

<document classification>

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# openETCS / UNISIG Subset-026-3.6

## Calculate Train Position

*Calculate the balise group locations and the actual train position*

Summary:  
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# 1. Calculate Train Position Implementation

This model serves to determine the train location information as specified in Subset026-3.6 "Location principles, train position and train orientation".

## 1.1.1. calculateTrainPosition Operator

Declared as **public node**

### 1.1.1.1. Comments and Information

calculateTrainPosition Comments:

- The main function calculating the locations of balise groups and the actual train position.

### 1.1.1.2. Interface

Table 1: Inputs of calculateTrainPosition

Name	Type	Properties	Comments and Information
currentOdometry	Obu_BasicTypes_Pkg::odometry_T		Comments: The current odometry values
passedBG	BG_Types_Pkg::passedBG_T		Comments: Input event reporting a balise group during its passage, if there is one.
reset	bool		Comments: Resets all to an initials state and deletes all stored BGs.
trainProperties	TrainPosition_Types_Pkg::trainProperties_T	hidden	Comments: The trains properties required for train position calculation.

Table 2: Outputs of calculateTrainPosition

Name	Type	Comments and Information
trainPosition	TrainPosition_Types_Pkg::trainPosition_T	Comments: The resulting train position with reference to the LRBG
BGs	TrainPosition_Types_Pkg::positionedBGs_T	Comments: The collection of currently known BGs.
errors	TrainPosition_Types_Pkg::positionErrors_T	Comments: Errors and inconsistencies detected by the calculation.

#### 1.1.1.3. Graphical and Textual Diagrams

#### 1.1.1.3.1. View of diagram\_calculateTrainPosition (calculateTrainPosition)

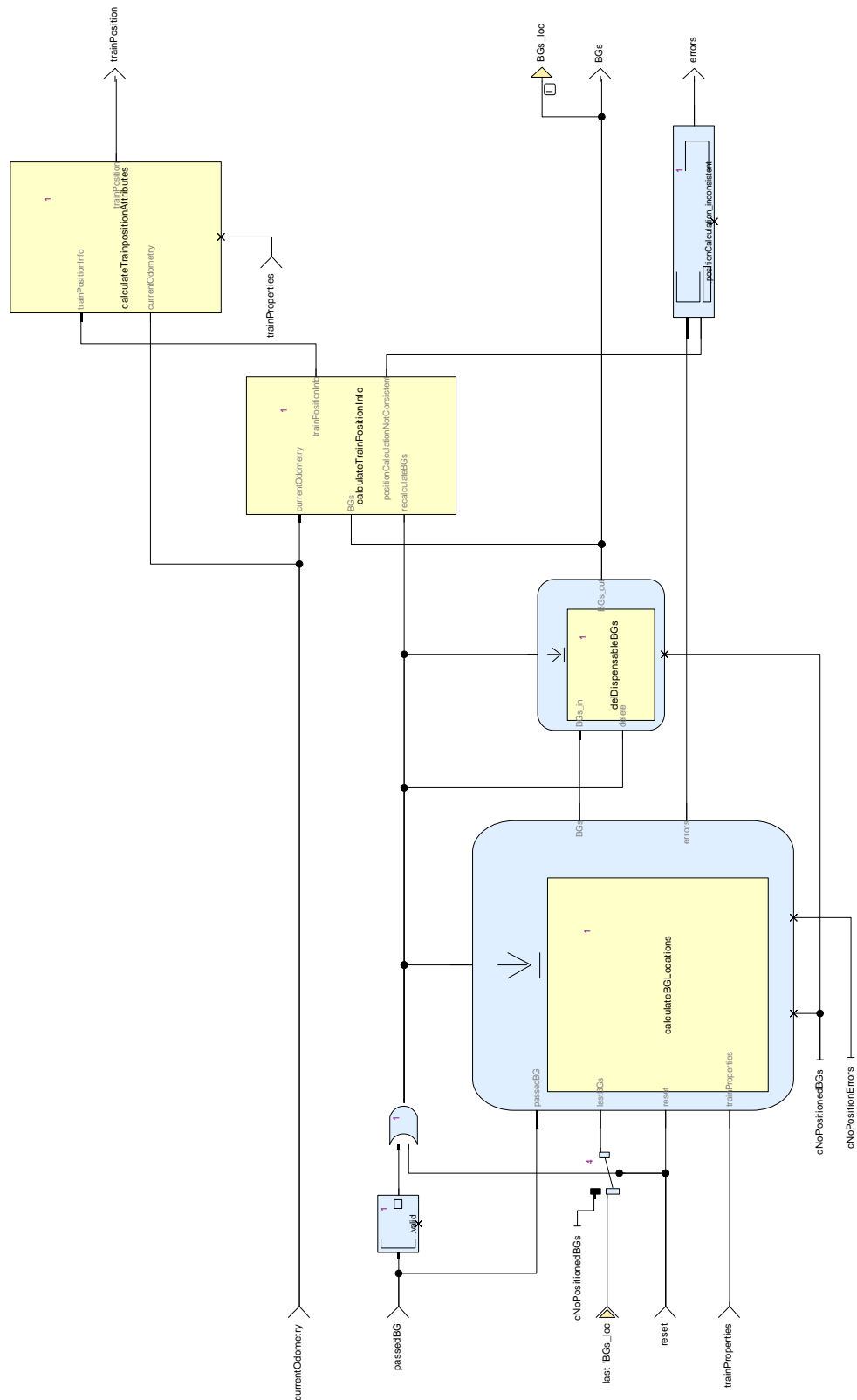


Figure 1: View of diagram\_calculateTrainPosition (calculateTrainPosition)

## 2. Project Library: Obu\_BasicTypes

### 2.1. Obu\_BasicTypes\_Pkg Package

#### 2.1.1. Comments and Information

Obu\_BasicTypes\_Pkg Comments:

- Standardized basic type definitions to be used within all internal OBU functions

#### 2.1.2. Types

Table 3: Public Types of Obu\_BasicTypes\_Pkg

Name	Definition	Comments and Information
A_internal_Type	int	Comments: Standardized acceleration type for all internal calculations: in 0.01 m/s <sup>2</sup>
G_internal_Type	int	Comments: Standardized gradient type for all internal gradient calculations: in per 0.1 mill
L_internal_Type	int	Comments: Standardized length type for all internal length, distance and location calculations: in cm
Location_T	Obu_BasicTypes_Pkg::L_internal_Type	Comments: Generic for all length, distance and location calculation: in cm
LocWithInAcc_T	{ nominal : Obu_BasicTypes_Pkg::L_internal_Type, d_min : Obu_BasicTypes_Pkg::L_internal_Type, d_max : Obu_BasicTypes_Pkg::L_internal_Type }	Comments: Location with +/- tolerance nominal Comments: Nominal location d_min Comments: Min Location = nominal + d_min (typically < 0) d_max Comments: Max Location = nominal + d_max
odometry_T	{ valid : bool, timestamp : Obu_BasicTypes_Pkg::T_internal_Type, odo : Obu_BasicTypes_Pkg::OdometryLocations_T, speed : Obu_BasicTypes_Pkg::Speed_T, acceleration : Obu_BasicTypes_Pkg::A_internal_Type, motionState : Obu_BasicTypes_Pkg::odoMotionState_T, motionDirection : Obu_BasicTypes_Pkg::odoMotionDirection_T }	Comments: Odometry values with time stamp timestamp Comments: time of the odometry stamp [ms] odo Comments: Odometry values speed Comments: speed given by the sensors of the odometer [km/h] acceleration Comments: acceleration provided by the odometer [0.01m/s <sup>2</sup> ] motionState Comments: "Train is in Motion" State motionDirection Comments: "Direction the train is moving"

Name	Definition	Comments and Information
OdometryLocations_T	{ o_nominal : Obu_BasicTypes_Pkg::L_internal_Type, o_min : Obu_BasicTypes_Pkg::L_internal_Type, o_max : Obu_BasicTypes_Pkg::L_internal_Type }	Comments: Location information provided by odometry o_nominal Comments: Nominal odometry value o_min Comments: Min. distance = o_min2 - o_min1 o_max Comments: Max distance = o_max2 - o_max1
odoMotionDirection_T	enum { unknownDirection, cabAFirst, cabBFirst }	Comments: Indicates the direction the train is moving. Based on the sensors of the Odometer.
odoMotionState_T	enum { noMotion, Motion }	Comments: Indicates whether from a Train point of View the train is in motion. Based on the sensors of the Odometer.
Speed_T	Obu_BasicTypes_Pkg::V_internal_Type	Comments: General speed type: in km/h.
T_internal_Type	int	Comments: Standardized system time type used for all internal time calculations: in ms
V_internal_Type	int	Comments: Standardized speed type used for all internal speed calculations: in km/h

## 3. Project Library: TrainPosition\_Types

### 3.1. TrainPosition\_Types\_Pck Package

#### 3.1.1. Comments and Information

TrainPosition\_Types\_Pck Comments:

- This library provides the data type definitions used in train position calculations

#### 3.1.2. Types

Table 4: Public Types of TrainPosition\_Types\_Pck

Name	Definition	Comments and Information
infoFromLinking_T	{ valid : bool, nid_bg_fromLinkingBG : NID_BG, nid_c_fromLinkingBG : NID_C, expectedLocation : Obu_BasicTypes_Pkg::LocWithInAcc_T, d_link : Obu_BasicTypes_Pkg::LocWithInAcc_T, linkingInfo : BG_Types_Pkg::LinkedBG_T }	Comments: Describes a linked BG as announced from the linking BG. Mainly, this information is taken from the linking packet. nid_bg_fromLinkingBG Comments: ID of the BG, where the linking information originates from expectedLocation Comments: Location, where the BG is expected to be found, calculated from announced linking distance. d_link Comments: Linking distance with inaccuracies, converted from Q_SCALE, D_LINK, Q_LOCACC of the linking packet. linkingInfo Comments: Linking info as announced from the linking BG, where this BG.
linkedBGs_asPositionedBGs_T	TrainPosition_Types_Pck::positionedBG_T ^BG_Types_Pkg::cMaxNoOfLinkedBGs	Comments: Array of linked balises groups in the format of positioned BGs
positionedBG_T	{ valid : bool, nid_c : NID_C, nid_bg : NID_BG, q_link : Q_LINK, location : Obu_BasicTypes_Pkg::LocWithInAcc_T, seqNoOnTrack : int, infoFromLinking : TrainPosition_Types_Pck::infoFromLinking_T, infoFromPassing : BG_Types_Pkg::passedBG_T }	location Comments: The best known location calculated from linking and from passing information seqNoOnTrack Comments: Sequence number: specifies the order of the BG passed or expected to be passed infoFromLinking Comments: If linked, this is the BG info as announced from a linked BG. Most of the data is taken from the linking information. infoFromPassing Comments: If the balise group was passed, this is the relevant information received from the BG.
positionedBGs_T	TrainPosition_Types_Pck::positionedBG_T ^cMaxNoOfStoredBGs	Comments: All balise groups stored for train position calculation

Name	Definition	Comments and Information
positionErrors_T	{ outOfMemSpace : bool, passedBG_notFoundWhereExpected : bool, positionCalculation_inconsistent : bool, BG_LinkingConsistencyError : bool, DoubleLinkingError : bool, DoubleRepositioningError : bool }	<p>outOfMemSpace Comments: Memory overrun: a passed or announced BG could not be stored</p> <p>passedBG_notFoundWhereEx pected Comments: The currently passed linked BG location does not match the expected location</p> <p>positionCalculation_inconsist ent Comments: A consistency problem arised during position calculation</p> <p>BG_LinkingConsistencyError Comments: Balise group: linking consistency error (ref. 3.16.2.3)</p> <p>DoubleLinkingError Comments: Double linking error (3.16.2.7.1)</p> <p>DoubleRepositioningError Comments: Double repositioning error (3.16.2.7.2)</p>



Name	Definition	Comments and Information
trainPosition_T	<pre> {valid : bool, timestamp : Obu_BasicTypes_Pkg::T_internal_Type, trainPositionIsUnknown : bool, noCoordinateSystemHasBeenAssigned : bool, trainPosition : Obu_BasicTypes_Pkg::LocWithInAcc_T, estimatedFrontEndPosition : Obu_BasicTypes_Pkg::Location_T, minSafeFrontEndPosition : Obu_BasicTypes_Pkg::Location_T, maxSafeFrontEndPosition : Obu_BasicTypes_Pkg::Location_T, LRBG : TrainPosition_Types_Pck::positionedBG_T, prvLRBG : TrainPosition_Types_Pck::positionedBG_T, nominalOrReverseToLRBG : Q_DLRBG, trainOrientationToLRBG : Q_DIRLRBG, trainRunningDirectionToLRBG : Q_DIRTRAIN, linkingIsUsedOnboard : bool} </pre>	<p>Comments:</p> <p>3.6.1.3 trainPositionIsUnknown</p> <p>Comments:</p> <p>3.6.3.1.3.1 noCoordinateSystemHasBeenAssigned</p> <p>Comments:</p> <p>3.4.2, 3.6.3.1.4: Every balise group has its own co-ordinate system</p> <p>trainPosition Comments:</p> <p>The calculated train position with inaccuracies.#</p> <p>estimatedFrontEndPosition</p> <p>Comments:</p> <p>3.6.4.4 a): Absolute train front end position since system start</p> <p>minSafeFrontEndPosition</p> <p>Comments:</p> <p>3.6.4.4 c) :Minimum safe front end position</p> <p>maxSafeFrontEndPosition</p> <p>Comments:</p> <p>3.6.4.4.b) : Maximum safe front end position</p> <p>LRBG Comments:</p> <p>LRBG = last passed linked balise group</p> <p>prvLRBG Comments:</p> <p>BG passed previously to LRBG</p> <p>nominalOrReverseToLRBG</p> <p>Comments:</p> <p>7.5.1.106: Q_DLRBG: Qualifier telling on which side of the LRBG the estimated front end is</p> <p>trainOrientationToLRBG</p> <p>Comments:</p> <p>3.6.1.3: Orientation of the train in relation to the direction of the LRBG</p> <p>trainRunningDirectionToLRBG</p> <p>Comments:</p> <p>3.6.1.3: Direction of train movement in relation to the LRBG orientation</p> <p>linkingIsUsedOnboard</p> <p>Comments:</p> <p>Designates, if at least one announced linked BG is ahead</p>

Name	Definition	Comments and Information
trainProperties_T	<pre>{nid_engine : NID_ENGINE, nid_operational : NID_OPERATIONAL, l_train : L_TRAIN, d_baliseAntenna_2_frontend : Obu_BasicTypes_Pkg::LocWithInAcc_ T, d_frontend_2_rearend : Obu_BasicTypes_Pkg::LocWithInAcc_ T, locationAccuracy_DefaultValue : Obu_BasicTypes_Pkg::LocWithInAcc_ T, centerDetectionAcc_DefaultValue : Obu_BasicTypes_Pkg::LocWithInAcc_ T}</pre>	<p>Comments: Static train properties necessary for train position calculation.</p> <p>nid_engine Comments: 7.5.1.88, Onboard ETCS identity.</p> <p>nid_operational Comments: 7.5.1.92, Train Running Number</p> <p>l_train Comments: 7.5.1.56, train length</p> <p>d_baliseAntenna_2_frontend Comments: Distance from the trains balise antenna to the trains front end.</p> <p>d_frontend_2_rearend Comments: Distance from the trains front end to rear end</p> <p>locationAccuracy_DefaultValue Comments: 3.6.4.3.2 centerDetectionAcc_DefaultValue Comments: Will be applied, if centerDetectionInaccuracy from BTM is not available, especially for announced and not yet passed BGs</p>

## 4. Project Library: BG\_Types

### 4.1. BG\_Types\_Pkg Package

#### 4.1.1. Types

Table 5: Public Types of BG\_Types\_Pkg

Name	Definition	Comments and Information
AdditionalInformation_T	{linkingPackets : BG_Types_Pkg::LinkedBGs_T}	Comments: Packets received from balises
BG_Header_T	{q_updown : Q_UPDOWN, m_version : M_VERSION, q_media : Q_MEDIA, n_total : N_TOTAL, m_mcount : M_MCOUNT, nid_c : NID_C, nid_bg : NID_BG, q_link : Q_LINK}	Comments: Common header of the balise group datagram
BG_Message_T	{present : bool, Telegrams : BG_Types_Pkg::TelegramArray_T, numberBalises : int, centerOfBalisePosition : BG_Types_Pkg::centerOfBalisePosition_T}	present Comments: indicates whether the bg-message present is. Telegrams Comments: headers of all received telegrams filled up from the start of the array numberBalises Comments: additional packets received with the balises centerOfBalisePosition Comments: position of the balise group as given by the Odometer
BG_Orientation_T	enum {BG_Orientation_Reverse, BG_Orientation_Nominal, BG_Orientation_Unknown}	Comments: gives the orientation of a balise group
centerOfBalisePosition_T	{odometerOfBaliseDetection : Obu_BasicTypes_Pkg::odometry_T, BG_centerDetectionInaccuracies : Obu_BasicTypes_Pkg::LocWithInAcc_T}	Comments: Gives the information for location and accuracy of measurements odometerOfBaliseDetection Comments: Location BG_centerDetectionInaccuracies Comments: Location inaccuracies caused by the balise group center detection

Name	Definition	Comments and Information
LinkedBG_T	{ valid : bool, nid_LRBG : NID_LRBG, q_dir : Q_DIR, q_scale : Q_SCALE, d_link : D_LINK, q_newcountry : Q_NEWCOUNTRY, nid_c : NID_C, nid_bg : NID_BG, q_linkorientation : Q_LINKORIENTATION, q_linkreaction : Q_LINKREACTION, q_locacc : Q_LOCACC }	<p>Comments:</p> <p>7.4.2.2: Single, but complete, element from LinkingPacket_Type</p> <p>valid Comments:</p> <p>This element has valid data</p> <p>nid_LRBG Comments:</p> <p>8.4.4.6.1: ID of the reference LRBG (refers to radio message)</p> <p>q_dir Comments:</p> <p>Validity direction of transmitted data with reference to directionality of the balise group sending the information or to directionality of the LRBG</p> <p>q_scale Comments:</p> <p>7.5.1.129: Qualifier for the distance scale: 10 cm, 1 m, 10 m</p> <p>d_link Comments:</p> <p>7.5.1.10: Incremental linking distance to next linked balise group</p> <p>q_newcountry Comments:</p> <p>7.5.1.121: New Country Qualifier</p> <p>nid_c Comments:</p> <p>7.5.1.86: Identity number of the country or region</p> <p>nid_bg Comments:</p> <p>7.5.1.85: Identity number of the balise group</p> <p>Identity number of a balise group or loop within the country or region defined by NID_C</p> <p>q_linkorientation Comments:</p> <p>7.5.1.116: Qualifier for the direction of the linked balise group: Indicates whether the linked balise group will be overpassed by the train in nominal or reverse direction.</p> <p>q_linkreaction Comments:</p> <p>7.5.1.117: Qualifier for the reaction to be performed if a linking or a balise group message consistency problem occurs with the balise group linked to</p> <p>q_locacc Comments:</p> <p>7.5.1.115: defines the absolute value of the accuracy of the Balise location (max +/- 63 m)</p>
LinkedBGs_T	BG_Types_Pkg::LinkedBG_T ^cMaxNoOfLinkedBGs	<p>Comments:</p> <p>Array of linked balise groups. This array replaces the linking packet (TrackToTrain::Linking )</p>

Name	Definition	Comments and Information
passedBG_T	<pre> { valid : bool, bgPosition : Obu_BasicTypes_Pkg::odometry_T, BG_centerDetectionInaccuracies : Obu_BasicTypes_Pkg::LocWithInAcc_ T, q_nvlocacc : Q_NVLOCACC, BG_Header : BG_Types_Pkg::BG_Header_T, linkedBGs : BG_Types_Pkg::LinkedBGs_T, noCoordinateSystemHasBeenAssigned : bool, trainOrientationToBG : Q_DIRLRBG, trainRunningDirectionToBG : Q_DIRTRAIN} </pre>	<p>Comments:</p> <p>Information received from a BG passed</p> <p>BG_centerDetectionInaccuracies Comments:</p> <p>Location inaccuracies caused by the balise group center detection</p> <p>q_nvlocacc Comments:</p> <p>3.6.4.3.2: Default accuracy of the balise location, specific to each balise and taken from the national values</p> <p>BG_Header Comments:</p> <p>Common header of the balise group datagram</p> <p>linkedBGs Comments:</p> <p>The linked balise groups announced from this BG.</p> <p>noCoordinateSystemHasBeenAssigned Comments:</p> <p>3.4.2, 3.6.3.1.4: Every balise group has its own co-ordinate system</p> <p>trainOrientationToBG</p> <p>Comments:</p> <p>3.6.1.3: Orientation of the train in relation to the direction of the BG</p> <p>trainRunningDirectionToBG</p> <p>Comments:</p> <p>3.6.1.3: Direction of train movement in relation to the BG orientation</p>