TECHNICAL DOCUMENTATION COMPLIANT TRAIN DETECTION SYSTEMS ETI CMS 2023

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1.-INTRODUCTION

On September 28, 2023, significant regulatory changes came into effect regarding the Technical Specification for Interoperability (TSI) for the Control-Command and Signalling Subsystems of the European Union's railway system. These extensive revisions to the various TSIs aim to further advance the interoperability of the European railway system, enhance the digitalization of the sector, and promote rail freight transport.

On November 10, 2023, a communication was received from the Spanish Railway Safety Agency (AESF), the entity responsible for functions related to the interoperability of the Spanish railway system, informing the various entities in the railway sector of the actions that must be taken to comply with the new obligations and the deadline for doing so. Particularly, it highlighted the most important actions that need to be undertaken following the entry into force of the aforementioned modified texts. These include:

- **Compatibility of non-compliant train detection systems with the CCS TSI.**

In compliance with Article 13.1 of Commission Implementing Regulation (EU) 2023/1695 (new CCS TSI), Member States whose infrastructure managers operate train detection systems that do not comply with the Regulation must request a specific case and notify the EU Agency for Railways (EUAR) of:

a. The interference current limits for track circuits, particularly the evaluation methods and vehicle impedance in accordance with clause 3.2.2 of document ERA/ERTMS/033281 v5.

b. The field limits for axle counters in the X, Y, and Z axes, particularly the evaluation methods in accordance with clause 3.2.1 of document ERA/ERTMS/033281 v5.

c. Specific cases of non-compliant train detection systems using the template referred to in Annex B.1 of document ERA/ERTMS 033281 v5.

ADIF complies with this requirement in document ERA-TDC-MS-ES.

- **Compatibility of train detection systems compliant with the CCS TSI.**

In compliance with Article 13.2 of Commission Implementing Regulation (EU) 2023/1695 (new CCS TSI), infrastructure managers will inform the EUAR of the necessary interference current limits or the frequency management frequencies for train detection systems compliant with the TSI, as specified in sections 3.2.2.1 to 3.2.2.6 of document ERA/ERTMS/033281 v5 for their relevant networks.

Prior to receiving this communication, ADIF's Subdirectorate of Installations, following the same premises outlined in Article 13 of the aforementioned CCS TSI, initiated a series of contacts with all technology companies supplying Train Detection Systems, requesting the required data and agreeing on a roadmap that will set the milestones to be met for the correct collection of information.

Therefore, the first step is the analysis, classification, and location of all axle counters and track circuits present in the RFIG, indicating compliance with the CCS TSI 2023, the certification forecast against said standard, the request for an exception for those cases where such compliance is not anticipated, and the demarcation of the frequency and induced current limits for the proper functioning of systems compatible with the TSI.

ADIF complies with this point in this document where, in its Annex 1, it includes all the interoperability certificates for the axle meter systems described in this document, with the exception of those that as of the date of writing this document have not yet been issued, but whose interim report has been approved.

Likewise, Annex 2 details the comparison of electromagnetic compatibility limits, the evaluation parameters and their acceptance criteria.

2.-SCOPE

The purpose of this document is to list the frequency management and current limits of all train detection systems (track circuits and axle counters) present on lines subject to interoperability installed in the Member State of **Spain (ES),** excluding the metric gauge network and lines managed by port authorities.

The requirements of this document ensure compatibility with the parameters described in ERA/ERTMS/033281 v5 of the following train detection systems:

Table 01

TECHNOLOGY	System	*SDT*	*Axle distances*					*Wheel geometry*						*Other parameters*						*EMC*	
			3.1.2.1	3.1.2.2	3.1.2.3	3.1.2.4	3.1.2.5	3.1.3.1	3.1.3.2	3.1.3.3	3.1.3.4	3.1.3.5	3.1.3.6	3.1.4	3.1.5	3.1.6	3.1.7	3.1.8	3.1.9	3.2.1	3.2.2
SIEMENS	FTG 46	TC	✓		✓	✓	✓							✓	✓	✓	✓	✓	✓		✓
	FTG 917	TC	✓		✓	✓	✓							✓	✓	✓	✓	✓	✓		✓
	TCM100	TC	✓		✓	✓	✓							✓	✓	✓	✓	✓	✓		✓
	ACM 250	AC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	
THALES	TTC	TC	✓		✓	✓	✓							✓	✓	✓	✓	✓	✓		✓
	AZLM	AC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	
ALSTOM	ITE JS (HVI)	TC	✓		✓	✓	✓							✓	✓	✓	✓	✓	✓		✓
	DIGICODE	TC	✓		✓	✓	✓							✓	✓	✓	✓	✓	✓		✓
	STDS	TC	✓		✓	✓	✓							✓	✓	✓	✓	✓	✓		✓
FRAUSCHER	RSR 123	AC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	
	RSR 180	AC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	
ELECTRANS	EAC-214-PLUS	AC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	
	ME 3091/ME 5091	TC	✓		✓	✓	✓							✓	✓	✓	✓	✓	✓		✓
ICF	AC900	AC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	

✓	V5 compliant
✓	Favourable interim report. Awaiting certification
✗	Not or partially compliant with V5
	Not relevant to this system

3.-NORMATIVE REFERENCES

- Commission Implementing Regulation (EU) 2023/1693 of August 10, 2023, amending Implementing Regulation (EU) 2019/773, concerning the technical specification for interoperability relating to the "operation and traffic management" subsystem of the European Union railway system.
- Commission Implementing Regulation (EU) 2023/1694 of August 10, 2023, amending Regulations (EU) No. 321/2013, (EU) No. 1299/2014, (EU) No. 1300/2014, (EU) No. 1301/2014, (EU) No. 1302/2014, and (EU) No. 1304/2014, and Implementing Regulation (EU) 2019/777.
- Commission Implementing Regulation (EU) 2023/1695 of August 10, 2023, on the technical specification for interoperability relating to the control-command and signalling subsystems of the European Union railway system, and repealing Regulation (EU) 2016/919.
- Commission Implementing Decision (EU) 2023/1696 of August 10, 2023, amending Implementing Decision 2011/665/EU concerning the specification for the European register of authorized vehicle types referred to in Article 48 of Directive (EU) 2016/797 of the European Parliament and of the Council.
- UNE-CLC/TS 50238-1:2020. Railway applications. Compatibility between rolling stock and train detection systems. Part 1: General.
- UNE-CLC/TS 50238-2:2020. Railway applications. Compatibility between rolling stock and train detection systems. Part 2: Compatibility with track circuits.
- UNE-CLC/TS 50238-3:2022. Railway applications. Compatibility between rolling stock and train detection systems. Part 3: Compatibility with axle counters (Ratified by the Spanish Association for Standardization in February 2022).
- Order TMA/576/2020 of June 22, approving the "Railway Instruction: Technical specifications for railway rolling stock for the entry into service of self-propelled units, locomotives, and coaches (IF MR ALC-20)."
- PNE-prEN 50728:2022. Railway applications. Rolling stock. Tests for electromagnetic compatibility with track circuits.
- UNE-EN 50592:2017. Railway applications. Testing of rolling stock for electromagnetic compatibility with axle counters.

4.-ELECTROMAGNETIC COMPATIBILITY

4.1.-ELECTROMAGNETIC FIELDS

4.1.1.-Frequency management

Compliance with ERA/ERTMS/033281 version 5 (1668mm and 1435mm track gauge), valid for all train detection systems described in this document.

The axle counters listed below are currently in operation in the Spanish railway infrastructure network, their frequency management limits being described in the following sections:

4.1.1.1.-ACM250

This system is in the process of being certified against ERA/ERTMS/033281 v5 (track gauge of 1668 mm and 1435 mm). The frequency management limits considered for this train detection system have been specified and documented by the company providing technical support to the system (SIEMENS).

It is equipped with **ZPD43/ZPD43I** axle counter sensors with frequency management limits described in Table 01:

Table 01

Band	Frequency range defined by the centre frequency [kHz]	Emission limit X Axis [dBµA/m] (RMS)	Emission limit Y Axis [dBµA/m] (RMS)	Emission limit Z Axis [dBµA/m] (RMS)	Evaluation method	Filter order (Butterworth) and 3 dB-bandwidth [Hz]	Evaluation parameters [ms]
Band 1	**42.98**	**109**	**94**	**107**	**BP**	2nd ± 160 Hz	**Integration Time: 1.8**

4.1.1.2.-AZLM

The system complies with the limits established by ERA/ERTMS 033281 v.5. The frequency management limits considered for this train detection system have been specified by the company providing technical support to the system (THALES-HITACHI).

Equipped with model **Zp30H/Zp30K** axle counter sensors with frequency management limits described in Table 02:

Table 02

Band	Frequency range defined by the centre frequency [kHz]	Emission limit X Axis [dBµA/m] (RMS)	Emission limit Y Axis [dBµA/m] (RMS)	Emission limit Z Axis [dBµA/m] (RMS)	Evaluation method	Filter order (Butterworth) and 3 dB-bandwidth [Hz]	Evaluation parameters [ms]
Band 1	**27.0 bis 32.0**	**114**	**94**	**101**	**BP**	4th ± 120 / ±450	**Integration Time: 4**

4.1.1.3.-RSR123

The system complies with the limits set by ERA/ERTMS 033281 v5. The frequency management limits considered for this train detection system will be those specified in the data provided by the company that provides technical support to the system (PASCH Y CIA., S.A.U.).

This sensor is part of axle counter systems such as the **FAdC** or **ACS2000** models. Its frequency management limits are described in Table 03:

Table 03

Type	Band	Frequency range defined by the centre frequency [kHz]	Emission limit X Axis [dBµA/m] (RMS)	Emission limit Y Axis [dBµA/m] (RMS)	Emission limit Z Axis [dBµA/m] (RMS)	Evaluation method	Filter order (Butterworth) and 3 dB-bandwidth	Evaluation parameters [ms]
SYS1	Band 3	1000.0 - ± 1.0	120.5	114.5	114.5	BP	4 ±3.0	Integration Time: 2
SYS2	Band 3	1228.8 - ± 1.0	119.5	113.6	113.6	BP	4 ±3.0	Integration Time: 2

4.1.1.4.-RSR180

The system complies with the limits set by ERA/ERTMS 033281 v5. The frequency management limits considered for this train detection system will be those specified in the data provided by the company that provides technical support to the system (PASCH Y CIA., S.A.U.).

This sensor is part of axle counter systems such as the **FAdC** or **ACS2000** models. Its frequency management limits are described in Table 04:

Table 04

Band	Frequency range defined by the centre frequency [kHz]	Emission limit X Axis [dBµA/m] (RMS)	Emission limit Y Axis [dBµA/m] (RMS)	Emission limit Z Axis [dBµA/m] (RMS)	Evaluation method	Filter order (Butterworth) and 3 dB-bandwidth	Evaluation parameters [ms]
Band 2	250.0 - ± 1.0	121	113.8	101.0	BP	4 ±5.0	Integration Time: 1.5214 sec.

Frequency range	Field direction	Increasing of magnetic field limits for a reduced integration time of 0,5 x T_{int} [dB]	Increasing of magnetic field limits for a reduced integration time of 0,25 x T_{int} [dB]
234 to 287 kHz	X, Y, Z	6	12

4.1.1.5.-AC900

The axle counter system complies with the limits set by ERA/ERTMS 033281 v5. The frequency management limits considered for this train detection system will be those specified in the data provided by the company that provides technical support to the system (INGENIERIA Y CONTROL FERROVIARIO S.A.).

Table 05

Band	Frequency range defined by the centre frequency [kHz]	Emission limit X Axis [dBµA/m] (RMS)	Emission limit Y Axis [dBµA/m] (RMS)	Emission limit Z Axis [dBµA/m] (RMS)	Evaluation method	Filter order (Butterworth) and 3 dB-bandwidth	Evaluation parameters [ms]
Out of band	Ages 10-27	135 to 130 dB/log(f) straight line	135 to 130 dB/log(f) straight line	135 to 130 dB/log(f) straight line	FFT		Recording Time 1ms, Hanning Window, 50% Overlay, Maximum Hold
Band 1	27 to 41.2 and 44.8 to 52	93	93	98	BP	4th order 300 Hz	20% overlap integration time (3 dB points): 1 ms
Band 1	From 41.2 to 44.8	93	93	98	BP	4th order 320 Hz	20% overlap integration time (3dB points):
Out of band	From 52 to 234	130	130	130	FFT		Recording Time 1ms, Hanning Window, 50% Overlay, Maximum Hold
Band 2	From 234 to 287	120	99	100	BP	4th order; 7500 Hz	20% overlap (3 dB-dots), integration time: 1.5 ms
Band 2	From 287 to 363	109	99	91	BP	4th order; 7500 Hz	20% overlap (3 dB-dots), integration time 1.5 ms
Out of band	From 363 to 740	125	125	125	FFT		Recording Time 1ms, Hanning Window, 50% Overlay, Maximum Hold
Band 3	From 740 to 1026	106	85	101	BP	4th order; 10 kHz	20% overlap (3 dB-dots), integration time: 1.5 ms
Band 3	From 1026 to 1250	119	113	113	BP	4th order; 10 kHz	20% overlap (3 dB points), integration time: 1.5 ms

4.1.1.1.-EAC-214-PLUS

Intermediate studies submitted by the manufacturer (ELECTRANS) ensure compliance with the limits established by ERA/ERTMS 033281. Pending the issuance of a report by the certifying body.

4.1.2.-Measurement, Test, and Evaluation Specification

The measurements have been provided by the respective suppliers of train detection systems, taking into account the specifications of the standard EN50592:2016 and data provided by previous standards such as EN 50238-3:2020, Annex A.

4.2.-CONDUCTED INTERFERENCE

4.2.1.-Vehicle impedance

Regarding vehicle impedance, in the Spanish legal framework, order TMA 576/2020 generally mandates that "each influencing unit (self-propelled unit, locomotive in simple composition, or car with a pantograph) must have a minimum input impedance of 2 Ω at 50 Hz."

NOTE: The same order, more specifically in section 4.2.3.3.1.1, specifies that to ensure compatibility with train detection systems based on track circuits, "all electric traction rolling stock operating on direct current lines equipped with 50 Hz track circuits must be equipped with a 50 Hz detector that will act on the traction system and the auxiliary services converter when it detects, for more than 2 seconds, an intensity level greater than 1.5 A RMS. The filter equipped by the detector will have a maximum bandwidth of ±2 Hz."

4.2.2.-Traction current: 25 kV AC, 50 Hz Electromagnetic induction current limits.

4.2.2.1.-FTGS

The track circuit, in both its FTGS46 and FTGS917 models, complies with the limits established by ERA/ERTMS 033281 v5. The interference current limits considered for the present train detection system will be those specified in the standard EN 50238-2:2020, Annex A.

Table 06: FTGS 46

Frequency Range	Interference Current Limit [rms value]	Evaluation method	Evaluation parameters
4686–4814 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 4750 Hz 3dB bandwidth: 200 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec
5186–5314 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 5250 Hz 3dB bandwidth: 206 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec

Frequency Range	Interference Current Limit [rms value]	Evaluation method	Evaluation parameters
5686-5814 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 5750 Hz 3dB bandwidth: 214 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec
6186-6314 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 6250 Hz 3dB bandwidth: 220 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec

** Where the integration time to calculate the RMS value is not indicated, the duration of one cycle at the frequency of the considered circuit will be used.

Table 07: FTGS 917

Frequency Range	Interference Current Limit [rms value]	Evaluation method	Evaluation parameters
9436-9564 Hz	0.33 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 9500 Hz 3dB bandwidth: 360 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec

Frequency Range	Interference Current Limit [rms value]	Evaluation method	Evaluation parameters
10436-10564 Hz	0.33 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 10500 Hz 3dB bandwidth: 380 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec
11436-11564 Hz	0.33 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 11500 Hz 3dB bandwidth: 400 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec
12436-12564 Hz	0.33 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 12500 Hz 3dB bandwidth: 425 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec
13436-13564 Hz	0.33 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 13500 Hz 3dB bandwidth: 445 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec

Frequency Range	Interference Current Limit [rms value]	Evaluation method	Evaluation parameters
14436-14564 Hz	0.33 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 14500 Hz 3dB bandwidth: 470 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec
15436-15564 Hz	0.33 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 15500 Hz 3dB bandwidth: 490 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec
16436-16564 Hz	0.33 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 16500 Hz 3dB bandwidth: 510 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec

** Where the integration time to calculate the RMS value is not indicated, the duration of one cycle at the frequency of the considered circuit will be used.

4.2.2.2.-TTC

The track circuit complies with the limits established by ERA/ERTMS 033281 according to the certificate provided by the company responsible for its technology (ALSTOM). The interference current limits considered for the current train detection system shall be those specified in EN 50238-2:2020, Annex A.

Table 08

EN 50238-2:2020			
Frequency range	**Interference Current Limit [rms value]**	**Evaluation method**	**Evaluation parameters**
4000 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 4000 Hz 3dB bandwidth: 158 Hz Butterworth, order 2· N= 6 • RMS Calculation: Integration Time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Minimum time between two exceedances: 0.35 sec
4500 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 4500 Hz 3dB bandwidth: 158 Hz Butterworth, order 2· N= 6 • RMS Calculation: Integration Time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Minimum time between two exceedances: 0.35 sec
5000 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 5000 Hz 3dB bandwidth: 158 Hz Butterworth, order 2· N= 6 • RMS Calculation: Integration Time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Minimum time between two exceedances: 0.35 sec
5500 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 5500 Hz 3dB bandwidth: 158 Hz Butterworth, order 2· N= 6 • RMS Calculation: Integration Time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Minimum time between two exceedances: 0.35 sec

EN 50238-2:2020			
Frequency range	**Interference Current Limit [rms value]**	**Evaluation method**	**Evaluation parameters**
6000 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 6000 Hz 3dB bandwidth: 158 Hz Butterworth, order 2· N= 6 • RMS Calculation: Integration Time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Minimum time between two exceedances: 0.35 sec
6500 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 6500 Hz 3dB bandwidth: 158 Hz Butterworth, order 2· N= 6 • RMS Calculation: Integration Time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Minimum time between two exceedances: 0.35 sec
9000 Hz	0.33 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 9000 Hz 3dB bandwidth: 158 Hz Butterworth, order 2· N= 6 • RMS Calculation: Integration Time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Minimum time between two exceedances: 0.35 sec
10000 Hz	0.33 A	Bandpass filter	• BP Filter characteristics: Centre Frequency Range: 10000 Hz 3dB bandwidth: 158 Hz Butterworth, order 2· N= 6 • RMS Calculation: Integration Time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Minimum time between two exceedances: 0.35 sec

EN 50238-2:2020			
Frequency range	**Interference Current Limit [rms value]**	**Evaluation method**	**Evaluation parameters**
11000 Hz	0.33 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 11000 Hz 3dB bandwidth: 158 Hz Butterworth, order 2· N= 6 • RMS Calculation: Integration Time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Minimum time between two exceedances: 0.35 sec
12000 Hz	0.33 A	Bandpass filter	• BP Filter characteristics: Centre Frequency Range: 12000 Hz 3dB bandwidth: 158 Hz Butterworth, order 2· N= 6 • RMS Calculation: Integration Time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Minimum time between two exceedances: 0.35 sec
13000 Hz	0.33 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 13000 Hz 3dB bandwidth: 158 Hz Butterworth, order 2· N= 6 • RMS Calculation: Integration Time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Minimum time between two exceedances: 0.35 sec
14000 Hz	0.33 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 14000 Hz 3dB bandwidth: 158 Hz Butterworth, order 2· N= 6 • RMS Calculation: Integration Time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Minimum time between two exceedances: 0.35 sec

EN 50238-2:2020			
Frequency range	**Interference Current Limit [rms value]**	**Evaluation method**	**Evaluation parameters**
15000 Hz	0.33 A	Bandpass filter	• BP Filter characteristics: Centre Frequency Range: 15000 Hz 3dB bandwidth: 158 Hz Butterworth, order 2· N= 6 • RMS Calculation: Integration Time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Minimum time between two exceedances: 0.35 sec
16000 Hz	0.33 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 16000 Hz 3dB bandwidth: 158 Hz Butterworth, order 2· N= 6 • RMS Calculation: Integration Time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Minimum time between two exceedances: 0.35 sec
17000 Hz	0.33 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 17000 Hz 3dB bandwidth: 158 Hz Butterworth, order 2· N= 6 • RMS Calculation: Integration Time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Minimum time between two exceedances: 0.35sec

4.2.2.3.-STDS

Intermediate studies submitted by the manufacturer (ALSTOM) ensure compliance with the limits established by ERA/ERTMS 033281. Pending the issuance of a report by the certifying body.

4.2.2.4.-ME 3091/ME 5091

The track circuit complies with the limits established by ERA/ERTMS 033281. The current limits considered for this train detection system will be those specified in the national standard Order TMA 576/2020.

Table 09

Frequency Range	Interference Current Limit [rms value]	Evaluation method	Evaluation parameters
11,000 Hz	1.5 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 11,000 Hz 3dB bandwidth: 1200 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec
12,000 Hz	1.5 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 12,000 Hz 3dB bandwidth: 1400 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec
13,000 Hz	1.5 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 13,000 Hz 3dB bandwidth: 1600 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec

Frequency Range	Interference Current Limit [rms value]	Evaluation method	Evaluation parameters
14,000 Hz	1.2 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 14,000 Hz 3dB bandwidth: 1600 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec
15,000 Hz	1.2 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 15,000 Hz 3dB bandwidth: 1800 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec
16,000 Hz	1.2 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 16,000 Hz 3dB bandwidth: 2000 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec
17,000 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 17,000 Hz 3dB bandwidth: 2600 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec

Frequency Range	Interference Current Limit [rms value]	Evaluation method	Evaluation parameters
18,000 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 18,000 Hz 3dB bandwidth: 2800 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec
19,000 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 19,000 Hz 3dB bandwidth: 3000 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec

** Where the integration time to calculate the RMS value is not indicated, the duration of one cycle at the frequency of the considered circuit will be used.

4.2.3.-DC Traction Current (1.5 kV and 3 kV): Limits of electromagnetic induction current.

4.2.3.1.-FTGS

The track circuit complies with the limits established by ERA/ERTMS 033281. The interference current limits considered for this train detection system shall be those specified in EN 50238-2:2020.

Table 10: FTGS 46

Frequency Range	Interference Current Limit [RMS]	Evaluation method	Evaluation parameters
4686–4814 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 4750 Hz 3dB bandwidth: 200 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec
5186-5314 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 5250 Hz 3dB bandwidth: 206 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec
5686-5814 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 5750 Hz 3dB bandwidth: 214 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec

Frequency Range	Interference Current Limit [RMS]	Evaluation method	Evaluation parameters
6186-6314 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 6250 Hz 3dB bandwidth: 220 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec

** Where the integration time is not indicated to calculate the RMS value, the duration of a cycle at the frequency of the circuit under consideration shall be used.

Table 11: FTGS 917

Frequency Range	Interference Current Limit [RMS]	Evaluation method	Evaluation parameters
9436-9564 Hz	0.33 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 9500 Hz 3dB bandwidth: 360 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec
10436-10564 Hz	0.33 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 10500 Hz 3dB bandwidth: 380 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec

Frequency Range	Interference Current Limit [RMS]	Evaluation method	Evaluation parameters
11436-11564 Hz	0.33 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 11500 Hz 3dB bandwidth: 400 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec
12436-12564 Hz	0.33 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 12500 Hz 3dB bandwidth: 425 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec
13436-13564 Hz	0.33 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 13500 Hz 3dB bandwidth: 445 Hz Butterworth, order 2 * N = 6 • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec
14436-14564 Hz	0.33 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 14500 Hz 3dB bandwidth: 470 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec

Frequency Range	Interference Current Limit [RMS]	Evaluation method	Evaluation parameters
15436-15564 Hz	0.33 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 15500 Hz 3dB bandwidth: 490 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec
16436-16564 Hz	0.33 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 16500 Hz 3dB bandwidth: 510 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec

** Where the integration time to calculate the RMS value is not indicated, the duration of one cycle at the frequency of the considered circuit will be used.

4.2.3.2.-TCM100

The track circuit complies with the limits set by ERA/ERTMS 033281 v5. The interference current limits considered for this train detection system will be those specified in the national standard Order TMA 576:2020 and the UNE 50238-2:2020 standard.

Table 12

Frequency Range	Interference Current Limit [RMS]	Evaluation method	Evaluation parameters
4686-4814 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 4750 Hz 3dB bandwidth: 300 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: 0.04 seconds Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec
5186-5314 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 5250 Hz 3dB bandwidth: 300 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: 0.04 seconds Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec
5686-5814 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 5750 Hz 3dB bandwidth: 300 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: 0.04 seconds Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec

Frequency Range	Interference Current Limit [RMS]	Evaluation method	Evaluation parameters
6186-6314 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 6250 Hz 3dB bandwidth: 300 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: 0.04 seconds Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec
9436-9564Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 9500 Hz 3dB bandwidth: 300 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: 0.04 seconds Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec
10436-10564 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 10500 Hz 3dB bandwidth: 300 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: 0.04 seconds Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec
11436-11564 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 11500 Hz 3dB bandwidth: 300 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: 0.04 seconds Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec

Frequency Range	Interference Current Limit [RMS]	Evaluation method	Evaluation parameters
12436-12564 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 12500 Hz 3dB bandwidth: 300 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: 0.04 seconds Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec
13436-13564 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 13500 Hz 3dB bandwidth: 300 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: 0.04 seconds Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec
14436-14564 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 14500 Hz 3dB bandwidth: 300 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: 0.04 seconds Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec
15436-15564 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 15500 Hz 3dB bandwidth: 300 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: 0.04 seconds Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec

Frequency Range	Interference Current Limit [RMS]	Evaluation method	Evaluation parameters
16436-16564 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 16500 Hz 3dB bandwidth: 300 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: 0.04 seconds Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec
17436-17564 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 17500 Hz 3dB bandwidth: 300 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: 0.04 seconds Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec
18436-18564 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 18500 Hz 3dB bandwidth: 300 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: 0.04 seconds Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec
19436-19564 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre Frequency Range: 19500 Hz 3dB bandwidth: 300 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: 0.04 seconds Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Minimum time between two exceedances: 0.08 sec

4.2.3.3.-TTC

The track circuit complies with the limits established by ERA/ERTMS 033281 according to the certificate provided by the company responsible for its technology (ALSTOM). The interference current limits considered for the current train detection system shall be those specified in EN 50238-2:2020, Annex A.

Table 13

Frequency range	Interference current limit [RMS Value]	Evaluation method	Evaluation parameters
4000 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec
4500 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec
5000 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec

Frequency range	Interference current limit [RMS Value]	Evaluation method	Evaluation parameters
5500 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec
6000 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec
6500 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec
9000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec

Frequency range	Interference current limit [RMS Value]	Evaluation method	Evaluation parameters
10000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec
11000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec
12000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec
13000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec

Frequency range	Interference current limit [RMS Value]	Evaluation method	Evaluation parameters
14000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec
15000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec
16000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec
17000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35sec

4.2.3.4.-DIGICODE

The track circuit complies with the limits set by ERA/ERTMS 033281 v5. The interference current limits considered for this train detection system will be those specified in the national standard Order TMA 576:2020 and the UNE 50238-2:2020 standard.

Table 14

Frequency Range	Interference Current Limit [RMS]	Evaluation method	Evaluation parameters
2100 Hz	2.2 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 2100 Hz 3dB bandwidth: 400 Hz Chebyshev order 2 * N = 10, ripple = 0.01 dB • RMS Calculation: Integration time: 1 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 1 sec
2500 Hz	2.2 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 2100 Hz 3dB bandwidth: 400 Hz Chebyshev order 2 * N = 10, ripple = 0.01 dB • RMS Calculation: Integration time: 1 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 1 sec
2900 Hz	1.5 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 2100 Hz 3dB bandwidth: 400 Hz Chebyshev order 2 * N = 10, ripple = 0.01 dB • RMS Calculation: Integration time: 1 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 1 sec
3300 Hz	1.5 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 2100 Hz 3dB bandwidth: 400 Hz Chebyshev order 2 * N = 10, ripple = 0.01 dB • RMS Calculation: Integration time: 1 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 1 sec

Frequency Range	Interference Current Limit [RMS]	Evaluation method	Evaluation parameters
3700 Hz	1.5 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 2100 Hz 3dB bandwidth: 400 Hz Chebyshev order 2 * N = 10, ripple = 0.01 dB • RMS Calculation: Integration time: 1 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 1 sec
4100 Hz	1.5 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 2100 Hz 3dB bandwidth: 400 Hz Chebyshev order 2 * N = 10, ripple = 0.01 dB • RMS Calculation: Integration time: 1 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 1 sec
4500 Hz	1.5 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 2100 Hz 3dB bandwidth: 400 Hz Chebyshev order 2 * N = 10, ripple = 0.01 dB • RMS Calculation: Integration time: 1 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 1 sec
4900 Hz	1.5 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 2100 Hz 3dB bandwidth: 400 Hz Chebyshev order 2 * N = 10, ripple = 0.01 dB • RMS Calculation: Integration time: 1 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 1 sec

4.2.3.5.-ITE JS (HVI)

Considered by Spanish national regulations (Order TMA 576-2020) within the Track Circuits *"immune to interference generated by rolling stock due to the waveform of the signal of the track circuit."*

4.2.3.6.-STDS

Compliance with the limits established by ERA/ERTMS 033281. Certified.

4.2.3.7.-M3091/M5091

The track circuit complies with the limits set by ERA/ERTMS 033281. The interference current limits considered for this train detection system will be those specified in the national standard Order TMA 576/2020.

Table 16

Frequency Range	Interference Current Limit [rms value]	Evaluation method	Evaluation parameters
11,000 Hz	1.5 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 11,000 Hz 3dB bandwidth: 1200 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec
12,000 Hz	1.5 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 12,000 Hz 3dB bandwidth: 1400 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec
13,000 Hz	1.5 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 13,000 Hz 3dB bandwidth: 1600 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec

Frequency Range	Interference Current Limit [rms value]	Evaluation method	Evaluation parameters
14,000 Hz	1.2 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 14,000 Hz 3dB bandwidth: 1600 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec
15,000 Hz	1.2 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 15,000 Hz 3dB bandwidth: 1800 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec
16,000 Hz	1.2 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 16,000 Hz 3dB bandwidth: 2000 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec
17,000 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 17,000 Hz 3dB bandwidth: 2600 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec

Frequency Range	Interference Current Limit [rms value]	Evaluation method	Evaluation parameters
18,000 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 18,000 Hz 3dB bandwidth: 2800 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec
19,000 Hz	1 A	Bandpass filter	• BP Filter characteristics: Centre frequency range: 19,000 Hz 3dB bandwidth: 3000 Hz Butterworth, order 2 * N = 6 • RMS Calculation: Integration Time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec

** Where the integration time to calculate the RMS value is not indicated, the duration of one cycle at the frequency of the considered circuit will be used.

4.2.4.-Measurement, Test, and Evaluation Specification

The measurements have been provided by the respective train detection system suppliers, taking into account the specifications of the prEN50728:2022 standard and the data provided by previous standards such as EN 50238-2:2020, Annex A, and the national standard Order 576/2022.

5.-ANNEX 2: COMPARISON OF EMC PARAMETERS

This Annex provides a detailed comparison of the electromagnetic compatibility values of each train detection system with the limit values provided in the reference standard EN 033281 v5. All results are assessed by indicating whether **OK (✓), NON-OK (✗)** or **significant differences in measurement parameters (✗).**

5.1.1.-COMPLIANCE BY FREQUENCY BANDS

TECHNOLOGY	System	25 KV AC 50 Hz										
		A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11
SIEMENS	FS2000/5000											
	FS3000						✗	✗	✗			
	DSA 50 Hz											
THALES	CV 50 Hz ALCATEL											
ALSTOM	TI21 I-M				✗	✗						
	EBITRACK 400				✗	✓		✗	✗			
	50 Hz (ERICSSON)											
	GRS											
ENYSE	50 Hz ENYSE											
HITACHI	UM71-2000				✗	✗						

3 KV CC										
A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11
			✓	✓	✓	✗	✗			
					✗	✗	✗			
			✗	✗						
			✓			✗				
✗	✗									

TECHNOLOGY	System	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11
SIEMENS	FTG 46						✓	✓	✓			
	FTG 917									✓	✓	✓
	TCM100											
THALES	TTC						✓	✓	✓		✓	✓
ALSTOM	ITE JS (HVI)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	DIGICODE											
ELECTRANS	ME 3091/ME 5091											✓

A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11
					✓	✓	✓			
								✓	✓	✓
					✓	✓	✓	✓	✓	✓
					✓	✓	✓		✓	✓
✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
			✓	✓	✓	✓	✓			
										✓

5.1.2.-FTGS 46

5.1.2.1.-25 kV AC, 50 Hz Electromagnetic Interference Limits

Table A2.1

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**		**Frequency range**	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**
4686-4814 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4750 Hz 3dB-Bandwidth: 200 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4750 Hz 3dB-Bandwidth: 200 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
5186-5314 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5250 Hz 3dB-Bandwidth: 206 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5250 Hz 3dB-Bandwidth: 206 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**		**Frequency range**	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**
5686-5814 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5750 Hz 3dB-Bandwidth: 214 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5750 Hz 3dB-Bandwidth: 214 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
6186-6314 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6250 Hz 3dB-Bandwidth: 220 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6250 Hz 3dB-Bandwidth: 220 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

** Where the Integration time to calculate the RMS value is not indicated, the duration of one cycle at the frequency of the considered circuit will be used.

5.1.2.2.-DC (3 kV, 1.5 kV) ELECTROMAGNETIC INTERFERENCE LIMITS

Table A2.2

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**		**Frequency range**	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**
4686–4814 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4750 Hz 3dB-Bandwidth: 200 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4750 Hz 3dB-Bandwidth: 200 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
5186–5314 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5250 Hz 3dB-Bandwidth: 206 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4750 Hz 3dB-Bandwidth: 200 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
5686–5814 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5750 Hz 3dB-Bandwidth: 214 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4750 Hz 3dB-Bandwidth: 200 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**		**Frequency range**	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**
6186-6314 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6250 Hz 3dB-Bandwidth: 220 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4750 Hz 3dB-Bandwidth: 200 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

** Where the Integration time to calculate the RMS value is not indicated, the duration of one cycle at the frequency of the considered circuit will be used.

5.1.3.-FTGS 917

5.1.3.1.-25 kV AC, 50 Hz Electromagnetic Interference Limits

Table A2.3

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
9436-9564 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 9500 Hz 3dB-Bandwidth: 360 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9320-16755	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 9500 Hz 3dB-Bandwidth: 360 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
10436-10564 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 10500 Hz 3dB-Bandwidth: 380 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9320-16755	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 10500 Hz 3dB-Bandwidth: 380 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
11436-11564 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 11500 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9320-16755	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 11500 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
12436-12564 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 12500 Hz 3dB-Bandwidth: 425 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9320-16755	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 12500 Hz 3dB-Bandwidth: 425 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
13436-13564 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 13500 Hz 3dB-Bandwidth: 445 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9320-16755	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 13500 Hz 3dB-Bandwidth: 445 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
14436-14564 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 14500 Hz 3dB-Bandwidth: 470 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9320-16755	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 14500 Hz 3dB-Bandwidth: 470 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
15436-15564 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 15500 Hz 3dB-Bandwidth: 490 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9320-16755	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 15500 Hz 3dB-Bandwidth: 490 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
16436-16564 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 16500 Hz 3dB-Bandwidth: 510 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9320-16755	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 16500 Hz 3dB-Bandwidth: 510 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

5.1.3.2.-DC (3 kV, 1.5 kV) ELECTROMAGNETIC INTERFERENCE LIMITS

Table A2.4

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**		**Frequency range**	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**
9436-9564 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 9500 Hz 3dB-Bandwidth: 360 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9436-19755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 9500 Hz 3dB-Bandwidth: 360 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
10436-10564 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 10500 Hz 3dB-Bandwidth: 380 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9436-19755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 10500 Hz 3dB-Bandwidth: 380 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
11436-11564 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 11500 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9436-19755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 11500 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
12436-12564 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 12500 Hz 3dB-Bandwidth: 425 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9436-19755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 12500 Hz 3dB-Bandwidth: 425 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
13436-13564 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 13500 Hz 3dB-Bandwidth: 445 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9436-19755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 13500 Hz 3dB-Bandwidth: 445 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
14436-14564 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 14500 Hz 3dB-Bandwidth: 470 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9436-19755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 14500 Hz 3dB-Bandwidth: 470 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
15436-15564 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 15500 Hz 3dB-Bandwidth: 490 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9436-19755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 15500 Hz 3dB-Bandwidth: 490 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
16436-16564 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 16500 Hz 3dB-Bandwidth: 510 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9436-19755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 16500 Hz 3dB-Bandwidth: 510 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

** Where the Integration time to calculate the RMS value is not indicated, the duration of one cycle at the frequency of the considered circuit will be used.

5.1.4.-TCM 100

5.1.4.1.-DC (3 kV, 1.5 kV) ELECTROMAGNETIC INTERFERENCE LIMITS

Table A2.5

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**		**Frequency range**	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**
4686–4814 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4750 Hz 3dB-Bandwidth: 300 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4750 Hz 3dB-Bandwidth: 200 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
5186-5314 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5250 Hz 3dB-Bandwidth: 300 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4750 Hz 3dB-Bandwidth: 206 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
5686-5814 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5750 Hz 3dB-Bandwidth: 300 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4750 Hz 3dB-Bandwidth: 214 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
6186-6314 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6250 Hz 3dB-Bandwidth: 300 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4750 Hz 3dB-Bandwidth: 220 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
9436-9564Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 9500 Hz 3dB-Bandwidth: 300 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9320-19755Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 9500 Hz 3dB-Bandwidth: 360 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
10436-10564 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 10500 Hz 3dB-Bandwidth: 300 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9320-19755Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 10500 Hz 3dB-Bandwidth: 380 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
11436-11564 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 11500 Hz 3dB-Bandwidth: 300 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9320-19755Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 11500 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
12436-12564 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 12500 Hz 3dB-Bandwidth: 300 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9320-19755Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 12500 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
13436-13564 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 13500 Hz 3dB-Bandwidth: 300 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9320-19755Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 13500 Hz 3dB-Bandwidth: 425 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
14436-14564 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 14500 Hz 3dB-Bandwidth: 300 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9320-19755Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 14500 Hz 3dB-Bandwidth: 445 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
15436-15564 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 15500 Hz 3dB-Bandwidth: 300 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9320-19755Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 15500 Hz 3dB-Bandwidth: 470 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
16436-16564 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 16500 Hz 3dB-Bandwidth: 300 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9320-19755Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 16500 Hz 3dB-Bandwidth: 490 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
17436-17564 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 17500 Hz 3dB-Bandwidth: 300 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9320-19755Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 17500 Hz 3dB-Bandwidth: 510 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
18436-18564 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 18500 Hz 3dB-Bandwidth: 300 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9320-19755Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 18500 Hz 3dB-Bandwidth: 510 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
19436-19564 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 19500 Hz 3dB-Bandwidth: 300 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec	✓	9320-19755Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 19500 Hz 3dB-Bandwidth: 510 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

5.1.5.-ACM 250

Table A2.6

THALES-HITACHI								EV	ERTMS 033281 v.5 ERA							
Band	Frequency range defined by the centre frequency [kHz]	Emission limit X Axis [dBµA/m] (RMS)	Emission limit and Axis [dBµA/m] (RMS)	Emission limit Z Axis [dBµA/m] (RMS)	Evaluation method	Filter order (butterworth) and 3 dB-bandwidth	Evaluation parameters		Band	Frequency range defined by the centre frequency [kHz]	Emission limit X Axis [dBµA/m] (RMS)	Emission limit and Axis [dBµA/m] (RMS)	Emission limit Z Axis [dBµA/m] (RMS)	Evaluation method	Filter order (butterworth) and 3 dB-bandwidth	Evaluation parameters
Band 1	42,98	109	94	107	BP	2 ± 160Hz	Integration time: 1.8 ms	✓	Band 1	41.2-44.8	93	83*/90*	98	BP	4th order 320 Hz	20% overlap (3dB points) Integration time: 1ms

5.1.6.-FS2000/5000

5.1.6.1.-DC (3 kV, 1.5 kV) ELECTROMAGNETIC INTERFERENCE LIMITS

Table A2.7

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**		**Frequency range**	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**
1682-1716 Hz	3.7 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 1699 Hz 3dB-Bandwidth: 50 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: 0.21 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.016 sec	×	1500-2700 Hz	0.3 A	FFT	• Time window 1s, Hanning window, • min. 80% overlap Maximum time of exceedance: 0.3s
1984-2018- Hz	3.2 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2001 Hz 3dB-Bandwidth: 50 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: 0.21 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.016 sec	×	1500-2700 Hz	0.3 A	FFT	• Time window 1s, Hanning window, • min. 80% overlap • Maximum time of exceedance: 0.3s

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
2282-2316 Hz	3.3 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2299 Hz 3dB-Bandwidth: 50 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: 0.21 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.016 sec	×	1500-2700 Hz	0.3 A	FFT	• Time window 1s, Hanning window, • min. 80% overlap • Maximum time of exceedance: 0.3s
2584-2618Hz	2.8 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2601 Hz 3dB-Bandwidth: 50 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: 0.21 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.016 sec Min. time between two exceedances: 0.88 sec	×	1500-2700 Hz	0.3 A	FFT	• Time window 1s, Hanning window, • min. 80% overlap • Maximum time of exceedance: 0.3s
4040-4120 Hz	0.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4080 Hz 3dB-Bandwidth: 160 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: 0.4 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.88 sec	× ×	2700-5100 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4100 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2· N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
4280-4360 Hz	0.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4320 Hz 3dB-Bandwidth: 160 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: 0.4 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.88 sec •	✗ ✗	2700-5100 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4500 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2· N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec • Min. time between two exceedances: 1.5 sec
4520-4600 Hz	0.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4560 Hz 3dB-Bandwidth: 160 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: 0.4 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.88 sec •	✗ ✗	2700-5100 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4500 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2· N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec • Min. time between two exceedances: 1.5 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
5000-5080 Hz	0.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5040 Hz 3dB-Bandwidth: 160 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: 0.4 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.88 sec •	✗	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4750 Hz 3dB-Bandwidth: 200 Hz Butterworth, order 2· N= 6 • RMS calculation: Integration time: 0.4 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.80 sec •
5240-5320 Hz	0.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5280 Hz 3dB-Bandwidth: 160 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: 0.4 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.88 sec •	✗	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4750 Hz 3dB-Bandwidth: 200 Hz Butterworth, order 2· N= 6 • RMS calculation: Integration time: 0.4 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.80 sec •

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
5480-5560 Hz	0.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5520 Hz 3dB-Bandwidth: 160 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: 0.4 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.88 sec •	✗	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4750 Hz 3dB-Bandwidth: 200 Hz Butterworth, order 2· N= 6 • RMS calculation: Integration time: 0.4 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.80 sec •
5960-6040 Hz	0.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6000 Hz 3dB-Bandwidth: 160 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: 0.4 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.88 sec •	✗	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4750 Hz 3dB-Bandwidth: 200 Hz Butterworth, order 2· N= 6 • RMS calculation: Integration time: 0.4 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.80 sec •

5.1.7.-FS 3000

5.1.7.1.-25 kV AC, 50 Hz Electromagnetic Interference Limits

Table A2.8

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
4080 Hz	0.52 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4080 Hz 3dB-Bandwidth: 124 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.016 sec Min. time between two exceedances: 0.514 sec	☒ ☒	2700-5100 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4100 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2· N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances:1.5 sec
4320 Hz	0.45 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4320 Hz 3dB-Bandwidth: 124 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.016 sec Min. time between two exceedances: 0.514 sec	☒ ☒	3450-7550 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4250 Hz 3dB-Bandwidth: 600 Hz Butterworth, order 2· N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances:1.5 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
4560 Hz	0.39 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4560 Hz 3dB-Bandwidth: 124 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.016 sec Min. time between two exceedances: 0.514 sec	☒ ☒	2700-5100 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4500 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2· N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances:1.5 sec
5040 Hz	0.66 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5040 Hz 3dB-Bandwidth: 124 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.016 sec Min. time between two exceedances: 0.514 sec	☒ ☒	2700-5100 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4900 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2· N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances:1.5 sec
5280 Hz	0.27 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5280 Hz 3dB-Bandwidth: 124 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.016 sec Min. time between two exceedances: 0.514 sec	☒ ☒	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5250 Hz 3dB-Bandwidth: 206 Hz Butterworth, order 2· N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
5520 Hz	0.27 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5520 Hz 3dB-Bandwidth: 124 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.016 sec Min. time between two exceedances: 0.514 sec	☒ ☒	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5250 Hz 3dB-Bandwidth: 206 Hz Butterworth, order 2· N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
6000 Hz	0.26 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6000 Hz 3dB-Bandwidth: 124 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.016 sec Min. time between two exceedances: 0.514 sec	☒ ☒	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6250 Hz 3dB-Bandwidth: 220 Hz Butterworth, order 2· N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
6480 Hz	0.25 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6480 Hz 3dB-Bandwidth: 124 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.016 sec Min. time between two exceedances: 0.514 sec	☒ ☒	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5250 Hz 3dB-Bandwidth: 206 Hz Butterworth, order 2· N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
6720 Hz	0.24 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6720 Hz 3dB-Bandwidth: 124 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.016 sec Min. time between two exceedances: 0.514 sec	☒ ✕	3450-7550 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6750 Hz 3dB-Bandwidth: 600 Hz Butterworth, order 2· N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances:1.5 sec
7200 Hz	0.24 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 7200 Hz 3dB-Bandwidth: 124 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.016 sec Min. time between two exceedances: 0.514 sec	☒ ✕	3450-7550 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 7250 Hz 3dB-Bandwidth: 600 Hz Butterworth, order 2· N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances:1.5 sec

5.1.7.2.-DC (3 kV, 1.5 kV) ELECTROMAGNETIC INTERFERENCE LIMITS

Table A2.9

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**		**Frequency range**	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**
4080 Hz	0.52 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4080 Hz 3dB-Bandwidth: 124 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.016 sec Min. time between two exceedances: 0.514 sec	✗ ✗	2700-5100 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4100 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2· N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec
4320 Hz	0.45 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4320 Hz 3dB-Bandwidth: 124 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.016 sec Min. time between two exceedances: 0.514 sec	✗ ✗	3450-7550 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4250 Hz 3dB-Bandwidth: 600 Hz Butterworth, order 2· N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
4560 Hz	0.39 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4560 Hz 3dB-Bandwidth: 124 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.016 sec Min. time between two exceedances: 0.514 sec	☒ ☒	2700-5100 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4500 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2· N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec
5040 Hz	0.66 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5040 Hz 3dB-Bandwidth: 124 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.016 sec Min. time between two exceedances: 0.514 sec	☒ ☒	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4750 Hz 3dB-Bandwidth: 200 Hz Butterworth, order 2· N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
5280 Hz	0.27 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5280 Hz 3dB-Bandwidth: 124 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.016 sec Min. time between two exceedances: 0.514 sec	☒ ☒	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5250 Hz 3dB-Bandwidth: 206 Hz Butterworth, order 2· N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
5520 Hz	0.27 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5520 Hz 3dB-Bandwidth: 124 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.016 sec Min. time between two exceedances: 0.514 sec	☒ ✕	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5750 Hz 3dB-Bandwidth: 214 Hz Butterworth, order 2· N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
6000 Hz	0.26 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6000 Hz 3dB-Bandwidth: 124 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.016 sec Min. time between two exceedances: 0.514 sec	☒ ✕	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6250 Hz 3dB-Bandwidth: 220 Hz Butterworth, order 2· N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
6480 Hz	0.25 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6480 Hz 3dB-Bandwidth: 124 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.016 sec Min. time between two exceedances: 0.514 sec	☒ ✕	3450-7550 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6250 Hz 3dB-Bandwidth: 600 Hz Butterworth, order 2· N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
6720 Hz	0.24 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6720 Hz 3dB-Bandwidth: 124 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.016 sec Min. time between two exceedances: 0.514 sec	☒ ✕	3450-7550 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6750 Hz 3dB-Bandwidth: 600 Hz Butterworth, order 2· N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec
7200 Hz	0.24 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 7200 Hz 3dB-Bandwidth: 124 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.016 sec Min. time between two exceedances: 0.514 sec	☒ ✕	3450-7550 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 7250 Hz 3dB-Bandwidth: 600 Hz Butterworth, order 2· N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec

5.1.8.-DSA 50 Hz

5.1.8.1.-DC (3 kV, 1.5 kV) ELECTROMAGNETIC INTERFERENCE LIMITS

Table A2.10

ORDER TMA 576-2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**		**Frequency range**	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**
50 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 50 Hz 3dB-Bandwidth: 2 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.2sec	×	NO DATA			

5.1.9.-TTC

5.1.9.1.-25 kV AC, 50 Hz Electromagnetic Interference Limits

Table A2.11

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
4000 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	×	2700-5100 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4100 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2· N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances:1.5 sec
4500 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4500 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	×	2700-5100 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4500 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2· N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances:1.5 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
5000 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	✓	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5250 Hz 3dB-Bandwidth: 206 Hz Butterworth, order 2· N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
5500 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5500 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	✓	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5250 Hz 3dB-Bandwidth: 206 Hz Butterworth, order 2· N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
6000 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	✓	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6250 Hz 3dB-Bandwidth: 220 Hz Butterworth, order 2· N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
6500 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6500 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	✓	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6250 Hz 3dB-Bandwidth: 220 Hz Butterworth, order 2· N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
9000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 9000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	✗	NO DATA			

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
10000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 10000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	✓	9320-16755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 9500 Hz 3dB-Bandwidth: 360 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
11000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 11000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	✓	9320-16755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 10500 Hz 3dB-Bandwidth: 380 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
12000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 12000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	✓	9320-16755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 11500 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
13000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 13000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	✓	9320-16755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 12500 Hz 3dB-Bandwidth: 425 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
14000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 14000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	✓	9320-16755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 13500 Hz 3dB-Bandwidth: 445 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
15000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 15000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	✓	9320-16755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 14500 Hz 3dB-Bandwidth: 470 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
16000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 16000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	✓	9320-16755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 15500 Hz 3dB-Bandwidth: 490 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
17000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 17000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35sec	✓	9320-16755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 16500 Hz 3dB-Bandwidth: 510 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

5.1.9.2.-DC (3 kV, 1.5 kV) ELECTROMAGNETIC INTERFERENCE LIMITS

Table A2.12

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**		**Frequency range**	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**
4000 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	✓	2700-5100 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4100 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2*N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec
4500 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4500 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	✓	2700-5100 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4500 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2*N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
5000 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	✓	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4750 Hz 3dB-Bandwidth: 200 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
5500 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5500 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	✓	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5250 Hz 3dB-Bandwidth: 206 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
6000 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	✓	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5750 Hz 3dB-Bandwidth: 214 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
6500 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6500 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	✓	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6250 Hz 3dB-Bandwidth: 220 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
9000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 9000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	✗	NO DATA			
10000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 10000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	✓	9320-19755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 9500 Hz 3dB-Bandwidth: 360 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
11000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 11000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	✓	9320-19755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 10500 Hz 3dB-Bandwidth: 380 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
12000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 12000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	✓	9320-19755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 11500 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
13000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 13000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	✓	9320-19755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 12500 Hz 3dB-Bandwidth: 425 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
14000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 14000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	✓	9320-19755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 13500 Hz 3dB-Bandwidth: 445 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
15000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 15000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	✓	9320-19755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 14500 Hz 3dB-Bandwidth: 470 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
16000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 16000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35 sec	✓	9320-19755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 15500 Hz 3dB-Bandwidth: 490 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
17000 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 17000 Hz 3dB-Bandwidth: 158 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.02 sec Min. time between two exceedances: 0.35sec	✓	9320-19755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 16500 Hz 3dB-Bandwidth: 510 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

5.1.10.-AZLM: Pedal Zp30H, Zp30K

Table A2.13

THALES-HITACHI								EV	ERTMS 033281 v.5 ERA							
Band	Frequency range defined by the centre frequency [kHz]	Emission limit X Axis [dBµA/m] (RMS)	Emission limit and Axis [dBµA/m] (RMS)	Emission limit Z Axis [dBµA/m] (RMS)	Evaluation method	Filter order (butterworth) and 3 dB-bandwidth	Evaluation parameters		Band	Frequency range defined by the centre frequency [kHz]	Emission limit X Axis [dBµA/m] (RMS)	Emission limit and Axis [dBµA/m] (RMS)	Emission limit Z Axis [dBµA/m] (RMS)	Evaluation method	Filter order (butterworth) and 3 dB-bandwidth	Evaluation parameters
Band 1	27-32	114	94	101	BP	4th order +-12 Hz	Integration time: 4 ms	✓	Band 1	27-41.2	93	93	98	BP	4th order 300 Hz	20% overlap (3dB points) Integration time: 1 ms

5.1.11.-SIG L90: Pedal Zp30C

Table A2.14

THALES-HITACHI								EV	ERTMS 033281 v.5 ERA							
Band	Frequency range defined by the centre frequency [kHz]	Emission limit X Axis [dBµA/m] (RMS)	Emission limit and Axis [dBµA/m] (RMS)	Emission limit Z Axis [dBµA/m] (RMS)	Evaluation method	Filter order (butterworth) and 3 dB-bandwidth	Evaluation parameters		Band	Frequency range defined by the centre frequency [kHz]	Emission limit X Axis [dBµA/m] (RMS)	Emission limit and Axis [dBµA/m] (RMS)	Emission limit Z Axis [dBµA/m] (RMS)	Evaluation method	Filter order (butterworth) and 3 dB-bandwidth	Evaluation parameters
Band 1	27-32	114	94	101	BP	4th order +-12 Hz	Integration time: 4 ms	✓	Band 1	27-41.2	93	93	98	BP	4th order 300 Hz	20% overlap (3dB points) Integration time: 1 ms

5.1.12.-RSL: Pedal Zp30C

Table A2.15

THALES-HITACHI								EV	ERTMS 033281 v.5 ERA							
Band	Frequency range defined by the centre frequency [kHz]	Emission limit X Axis [dBµA/m] (RMS)	Emission limit and Axis [dBµA/m] (RMS)	Emission limit Z Axis [dBµA/m] (RMS)	Evaluation method	Filter order (butterworth) and 3 dB-bandwidth	Evaluation parameters		Band	Frequency range defined by the centre frequency [kHz]	Emission limit X Axis [dBµA/m] (RMS)	Emission limit and Axis [dBµA/m] (RMS)	Emission limit Z Axis [dBµA/m] (RMS)	Evaluation method	Filter order (butterworth) and 3 dB-bandwidth	Evaluation parameters
Band 1	27-32	114	94	101	BP	4th order +-12 Hz	Integration time: 4 ms	✓	Band 1	27-41.2	93	93	98	BP	4th order 300 Hz	20% overlap (3dB points) Integration time: 1 ms

5.1.13.-CV 50 Hz ALCATEL

5.1.13.1.-DC (3 kV, 1.5 kV) ELECTROMAGNETIC INTERFERENCE LIMITS

Table A2.16

ORDER TMA 576-2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**		**Frequency range**	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**
50 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 50 Hz 3dB-Bandwidth: 2 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.2sec	✕	NO DATA			

5.1.14.-ITE JS (HVI)

5.1.14.1.-DC (3 kV, 1.5 kV) ELECTROMAGNETIC INTERFERENCE LIMITS

Considered by Spanish national regulations (Order TMA 576-2020) within the Track Circuits *"immune to interference generated by rolling stock due to the waveform of the signal of the track circuit."*

5.1.15.-DIGICODE

5.1.15.1.-DC (3 kV, 1.5 kV) ELECTROMAGNETIC INTERFERENCE LIMITS

Table A2.17

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
2100 Hz	2.2 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2100 Hz 3dB-Bandwidth: 400 Hz Tchebyshev order 2*N= 10, Ripple= 0.01 dB • RMS calculation: Integration time: 1 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 1 sec	✓	1900-2700 Hz	2.2 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2100 Hz 3dB-Bandwidth: 400 Hz Tchebyshev order 2*N= 10, Ripple= 0.01 dB • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec
2500 Hz	2.2 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2500 Hz 3dB-Bandwidth: 400 Hz Tchebyshev order 2*N= 10, Ripple= 0.01 dB • RMS calculation: Integration time: 1 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 1 sec	✓	1900-2700 Hz	2.2 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2500 Hz 3dB-Bandwidth: 400 Hz Tchebyshev order 2*N= 10, Ripple= 0.01 dB • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
2900 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2900 Hz 3dB-Bandwidth: 400 Hz Tchebyshev order 2*N= 10, Ripple= 0.01 dB • RMS calculation: Integration time: 1 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 1 sec	✓	2700-5100 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2900 Hz 3dB-Bandwidth: 400 Hz Tchebyshev order 2*N= 10, Ripple= 0.01 dB • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec
3300 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 3300 Hz 3dB-Bandwidth: 400 Hz Tchebyshev order 2*N= 10, Ripple= 0.01 dB • RMS calculation: Integration time: 1 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 1 sec	✓	2700-5100 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 3300 Hz 3dB-Bandwidth: 400 Hz Tchebyshev order 2*N= 10, Ripple= 0.01 dB • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec
3700 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 3700 Hz 3dB-Bandwidth: 400 Hz Tchebyshev order 2*N= 10, Ripple= 0.01 dB • RMS calculation: Integration time: 1 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 1 sec	✓	2700-5100 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 3700 Hz 3dB-Bandwidth: 400 Hz Tchebyshev order 2*N= 10, Ripple= 0.01 dB • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
4100 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2100 Hz 3dB-Bandwidth: 400 Hz Tchebyshev order 2*N= 10, Ripple= 0.01 dB • RMS calculation: Integration time: 1 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 1 sec	✓	2700-5100 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4100 Hz 3dB-Bandwidth: 400 Hz Tchebyshev order 2*N= 10, Ripple= 0.01 dB • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec
4500 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2100 Hz 3dB-Bandwidth: 400 Hz Tchebyshev order 2*N= 10, Ripple= 0.01 dB • RMS calculation: Integration time: 1 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 1 sec	✓	2700-5100 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4500 Hz 3dB-Bandwidth: 400 Hz Tchebyshev order 2*N= 10, Ripple= 0.01 dB • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec
4900 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2100 Hz 3dB-Bandwidth: 400 Hz Tchebyshev order 2*N= 10, Ripple= 0.01 dB • RMS calculation: Integration time: 1 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 1 sec	✓	2700-5100 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 4900 Hz 3dB-Bandwidth: 400 Hz Tchebyshev order 2*N= 10, Ripple= 0.01 dB • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec

5.1.16.-TI21 I-M

5.1.16.1.-25 kV AC, 50 Hz Electromagnetic Interference Limits

Table A2.18

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
1533-1566 Hz	0.806 A	Band-Pass Filter	• BP filter characteristics: 1550 Centre frequencies range: 1549 Hz 3dB-Bandwidth: 12 Hz Butterworth, order 2*N= * • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec	☒ ☒	1500-3200 Hz	3 A	FFT	• Time window 1s, Hanning window, • Min. 80% overlap • Maximum time of exceedance: 0.3s
1682-1716 Hz	0.731 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 1699 Hz 3dB-Bandwidth: 12 Hz Butterworth, order 2*N= * • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec	☒ ☒	1500-3200 Hz	3 A	FFT	• Time window 1s, Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
1831-1865 Hz	0.753 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 1848 Hz 3dB-Bandwidth: 12 Hz Butterworth, order 2*N= * • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec	☒ ✕	1500-3200 Hz	3 A	FFT	• Time window 1s, Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
1979-2013 Hz	0.696 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 1996 Hz 3dB-Bandwidth: 12 Hz Butterworth, order 2*N= * • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec	☒ ✕	1900-2700 Hz	2.2 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2100 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2*N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec
2129-2163 Hz	0.498 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2146 Hz 3dB-Bandwidth: 12 Hz Butterworth, order 2*N= * • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec	☒ ✕	1900-2700 Hz	2.2 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2100 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2*N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
2279-2313 Hz	0.492 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2296 Hz 3dB-Bandwidth: 12 Hz Butterworth, order 2*N= * • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec	☒ ✕	1900-2700 Hz	2.2 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2100 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2*N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec
2428-2462 Hz	0.44 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2445 Hz 3dB-Bandwidth: 12 Hz Butterworth, order 2*N= * • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec	☒ ✕	1900-2700 Hz	2.2 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2100 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2*N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec
2576-2610 Hz	0.416 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2593 Hz 3dB-Bandwidth: 12 Hz Butterworth, order 2*N= * • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec	☒ ✕	1900-2700 Hz	2.2 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2100 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2*N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec

5.1.16.2. DC (3 kV, 1.5 kV) ELECTROMAGNETIC INTERFERENCE LIMITS

Table A2.19

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**		**Frequency range**	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**
1533-1566 Hz	0.134 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 1549 Hz 3dB-Bandwidth: 12 Hz Butterworth, order 2*N= * • RMS calculation: Integration time: 2 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec	☒ ☒	1500-2700 Hz	3 A	FFT	• Time window 1s, Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
1682-1716 Hz	0.101 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 1699 Hz 3dB-Bandwidth: 12 Hz Butterworth, order 2*N= * • RMS calculation: Integration time: 2 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec	☒ ☒	1500-2700 Hz	0.3 A	FFT	• Time window 1s, Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
1831-1865 Hz	0.142 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 1848 Hz 3dB-Bandwidth: 12 Hz Butterworth, order 2*N= * • RMS calculation: Integration time: 2 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec	☒ ☒	1500-2700 Hz	3 A	FFT	• Time window 1s, Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
1979-2013 Hz	0.091 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 1996 Hz 3dB-Bandwidth: 12 Hz Butterworth, order 2*N= * • RMS calculation: Integration time: 2 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec	☒ ✕	1900-2700 Hz	2.2 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2100 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2*N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec
2129-2163 Hz	0.148 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2146 Hz 3dB-Bandwidth: 12 Hz Butterworth, order 2*N= * • RMS calculation: Integration time: 2 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec	☒ ✕	1900-2700 Hz	2.2 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2100 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2*N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec
2279-2313 Hz	0.132 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2296 Hz 3dB-Bandwidth: 12 Hz Butterworth, order 2*N= * • RMS calculation: Integration time: 2 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec	☒ ✕	1900-2700 Hz	2.2 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2100 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2*N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
2428-2462 Hz	0.143 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2445 Hz 3dB-Bandwidth: 12 Hz Butterworth, order 2*N= * • RMS calculation: Integration time: 2 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec	☒ ☒	1900-2700 Hz	2.2 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2500 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2*N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec
2576-2610 Hz	0.167 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2593 Hz 3dB-Bandwidth: 12 Hz Butterworth, order 2*N= * • RMS calculation: Integration time: 2 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec	☒ ☒	1900-2700 Hz	2.2 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2500 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2*N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec

5.1.17.-EBITRACK 400

5.1.17.1.-25 kV AC, 50 Hz Electromagnetic Interference Limits

Table A2.20: EBITRACK 400:25kv 50Hz Frequency Limits in Double-Track Track Circuits in Full Track for In-Band Frequencies

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
1544-1554 Hz	0.953 [A]	FFT	• Time window 1s • Hanning window • 50% overlap	✗	1500-3200 Hz	3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap • Maximum time of exceedance: 0.3s
1694-1704 Hz	0.936 [A]	FFT	• Time window 1s • Hanning window • 50% overlap	✗	1500-3200 Hz	3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
1843-1853Hz	0.810 [A]	FFT	• Time window 1s • Hanning window • 50% overlap	✗	1500-3200 Hz	3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
1991-2001 Hz	0.778 [A]	FFT	• Time window 1s • Hanning window • 50% overlap	✗	1500-3200 Hz	3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
2141-2151 Hz	0.663 [A]	FFT	• Time window 1s • Hanning window • 50% overlap	✗	1500-3200 Hz	3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
2291-2301 Hz	0.628 [A]	FFT	• Time window 1s • Hanning window • 50% overlap	✗	1500-3200 Hz	3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
2440-2450 Hz	0.545 [A]	FFT	• Time window 1s • Hanning window • 50% overlap	✗	1500-3200 Hz	3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**		**Frequency range**	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**
2588-2598 Hz	0.547 [A]	FFT	• Time window 1s • Hanning window • 50% overlap	✓	1500-3200 Hz	0.3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s

Table A2.21: EBITRACK 400 25kv 50Hz: Out-of-Band Frequency Limit in Double-Lane Track Circuits in the Track

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**		**Frequency range**	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**
1554-1594 Hz	2,383 A	FFT	• Time window 1s • Hanning window • 50% overlap	✓	1500-3200 Hz	0.3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
1705-1744 Hz	2,340 A	FFT	• Time window 1s • Hanning window • 50% overlap	✓	1500-3200 Hz	0.3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
1854-1894 Hz	2,025 A	FFT	• Time window 1s • Hanning window • 50% overlap	✓	1500-3200 Hz	0.3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
2002-204 Hz	1.945 A	FFT	• Time window 1s • Hanning window • 50% overlap	✓	1500-3200 Hz	0.3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
2152-2194 Hz	1,658 A	FFT	• Time window 1s • Hanning window • 50% overlap	✓	1500-3200 Hz	0.3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
2302-2344 Hz	1,570 A	FFT	• Time window 1s • Hanning window • 50% overlap	✓	1500-3200 Hz	0.3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
2451-2494 Hz	1,363 A	FFT	• Time window 1s • Hanning window • 50% overlap	✓	1500-3200 Hz	0.3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
2599-2644 Hz	1,368 A	FFT	• Time window 1s • Hanning window • 50% overlap	✗	1500-3200 Hz	3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s

Table A2.22: EBITRACK 400 25kv 50Hz: Frequency Limit in Double Lane Track Circuits in Station Areas

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**		**Frequency range**	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**
5665-5735 Hz	1,081 A	FFT	• Time window 1s • Hanning window • 50% overlap	☒ ☓	3450-7550 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5750 Hz 3dB-Bandwidth: 600 Hz Butterworth, order 2· N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances:1.5 sec
6065-6135 Hz	1,073 A	FFT	• Time window 1s • Hanning window • 50% overlap	☒ ☓	3450-7550 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6250 Hz 3dB-Bandwidth: 600 Hz Butterworth, order 2· N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances:1.5 sec
6465-6535 Hz	1.052 A	FFT	• Time window 1s • Hanning window • 50% overlap	☒ ☓	3450-7550 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6250 Hz 3dB-Bandwidth: 600 Hz Butterworth, order 2· N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances:1.5 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
6865-6935 Hz	1.062 A	FFT	• Time window 1s • Hanning window • 50% overlap	✗ ✗	3450-7550 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range:6750 Hz 3dB-Bandwidth: 600 Hz Butterworth, order 2· N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances:1.5 sec
7265-7335 Hz	1,046 A	FFT	• Time window 1s • Hanning window • 50% overlap	✗ ✗	3450-7550 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 7250 Hz 3dB-Bandwidth: 600 Hz Butterworth, order 2· N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances:1.5 sec
7665-7735 Hz	1.058 A	FFT	• Time window 1s • Hanning window • 50% overlap	✗	NO DATA			
8065-8135 Hz	1,053 A	FFT	• Time window 1s • Hanning window • 50% overlap	✗	NO DATA			
8465-8535 Hz	1,149 A	FFT	• Time window 1s • Hanning window • 50% overlap	✗	NO DATA			

5.1.17.2. DC (3 kV, 1.5 kV) ELECTROMAGNETIC INTERFERENCE LIMITS

Table A2.23: EBITRACK 400:3kv DC Frequency Limits in Double-Lane Track Circuits in Full Track for In-Band Frequencies

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**		**Frequency range**	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**
1544-1554 Hz	0.953 [A]	FFT	• Time window 1s • Hanning window • 50% overlap	✗	1500-2700 Hz	3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
1694-1704 Hz	0.936 [A]	FFT	• Time window 1s • Hanning window • 50% overlap	✓	1500-2700 Hz	0.3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
1843-1853Hz	0.810 [A]	FFT	• Time window 1s • Hanning window • 50% overlap	✗	1500-2700 Hz	3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
1991-2001 Hz	0.778 [A]	FFT	• Time window 1s • Hanning window • 50% overlap	✓	1500-2700 Hz	0.3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
2141-2151 Hz	0.663 [A]	FFT	• Time window 1s • Hanning window • 50% overlap	✗	1500-2700 Hz	3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
2291-2301 Hz	0.628 [A]	FFT	• Time window 1s • Hanning window • 50% overlap	✓	1500-2700 Hz	0.3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
2440-2450 Hz	0.545 [A]	FFT	• Time window 1s • Hanning window • 50% overlap	✗	1500-2700 Hz	3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
2588-2598 Hz	0.547 [A]	FFT	• Time window 1s • Hanning window • 50% overlap	✓	1500-2700 Hz	0.3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s

Table A2.24: EBITRACK 400 3kv DC: Frequency Limits in Double-Lane Track Circuits in Full Track for In-Band Frequencies

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**		**Frequency range**	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**
1554-1594 Hz	2,383 A	FFT	• Time window 1s • Hanning window • 50% overlap	✗	1500-2700 Hz	3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
1705-1744 Hz	2,340 A	FFT	• Time window 1s • Hanning window • 50% overlap	✓	1500-2700 Hz	0.3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
1854-1894 Hz	2,025 A	FFT	• Time window 1s • Hanning window • 50% overlap	✓	1500-2700 Hz	0.3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
2002-2044 Hz	1.945 A	FFT	• Time window 1s • Hanning window • 50% overlap	✗	1500-2700 Hz	3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
2152-2194 Hz	1,658 A	FFT	• Time window 1s • Hanning window • 50% overlap	✗	1500-2700 Hz	3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
2302-2344 Hz	1,570 A	FFT	• Time window 1s • Hanning window • 50% overlap	✗	1500-2700 Hz	3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
2451-2494 Hz	1,363 A	FFT	• Time window 1s • Hanning window • 50% overlap	✗	1500-2700 Hz	3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s
2599-2644 Hz	1,368 A	FFT	• Time window 1s • Hanning window • 50% overlap	✓	1500-2700 Hz	0.3 A	FFT	• Time window 1s, • Hanning window, • Min. 80% overlap Maximum time of exceedance: 0.3s

Table A2.25: EBITRACK 400 3kv DC: Frequency Limits in Double-Lane Track Circuits in Full Track for In-Band Frequencies

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**		**Frequency range**	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**
5665-5735 Hz	1,081 A	FFT	• Time window 1s • Hanning window • 50% overlap	×	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5250 Hz 3dB-Bandwidth: 206 Hz Butterworth, order 2· N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
6065-6135 Hz	1,073 A	FFT	• Time window 1s • Hanning window • 50% overlap	×	4650-6360 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 5250 Hz 3dB-Bandwidth: 206 Hz Butterworth, order 2· N= 6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
6465-6535 Hz	1.052 A	FFT	• Time window 1s • Hanning window • 50% overlap	☒ ☒	3450-7550 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6750 Hz 3dB-Bandwidth: 600 Hz Butterworth, order 2· N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances:1.5 sec
6865-6935 Hz	1.062 A	FFT	• Time window 1s • Hanning window • 50% overlap	☒ ☒	3450-7550 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6750 Hz 3dB-Bandwidth: 600 Hz Butterworth, order 2· N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances:1.5 sec
7265-7335 Hz	1,046 A	FFT	• Time window 1s • Hanning window • 50% overlap	☒ ☒	3450-7550 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 6750 Hz 3dB-Bandwidth: 600 Hz Butterworth, order 2· N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances:1.5 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
7665-7735 Hz	1.058 A	FFT	• Time window 1s • Hanning window • 50% overlap	×	NO DATA			
8065-8135 Hz	1,053 A	FFT	• Time window 1s • Hanning window • 50% overlap	×	NO DATA			
8465-8535 Hz	1,149 A	FFT	• Time window 1s • Hanning window • 50% overlap	×	NO DATA			

5.1.18.-50 Hz (ERICSSON)

5.1.18.1.-DC (3 kV, 1.5 kV) Electromagnetic interference limits

Table A2.26

ORDER TMA 576-2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
50 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 50 Hz 3dB-Bandwidth: 2 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.2sec	×	NO DATA			

5.1.19.-GRS

5.1.19.1.-DC (3 kV, 1.5 kV) ELECTROMAGNETIC INTERFERENCE LIMITS

Table A2.27

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
75 Hz	0.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 57 Hz 3dB-Bandwidth: 20 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.2 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.2 sec Min. time between two exceedances: 1.7 sec	✗ ✗	70.5-79.5 Hz	1.9 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 75 Hz 3dB-Bandwidth: 5 Hz Butterworth, order 2*N= 8 • RMS calculation: Integration time: 0.5 sec Time overlap: min 75% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 2 sec
225 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 225 Hz 3dB-Bandwidth: 20 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.2 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.2 sec Min. time between two exceedances: 1.7 sec	✗	205.5-245.4 Hz	4 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 225.45 Hz 3dB-Bandwidth: 6.5 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.5 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.2 sec Min. time between two exceedances: 2 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
375 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 375 Hz 3dB-Bandwidth: 20 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.2 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.2 sec Min. time between two exceedances: 1.7 sec	×	NO DATA			
525 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 525 Hz 3dB-Bandwidth: 20 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.2 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.2 sec Min. time between two exceedances: 1.7 sec	×	NO DATA			
675 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 675 Hz 3dB-Bandwidth: 20 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: 0.2 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.2 sec Min. time between two exceedances: 1.7 sec	×	NO DATA			

5.1.20.-50 Hz ENYSE

5.1.20.1.-DC (3 kV, 1.5 kV) ELECTROMAGNETIC INTERFERENCE LIMITS

Table A2.28

ORDER TMA 576-2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**		**Frequency range**	**Interference current limit [rms value]**	**Evaluation method**	**Evaluation parameters**
50 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 50 Hz 3dB-Bandwidth: 2 Hz Butterworth, order 2· N= * • RMS calculation: Integration time: 0.02 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.2sec	×	NO DATA			

5.1.21.-UM71-2000

5.1.21.1.-25 kV AC, 50 Hz Electromagnetic Interference Limits

Table A2.29

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
1700 Hz	0.3 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 1700 Hz 3dB-Bandwidth: 90 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.3 sec	☒ ☒	1500-3200 Hz	3 A	FFT	• Time window 1s • Hanning window, • Min. 80% overlap • Maximum time of exceedance: 0.3s
2000 Hz	0.3 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2000 Hz 3dB-Bandwidth: 90 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.3 sec	☒ ☒	1900-2700 Hz	2.2 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2100 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2*N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec

EN 50238-2:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
2300 Hz	0.3 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2300 Hz 3dB-Bandwidth: 90 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.3 sec	☒ ☒	1900-2700 Hz	2.2 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2100 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2*N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec
2600 Hz	0.3 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2600 Hz 3dB-Bandwidth: 90 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.3 sec	☒ ☒	1900-2700 Hz	2.2 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 2100 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2*N= 10 • RMS calculation: Integration time: 1 sec Time overlap: min 90% • Evaluation criteria: Maximum time of exceedance: 1 sec Min. time between two exceedances: 1.5 sec

5.1.22.-RSR122

Table A2.30

FRAUSCHER								EV	ERTMS 033281 v.5 ERA							
Band	Frequency range defined by the centre frequency [kHz]	Emission limit X Axis [dBµA/m] (RMS)	Emission limit and Axis [dBµA/m] (RMS)	Emission limit Z Axis [dBµA/m] (RMS)	Evaluation method	Filter order (butterworth) and 3 dB-bandwidth	Evaluation parameters		Band	Frequency range defined by the centre frequency [kHz]	Emission limit X Axis [dBµA/m] (RMS)	Emission limit and Axis [dBµA/m] (RMS)	Emission limit Z Axis [dBµA/m] (RMS)	Evaluation method	Filter order (butterworth) and 3 dB-bandwidth	Evaluation parameters
Band 3 (RSR122 SYS1)	1115 to 1145	99,7	78,6	61,7	BP	4th order; 6.0 kHz	20% overlap (3dB points) Integration time: 2 ms	✗	Band 3	1026-1250	119	113	113	BP	4th order; 10 kHz	20% overlap (3dB-points), Integration time 1.5 ms
Band 3 (RSR122 SYS2)	1020 to 1050	99,8	78,3	61,8	BP	4th order 6.0 kHz	20% overlap (3dB points) Integration time: 2 ms	✗	Band 3	1026-1250	119	113	113	BP	4th order; 10 kHz	20% overlap (3dB-points), Integration time 1.5 ms

Table A2.31

Frequency Range	Field Address	Increased magnetic field limits for a reduced integration time of 0.5 x T_{int} [dB]	Increased magnetic field limits for a reduced integration time of 0.25 x T_{int} [dB]
27 to 52 kHz	X	2	6
27 to 52 kHz	Y, Z	6	12
234 to 287 kHz	X, Y, Z	6	12
287 to 363 kHz	X, Y, Z	3	6
740 to 1026 kHz	X, Y, Z	6	12
1020 to 1050 kHz	X, Y, Z	6	12
1115 to 1145 kHz	X, Y, Z	6	12

5.1.23.-RSR123

Table A2.32

FRAUSCHER								EV	ERTMS 033281 v.5 ERA							
Band	Frequency range defined by the centre frequency [kHz]	Emission limit X Axis [dBµA/m] (RMS)	Emission limit and Axis [dBµA/m] (RMS)	Emission limit Z Axis [dBµA/m] (RMS)	Evaluation method	Filter order (butterworth) and 3 dB-bandwidth	Evaluation parameters		Band	Frequency range defined by the centre frequency [kHz]	Emission limit X Axis [dBµA/m] (RMS)	Emission limit and Axis [dBµA/m] (RMS)	Emission limit Z Axis [dBµA/m] (RMS)	Evaluation method	Filter order (butterworth) and 3 dB-bandwidth	Evaluation parameters
SYS1	1000.0 - ± 1.0	120.5	114.5	114.5	BP	4 ±3.0	Integration time: 2 ms	✓	Band 3	740-1026	106	85	101	BP	4th order; 10 kHz	20% overlap (3dB-points), Integration time: 1.5 ms
SYS2	1228.8 - ± 1.0	119.5	113.6	113.6	BP	4 ±3.0	Integration time: 2 ms	✓	Band 3	1026-1250	119	113	113	BP	4th order; 10 kHz	20% overlap (3dB-points), Integration time 1.5 ms

5.1.24.-RSR180

Table A2.33

FRAUSCHER								EV	ERTMS 033281 v.5 ERA							
Band	Frequency range defined by the centre frequency [kHz]	Emission limit X Axis [dBµA/m] (RMS)	Emission limit and Axis [dBµA/m] (RMS)	Emission limit Z Axis [dBµA/m] (RMS)	Evaluation method	Filter order (butterworth) and 3 dB-bandwidth	Evaluation parameters		Band	Frequency range defined by the centre frequency [kHz]	Emission limit X Axis [dBµA/m] (RMS)	Emission limit and Axis [dBµA/m] (RMS)	Emission limit Z Axis [dBµA/m] (RMS)	Evaluation method	Filter order (butterworth) and 3 dB-bandwidth	Evaluation parameters
Band 2	250.0 - ± 1.0	121	113.8	101.0	BP	4 ±5.0	Integration time: 1.5 ms	✓	Band 2	234-287	120	99	100	BP	4th order; 7500 Hz	20% overlap (3dB-points), Integration time: 1.5 ms

5.1.1.-DEF 87-CE (E-CE-95)

Table A2.34

EN 50238-3:2020								EV	ERTMS 033281 v.5 ERA							
Band	Frequency range defined by the centre frequency [kHz]	Emission limit X Axis [dBµA/m] (RMS)	Emission limit and Axis [dBµA/m] (RMS)	Emission limit Z Axis [dBµA/m] (RMS)	Evaluation method	Filter order (butterworth) and 3 dB-bandwidth	Evaluation parameters		Band	Frequency range defined by the centre frequency [kHz]	Emission limit X Axis [dBµA/m] (RMS)	Emission limit and Axis [dBµA/m] (RMS)	Emission limit Z Axis [dBµA/m] (RMS)	Evaluation method	Filter order (butterworth) and 3 dB-bandwidth	Evaluation parameters
Band 1	34.1- ± 7.1	93	93	98	BP	4th order 300 Hz	20% overlap (3dB points) Integration time: 1 ms	✓	Band 1	27-41.2	93	93	98	BP	4th order 300 Hz	20% overlap (3dB points) Integration time: 1 ms
Band 1	43- ± 1.8	93	83 / 90	98	BP	4th order 300 Hz	20% overlap (3dB points) Integration time: 1 ms	✓	Band 1	44.8-52	93	93	98	BP	4th order 300 Hz	20% overlap (3dB points) Integration time: 1 ms
Band 1	48.4- ± 3.6	93	93	98	BP	4th order 300 Hz	20% overlap (3dB points) Integration time: 1 ms	✓	Band 1	44.8-52	93	93	98	BP	4th order 300 Hz	20% overlap (3dB points) Integration time: 1 ms

5.1.3.-ME3091 /ME 5091

5.1.3.1.-25 kV AC, 50 Hz Electromagnetic Interference Limits

Table A2.35

Order TMA 576:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
11,000 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 11,000 Hz 3dB-Bandwidth: 1200 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec	✓	9320-16755	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 11500 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
12,000 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 12,000 Hz 3dB-Bandwidth: 1400 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec	✓	9320-16755	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 12500 Hz 3dB-Bandwidth: 425 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

Order TMA 576:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
13,000 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 13,000 Hz 3dB-Bandwidth: 1600 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec	✓	9320-16755	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 13500 Hz 3dB-Bandwidth: 445 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
14,000 Hz	1.2 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 14,000 Hz 3dB-Bandwidth: 1600 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec	✓	9320-16755	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 14500 Hz 3dB-Bandwidth: 470 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

Order TMA 576:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
15,000 Hz	1.2 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 15,000 Hz 3dB-Bandwidth: 1800 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec	✓	9320-16755	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 15500 Hz 3dB-Bandwidth: 490 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
16,000 Hz	1.2 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 16,000 Hz 3dB-Bandwidth: 2000 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec	✓	9320-16755	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 16500 Hz 3dB-Bandwidth: 510 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
17,000 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 17,000 Hz 3dB-Bandwidth: 2600 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec	✗	NO DATA			

Order TMA 576:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
18,000 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 18,000 Hz 3dB-Bandwidth: 2800 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec	×	NO DATA			
19,000 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 19,000 Hz 3dB-Bandwidth: 3000 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec	×	NO DATA			

5.1.3.2.-DC (3 kV, 1.5 kV) Electromagnetic interference limits

Table A2.36

Order TMA 576:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
11,000 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 11,000 Hz 3dB-Bandwidth: 1200 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec	✓	9436-19755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 11500 Hz 3dB-Bandwidth: 400 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
12,000 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 12,000 Hz 3dB-Bandwidth: 1400 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec	✓	9436-19755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 12500 Hz 3dB-Bandwidth: 425 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
13,000 Hz	1.5 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 13,000 Hz 3dB-Bandwidth: 1600 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec	✓	9436-19755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 13500 Hz 3dB-Bandwidth: 445 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

Order TMA 576:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
14,000 Hz	1.2 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 14,000 Hz 3dB-Bandwidth: 1600 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec	✓	9436-19755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 14500 Hz 3dB-Bandwidth: 470 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
15,000 Hz	1.2 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 15,000 Hz 3dB-Bandwidth: 1800 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec	✓	9436-19755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 15500 Hz 3dB-Bandwidth: 490 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
16,000 Hz	1.2 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 16,000 Hz 3dB-Bandwidth: 2000 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec	✓	9436-19755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 16500 Hz 3dB-Bandwidth: 510 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

Order TMA 576:2020				EV	ERTMS 033281 v.5 ERA			
Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters		Frequency range	Interference current limit [rms value]	Evaluation method	Evaluation parameters
17,000 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 17,000 Hz 3dB-Bandwidth: 2600 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec	✓	9436-19755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 17500 Hz 3dB-Bandwidth: 510 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
18,000 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 18,000 Hz 3dB-Bandwidth: 2800 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec	✓	9436-19755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 18500 Hz 3dB-Bandwidth: 510 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec
19,000 Hz	1 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 19,000 Hz 3dB-Bandwidth: 3000 Hz Butterworth, order 2*N= 6 • RMS calculation: Integration time: ** sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.5 sec	✓	9436-19755 Hz	0.33 A	Band-Pass Filter	• BP filter characteristics: Centre frequencies range: 19500 Hz 3dB-Bandwidth: 510 Hz Butterworth, order 2*N=6 • RMS calculation: Integration time: 0.04 sec Time overlap: min 50% • Evaluation criteria: Maximum time of exceedance: 0.04 sec Min. time between two exceedances: 0.08 sec

5.1.4.-AC900

Table A2.38

ICF								EV	ERTMS 033281 v.5 ERA							
Band	Frequency range defined by the centre frequency [kHz]	Emission limit X Axis [dBµA/m] (RMS)	Emission limit and Axis [dBµA/m] (RMS)	Emission limit Z Axis [dBµA/m] (RMS)	Evaluation method	Filter order (butterworth) and 3 dB-bandwidth	Evaluation parameters		Band	Frequency range defined by the centre frequency [kHz]	Emission limit X Axis [dBµA/m] (RMS)	Emission limit and Axis [dBµA/m] (RMS)	Emission limit Z Axis [dBµA/m] (RMS)	Evaluation method	Filter order (butterworth) and 3 dB-bandwidth	Evaluation parameters
Out of band	10-27	straight line from 135-130 dB/log(f)	straight line from 135-130 dB/log(f)	straight line from 135-130 dB/log(f)	FFT		Record time 1 ms, Hanning window, 50% overlap, max hold	✓	Out of band	10-27	straight line from 135-130 dB/log(f)	straight line from 135-130 dB/log(f)	straight line from 135-130 dB/log(f)	FFT		Record time 1 ms, Hanning window, 50% overlap, max hold
Band 1	27-41.2 44.8-52	93	93	98	BP	4th order 300 Hz	20% overlap (3dB points) Integration time: 1 ms	✓	Band 1	27-41.2 44.8-52	93	93	98	BP	4th order 300 Hz	20% overlap (3dB points) Integration time: 1 ms
Band 1	41.2-44.8	93	93	98	BP	4th order 320 Hz	20% overlap (3dB points) Integration time: 1ms	✓	Band 1	41.2-44.8	93	83*/90*	98	BP	4th order 320 Hz	20% overlap (3dB points) Integration time: 1ms
Out of band	52-234	130	130	130	FFT		Record time 1 ms, Hanning window, 50% overlap, max hold	✓	Out of band	52-234	130	130	130	FFT		Record time 1 ms, Hanning window, 50% overlap, max hold
Band 2	234-287	120	99	100	BP	4th order; 7500 Hz	20% overlap (3dB-points), Integration time: 1.5 ms	✓	Band 2	234-287	120	99	100	BP	4th order; 7500 Hz	20% overlap (3dB-points), Integration time: 1.5 ms
Band 2	287-363	109	99	91	BP	4th order; 7500 Hz	20% overlap (3dB-points), Integration time 1.5 ms	✓	Band 2	287-363	109	99	91	BP	4th order; 7500 Hz	20% overlap (3dB-points), Integration time 1.5 ms
Out of band	363-740	125	125	125	FFT		Record time 1 ms, Hanning window, 50% overlap, max hold	✓	Out of band	363-740	125	125	125	FFT		Record time 1 ms, Hanning window, 50% overlap, max hold
Band 3	740-1026	106	85	101	BP	4th order; 10 kHz	20% overlap (3dB-points), Integration time: 1.5 ms	✓	Band 3	740-1026	106	85	101	BP	4th order; 10 kHz	20% overlap (3dB-points), Integration time: 1.5 ms
Band 3	1026-1250	119	113	113	BP	4th order; 10 kHz	20% overlap (3dB-points), Integration time 1.5 ms	✓	Band 3	1026-1250	119	113	113	BP	4th order; 10 kHz	20% overlap (3dB-points), Integration time 1.5 ms