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Contents

Foreword

This document has been prepared by Technical Committee 225 CEN/TC225 AIDC Technologies.

Introduction

The aim of this standard is to describe the implementation of the European Vehicle Number (EVN) of the railway rolling stock in an electronic format via the ISO/IEC 18000-63 UHF Radio Frequency Identification (RFID) technology in order to enable a consistent approach for an interoperable implementation.

Furthermore, the authors of this standard recognise that there exists today rolling stock which uses other numbering schemes than the EVN, for example in the Baltic states. Some of these cases are addressed in this standard for informative purposes.

1 Scope

The RFID tag location, tag data content and functional requirements have been developed for application on the main line railway networks. Other networks (such as metro) may apply this standard but are outside of its scope.

This document contains:

-Description of the RFID tag installation location

-Description of the RFID tag data content

-Description of the functional requirements in relation to the RFID tag track side reading performance

2 Normative references

The following documents, in whole or in part, are normatively referred to in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ANS MH 10.8.2, Data Identifier and Application Identifier Standard

ISO/IEC 15418, Information technology — Automatic identification and data capture techniques — GS1 Application Identifiers and ASC MH10 Data Identifiers and maintenance

ISO/IEC 15459-4, Information technology — Unique identifiers — Part 4: Individual items

ISO/IEC 15962, Information technology — Radio frequency identification (RFID) for item management — Data protocol: data encoding rules and logical memory functions

ISO/IEC 18000-63, Information technology — Radio frequency identification for item management — Part 63: Parameters for air interface communications at 860 MHz to 960 MHz Type CISO/IEC 18004,

Information technology — Automatic identification and data capture techniques — QR Code 2005 bar code symbology specification

GS1 EPC Tag Data Standard

GS1 General Specifications

ISO/IEC 19762, Information technology — Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary

EN 13775:2003 – part 1, Railway applications. Measuring of new and modified freight wagons. Measuring principles

EN 50121:2015 – part 4 - Railway applications - Electromagnetic compatibility: Emission and immunity of the signalling and telecommunications apparatus

Railway applications - Electromagnetic compatibility - Part 4: Emission and immunity of the signalling and telecommunications apparatus

EN 50125-3:2003, Railway applications. Environmental conditions for equipment. Equipment for signalling and telecommunications

EN 302-208, Radio Frequency Identification Equipment operating in the band 865 MHz to 868 MHz with power levels up to 2 W and in the band 915 MHz to 921 MHz with power levels up to 4 W; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 19762 and the following apply.

vehicle means a railway vehicle suitable for circulation on wheels on railway lines, with or without traction; a vehicle is composed of one or more structural and functional subsystems. Furthermore, a vehicle carries its own EVN;

unit is the generic term used to name the rolling stock which is subject to the application of this standard. A unit may be composed of several vehicles;

train is an operational formation consisting of one or more units;

fixed formation is a train formation that can only be reconfigured within a workshop environment;

trainset is a fixed formation that can operate as a train; it is by definition not intended to be reconfigured, except within a workshop environment. It is composed of only motored or of motored and non-motored vehicles;

network means the lines, stations, terminals, and all kinds of fixed equipment needed to ensure safe and continuous operation of the Union rail system;

keeper means the natural or legal person that, being the owner of a vehicle or having the right to use it, exploits the vehicle as a means of transport and is registered as such in a vehicle register referred to in Article 47 of the Directive (EU) 2016/797;

entity in charge of maintenance (ECM) means an entity in charge of maintenance as defined in point (20) of Article 3 of Directive (EU) 2016/798;

infrastructure manager means a rail infrastructure manager as defined in point (2) of Article 3 of Directive 2012/34/EU of the European Parliament and of the Council;

railway undertaking means a railway undertaking as defined in point (1) of Article 3 of Directive 2012/34/EU, and any other public or private undertaking, the activity of which is to provide transport of goods and/or passengers by rail on the basis that the undertaking is to ensure traction; this also includes undertakings which provide traction only;

vehicle end means any longitudinal position between the centre of the vehicle and the end of the vehicle;

vehicle side means, any horizontal position between the centre of the vehicle and the side of the vehicle.

running gear means wheelsets, bogies and associated suspension components;

articulated vehicle with a shared running gear means a system of articulation where each vehicle has its own secondary suspension but shares the running gear with an adjacent vehicle (often referred to as Jacobs bogie). Typically, each car body is supported at 4 points. Trains made up of vehicles of this type are a particular type of fixed formation train;

European vehicle number (EVN) means the unique 12-digit vehicle identification number, which is assigned to each rail vehicle on the European Community Rail Network according to Article 32 of EU Directive 2008/57 EC.

8-digit Russian vehicle number means the unique 8-digit vehicle identification number, which is assigned to each rail vehicle on the Rail Network of the Commonwealth of Independent States (CIS) according to *[The Permanent Working Group for the Railway Administrative Offices Information Exchange at the Railway Transport IT Specialists Committee & The Directorate for the Railway Transport Council of the Member States of the Commonwealth of Independent States (CIS): S ZhA 8001 16, Minutes of 2016 – Reference Guide 8-Digit Numbering System for 1,520 mm Track Gauge for Passenger Railway Vehicles. 2016]* and *[The Railway Transport IT Specialists Committee: -Minutes No. 32 dated 29th April 2005 – Reference Guide 8-Digit Numbering System for 1,520 mm Track Gauge for Freight Railway Vehicles. 2005].*

4 Symbols and abbreviations

For the purposes of the present document, the following abbreviations apply:

AC	Alternating Current
AFI	Application Family Identifier
ASC	Accredited Standards Committee
CSM	Common Safety Method
ECM	Entity in Charge of Maintenance

EMC	Electro Magnetic Compatibility
EPC	Electronic Product Code
EUAR	European Union Agency for Railways
ECVVR	European Centralised Virtual Vehicle Register
EVN	European Vehicle Number
GIAI	Global Individual Asset Identifier
MH10	Material Handling committee 10
NVR	National Vehicle Register
RFID	Radio Frequency Identification
TSI	Technical Specification for Interoperability
UHF	Ultra High Frequency
UII	Unique Item Identifier

5 Concept

The concept is to identify rolling stock automatically based on UHF RFID tags. The main focus of this standard is to clarify applications using fixed track side readers.

Each RFID tag contains a globally unique asset reference encoded according to the chapter 7.

This standard aims to achieve global uniqueness and interoperability.

RFID tag content used in rolling stock identification shall not overlap with any other globally unique identifier coded into RFID tags.

6 RFID tag location

6.1 General

Each vehicle shall be tagged with two UHF-RFID-tags according to ISO/IEC 18000-63.

While all other encoded information on the two tags per vehicle is 100% identical, the content of the two tags differ only by an encoded end/side information. On one tag per vehicle the encoded end/side information is "1", on the other one the encoded end/side information is "2". For further details see chapter 7.

The RFID tag location is to be implemented as in the chapters 6.2 and 6.3. If this is not possible, the implementation should be done into a location closest to the area fulfilling the functional requirements set in this standard.

The physical interactions between the reader and the tag, the protocols and the commands, and the collision arbitration schemes, shall conform to ISO/IEC 18000-63.

Chapter 6.4 explains how to use/relate the end/side information on the tag in order to create a correlation between them and the already existing physical agreed end/side markings of the vehicle.

6.2 Height of the tag in relation to the railhead

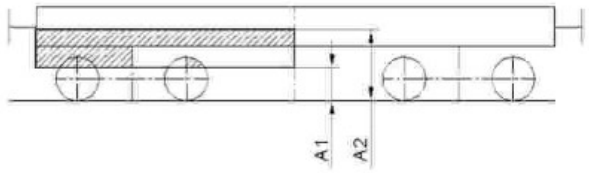

Figure 1: Allowed range of vertical tag positions

In Figure 1 above, A1 and A2 are respectively the minimum and maximum height above rail for positioning the centres of the tags in all conditions of wagon loading and suspension movement[1]:

A1 = 500 mm

A2 = 1300 mm for vehicles with maximum speed > 100 km/h, 1800 mm for vehicles with maximum speed <= 100km/h.

If the installation is done outside the range A1 - A2, the trackside reading performance as in the paragraph 8.2 Tag performance requirements cannot be guaranteed.

[1] Informative note: When planning reader installations, it is recommended to take in account that there might be existing vehicle implementations outside this range

6.3 Horizontal tag location

Regarding the horizontal range of allowed tag positions for vehicle ends which **can** be leading on the main line, the tag has to be installed in relation to the horizontal axis in the area B1 in Figure 2.

For vehicles without bogies (for example two axle wagons) which could be the leading vehicle on the mainline, the RFID tag has to be installed at least 0.6 meters behind the first axle towards the centre of the vehicle.[2]

The horizontal range of allowed tag positions for vehicle ends which **cannot** be leading on the main line, is limited from the left vehicle end to the vehicle centre axis (see area B2 in Figure 2).

Remark:

The limitation of horizontal tag positions for vehicle ends which can be leading on the main line is meant to allow reader layouts with one reader and one axle counter for tracks with alternating direction of traffic (see Annex B).

[2] When planning reader installations, please take in account that there might be older vehicle implementations outside this range

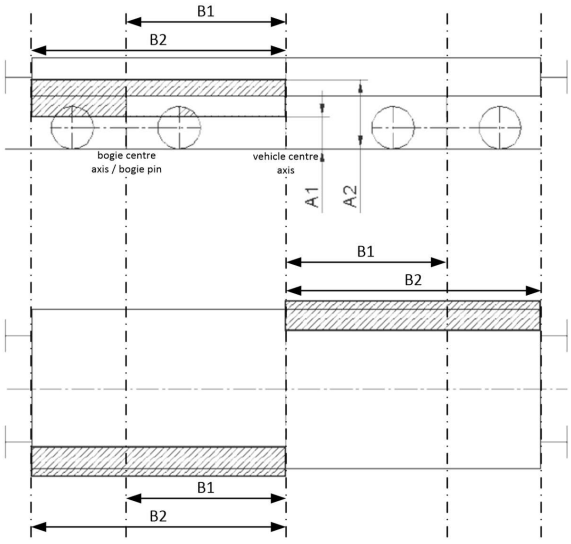

Figure 2: Allowed range of vertical tag positions

6.4 Defining the orientation of the vehicle

6.4.1 Introduction

The chapter 6.4 is only mandatory for vehicles constructed according to EN 13775. For all others, it only provides a recommendation on how to use the end/side indications on the tag in order to create a correlation between them and the physical characteristics of the vehicle. On those vehicles, the end/side indicator of the tag should be correlated to the first possible element of the following hierarchy of vehicle characteristics (see chapter 6.4.4):

1. Possibly existing vehicle end markings
2. Possibly existing vehicle side markings
3. Possibly existing axle numbering schemes

6.4.2 Flowchart for defining the vehicle end/side naming

The implementer shall work through the sections below in the order given until one is found which matches the particular vehicle under consideration (see Figure 4).

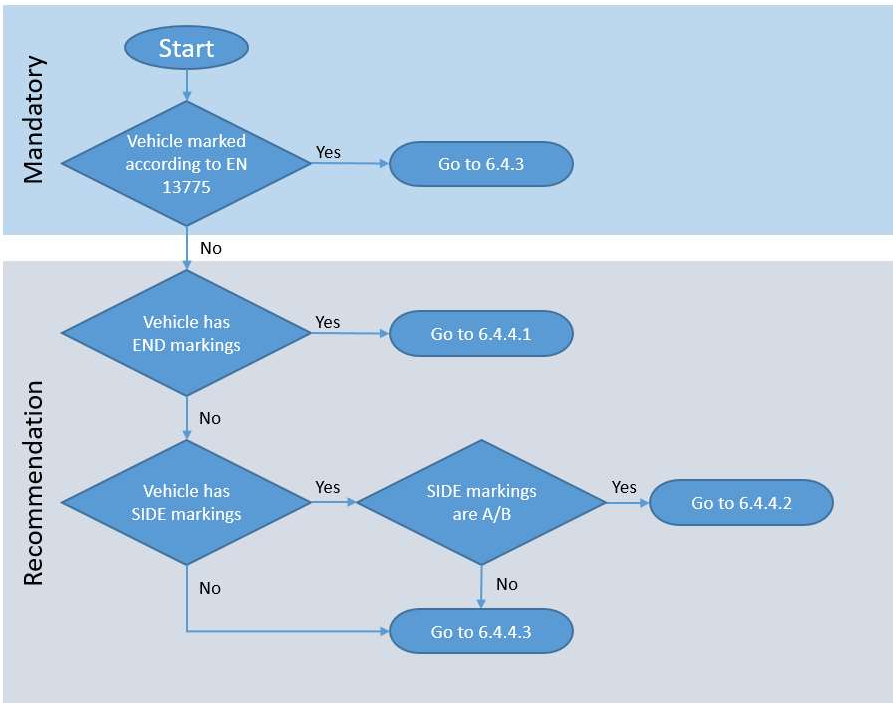

Figure 3: Procedure to define end / side information in the tags

6.4.3 Vehicle with existing end / side markings according to EN 13775

Each vehicle constructed according to EN 13775 has a constructional end 1, an end 2 a left side and a right side along Figure 4. The end/side information is either physically marked on the vehicle or at least apparent from the dedicated constructional drawings.

On those vehicles, the tag with the end/side information "1" shall be mounted on the left vehicle side towards vehicle end 1, the tag with the end/side information "2" on the right vehicle side towards vehicle end 2, respectively (Figure 4).

For details, concerning vertical and horizontal tag position, see chapters 6.2 and 6.3.

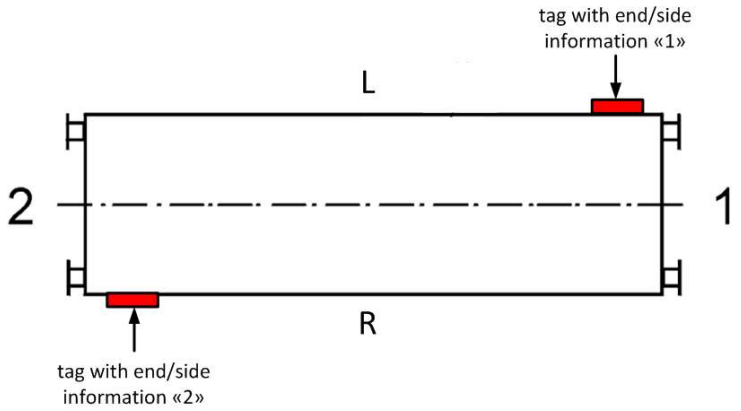

Figure 4: Vehicle end/side indication according to EN 13775 with correlation of tag information[3]

6.4.4 Vehicle with existing end/side markings other than EN 13775 or without any existing end/side markings

6.4.4.1 Vehicles with existing ***end*** markings A/B or 1/2

On vehicles for which end markings A/B or 1/2 already exist, the tag with the end/side information "1" is recommended to be mounted towards end A or 1, and the tag with the end/side information "2" towards end B or 2, respectively (Figure 5).

For details, concerning vertical and horizontal tag position, see chapters 6.2 and 6.3.

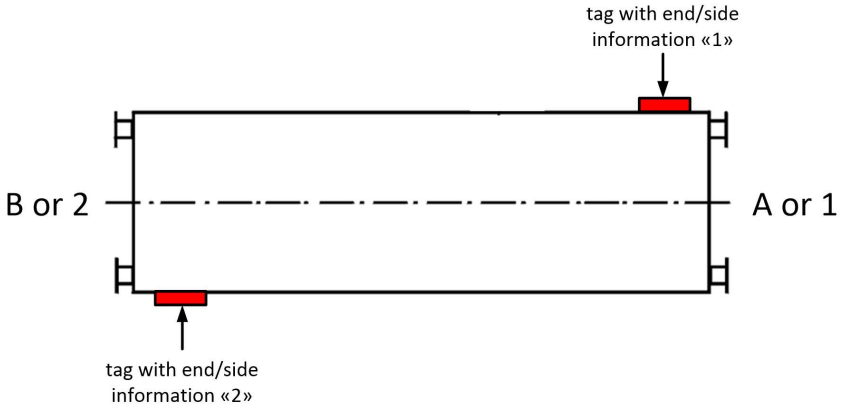

Figure 5: Vehicle with end marking A/B & recommended correlation of tag information[3]

[3] tag position in picture only shown characteristically; for details see chapters 6.2 and 6.3

6.4.4.2 Vehicles with existing *side* marking A/B

On vehicles for which side markings A/B already exist, the tag with the end/side information "2" is recommend be mounted on side A, the tag with the end/side information "1" on side B, respectively (Figure 6); see also GS1 Guideline AutoID in Rail.

For details, concerning vertical and horizontal tag position, see chapters 6.2 and 6.3.

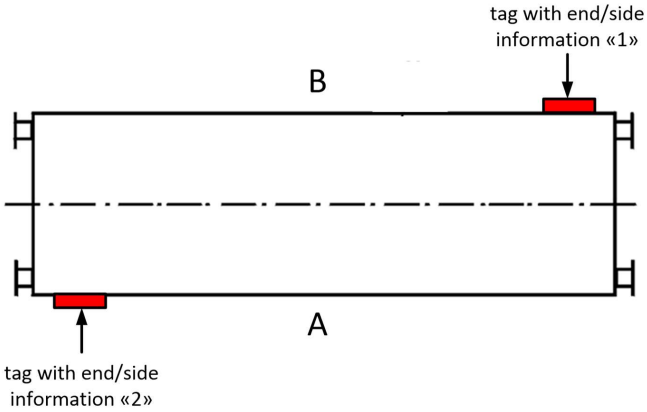

Figure 6: Vehicle with side marking A/B & recommended correlation of tag information[3]

6.4.4.3 Vehicles with *any other* or *without* existing end/side markings

On vehicles for which any other end/side markings already exist or without any existing end/side markings, the entity mounting the tags may freely define which tag to mount towards which physical vehicle end, respectively (Figure 7).

If no meaningful correlation to existing end or side markings can be created, whenever possible, the tag with the end/side indicator 1 should be mounted closest to the axle of the lowest number, which is in most cases 1.

For details, concerning vertical and horizontal tag position, see chapters 6.2 and 6.3.

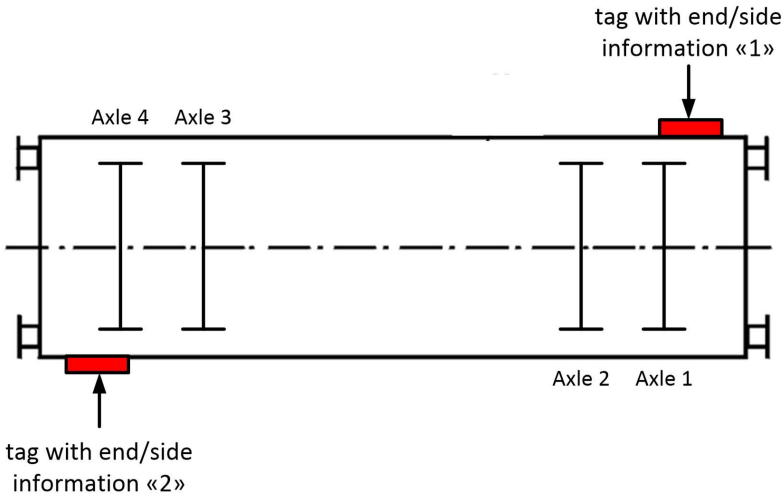

Figure 7: Vehicle with any other or without existing end/side & correlation of tag information

7 Data on the tag

7.1 General

The RFID tag holds a globally unique identification with an asset reference based on the European Vehicle Number and a side/end indicator.

Data length and data structure are defined by the content of StoredPC as described in ISO/IEC 18000-63. The number of 16 bit words is stored in the length field, bits 10h to 14h. The range of the length is 0 to 31 words i.e. 0 to 496 bits. The toggle bit 17h specifies the data structure. If bit 17h is 0 then the application is referred to as GS1 data structure. If bit 17h is 1 then the application is referred to as ASC data structure.

7.2 GS1 data structure

7.2.1 General

An EPC/RFID tag's EPC memory bank (MB 01) includes an Electronic Product Code (EPC), which is a globally unique identifier for the physical object to which the tag is attached, as well as control information, which not part of the EPC but used by RFID data capture applications to guide the data capture process.

The general structure of an EPC Binary Encoding as used on an RFID tag is as a string of bits (i.e., a binary representation), consisting of a fixed length header followed by a series of fields whose overall length, structure, and function are determined by the header value.

When using GS1 identification, implementations of RFID for the identification of rolling stock must use the GS1 Global Individual Asset Identifier (GIAI) in its 96-bit variant (GIAI-96).

The **GIAI-96** is comprised of:

- **EPC Binary Header** (8 bits) – 00110100 to indicate GIAI-96 EPC encoding scheme
- **Filter** (3 bits) – 001 indicating "Rail Vehicle", to improve tag read efficiency by targeting only the subset of tags that refer to rolling stock
- **Partition** (3 bits) – code that indicates the number of bits in the GS1 Company Prefix field and the Individual Asset Reference field
- **GS1 Company Prefix** or "**GCP**" (20-40 bits) – assigned by GS1 (an issuing agency under ISO 15459) to a managing entity (e.g. vehicle owners, transport agencies, infrastructure managers, etc.) as the basis to create any of the GS1 Identification Keys to identify their business objects
- **Individual Asset Reference** (42-62 bits) – unique serial number allocated to identify each asset (e.g. vehicle)

Numerical asset reference, which when converted to decimal must be 13 digits long, and consists of:

- End/side indicator (first digit which is either a "1" or a "2" as defined in the tag location chapter of this standard 6.4)[1] and
- EVN (remaining 12 digits) as allocated for that particular vehicle in question in the NVR / ECVVR. The EVN is represented only in numeric value without any other characters such as blanks or hyphens but including the check digit.
    - Exception: Vehicles with only an 8 digit vehicle number along Russian numbering scheme shall fill the first 4 digits after the end/side indicator with zeros (0) in order to get the 13 digit asset reference.

The Individual Asset Reference of the GIAI-96 must be Numeric-only, with no leading zeros and have a decimal value less than a limit that varies inversely with the length of the GS1 Company Prefix.

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1) 0) not allowed
3) has been used for legacy markings at vehicle
4) used for MRO parts
5-9) reserved for further implementations according to the guideline RFID for rail.

Please refer to GS1's EPC Tag Data Standard (http://www.gs1.org/epc/tag-data-standard), particularly the sections "Global Individual Asset Identifier" and "GIAI-96 Partition Table and coding table" for GIAI-96 composition details and partition values, as well as the "Unpadded Partition Table Encoding Method" section.

Please also refer to Appendix 3 of the GS1 in Europe guideline on AutoID in Rail (http://www.gs1.eu/automatic-identification-and-gs1-epcis-sharing-standard-in-rail#publications) for examples on Encoding and Marking.

Met opmerkingen [SV1]: To be made into a note.

Notes:

1) Further information related to this vehicle can be found in the European Railway Agency´s Virtual Vehicle Register, using the EVN as key for the search.

A company code, the side indication and the EVN are encoded into a globally unique asset reference.

See also the informative Annex E.

7.2.2 Example tag numbering in the GS1 scheme

The following table sets out an example tag number for a Class 73 locomotive (number 73 952) owned by Network Rail.

Name	Size (bits)	Bit numbers	Value (dec)	Value (bin)	Meaning	Notes
EPC header	8	95-88	52	0011 0100	This tag uses GIAI-96	Fixed
Filter	3	87-85	1	001	This tag denotes a rail vehicle	Fixed, depending on RFID system
Partition	3	84-82	5	1 01	This tag has a 24 bit company prefix and a 58 bit asset reference	Variable, depending on owner
GS1 company prefix	24	81-58*	5053555	01 0011 0100 0111 0001 1100 11	Owned by Network Rail	Variable, depending on owner
Individual asset ref. (side and tag)	58	57*--0	1917000732110	00 0000 0000 0000 0001 1011 1110 0101 0110 0010 0101 1100 1101 1100 1110	Side digit 1, EVN 917000732110	Actual value dependent on owner and item being monitored. Side digit (1 or 2) concatenated to EVN. When converted to binary, must exactly fill the available bits. In this case, there need to be 58 bits, so there are 17 leading bits set to zero.
The complete 96 binary tag code is 0011 0100 0011 0101 0011 0100 0111 0001 1100 1100 0000 0000 0000 0001 1011 1110 0101 0110 0010 0101 1100 1101 1100 1110.						
The complete tag code in hex is 34353471CC0001BE5625CDCE.						
*These bit numbers will be dependent on the length of the company prefix and the individual asset						

reference. The maximum number of bits for the company prefix and the individual asset reference including leading zeros is 82.

Thus the Gen2 EPC Memory Memory Bank (MB 01) encoding of "EPC" field (beginning at bit 20h), in **hexadecimal** form is:

34353471CC0001BE5625CDCE

The Gen2 EPC Memory Memory Bank (MB 01) encoding of "EPC" field (beginning at bit 20h), in **binary and hexadecimal** form, broken down by EPC component is shown in the table below. AFI is stored in StoredPC bits 18h (MSB) to 1Fh (LSB).

	Header								Filter			Partition			GCP	
Bit addr.	20h	21h	22h	23h	24h	25h	26h	27h	28h	29h	2Ah	2Bh	2Ch	2Dh	2Eh	2Fh
Bin	0	0	1	1	0	1	0	0	0	0	1	1	0	1	0	1
Hex	3				4				3			5				
Bit addr.	30h	31h	32h	33h	34h	35h	36h	37h	38h	39h	3Ah	3Bh	3Ch	3Dh	3Eh	3Fh
Bin	0	0	1	1	0	1	0	0	0	1	1	1	0	0	0	1
Hex	3				4				7			1				
												Individual Asset Reference				
Bit addr.	40h	41h	42h	43h	44h	45h	46h	47h	48h	49h	4Ah	4Bh	4Ch	4Dh	4Eh	4Fh
Bin	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Hex	C				C				0			0				
Bit addr.	50h	51h	52h	53h	54h	55h	56h	57h	58h	59h	5Ah	5Bh	5Ch	5Dh	5Eh	5Fh
Bin	0	0	0	0	0	0	0	1	1	0	1	1	1	1	1	0
Hex	0				1				B			E				
Bit addr.	60h	61h	62h	63h	64h	65h	66h	67h	68h	69h	6Ah	6Bh	6Ch	6Dh	6Eh	6Fh
Bin	0	1	0	1	0	1	1	0	0	0	1	0	0	1	0	1
Hex	5				6				2			5				
Bit addr.	70h	71h	72h	73h	74h	75h	76h	77h	78h	79h	7Ah	7Bh	7Ch	7Dh	7Eh	7Fh
Bin	1	1	0	0	1	1	0	1	1	1	0	0	1	1	1	0
Hex	C				D				C			E				

Table 1: An example with GS1 scheme including the bit addresses

The result provides a total of 96 bits (i.e., 6 Words), broken down as follows:

- EPC Binary Header: 8 bits
- Filter: 3 bits
- Partition: 3 bits
- GCP: 24 bits
- Individual Asset Reference: 58

The EPC Tag URI (as used in RFID middleware):

urn:epc:tag:giai-96:1.5053555.1917000732110

EPC Pure Identity URI (as used in EPCIS):
urn:epc:id:giai:5053555.1917000732110

7.3 Data structure with ASC Data Identifiers

7.3.1 General

The data are stored in memory bank 01 (also referred as UII or EPC memory bank) and are encoded with 6 bits per character.

In order to have all the relevant ASC data encoded, tags with memory capacity of 128bits are needed (memory bank 01). If there are further optional data elements to be stored in the tag, larger memories are needed. For high speed applications it is not recommended to use tags with more than 240 bits.

7.3.2 Application Family Identifier (AFI)

The Application Family Identifier (AFI) 0xC0 (1100 0000b) for railway vehicles is to be used as defined in ISO/IEC 18000-63.

7.3.3 Unique Item Identifier (UII) content

The data structure of the UII consists of:

- Data Identifier: fix value "5R" [1)]
- Data scheme prefix consisting of issuing agency code (IAC) according to ISO/IEC 15459 and company code (CIN) for the company or organization related to the vehicle number scheme. For vehicles identified with EVN numbers the data scheme prefix is the fixed value "LEERA". [2) 3) 4) 5)]
- Fix value ":" (colon)
- Side information, one numeric character. This is one digit, either a "1" or a "2", as defined in the tag location chapter 6.4 of this standard
- Vehicle number assigned by the vehicle owner, according to the vehicle number scheme related to the data scheme prefix
- Optionally followed by a plus sign and additional information, for example the axle number. As this is not mandatory or standardised content, it is intended for internal use only.

Notes:

1) *"5R" is defined in ISO 15418 / ANS MH10.8.2 as:*
   Data in the format and using semantics defined by the holder of a Company Identification Number (CIN) that has been issued by an Issuing Agency Code (IAC) in accordance with

ISO/IEC 15459, defined as a sequence of concatenated data elements: IAC, followed by CIN, followed by the separator character ":" (colon) followed by the data in the format and using semantics as defined by the CIN holder.

2) *Only the data syntax rules (if any) as provided by the declared prefix (IAC+CIN) within each DI "5R" data stream shall be applied to the data following DI 5R+IAC+CIN.*
3) The *Issuing agency code "LE" is assigned to EDIFICE, a user association network for B2B integration in high Tech industries.*
4) *"ERA" is assigned by EDIFICE to the European Railway Organisation (EUAR) as company prefix. Thus vehicles with EVN numbers have the data scheme prefix "LEERA".*
5) *Vehicles marked with other numbering schemes than EVNs, e.g. Russian vehicles using the 8 digit Russian vehicle numbering scheme, shall use a different ISO/IEC 15459 compliant prefix of a company/organisation related to this vehicle numbering scheme.*

7.3.4 Example with data structure using ASC Data Identifiers

Data string is "5RLEERA:1917000732110".

The result provides a total of 126 bits (i.e., 8 Words less two bits).

5R	Data identifier
LE	Issuing agency
ERA	Company code
:	Separator
1	End/side indicator
917000732110	EVN

Name	Size (bits)	Bit numbers	String value	Value (binary) 6 bit code
Data identifier	12	125…114	5R	110101 010010
Issuing agency	12	113…102	LE	001100 000101
Company code	18	101…84	ERA	000101 010010 000001
Separator	6	83…78	:	111010
End/side indicator	6	77…72	1	110001
EVN	72	71…0	917000732110	111001 110001 110111 110000 110000 110000 110111 110011 110010 110001 110001 110000

The UII Memory Bank 01 encoding of above data (beginning at bit 20h), in binary and hexadecimal form:

	Data identifier (5R)												Issuing agency (LE)			
Bit addr.	20h	21h	22h	23h	24h	25h	26h	27h	28h	29h	2Ah	2Bh	2Ch	2Dh	2Eh	2Fh
Bin	1	1	0	1	0	1	0	1	0	0	1	0	0	0	1	1
Hex	D				5				2				3			
	Issuing agency (LE)								Company code (ERA)							
Bit addr.	30h	31h	32h	33h	34h	35h	36h	37h	38h	39h	3Ah	3Bh	3Ch	3Dh	3Eh	3Fh
Bin	0	0	0	0	0	1	0	1	0	0	0	1	0	1	0	1
Hex	0				5				1				5			
	Company code (ERA)										Separator (:)					
Bit addr.	40h	41h	42h	43h	44h	45h	46h	47h	48h	49h	4Ah	4Bh	4Ch	4Dh	4Eh	4Fh
Bin	0	0	1	0	0	0	0	0	0	1	1	1	1	0	1	0
Hex	2				0				7				A			
	End/side indicator (1)						EVN									
Bit addr.	50h	51h	52h	53h	54h	55h	56h	57h	58h	59h	5Ah	5Bh	5Ch	5Dh	5Eh	5Fh
Bin	1	1	0	0	0	1	1	1	1	0	0	1	1	1	0	0
Hex	C				7				9				C			
	EVN															
Bit addr.	60h	61h	62h	63h	64h	65h	66h	67h	68h	69h	6Ah	6Bh	6Ch	6Dh	6Eh	6Fh
Bin	0	1	1	1	0	1	1	1	1	1	0	0	0	0	1	1
Hex	7				7				C				3			
	EVN															
Bit addr.	70h	71h	72h	73h	74h	75h	76h	77h	78h	79h	7Ah	7Bh	7Ch	7Dh	7Eh	7Fh
Bin	0	0	0	0	1	1	0	0	0	0	1	1	0	1	1	1
Hex	0				C				3				7			
	EVN															
Bit addr.	80h	81h	82h	83h	84h	85h	86h	87h	88h	89h	8Ah	8Bh	8Ch	8Dh	8Eh	8Fh
Bin	1	1	0	0	1	1	1	1	0	0	1	0	1	1	0	0
Hex	C				F				2				C			
	EVN														pad	
Bit addr.	90h	91h	92h	93h	94h	95h	96h	97h	98h	99h	9Ah	9Bh	9Ch	9Dh	9Eh	9Fh
Bin	0	1	1	1	0	0	0	1	1	1	0	0	0	0	1	0
Hex	7				1				C				2			

Table 2: An example with ASC scheme including the bit addresses

7.4 Data protection on the TAG

To prevent unauthorised alteration of tag data, memory addresses to be protected must be locked or permalocked[1)] in conjunction with an Access Password, as specified by the EPC Gen2 ISO/IEC 18000-63 standard.

[1)] Permalocking prevents the user changing the content further down the life cycle.

7.5 Data integrity between the tag content and the NVR

Prior to launching a service for a new, overhauled or rebuilt rolling stock, it must be assured that the EVN encoded on the tag is aligned with the current EVN in the NVR.[2)]

[2)] For the potential cases for changing the EVN in the NVR refer to the TSI OPE Appendix 6 part 0.

7.6 Data authentication

This standard does not require authentication. In case authentication is added, it shall follow ISO/IEC 20248.

8 Tag characteristics

8.1 Mounting the RFID tag on the rolling stock

Mounting has to be conducted taking into account any other relevant standard or legislation. However, the performance requirements defined in 8.2 have to be met.

8.2 Tag performance requirements

This chapter describes the reference setup for the UHF GEN 2 RFID tag reading event performance measurements.

Tag shall be fully operating with an ISO/IEC 18000-63 standard compliant reader with an output power from the antenna (ERP, effective radiated power) transmitting power of 33dBm and a radiation pattern of 45 degrees with following constrains (environmental conditions in line with the EN 50125-3:2003 value T2 for temperature, rain and humidity):

- Minimum read ranges 5m (tag reader typical installation distance is 3.1-5m from rail)
- Maximum read range 15m (should define also maximum range to limit cross/over reading)
- Minimum tag backscatter signal strength (power) of -70dBm (at distance of 5m)
- RX Data transmission with 62,5 Kbit/s is to be supported
- The assumption is that the tag and antenna are on the same height and their normals are coaxial (Figure 8).

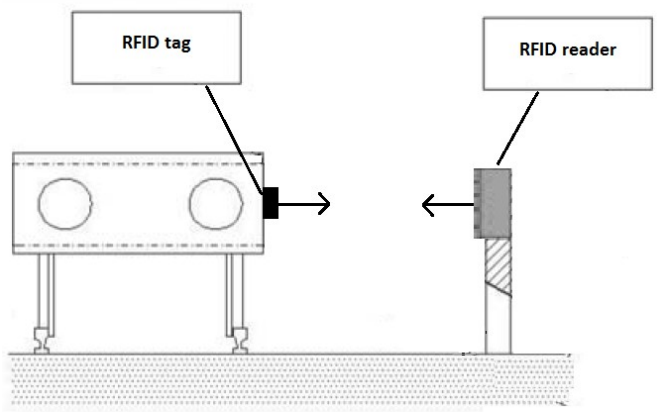


Figure 8: RFID tag and the track side RFID reader on the same height with their normals being coaxial i.e. having a common axis.

For the conformity test of the reader the reader must be capable of reading the data as defined in the tag locations chapters.

Informative note: A difference of the length of the memory of 96 bit or e.g. 240 bit in the memory bank 01 has no critical impact on the system. For example, with a RX data rate of 62,5 kbit/s, reading 244 bits instead of 96 bits requires only 2,3 milliseconds longer.

Practical tests have confirmed the theoretical additional delay. Times for reading 96 bits tags have been measured with 11,5 ms to 12 ms, and for 240 bit tags with 13 ms to 13,5 ms. Thus there is no decisive difference.

However when addressing other memory banks in addition to the memory bank for the unique identification the tag read performance degrades very significantly. Therefore, it is not recommended to read other memory banks than EPC when the vehicles are operating at higher speeds. Additional information that should be readable when the vehicles are moving at higher speeds should not be encoded into the user memory.

8.3 Tag lifetime

It should be understood that the tag as any other solid-state memory has a certain lifetime which can be shorter than that of the vehicle. Tags used in railway environment should be selected based on their long-term performance in demanding environment in terms of EMC and climate conditions. Furthermore, it is recommended to include the checking of the tags into the vehicles maintenance program and the tag data being backed up in a database.

For utilisation in safety critical applications, the potential loss of information in the tags should be taken into account.

9 Reader requirements

Mobile readers are not in the scope of this standard.

The reader shall meet the requirements of the Radio Equipment Directive EU 2014/53.

EN 302 208:2014- Electromagnetic compatibility and Radio spectrum Matters (ERM); Radio Frequency Identification Equipment operating in the band 865 MHz to 868 MHz with power levels up to 2 W; - shall be taken into account.

It is recommended that the RFID track side readers are designed taking into account the requirements of the EN 50 121 series.

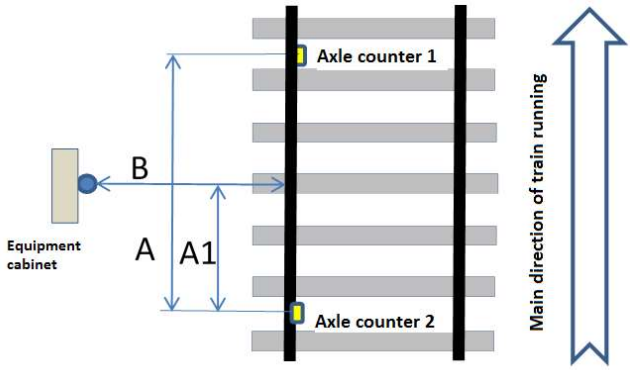
The reader has to be installed so that it can read tags, which are installed in any location according to the principles described for the tag installation in this standard.

The reader shall be configured to read the data relevant for railway vehicles as described in this standard.

Annex A –
Trackside implementation examples
two axle counters
(informative)

When doing the installation, it is advised to take into account that not every vehicle operating on the network is tagged or there is a reading error or tags which have fallen off. Therefore there might be a need to recognise the "non-tagged" rolling stock during the reading event. In addition, the direction of travel needs to be known in certain use cases. Axle counters are one way of managing the aforementioned scenarios (solutions in production operate with two axle counters or dual-sensor counters)

Figure: RFID reader solution with two axle counters.



Annex B -
Trackside implementation examples
one axle counter
(informative)

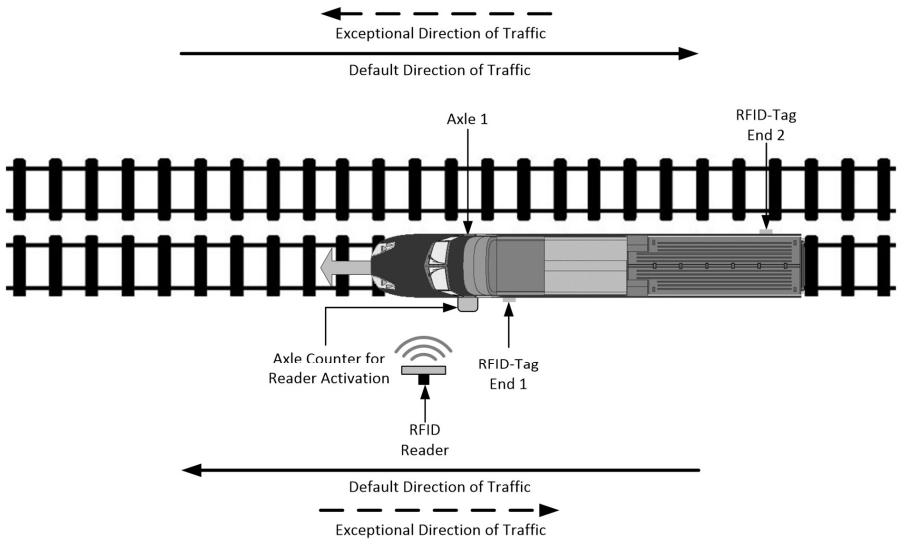


Figure 9: RFID reader solution with one axle counter.

Figure 09 depicts an example of a layout with one reader and one axle counter for tracks with alternating direction of traffic, showing the allowed horizontal tag positions for vehicle ends with a driver's cab.

With the tag behind the bogie centre axis and optimised reader position, the tag is still within the reader's field when activated by the axle counter. The figure depicts left hand traffic.

During the next few years there will be vehicles in service with tags in front of the first axle. During this time it is recommended to have the RFID trackside antennas on all the time since they cannot be triggered by the axle counters in these cases.

Annex C-
(informative)

Examples of use cases

The unique and unambiguous identification of Rail Vehicles enables real-time capturing and sharing of data/information.
The needs for information sharing are mainly found to be two-fold:

(i) there is a need for tracking of vehicles as they travel within countries and across different countries ("asset tracking"), and

(ii) there is a need to associate the vehicle data with the Wayside Train Monitoring System (WTMS) data about vehicles and vehicle components to enhance preventive maintenance

Asset tracking allows the Rail sector to respond to a number of challenges that it was not able to respond to (as well) before such as:

- Shippers/Cargo Owners asking: "Where are my Goods / Where is my Cargo?".
- Operators planning condition-based maintenance asking: "How much distance has my asset travelled?".
- Operators wanting to increase Asset Utilisation asking: "Where are my vehicles?".

Linking WTMS to Vehicle-ID enables the Rail sector to take the concepts of condition-based maintenance even further.

- Infrastructure managers can accurately and unambiguously inform owners/operators of the vehicles regarding the actual condition of their vehicles based on the WTMS measurements.
- Owners/Operators can plan for appropriate maintenance before the vehicle fails in operations.
  NOTE: Having this actual information regarding the condition of the vehicle will also allow Owners/Operators to postpone planned maintenance because they have independent solid evidence that maintenance really is not required yet.
- Safety / Risk management may be improved.
  WTMS can detect situations like ill-balanced vehicles that indicate that the operational processes of the Operator/Loader may require attention and/or improvements.

As a result

- Infrastructure managers will see a significant drop in delays on the network as well as a substantial reduction in incidents and related damages to the infrastructure.
- Owners/Operators will see
  - A significant drop in expensive emergency maintenance. Since emergency repairs related to incidents generally also involve very significant additional costs as a result of the incident the impact of the decrease in

emergency repairs occurrences will have a major impact on the total cost of maintenance for Operators/Owners;

- A significant drop in maintenance activities that were not really necessary yet.
- An increase in the availability of their vehicles and the reliability of their operations because the vehicles would be out-of-service only when planned to be so.
- Because Owners/Operators may always know exactly where their assets are they are in principle able to always allocate the nearest appropriate vehicle for the Cargo to be moved, thus reducing the operations costs for transport as well as avoiding having to own spare capacity to cater for "lost"/ "misplaced" assets.

The above benefits of unambiguous Rail Vehicle Identification is a non-exhaustive list of business cases, which can be used as an input for example when designing an RFID implementation project.

Annex F

Padding Rules

(informative)

The rules how to fill the remaining memory space with padding characters are defined in ISO/IEC 15962.
As the tag architecture according ISO/IEC 18000-63 uses 16-bit words then a pad string “100000” is added and repeated as necessary in full and then truncated to fill the encoding space. Using the example of encoding on a 16-bit word structure, here are the eight end conditions:
Exactly on the boundary – no action
Requiring two pad bits – encode 10
Requiring four pad bits – encode 1000
Requiring six pad bits – encode 100000
Requiring eight pad bits – encode 10000010
Requiring ten pad bits – encode 1000001000
Requiring twelve pad bits – encode 100000100000
Requiring fourteen pad bits – encode 10000010000010

If pad strings “10”, “1000” or “100000” or repeated patterns, as shown above, are present at the end of the encoded bit string, they are discarded.

Bibliography

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Commission Decision on adopting a common specification of the national vehicle register (NVR Decision 2007/756/EC (9 November 2007) amended by Decision 2011/107/EU (10 February 2011))

ECVVR Application Guide ERA/GUI/01-2010/INT (ECVVR stands for European Centralised Virtual Vehicle Register – composed of two parts: VVR, which is the central search engine in ERA, NVRs, which are local national vehicle registers)

GS1 Guideline AutoID in Rail (Ref. "*European Guideline for the Identification of Railway Assets using GS1 Standards*" http://www.gs1.eu/automatic-identification-and-gs1-epcis-sharing-standard-in-rail#publications)

Radio Equipment Directive EU 2014/53