wit text "ATB"
If StateIndicator = "not displayed" then the indicator shall not be displayed

Update indicators

STMA-2842 -

If the status of one of the indicators changes then

the STM ATB shall sent an update off all ATB indicators to the ETCS on-board

BUTTONS

BUTTONS TO BE DISPLAYED

- a release button
- an attention button (if BD is enabled)
- a BD button (if BD is enabled)
- an STS button (to override ATBVv)
- a "kwiteren" button (vigilance) if "kwiteren" is enabled
- a test button (optionally, e.g. to ask for version or fault information)

STMA-3259 -

The status of the buttons can be "displayed" or "not displayed".

If the status of one or more of the buttons changes then

the STM ATB shall sent a message to the ETCS on-board to update the status of all the buttons

DEFINITIONS OF ACOUSTICAL INFORMATION

Acoustical information is sent via profibus to the ETCS on-board and in parallel provided via digital outputs (galvanically isolated outputs). There are three digital outputs available: "gong", "bel" and "zoemer".
Concerning the output via Profibus a difference is made between "one-stroke signals" and "continuous signals":
- as a response on triggering a one-stroke signal the ETCS on-board shall play a predefined x.wav once
- as a response on starting a continuous signal the ETCS on-board shall start playing cyclically a predefined y.wav
- as a response on stopping a continuous signal the ETCS on-board shall stop a predefined y.wav

STMA-2191 - SOUNDS via Profibus

The STM shall provide the following sound information to the DMI:

- "gong", "losbel", BD signal: one stroke signal
- "bell" and "zoemer" continous signals (to be switched on and off.

STMA-2787 - "Trigger the gong" shall mean:
The STM ATB shall close the digital output "gong" during 50ms and
The STM ATB shall sent the acoustical information "gong" to the ETCS on-board using packet STM-46 and according to the DMI configuration table

STMA-2788 - "Trigger the "BD signal" shall mean"
close the digital output "gong" five times during 50ms, starting with 800ms intervals, and
Send a packet STM-46 to trigger the "BD signal" to the ETCS on-board using packet STM-46 and according to the DMI configuration table.

STMA-2789 - "Trigger the "losbel" shall mean:
close the digital output "bell" three times during 300ms, starting with 600ms intervals
(if the state of the rembel changes to "on" during this 1,5s, then the rembel prevails) and
Send a packet STM-46 to trigger the "losbel" to the ETCS on-board using packet STM-46 and according to the DMI configuration table.

STMA-2790 - "Start the "rembel" shall mean:
close the digital output "bell" and
send a message to start the rembel to the ETCS on-board using packet STM-46 and according to the DMI configuration table

STMA-2791 - Stop the "rembel" shall mean:
open the digital output "bell" and
send a message to stop the rembel to the ETCS on-board using packet STM-46 and according to the DMI configuration table

STMA-2792 - "Start the "zoemer" shall mean:
close the digital output "zoemer" and
send a message to start the zoemer to the ETCS on-board using packet STM-46 and according to the DMI configuration table

STMA-2793 - Stop the "zoemer" shall mean:
open the digital output "zoemer" and
stop the rembel to the ETCS on-board using packet STM-46 and according to the DMI configuration table

3 (DE)ACTIVATING THE ATB FUNCTION

STM states are defined in the ERA subset035 (v3.0.0). The STM states are used to enable smooth transitions between ATBEG area's and ETCS area's, and between ATBEG area's and other national systems. States are defined as follows:

- Cold stand-by (CS): the STM is completely prepared (configured, tested etc.), but not responsible nor reading track signals.
- Hot stand-by (HS): to prepare on an expected transition to ATBEG area the STM started reading the track signals, but is not responsible for guarding train movements.
- Data available (DA): the STM is responsible for guarding the train movements.
- Power on (PO), Configuration (CO) and Data Entry (DE) are states used during start-uP

STMA-2183 - Three different state machines are defined for the STM ATBEG:
- The "STM state" according to ss035 (PO, CO, DE, CS, HS, DA), see ERA ss035, v3.0.0, 9.2
- The "STM ATB state": see below (inactive, preparing, responsible)
- The "ATBEG state": the state of the ATBEG function when the STM ATB state is responsible

3.1 STM STATE (ACC. TO ETCS DEFINITION)

STMA-2179 - If the STM state is CO or DE(only to CS) or CS, HS or DA and an order to go to another STM state (CS, HS or DA) is received then
The STM ATBEG shall change the STM state to the requested state and
The STM ATBEG shall adapt its behavior to the new state and
The STM ATBEG shall report the new state to the ETCS on-board
within 0,5s after the the request was received.

note: in case of a condition CS order, this requirement only applies after the intervention has been released.

STMA-2180 - If the STM state changes to HS then
The STM ATBEG shall report "STM max Speed" immediately (within 0,5s) after HS is reported to the ETCS on-board.
The maximum value shall be 140km/h.

3.2 STM ATB STATE

STMA-2824 -
The STM ATB shall have three states plus"power off" (not shown below):
- Inactive

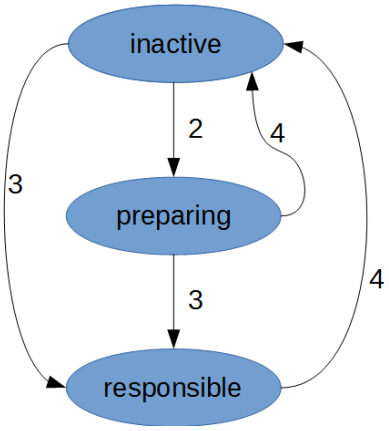
- preparing

- responsible

Those states relate to the generic STM state and ETCS state as shown below:

STM ATB states

1: Power on
2: STM state = HS (and ETCS state = SN) and a cabin is selected
3: STM state = DA (and ETCS state = SN) and a cabin is selected
4: No cabin selected and/or STM state different from DA or HS



STMA-2675 -

The ATBEG function shall only be active in case the ETCS mode is „system national“ (SN), even if the STM state is HS or DA.
Therefore STM ATB states are defined:

- „Inactive“ in case the STM state (as commanded by the ETCS on-board) is different from „hot stand-by“ (HS) or „data available“ (DA),

  or

  if the ETCS mode is "sleeping" or "non leading".

  or

  if the EB is not available (according to information received from the ETCS on-board)
- „Preparing“ in case the STM state is HS and the ETCS mode is different from sleeping or non-leading
- „Responsible“ in case the STM state is DA and the ETCS mode is different from sleeping or non-leading

INACTIVE:

The STM shall not guard the speed when the STM-state and/or ETCS-mode indicate that the STM is not responsible for guarding train movements and in case the EB is not available. This function is detailed in the requirements listed below in this document.

PREPARING

In the STM ATB state "preparing" the STM ATB shall prepare for the switch to "responsible", i.e.
The STM ATB shall start decoding the track signal and prepare the optical signals for the moment the transition to "responsible is made.
However the external behaviour of the STM ATB shall be equal to the behaviour in the state "inactive".

STMA-2768 -
If the STM ATB state changes to "inactive" from "preparing" or "responsible" then the ATBEG + Vv decoder state variables and timers shall all be reset

STMA-3247 -

If the STM ATB state changes to "preparing" then D_STS shall be set to infinite

RESPONSIBLE

In the state responsible the STM ATB shall perform the ATBEG and ATBVv function

4 FUNCTIONS IN STM ATB STATE "INACTIVE"

The following functions shall be performed in the STM ATB state "inactive":

STMA-2198 -

If the "STM ATB state" is "inactive" then the EB is not commanded

STMA-3263 -

If the "STM ATB state" is "inactive" then the STM ATB shall set the status of the cab signals to "not displayed"

STMA-3264 -
If the "STM ATB state" is "inactive" then the STM ATB shall set the status of the "WhiteLamp" to "not displayed"

STMA-3274 -
If the "STM ATB state" is "inactive" then the STM ATB shall set the status of the StateIndicator to "not displayed"

STMA-3275 -

If the "STM ATB state" is "inactive" then the STM ATB shall set the status of the buttons to " not displayed"

5 FUNCTIONS IN STM ATB STATE "PREPARING"

The following functions shall be performed in the STM ATB state "preparing":
In the STM ATB state "preparing" the STM ATB shall prepare for the switch to "responsible", i.e.
The STM ATB shall start decoding the track signal and prepare the optical signals for the moment the transition to "responsible is made.
However the external behaviour of the STM ATB shall be equal to the behaviour in the state "inactive".

STMA-3240 -

The STM ATB shall calculate the "ATBEG code" as described in chapter 9.

STMA-3244 -

The STM ATB shall calculate the "ATBVv code" as described in chapter 10.

STMA-3276 -

If the "STM ATB state" is "decoding" then the EB is not commanded

STMA-3250 -

If the "STM ATB state" is "decoding" then the status of the cab signals shall be determined as follows:
If the "EB is available" (information received from ETCS)
then
the STM ATB shall set the cab signal corresponding to the currently guarded speed equal to "on" and
the STM ATB shall set the other cab signals equal to "off"

else
the STM ATB shall set all cab signals to "not displayed"

STMA-3277 -

If the "STM ATB state" is "decoding" then the status of the WhiteLamp shall be determined as follows

If DriverOperatesBrakes is true then the STM ATB shall set the WhiteLamp to "on"
If DriverOperatesBrakes is false then the STM ATB shall set the WhiteLamp to "off"

STMA-3278 -

If the "STM ATB state" is "decoding" then the STM ATB shall set the StateIndicator to "ATBEG_Active"

STMA-3279 -

If the "STM ATB state" is "decoding" then the STM ATB shall set the buttons to "displayed"

STMA-3246 -

The STM ATB shall calculate D_STS according to:
If ATBVv signal = "beacon 3" then D_STS shall be set to 120m
If ATBVv signal ="beacon 2 signal" then D_STS shall be set to 30m
If ATBVv signal ="beacon 1 signal" then D_STS shall be set to 3m
If ATBVv signal = "beacon release signal" then D_STS shall be set to "infinite"
If ATBVv signal = "loop release signal" then D_STS shall be set to "infinite"
If ATBVv signal = "none" and D_STS is different from "infinite" then
D_STS shall be updated according to the distance travelled in the forward direction
(thus D_STS decreases if the driving direction is forward and D_STS increases if the driving direction is backward)

6 FUNCTIONS IN STM ATB STATE "RESPONSIBLE"

In the state responsible the STM ATB shall perform the ATBEG and ATBVv function.

STMA-3272 -

The STM ATB shall calculate the "ATBEG code" as described in chapter 9.

STMA-3273 -

The STM ATB shall calculate the "ATBVv code" as described in chapter 10.

In the STM ATB state "responsible" the outputs shall be determined depending on the ATBEG state

6.1 ATBEG STATES

In the RIS six ATBEG states are defined. The states „uitgeschakeld“ and „stand-by“ are covered by ETCS states in which the ATBEG function is not responsible. Therefore the ATBEG states are limited to „constant“ (CONST), „braking“ (REM), „out of ATBEG area“ (BD) and „intervention“ (I).
In the figure below also a state "off" is shown. This state is valid for all situations if the "STM ATB state" is different from responsible.

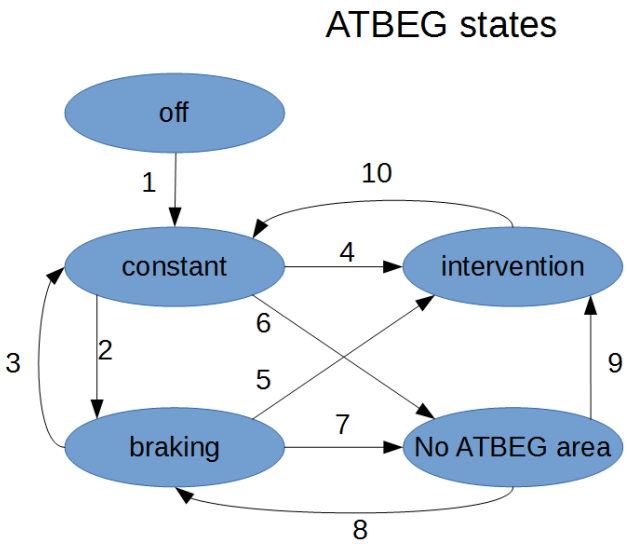
STMA-2184 -

The ATB states as defined in the RIS (bijlage 1) are translated to "ATBEG states" as follows (in case the the "STM ATB state" = "responsible") :

- I: Intervention
- CONST: constant
- REM: braking
- BD: No ATBEG area

The STM ATB doesn't have an ATBEG state "Uitgeschakeld" as the behaviour when the system is switched off is an ETCS on-board responsibility

The STM ATB doesn't have an ATBEG state "stand-by" as the behaviour conform the state standby as defined in the RIS is an ETCS on-board responsibility



ATBEG STATE CHANGES

STMA-2181 - 1: SWITCH ON THE ATB FUNCTION

if the "STM ATB state" changes to "responsible" then

the STM ATB shall set the ATBEG state to "constant"

the STM ATB shall reset all ATBEG timers (excluding decoder timers) to their default values

STMA-7182 - SWITCH OFF THE ATB FUNCTION

If the "STM ATB state" changes from "responsible" to another state then

the STM ATB shall set the ATBEG state to "off"

STMA-2201 - 4: FROM CONSTANT TO INTERVENTION

If the ATB state is "constant" and for an uninterrupted time Twarning and the current train speed exceeds the guarded speed plus V_marge while the brake is not operated by the driver (DriverOperatesBrakes)

then

The STM ATBEG function shall change the ATBEG state to "intervention".

STMA-2202 -

Twarning =< 4,0s

note: taking into account the cycle times and transfer times for the EB command through ETCS

STMA-2203 - 5: FROM BRAKING TO INTERVENTION

If the ATBEG state is "braking" and

(

for an uninterrupted time of at least ‘Tintervention_yellow’ the current train speed exceeds the guarded speed plus V_los while the brake is not operated by the driver (DriverOperatesBrakes) and the value of the input ATBEG code = nocode.

or

for an uninterrupted time of at least ‘Tintervention’ the current train speed exceeds the guarded speed plus V_los while the brake is not operated by the driver (DriverOperatesBrakes) and the value of the input ATBEG code = code96, or code120, or....., code220.)

then

The ATBEG function shall change the state to "intervention"

STMA-2209 -

If the ATBEG state is "braking" then

The minimum time between the start of the sound "bell" and the moment sending an EB command cannot be avoided anymore by providing the digital input signal "brakes sufficiently operated" and/or "brake handle applied" shall be at least 2,0s.

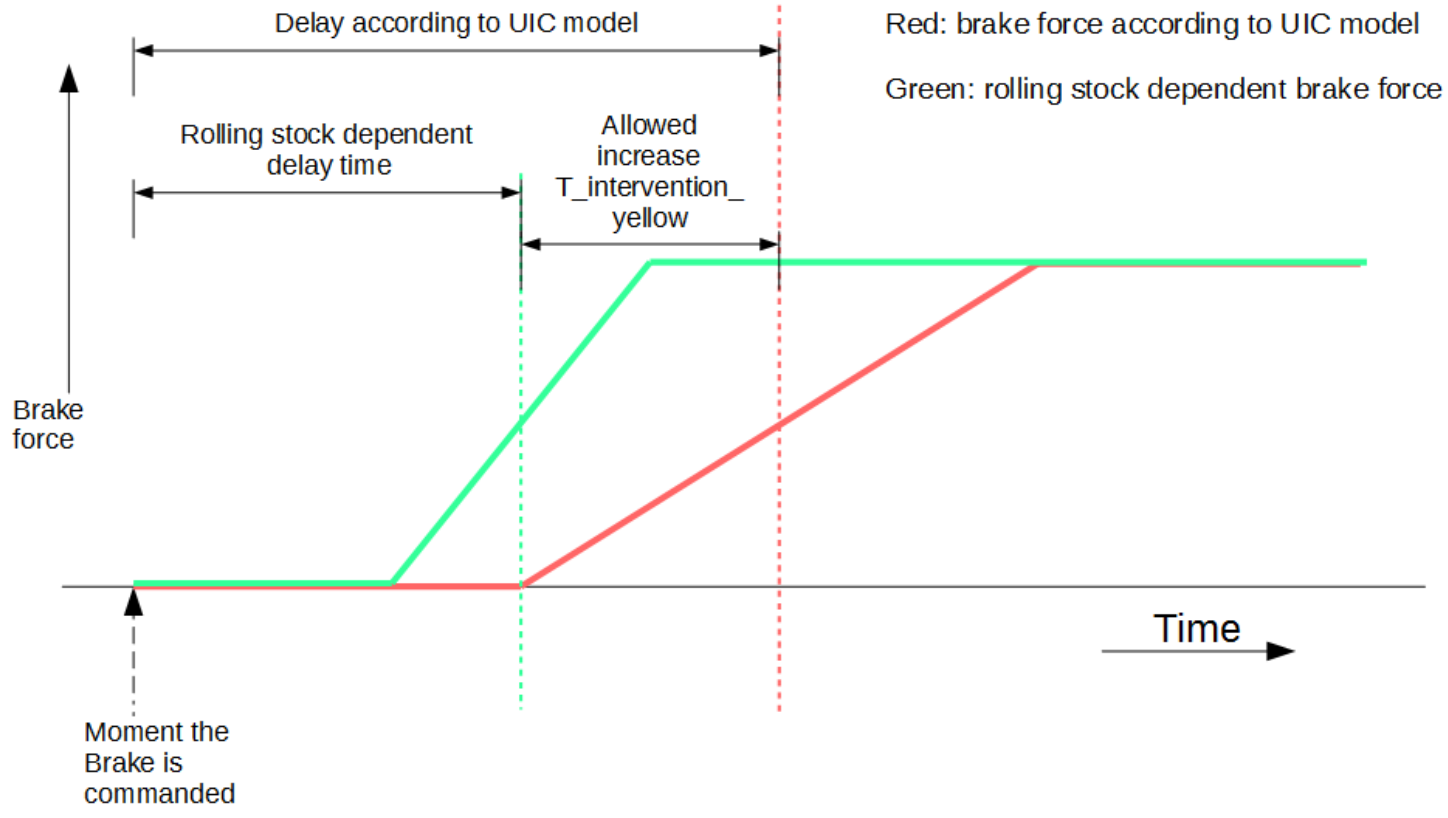
note: This is 0,3s longer than stated in the RIS

STMA-2204 - Tintervention_yellow:

The maximum time between the moment the track signal didn't contain an ATBEG code anymore (i.e. the 75Hz level became constantly high or constantly low) (for which the current train speed is too high while the driver doesn't respond by braking) and the moment the EB command is sent to the ETCS on-board shall be less than:

- in any case: 4,6s
- nominal case: 4,4s (>95% of the cases)

This time may be increased with the time the braking system of the specific rolling stock type, builds up brake force faster than the time specified in UIC standards.



STMA-2210 - Tintervention

The maximum time between the moment the track signal contains another ATBEG code ATBEG (for which the current train

speed is too high while the driver doesn't respond by braking) and the moment the EB is commanded by the ETCS system shall be less than 8,1s

This time may be increased with the time the braking system builds up brake force faster than the time specified in the UIC standards, i.e

The reduced braking distance (S_brake_ATB - S_EB) due to (and only due to) a shorter brake build up time after an ETCS EB command compared to the brake build up time when determining the braking percentage of the train, divided by the train speed

STMA-2213 - 8: FROM NO ATBEG AREA TO BRAKING

If the ATBEG state is "no ATBEG area" and

(

1. Since the last transition of the ATBEG state to "no ATBEG area"

The "Attention button" has been operated and

the track signal contained a code other value than "nocode" or "code75"

or

2. the track signal contains a code other value than "nocode" or "code75" and the train is at standstill (current train speed < 1km/h)

or

3.the track signal contains "nocode" and the "Attention button" is operated during a time T_operate

) then

"The ATBEG function shall change the state to "braking"

note: not to constant because a transition to constant could lead to braking to late in case of overspeed

STMA-2783 - T_operate

T_operate shall be at least 2s

STMA-2214 - 9: FROM NO ATBEG AREA TO INTERVENTION

If the ATBEG state is "no ATBEG area" and

(

1. If the "Attention button" is operated and

the track signal doesn't contain a code other than "nocode" or "code75" within a time T_MaxPreAtt after the start operation of the button

or

2. the track signal contains a code other than "nocode" or "code75" uninterruptally longer than T_MaxPostAtt,

and the "attention button" is not operated during this time

) then

The STM ATBEG shall change the "ATBEG state" to "intervention"

STMA-2779 - T_MaxPreAtt

T_MaxPreAtt shall be 5s +/- 1s

T_MaxPreAtt is the maximum time the driver may push the attention button before code in the track starts.

STMA-2780 - T_MaxPostAtt

T_MaxPostAtt shall be 5s +/- 1s

T_MaxPostAtt is the maximum time the driver may push the attention button after code in the track starts.

STMA-2217 - 6/7: FROM CONSTANT OR BRAKING TO NO ATBEG AREA

If "Q_BuitenDienst" is enabled and

the ATBEG state is "constant" or "braking" and the STM ATBEG detects code75 during a time Tblue then

The STM ATBEG shall change the ATBEG state to "no ATBEG area"

STMA-2773 - Tblue

Tblue shall be 6s +/-1s

STMA-2218 - 6: FROM CONSTANT TO NO ATBEG AREA (AT STANDSTILL)

If "Q_BuitenDienst" is enabled and the ATBEG state is "constant" and

The BD button is operated for an uninterrupted time longer than T_Operate while the train is at standstill (current train speed < 1km/h) and the track signal doesn't contain a code different from code75 (or nocode) then

The STM ATBEG shall change the ATBEG state to "no ATBEG area"

STMA-2858 -

The STM ATB shall enable the user to set a parameter "Q_BuitenDienst" to switch the "buiten dienst function" on and off
- Q_BuitenDienst = enabled: function buiten dienst is active (on), i.e. ATBEG state "no ATB area" is allowed
- Q_BuitenDienst = disabled: function buiten dienst is not active (off), i.e. ATBEG state "no ATB area" is not allowed

STMA-2220 - 2: FROM CONSTANT TO BRAKING

If the ATBEG state is "constant" and

the guarded speed changes to a lower value and

the current train speed is above the new guarded speed plus V_marge then

The STM ATBEG shall change the ATBEG state to "braking"

STMA-2221 - 3: FROM BRAKING TO CONSTANT

If the ATBEG state is "braking" and

(

1. The current train speed is below the guarded speed plus V_marge or

2. The current train speed has been lower than the guarded speed plus Vlos after the state change to "braking" during an uninterrupted time Tlos

) then

The STM ATB shall change the ATBEG state to "constant".

STMA-2222 - V_marge

V_marge = 5km/h for multiple units, V_marge = 3km/h for locomotives

STMA-2223 - Tlos

Tlos = 20 s

STMA-2224 - Vlos

Vlos = 5km/h for multiple units, Vlos = 12km/h for locomotives

STMA-2207 - 10: FROM INTERVENTION TO CONSTANT

If the ATBEG state is "intervention" and

If the input "release button" is operated (message from the ETCS on-board) and

the train is at standstill (current train speed < 1km/h) then

The STM ATB shall change the "ATBEG state" to "constant"

STMA-2308 - 4: FROM CONSTANT TO INTERVENTION

If the output "zoemer" has been activated uninterruptedly for 5s

then the STM ATB shall change the ATBEG state to "intervention"

6.2 ATBEG + ATBVv OUTPUTS

Below the ATBEG outputs are specified depending on the current state, divided in:
- Brake commands
- Optical information to be displayed on the DMI
- Acoustical information to be played in the cabin

BRAKE COMMANDS

STMA-2199 -

The status of the EB is determined as follows:
If
the ATBEG state is "intervention" or the ATBVv state is "intervention" or the ATBVv state is "STS"
then the status of the EB shall be "commanded"
else the status of the EB shall be "not commanded"

OPTICAL INDICATORS

In case the STM ATB is responsible the speed, the "cab signals" shall be shown to the driver. Further information to be shown using indicators at the DMI are the ATBEG state (ATBEGstateIndicator) and an indicator to show if the driver is operating the brakes (DriverOperatesBrakes)

ATBEG STATE INDICATOR

STMA-2840 -

the ATBEG state indicator (ATBEGStatusIndicator) shall be determined as follows:
If the ATBEG state = intervention then the STM ATB shall set the StateIndicator to "ATBEG_Intervention"
else, if the ATBVv state = "intervention" or "STS" then the STM ATB shall set the StateIndicator to "ATBVv_Intervention"
else, if the ATBVv state = overridden then the STM ATB shall set the StateIndicator to "ATBVv_Overridden"
else, if the ATBEG state = "no ATB area" and the "attentieknop" has not been operated since entering the ATBEG state "no ATB area" for the last time then the STM ATB shall set the StateIndicator to "ATBEG_BD"
else if the ATBEG state = "monitoring" or "braking" then the STM ATB shall set the StateIndicator to "ATBEG_Active"
else the STM ATB shall set the StateIndicator to "off"

ATBEG CAB SIGNALS

STMA-2227 -

The current cab signals shall be determined as follows:
If the ATBEG state = "constant" or "braking" and
the "EB is available" (information received from ETCS)
then
the STM ATB shall set the cab signal corresponding to the currently guarded speed equal to "on" and
the STM ATB shall set the other cab signals equal to "off"
else
the STM ATB shall set all cab signals to "not displayed"

WHITE LAMP (DriverOperatesBrakes indicator)

STMA-2229 -

The current color of the indicator showing if the driver is operating the brakes (WhiteLamp) shall be determined as follows

If DriverOperatesBrakes is true and the ATBEG state is "constant" or "braking"

then the STM ATB shall set the WhiteLamp to "on"
If DriverOperatesBrakes is false and the ATBEG state is "constant" or "braking"
then the STM ATB shall set the WhiteLamp to "off"
If the ATBEG state is different from "constant" or "braking"
then the STM ATB shall set the WhiteLamp to "not displayed"

SOUNDS

GENERATING SOUNDS, REMBEL

STMA-2847 -

The current status of the "rembel" shall be determined as follows:
If the ATBEG state is "constant" and the current train speed is higher than the guarded speed plus Vmarge, **or**
if the ATBEG state is "braking" and the current train speed becomes higher than the guarded speed plus Vlos and
the latest cøhange of the latest change to the ATBEG state "braking" is more than T_gong ago
then the STM ATB shall set the state of the "rembel" to "on"
else the STM ATB shall set the state of the "rembel" to "off"

STMA-2243 -

T_gong shall be 0,3s

T_gong is the minimum time between a "gong" and the start of the "rembel"

STMA-2241 -

If the state of the "rembel" changes to "on" then the STM ATB shall start the "rembel"

STMA-2242 -

if the state of the "rembel" changes to "off" then the STM ATB shall stop the "rembel"

GENERATING SOUNDS, GONG

STMA-2240 -

If the ATBEG state is "constant" or "braking" and the guarded speed changes then

The STM ATB shall trigger the acoustical signal "gong" (as defined in the DMI configuration table).

GENERATING SOUNDS, LOSBEL

STMA-2245 -

If the ATBEG state is "constant" and

the current train speed undershoots the guarded speed plus Vmarge while "DriverOperatesBrakes" is true then

The STM ATBEG shall trigger the acoustical signal "losbel" (as defined in the DMI configuration table).

note: once triggered the complete sound of the losbel (3 times 300ms bell) shall sound in the cabin.

STMA-2246 -

if the ATBEG state is "braking" and

the current train speed undershoots the guarded speed plus Vlos while "DriverOperatesBrakes" is true then
The STM ATBEG shall trigger the acoustical signal "losbel" (as defined in the DMI configuration table).
note: once triggered the complete sound of the losbel (3 times 300ms bell) shall sound in the cabin.

GENERATING SOUNDS, BD-SIGNAL

STMA-2850 -

If the ATBEG state changes to "no ATBEG area" while the train is not at standstill (> 1km/h)
The STM ATBEG shall trigger a BD signal (as defined in the DMI configuration table).
note: once triggered the complete sound of the BD signal (5 times gong) shall sound in the cabin.

GENERATING SOUNDS, ZOEMER (KWITEREN)

"Kwiteren" is a kind of vigilance function, which is only active in case the maximum speed is 40km/h (next signal may be at danger) and the speed is below 40km/h plus Vmargin (thus no brake commands to the driver). The driver is warned using a "zoemer". Requirements detailing the function are:

STMA-2307 - The state of the acousitical output "zoemer" is determined as follows
In case "Q_kwiteren" is enabled and during an uninterrupted time of 20s:
The ATBEG state is "constant" and the code has been no code and the "kwitereren button" has not been presssed
then the status of the "zoemer" shall be "on"
else the status of the "zoemer shall be "off"

STMA-2854 -

The STM ATB shall enable the user to set a parameter "Q_kwiteren" to switch the "kwiteren function" on and off
- Q_kwiteren = enabled: function kwiteren is active (on)
- Q_kwiteren = disabled: function kwiteren is not active (off)

STMA-2855 -

If the state of the "zoemer" changes to "on" then the STM ATB shall start the "zoemer"

STMA-2856 -

if the state of the "zoemer" changes to "off" then the STM ATB shall stop the "zoemer"

STMA-4884 -

The STM ATB shall not communicate the ATBVv information "distance to STS" nor "ATBVv state" to the ETCS on-board (as there's no other way to communicate to the driver).

7 ATBVv

The purpose of the ATBVv function is to guard the distance to a "signal at danger", and to initiate braking if the signal is overpassed otherwise.
As the ATBVv infrastructure is not fail safe, the ATBVv function is not seen as safety critical. A reliability and availability which is an order better compared to the ATBVv track side is sufficient. Below the ATBVv state machine and the functions per state are described.
The ATBVv infrastructure provides signals at 120m, 30m and 3m in rear of the signal at danger ("STS"). Further the ATBVv infrastructure can provide a "release signal" via a beacon or loop. The ATBVv on-board function has to calculate the current distance to the STS continuously based on the track side information and the train speed as received from the ETCS on-board, and compare this distance with the available braking distance.

7.1 Braking curve

The braking curve speed is the maximum speed from which the train will come to standstill within a distance D_STS (distance to STS), after initiating emergency braking, taking into account:
- the brake parameters (maximum deceleration, brake built up time, traction cut of time)
- the current train speed
- the brake operation by the driver (reducing the brake build-up time, depending on the time the brake is already operated)
- the actual acceleration (will remain during traction cut off)/actual deceleration
-D_STS

If the braking curve speed is exceeded can be determined by calculating the braking curve speed and compare it to the current train speed, or by determining the braking distance at the current train speed and check if this distance exceeds D_STS.

STMA-2285 - The braking curve speed shall be calculated as (with s=D_STS and V_max in km/h): (see equation below)

$$V\_max(s) = 3{,}6 * (-a * t_a + \sqrt{2 * s * a + a^2 * t_a^2})$$

note: It is also possible to calculate the necessary braking distance at the current train speed. That way a "sqrt" function is avoided.
V_max(s) is the maximum allowed speed as a function of the distance to the signal at danger
a: is the maximum deceleration of the train as derived from the braking percentage received from the ETCS on-board.
t_a: is the brake build up delay time as received from the ETCS on-board

STMA-3171 -
The ATBVv function shall use the braking percentage and brake type as received from the ETCS on-board for calculating the brake build up time (t_a) and the EB deceleration (a)

7.2 ATBVv states

The ATBVv distance monitoring shall only be active if the STM ATB state is "responsible". In all other cases the ATBVv function shall be inactive and reset to the initial status:

STMA-2287 -
If the STM ATB state is different from "responsible" then
ATBVv shall set the values of all the ATBVv outputs [6.x] to their default values
else
the outputs shall be determined according to the ATBVv functions

STMA-3188 -
see STMA-3246

STMA-2301 -
see STMA-3246

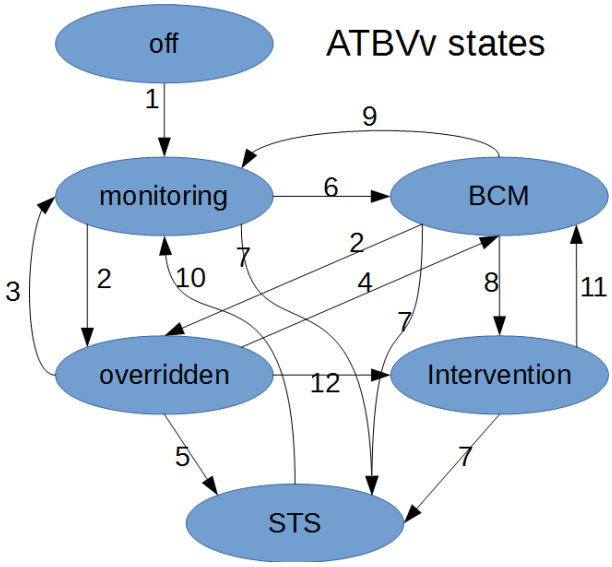
STMA-2288 - The ATBVv states are:

- off: the ATBVv is not active, the only way to leave this state is a change of the STM ATB state to responsible
- Monitoring**:** the ATBVv function doesn't have distance information and is ready to detect track side information
- BCM; the ATBVv function knows the distance to the nearest signal at danger (<120m) and is in "braking curve

monitoring"

- Overridden: the driver overruled (before or after receiving distance information) the monitoring of the distance to the signal at danger
- Intervention: The ATBVv function commanded the brake and the "signal at danger" is not (yet) passed.
- STS: The ATBVv function commanded the brake and the "signal at danger" is passed.

ATBVv state machine:



STMA-2873 - 1: **from off to monitoring**

if the STM ATB state changes to "responsible then

The STM ATB shall set the ATBVv state to "monitoring" and

the STM ATB shall reset all ATBVv state variables (including timers and decoding variables) to their default values

STMA-2874 - to off

if the STM ATB state changes from "responsible to another state or

if the system is "powered on" then

the STM ATB shall set the ATBVv state to "off"

STMA-2289 - 2: **from monitoring or BCM to overridden:**

if the train is at standstill (speed < 1km/h) and

the ATBVv state is "monitoring" or "BCM" and the ATBEG state is different from "intervention" and

the "STS button operated" is operated (input from ETCS) then

The STM ATB shall set the ATBVv state to "overridden"

STMA-2290 - 3:

Transition from overridden to monitoring:

if the input ATBVv code has the value 3m or

the distance run since the transition to the state "overridden" exceeds Soverridden or

the input STS button is operated (input from ETCS) while the calculated distance to the STS is infinite (i.e. no braking curve monitoring before going to override) then

The STM ATBEG shall set the ATBVv state to "monitoring"

STMA-3154 -

the maximum distance to drive in the state "overridden" (Soverridden) shall be configurable by the user

STMA-2291 - 4:

Transition from overridden to BCM:

if the input "STS button operated" is "on" and

the calculated distance to the STS is =<120m (i.e. braking curve monitoring before going to override) then

The STM ATBEG shall set the ATBVv state to "BCM" (from the state "overridden")

STMA-2292 - 5: Transition from overridden to STS:

If the state is "overridden" and

the value of the input ATBVv code is "release" from a beacon then

The STM ATBEG shall set the ATBVv state to "STS"

STMA-2293 - 6: Transition from monitoring to BCM:

The STM ATBEG shall set the ATBVv state to "BCM" (from the state "monitoring") if

the value of the input ATBVv code is 30m or 120m and

the value of the input ATBEG code is none or code75

STMA-2294 - 7A: Transition from monitoring, BCM or intervention to STS:

If the state is "monitoring", "BCM" or "intervention and

the value of the input ATBVv code is " 3m" and

the value of the input ATBEG code is none or code75 then

The STM ATBEG shall set the ATBVv state to "STS"

STMA-3150 - 7B: Transition from BCM to STS:

if

The current train speed is above the braking curve speed (see definition below) and

The current train speed is above the release speed (V_release) and

the distance to the STS is "0" or negative (STS is reached)

then

The STM ATBEG shall set the ATBVv state to "STS" (from the state "BCM")

STMA-2882 - 7C: Transition from BCM to STS:

if The distance to the STS is a lower value than D_release_min (as D_release_min is a negative value, this will be after passing the STS position) then

The STM ATBEG shall set the ATBVv state to "STS" (from the state "BCM")

STMA-2295 - 8: Transition from BCM to intervention:

if

The current train speed is above the braking curve speed (see definition below) and

the current train speed is above the release speed (V_release) and

the distance to the STS is positive (STS is not yet reached)

then

The STM ATBEG shall set the ATBVv state to "intervention" (from the state "BCM")

STMA-2296 - 9: Transition from BCM to Monitoring:

if the value of the input ATBVv code = release or

the value of the input ATBEG code = code96,….,code220 then

The STM ATBEG shall set the ATBVv state to "monitoring" (from the state BCM)

STMA-2297 - 10: Transition from STS to monitoring

If the state is STS and
If the input "release button" is operated (message from the ETCS on-board) and
the current train speed = 0 (<1km/h) then
The STM ATBEG shall set the ATBVv state to "monitoring"

STMA-2298 - 11: Transition from intervention to BCM

If the state is intervention and
If the input "release button" is operated (message from the ETCS on-board) and
the current train speed = 0 (<1km/h) then
The STM ATBEG shall set the ATBVv state to "BCM"

7.3 ATBVv functions

STMA-2300 - ATBVv shall set D_STS to infinite if the state changes to "monitoring"

STMA-2303 -

if the ATBVv state becomes "STS" from the state "overridden" (transitions 5) then
The STM ATB shall sent a text message "ingreep door onterrecht gebruik van de overrule functie" to the ETCS on-board for displaying at the DMI

8 JURIDICAL RECORDING

STMA-3190 -

If one of values of "STM-state", " STM ATB-state", "ATBEG code" (ATB output), ATBEG state, ATBVv state, an ATBVv frequency is detected (signal is received), the status "brakes operated" changes, an ATB button is operated, or the status of the EB command changes then
The STM ATB shall sent the following data time stamped to the Juridical recorder
- data & time (as received from the ETCS on-board with resolution seconds)
- STM-state
- STM ATB state
- ATBEG-state
- ATBVv-state
- D_STS
- guarded speed (ATBEG output)
- Brake operated: Yes/No (ATBEG input)
- Selected Cabin: A, B, none (input from ETCS on-board)
- Selected direction: forward, reverse, neutral or other (input from ETCS on-board)
- ATB button operation by the driver
- ATBVv signal received.
- current ATBEG code

9 ATBEG decoding

STMA-2833 -

If the selected driving direction is different from forward then
The ATBEG code shall be "nocode" (independent from the currents in the rails) and
after switching to forward all state variables in the decoding function shall be set to their default values.

Note: this will lead to "nocode" for at least the time needed to detect a code. this way simulating code by switching driving direction is prevented

STMA-2834 -

If the selected driving direction is forward then

The ATBEG code as present in the current through the rails underneath the front end of the train shall be used.

STMA-2264 -

if the ATBEG track signal complies with the characteristics given in STMA-2271, STMA-2272, STMA-2273, STMA-2275, STMA-2276, STMA-2277, STMA-2278 and STMA-2281 provided that the disturbances are less than specified in STMA-2279 en STMA-2280

then

The STM ATBEG shall determine the "ATBEG code" present in the track signal according to the definition in STMA-2274

STMA-2265 -

The STM ATBEG shall not accept a code unless:

The code is present in both rails

thus the code is found in the left and right coil signal

and

it is guaranteed that the code is not "simulated" by currents from other kinds or track circuits or currents as defined in STMA-2279 and STMA-2280, i.e.:

The source of the code is from an ATB coded track circuit in the section the train is currently in.

If that's case, then this can for example be recognised from

- the direction of current transmitting the code is opposite between the left and right rail current, thus
  - the code in the difference between the left and right coil signal is (significantly) bigger than the code in the sum of the left and right coil signal (code in parallel currents)
    and
- The phase of the modulation in the left and right coil signal is equal (or limited difference), and
- The difference in the code level between the left and right coil signal is limited (e.g. < a factor 2), and
- The duty cycle of the signal isn't exceptional (75Hz content could be caused by a pulse signal)

STMA-7263 - When proving that the code is not "simulated" the signal variations caused by antenna movements, EM-sources in the rolling stock, ATBEG currents floating through the wheels at the first axles, inaccuracies in the coil circuits, etc. as defined in [4.6] shall be taken into account.

STMA-2266 -

The sensitivity of the STM ATBEG for track currents with a base frequency outside the specified bandwidth (72-78Hz) compared to currents inside the band, shall decrease from 72Hz downwards with 96dB/oct. (till 50dB) and from 78Hz upwards with 120dB/oct. (till 50dB). (>48dB damping at 50Hz)

STMA-2267 -

The available time for decoding is not sufficient for a frequency resolution of +/- 3 pulses per minute (0,05Hz).
Therefore the STM ATBEG might accept a code with a code frequency outside the specified bandwidth, however to avoid undetected slow degradation of track side equipment:

The STM ATBEG shall not accept a code as valid at all code frequencies between two specified code frequencies (e.g. 75, 96, 120, 147, 180, 220 and 270 pulses/minute), There shall be a gap of at least 3 pulses/minute where no code is accepted, and

The STM ATBEG shall only accept a code if the code frequency of the track currents lies in the range between the two

adjacent gaps around the specified code frequency.

The number of occasions at which a code is available in the track (can be out of specification), but is not recognized and accepted ("geelvaller") by the STM ATBEG shall not exceed this number for the ATBEG systems currently in use, as far as those respond according to the above safety requirements.
(A test file containing > 1500 hours of test data including the response of a currently used system will be provided)

STMA-2269 -
The STM ATBEG shall not accept noCode within 1,4s after the ATBEG antenna passed the section border from where the track current contains no code (provided that there was code available before the border)

9.1 Track signal characteristics

STMA-2271 - 1.
The ATB code consist of an amplitude modulated 75Hz current through the rails in front of the first axle.
The current direction between left and right is opposite.

STMA-2272 - 2.
The carrier frequency is 75Hz +/- 3Hz.
The frequency can change instantaneously at any time, however with a constant phase.
note: changes in the base frequency could be used for improving the quality of the train detection function

STMA-2273 - 3.
The carrier (75Hz current) is modulated between a low and high signal level.
The modulation frequency (code frequency) represents the maximum speed to be guarded according to signal aspects.

STMA-2274 - 4.
The modulation frequencies are:
• 75 pulses/minute (code75)
• 96 pulses/minute(code96)
• 120 pulses/minute (code120)
• 147 pulses/minute (code147)
• 180 pulses/minute(code180)
• 220 pulses/minute(code220)
• 270 pulses/minute (code270)
all +/- 3 pulses/minute

STMA-2275 - 5.
The high level of the carrier signal is between 6,5A en 25A.
The low level of the carrier signal is below 3A.

STMA-2276 - 6.
The level of the carrier signal signal can differ up to 3,5A between the left and right rail.

STMA-2277 - 7.
To calculate the availability of the decoding the following possibilities for the duty cycles of the signal may be assumed:
- Between 40/60 en 60/40: 99%
- Between30/70 en 70/30: 99,9%
- Between20/80 en 80/20: 99,99%
Outside the range 20/80 en 80/20 the signal shall be rejected

note concerning duty cycles outside 20/80-80/20: to avoid accepting a signal consisting of transients (like from a PSSL = "prik spanning spoorstroomlopen" system).

STMA-2278 - 8.

The ATB infrastructure is divided in sections:

- Each ATB section is long enough to ensure in most cases the reception of at least 4 periods of the slowest ATB code in the section for a train driving at the maximum speed for that section

(if the distance is shorter measures to avoid disturbances might have been taken)

- In case the section is an "inschakelsectie" were the ATBEG state shall change from "no ATB area" to "monitoring", the length is enough for 10s at maximum speed for that section in case of code96 and 8s at maximum train speed in case of other codes.

- In case the section is an "uitschakelsectie" were the ATBEG state shall become "no ATB area", the length is enough for 12s at maximum speed for that section

At transitions from one section to the next one:

- it can take up to 1,4s until the ATB signal is "turned on" (i.e. the carrier signal is available or modulation starts)

-The phase of the carrier signal can change by 180 degrees

-The phase of the modulation can change by any angle

-Any change between different codes is possible

The phase of the modulation between different codes is random. Therefore at a code change the starting phase of the new modulation is random

Changes in code frequency can occur at the same time with other disturbances, e.g. at a transition to another section.

Code changes are possible at any moment.

STMA-2279 - 9.

ATB currents from other sections might float in the rails (parallel in both rails or just in one).

Those currents float via rolling stock and/or substations. The currents are below 3,5A. The currents can be coded.

STMA-2280 - 10.

The rails are also used for traction return currents. These currents float through both rails in parallel or just in one rail.

The traction return currents can contain the following components:

• ADC component up to 4000A.

• A 50Hz component up to 250A

• Harmonics of the motor frequencies (up to 3A)

• Switching frequencies of choppers, amongst others: 66,67Hz, 100Hz, 300Hz, ca. 315Hz, 400Hz en 450Hz. The maximum value of those currents is 5A.

• Wide band disturbances from inverter driven traction equipment. In the frequency range from 68 to 82Hz this current can be 2A per train.

Harmonics of the power supply

• 50 and 100 Hz in case of asymetric rectifiers

• 300Hz in case of 6 pulse rectifiers (including semi 12 pulse)

• 600Hz in case of 12 pulse rectifiers (including semi 24 pulse)

STMA-2281 - 11.

The smallest curves are (radius): 350m

STMA-2657 -

The ATBEG decoding may not be disturbed by the ATBVv signals:

1145Hz.+/– 0,2Hz with a minimum field of 4,75 Am/m +/–10% (thus minimum app. 4,25Am/m) and

1445Hz, 1744,5Hz, 2353Hz en 2670,5Hz +/– 0,2% 15,75 Am/m +/–10% (thus minimum app. 15,2 Am/m).

10 ATBVv decoding

STMA-3243 -

The ATBVv function shall set D_STS to the distance according to the ATBVv signal frequency as detected above the right rail in front of the train (with a level above the level specified in STMA-3223 and a minimum time specified in STMA-3224):
if the signal is within the frequency band 1744,5Hz (+/- 0,2%) the ATBVv signal shall be "beacon 3"
if the signal is within the frequency band 2353Hz (+/- 0,2%) the ATBVv signal shall be "beacon 2"
if the signal is within the frequency band 2670,5Hz (+/- 0,2%) the ATBVv signal shall be "beacon 1"
if the signal is within the frequency band 1445Hz (+/- 0,2%) the ATBVv signal shall be "release"
if the signal is within the frequency band 1145Hz (+/- 0,2%) the ATBVv signal shall be "release"
else, or if more than one (other than the combination of 1445Hz and 1145Hz) the ATBVv signal shall be "none"

STMA-4885 -

he ATBVv decoder shall not to be influenced by EM-fields from other sources (than ATBVv) in the infrastructure or rolling stock

STMA-3223 -

ATBVv signal levels (taking into account 40% damping at the edges of the beacon and >50% margin to be sure of detection):

- 1145Hz: 1A/m
- 1445Hz, 1744,5Hz, 2353Hz en 2670,5Hz: 4A/m

STMA-3228 -

ATBVv signals from the left rail shall be ignored, levels to be taken into account (including 30% margin):
- 1145Hz: 8A/m
- 1445Hz, 1744,5Hz, 2353Hz en 2670,5Hz: 25A/m

STMA-3224 -

Minimum time an ATBVv beacon signal (1445Hz, 1744,5Hz, 2353Hz en 2670,5Hz) is available (taking into account a speed of 70km/h): 38ms

Minimum time an ATBVv loop signal shall be available: 100ms

11 INSTALLATION & MAINTENANCE

To ease the replacement of existing (stand alone) ATB on-board equipment the STM ATB shall be able to interface with the existing peripherals and no configuration shall be needed

STMA-5083 -

The STM ATB shall not need any rolling stock depending configuration at installation, i.e. all rolling stock dependent parameters shall be read from the rolling stock (and/or ETCS on-board), and no calibration of the coil signals shall be needed. Configuration independent from the rolling stock type, like switching on/off kwiteren or BD, is allowed.

STMA-5086 -

The STM ATB shall be able to operate with all existing ATB coils without configuration of the system. (on-board adaptations, e.g. concerning the impedance of the coil circuits is allowed)

STMA-5087 -

The STM ATB shall be able to operate with all existing sound generators.

STMA-6782 -

The STM ATB shall be compatible with the commonly used supply voltages: 24Vdc, 72Vdc and 110Vdc nominal. I.e. the STM ATB shall be able to operate those supply voltages as specified according to SID-803, without configuration or variants.

STMA-2643 -

The STM ATBEG shall not require maintenance other than repairs/replacements.

STMA-2644 -

All equipment necessary detection of failures in the STM ATB shall be provided, including the design of this equipment.
Note: the user/customer shall be enabled to purchase maintenance equipment independent from the ATB supplier

STMA-2645 - The STM ATB shall report deviations (from the specification) of the track side ATBEG signal to the driver. The criteria shall be agreed with the customer

12 MECHANICAL

STMA-7013 - The size of the STM ATB enclosure (for 19" mounting) shall not exceed (WxHxD): 20TE x 3HE x 20cm

STMA-7014 - The weight of the STM ATB shall not exceed 2kg.

STMA-7015 - The power consumption of the STM ATB shall not exceed 20W.

STMA-7016 - All connectors shall be front mounted

STMA-7017 - For the profibus connection two sub-D9 connectors shall be used

STMA-7018 - The left and right coil signal related to the same cabin shall be connected using different, not exchangeable, connectors (e.g. two sub_D15 connectors, one male, one female, for two coil signals plus the brake pipe pressure each).

STMA-7019 - The power supply and digital I/O shall be connected using a connector with sufficient mutual isolation (e.g. 48pin DIN41612, male as power is provided via this connector)

STMA-7020 - Interfaces using to upload software, parameters (not rolling stock dependent), etc. shall not be reachable while the STM ATB is installed.

STMA-7021 - The STM ATB shall have LED indicators at the front to communicate fail states

13 RELIABILITY AND SAFETY

STMA-2258 - The STM ATBEG failure rate concerning failures preventing the sending of an EB command (in case it is required according to the current specification) to the ETCS on-board (up to reception of the message) for maximum 3s or preventing disconnection from the Profibus for maximum 1,5s
shall be < 2*10^-6/hour

STMA-2259 - The STM ATBEG failure rate concerning failures preventing the sending of an EB command (in case it is required according to the current specification) to the ETCS on-board (up to reception of the message)) for more than 3s and preventing disconnection from the Profibus more than 1,5s
shall be < 2*10^-8/hour

STMA-2260 - The STM ATBEG failure rate concerning failures leading to unsafely false information at the DMI shall be < 1*10^-5/hour

STMA-2261 - The STM ATBEG failure rate concerning failures leading to a disturbance < 10 minutes shall be < 1*10^-5/hour, e.g.:

- unnecessary interventions
- (automatic) restarts of the system

STMA-2262 - The STM ATBEG failure rate concerning failures preventing to continue ATBEG operation shall be < 0,5*10^-5/hour, e.g.:
- hardware defects
- fault detection, leading to switching off the system

STMA-3300 -
The STM ATB shall not disturbe communication between other (different from the STM ATB node) nodes at the Profibus more often than 1,2*10^-6/operational hour