TSU®
Technický skúšobný ústav Piešťany, a. s.
Krajinská cesta 2929/9, 921 01 Piešťany, Slovak Republic

SNAS Reg. No. 009/S-047

Testing laboratory of machinery, EMC and RED
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TEST REPORT
No. 254000057/EMC

Test name:	Testing of the heater type 41.409.X* for compliance with the ECE R10 certificate
Product name:	Electric Heater
Type mark:	41.409.X
Manufacturer:	SELFA GE S.A. Bieszczadzka 14 71-042 Szczecin Poland
Applicant:	SELFA GE S.A. Bieszczadzka 14 71-042 Szczecin Poland
Order no.:	254000057
Testing location:	EMC Test Laboratory TSÚ Piešťany Krajinská cesta 2929/9 921 01 Piešťany Slovak Republic
Test procedure:	See chap. 1
Date of test:	See chap. 4
Identification code of measuring instruments & test equipment:	See chap. 5
Distribution:	1x – Manufacturer 1x – TSÚ Piešťany, a. s.
Date of issue:	30.05.2025

TECHNICKÝ SKÚŠOBNÝ ÚSTAV PIEŠŤANY, a. s.
Krajinská cesta 2929/9
921 01 PIEŠŤANY
-213

Tested and made by: **Jozef Marikovič**, Test engineer

Checked and approved by: **Ing. Ľuboš Vančo**, Technical Head of Testing Body

Test results introduced in this test report are related to the test subject only and do not replace other documents required by the state supervisory authorities and according to other specific regulations. Test report can be reproduced or published as a whole, in parts only with written approval of TSÚ test body. The testing laboratory declines responsibility for information supplied by the customer that may affect the validity of the results.

CONTENTS

1 GENERAL INFORMATION

EMC emissions and immunity tests were performed on the equipment under test (EUT) in the testing laboratory of TSÚ, a. s. Piešťany, Slovak Republic, accredited by the SNAS.

All tests were conducted in an environment which ensured that the measurable influence or interference (background noise) not generated by EUT, was below the threshold limits defined in the standards.

2 TEST METHODS AND CONDITIONS

Test methods used :	MPS 01/5.11/2018 Measurement of electromagnetic compatibility
Standards :	EHK 10 CISPR 12 CISPR 25 ISO 7637-2
Place of testing :	☒ EMC testing laboratory TSÚ Piešťany, š.p. ☐ Laboratory Pobedim TSÚ Piešťany, š.p. ☐ on-site:
Start of test :	27.5.2025
End of test :	28.5 2025
Test procedure deviations :	Without test procedure deviation.
Tests conditions and results :	See chap. 3, 7, 8, 9

2.1 Environmental Conditions

Temperature :	21,5 °C
Relative Humidity :	47 %
Atmospheric Pressure :	998 hPa

3 SUMMARY OF TESTS AND TEST RESULTS

Possible test case verdicts

- test not applicable: **N/A**
- test object does meet the requirement: **PASS**
- test object does not meet the requirement: **FAIL**

The tests were performed in accordance with the requirements of Regulation of the Economic Commission for Europe of the United Nations (EHK / OSN) No 10 - Uniform provisions concerning the approval of vehicles with regard to electromagnetic compatibility

EHK 10				
Classification of EUT: components and separate technical units intended for installation in vehicles				
Emissions				
Clause No. of EHK 10 / Clause in test report	**Test Description**	**Referenced standard**	**Test Result**	**Condition**
6.2 / 6.1	broadband electromagnetic radiation from vehicles	CISPR 12	PASS	Annex 4 in EHK 10
6.3 / 6.2	narrowband electromagnetic radiation from vehicles	CISPR 12 CISPR 25	PASS	Annex 5 in EHK 10
6.5 / 6.3	broadband electromagnetic interference generated by EMP	CISPR 25 ALSE CISPR 12	PASS	Annex 7 in EHK 10
6.6 / 6.4	narrowband electromagnetic interference generated by EMP	CISPR 25 ALSE CISPR 12	PASS	Annex 8 in EHK 10
Immunity				
Clause No. of EHK 10	**Test Description**	**Referenced standard**	**Test Result**	**Condition**
6.4 / 7.1	resistance of vehicles to electromagnetic radiation	ISO 11451-2 EN 61000-4-3	PASS	Annex 6 in EHK 10
6.8 / 7.2	resistance to transient disturbances on power lines	ISO 7637-2	PASS	Annex 10 in EHK 10
Note: Test is not applicable to the EUT for vehicular use.				

4 EQUIPMENT UNDER TEST

4.1 Description of EUT

Prototype: ☐

Production Version: ☒

Number of samples tested	:	1
Product name	:	Electric heater
Type / model	:	41.409.X
Variants	:	-
Manufacturer	:	J.S.Hamilton Poland Ltd.sp.z o.o 002893048, NIP:586-000-60-39 ul. Chwaszczyńska 180 81-571 Gdynia Poland
Serial number	:	-
Number of test samples	:	1 pc.
Place and date of taking samples	:	The sample delivered to TSÚ Piešťany, a. s. on 12.5.2025 and recorded under the registration number 254000057/213/1.
Description	:	-
Any deviations from the Basic EMC standards	:	None

4.2 EUT operation mode

The equipment under test was operated during the measurement:

- powered by laboratory power source 12 V_{DC}

5 TEST EQUIPMENT USED

Measure of emission						
Used eq.	**Name**	**Manufacturer**	**Type**	**Serial no.**	**Registration no.**	**Calibration validity**
☒	EMI Test Receiver	Rohde & Schwarz	ESR7	1316.30003K07	540-316-022	23.06.2025
☐	CISPR Passive Probe	PMM Italy	SHC-2-1000	1022K50201	130-317-094	22.03.2026
☐	Artificial Mains Network	PMM Italy	PMM L3-32	122WT50407	540-316-018	24.04.2026
☐	Artificial Mains Network	PMM Italy	PMM L3-64	1102240303	540-317-102	30.05.2029
☐	FOUR-LINE V-NETWORK	Rohde & Schwarz	ENV4200	100782	540-317-100	13.02.2028
☐	Coupling and Decoupling network	EM test	CDN T8 RJ45	P1510151693	540-316-021	---
☐	Bilogical Antenna, Folding	A.H. System	SAS-521F-2	272	540-317-097	24.08.2025
☒	BiConiLog Antenna	ETS-Lindgren	3143B	00157570	540-316-017	23.11.2025
☐	Horn Antenna	ETS-Lindgren	3119	00157903	540-316-016	05.03.2030
☐	3-phase network analyser	Fluke	Fluke 435	DM9631006	130-316-85	31.10.2028
☐	Harmonic current analyser	Spitzenberger	B10	G80588	540-316-025	11.11.2025
☐	LISN – 16A	Spitzenberger	Line – 16A	A2793 07/0 0701	540-316-023	11.11.2025
☐	AC / DC Power source	Spitzenberger	PAS 5000	A2793 01/0 0701	540-316-024	11.11.2025
☒	Antenna mast	ETS-Lindgren	2175	---	---	---
☒	Turntable	ETS-Lindgren	2188	---	---	---
☒	Anechoic chamber	ETS-Lindgren	FACT 3	---	---	---
☒	Atmosphere recorder	Comet System	C4130	13900371	412-316-001	25.04.2030
☐	Magnetic field tester	HIOKI	FT3470-50	600355260	540-317-085	07.06.2025

Measure of susceptibility						
Used eq.	**Name**	**Manufacturer**	**Type**	**Serial no.**	**Registration no.**	**Calibration validity**
☐	Multifunctional test generator for transients	EM test	UCS500 N5	07430/06	540-323-77	07.07.2025
☐	Compact NX Generator	AMETEK CTS	NX5	1824221146	540-317-091	13.03.2026
☐	ESD Simulator	Schaffner	NSG 432	1450	540-316-019	17.08.2025
☐	Generator – ESD NX 30.1	EM test	ESD NX 30.1	11944	540-317-098	05.03.2026
☐	Compact simulator conducted immunity	EM test	CWS500 N1	P1315117094	540-316-001	08.08.2025
☐	Coupling and Decoupling network	EM test	CDN M2/M3	P1343125199	540-316-003	---
☐	Coupling and Decoupling network	EM test	CDN M5-63A	P1315117419	540-316-005	---
☐	Coupling and Decoupling network	EM test	CDN S19 HDMI	P1529161237	540-316-020	---
☐	Coupling and Decoupling network	EM test	CDN T8 RJ45	P1510151693	540-316-021	---

Measure of susceptibility						
Used eq.	**Name**	**Manufacturer**	**Type**	**Serial no.**	**Registration no.**	**Calibration validity**
☐	Coupling and Decoupling network	AMETEK CTS	CNI 508N2	P1907226998	540-317-090	24.03.2030
☐	Coupling and decoupling network	Schaffner	8014	17312	540-317-089	---
☐	EM CLAMP	AMETEK CTS	KEMZ 801B	63974	540-317-099	---
☐	RF Amplifier	Rohde & Schwarz	BBA150	5355.9004K40	540-317-095	06.12.2025
☒	RF Amplifier	Prana	MT-200	---	1312-1464	---
☒	RF Amplifier	Prana	SV-40DC	---	1312-1465	---
☒	RF Amplifier	Prana	UX-30DC	---	1312-1466	---
☐	Attenuator 6 dB	EM test	ATT 6 / 75	P1306112990	540-316-010	---
☒	Field Probe	PMM Italy	EP 601	511WX30645	540-317-014	05.12.2025
☒	Signal Generator	Rohde & Schwarz	SMB100A03	180253	540-316-027	22.06.2026
☐	AC / DC Power source	Spitzenberger	PAS 5000	A2793 01/0 0701	540-316-024	11.11.2025
☐	Magnetic field immunity measurement kit	TSU Piešťany	9.15	201501	540-317-084	---
☐	Bilogical Antenna, Folding	A.H. System	SAS-521F-2	272	540-317-097	24.08.2025
☒	BiConiLog Antenna	ETS-Lindgren	3143B	00157570	540-316-017	23.11.2025
☒	Horn Antenna	ETS-Lindgren	3119	00157903	540-316-016	05.03.2030
☒	Antenna mast	ETS-Lindgren	2175	---	---	---
☒	Turntable	ETS-Lindgren	2188	---	---	---
☒	Anechoic chamber	ETS-Lindgren	FACT 3	---	---	---
☒	Atmosphere recorder	Comet System	C4130	13900371	412-316-001	25.04.2030

6 EMISSIONS TESTS DESCRIPTION AND RESULTS

6.1 Broadband electromagnetic radiation from vehicles

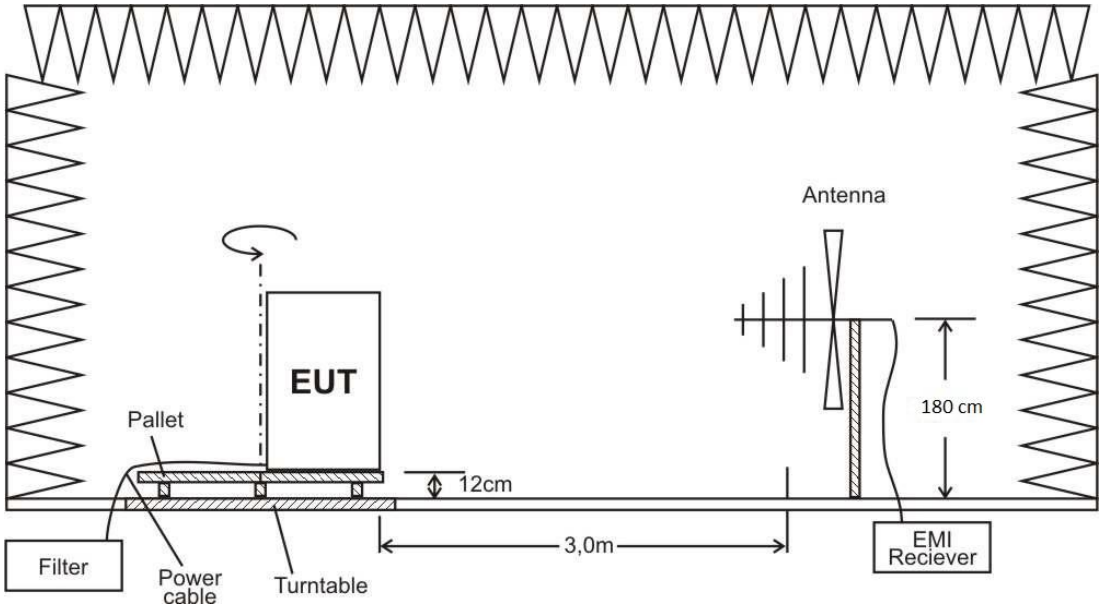
General description:

Measuring method: The electromagnetic radiation generated by the vehicle representative of its type shall be measured by the method described in Annex 4 in EHK 10. The method of measurement shall be defined by the vehicle manufacturer in conformity with the technical service.

Broadband limit values for vehicle type – approval
When measured by the method described in annex 4 in EHK 10 at a distance of 3,0 ± 0,05 m between the vehicle and the antenna, the limits are 42 dBµV / m in the frequency range 30 to 75 MHz and 42 to 53 dBµV / m in the frequency range 75 to 400 MHz; this limit value increases from 75 MHz on the logarithmic frequency scale, as shown in Appendix 3. In the frequency band 400 to 1 000 MHz, the limit value is constant at 53 dBµV / m.

The values measured on the vehicle type representative, expressed in dBµV / m, must be lower than the type-approval limits.

Test method: The test method shall be in accordance with CISPR 12.



Typical test setup in SAC at 3 m measurement distance up to 1 GHz

Description of the test location:

- Test location: **Anechoic chamber**
- Test distance: **3 meters**

Limit values:

Frequency range / Detector (MHz)	**Average dB** (µV/m) measure distance 3 m	**Quasi peak dB** (µV/m) measure distance 3 m
30 – 75	---	42
75 – 400	---	42 – 53
400 – 1000	---	53

You can see also in supplement D3 and in EHK 10

ANNEX 3

Vehicle broadband reference limits

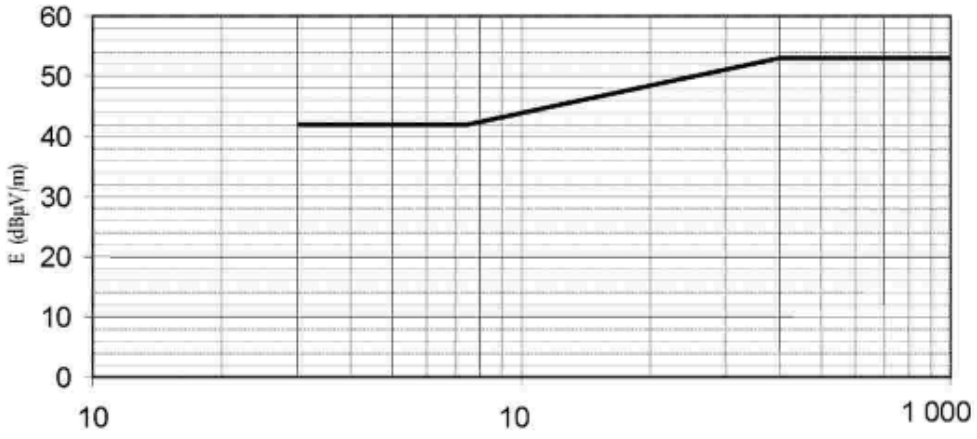
Distance antenna – vehicle: 3 m

Limit value E (dBµV/m) for frequency F (MHz)		
30 – 75 MHz	75 – 400 MHz	400 – 1 000 MHz
E = 42	E = 42 + 15,13 log (F / 75)	E = 53

Vehicle emission limit value

Broadband type approval limit – 3 m

Quasi-peak detector – bandwidth 120 kHz



Polarization: **Horizontal**

Scan Table

Scan Start	30.000000000 MHz
Scan Stop	1.000000000 GHz
Scan Type	TD Scan
Transducer	Antenna 3143B new cal + cable

Detector Trace 1: Quasi Peak

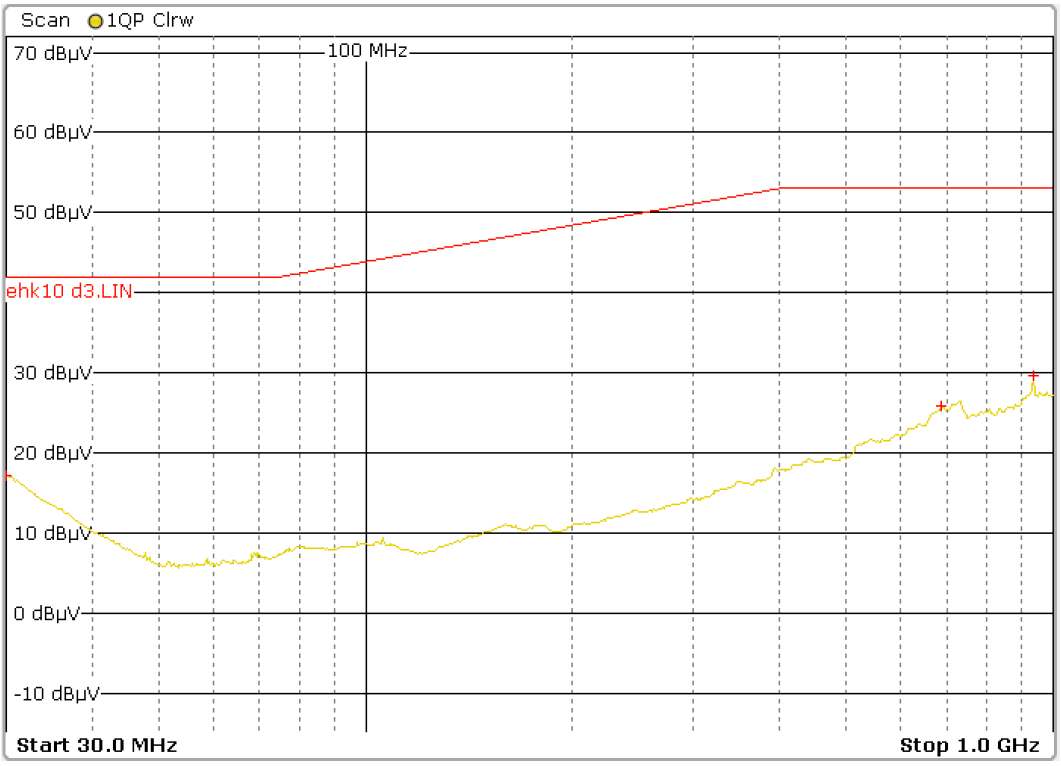
Start Frequency	Stop Frequency	Step Size	RBW	Meas Time	RF Atten	Preamp	Input
30.000 MHz	1.000 GHz	30.000 kHz	120.0 kHz	500.0 µs	10.0 dB	20.0 dB	INPUT1

Peak List

Margin	30.0 dB
Peaks	25

Trace	Frequency	Level (dBµV)	Detector	Delta Limit/dB
1	30.030000000 MHz	17.17	Quasi Peak	-24.83
1	686.250000000 MHz	25.86	Quasi Peak	-27.14
1	938.250000000 MHz	29.69	Quasi Peak	-23.31

Scan Diagram



Result of measurement: PASS

Polarization: **Vertical**

Scan Table

Scan Start	30.000000000 MHz
Scan Stop	1.000000000 GHz
Scan Type	TD Scan
Transducer	Antenna 3143B new cal + cable

Detector Trace 1: Quasi Peak

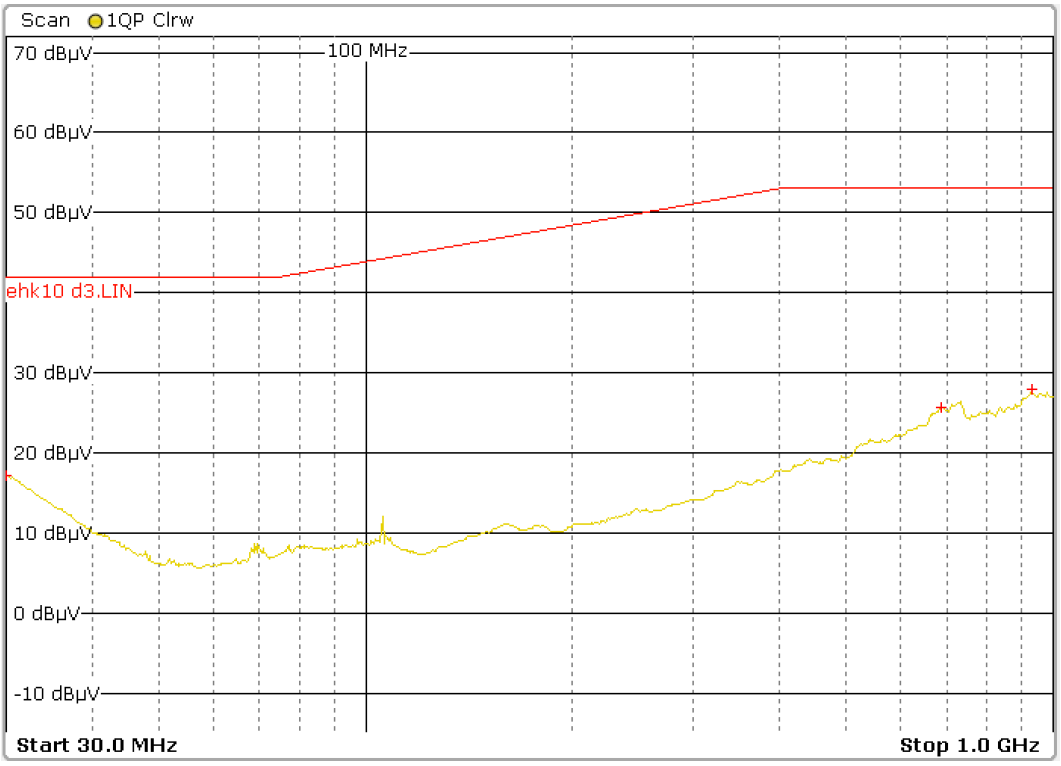
Start Frequency	Stop Frequency	Step Size	RBW	Meas Time	RF Atten	Preamp	Input
30.000 MHz	1.000 GHz	30.000 kHz	120.0 kHz	500.0 µs	10.0 dB	20.0 dB	INPUT1

Peak List

Margin	30.0 dB
Peaks	25

Trace	Frequency	Level (dBµV)	Detector	Delta Limit/dB
1	30.060000000 MHz	17.20	Quasi Peak	-24.80
1	686.670000000 MHz	25.73	Quasi Peak	-27.27
1	929.460000000 MHz	27.92	Quasi Peak	-25.08

Scan Diagram



Result of measurement: PASS

6.2 Narrow electromagnetic radiation from vehicles

General description:

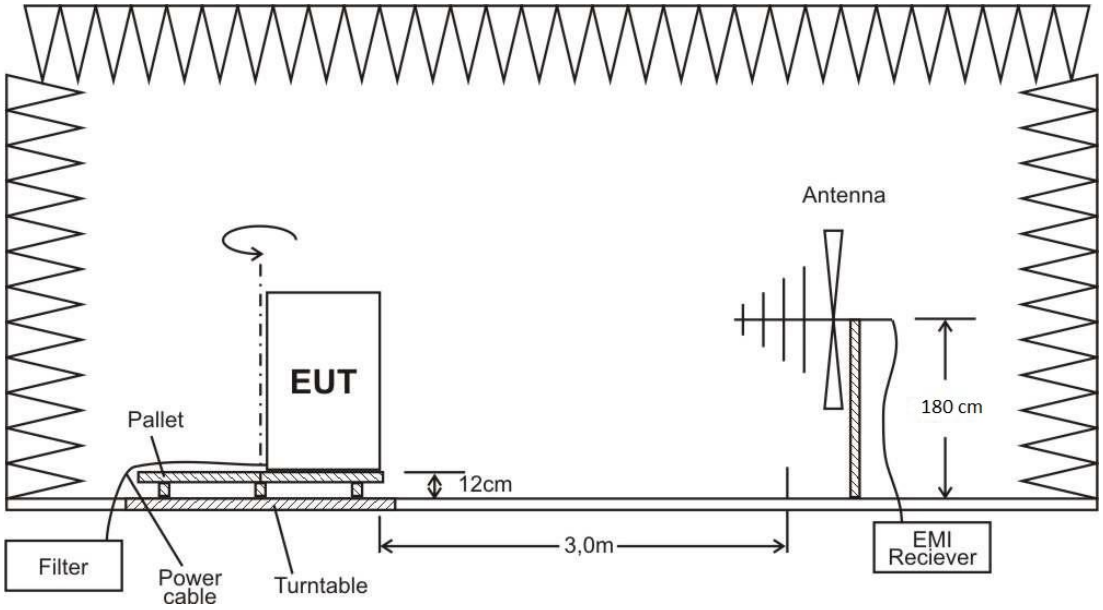
The electromagnetic radiation generated by the vehicle representative of its type shall be measured by the method described in annex 5 in EHK 10. The method of measurement must be defined by the vehicle manufacturer in agreement with the technical service.

Narrowband limits for vehicle type – approval.
When measured by the method described in annex 5 at a distance of 3,00 ± 0,05 m between the vehicle and the antenna, the limits are 32 dBµV / m in the frequency range 30 to 75 MHz and 32 to 43 dBµV / m in the frequency range 75 to 400 MHz; this limit value increases from 75 MHz on the logarithmic frequency scale, as shown in Appendix 5. In the frequency band 400 to 1 000 MHz, the limit value is constant at 43 dBµV / m.

The values measured on the vehicle type representative, expressed in dBµV / m, must be lower than the type-approval limit.

Test method:
The test method shall be in accordance with CISPR 12.

Typical test setup in SAC at 3 m measurement distance up to 1 GHz:



Description of the test location:

Test location: **Anechoic chamber**
Test distance: **3 meters**

Limit values:

Frequency range / Detector (MHz)	**Average dB** (µV/m) measure distance 3 m	**Quasi peak dB** (µV/m) measure distance 3 m
30 – 75	32	---
75 – 400	32 – 43	---
400 – 1 000	43	---

You can see also in supplement D5 and in EHK 10

ANNEX 5

Vehicle broadband reference limits

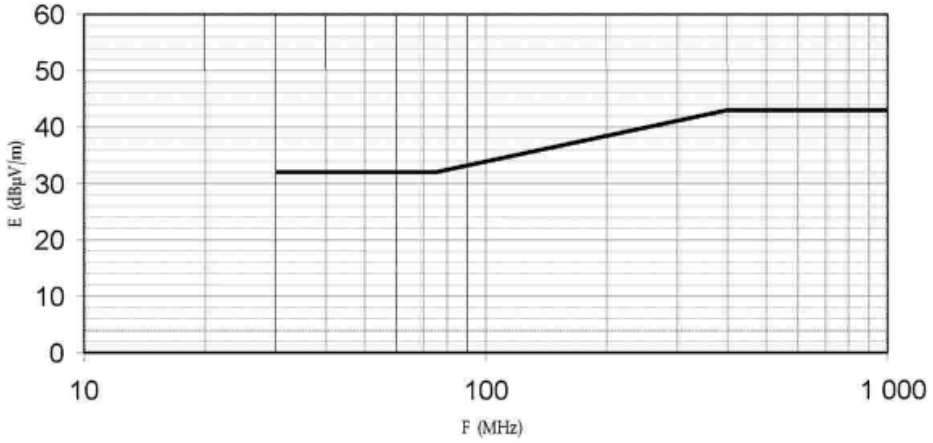
Distance antenna – vehicle: 3 m

Limit value E (dBµV/m) for frequency F (MHz)		
30 – 75 MHz	75 – 400 MHz	400 – 1 000 MHz
E = 32	E = 32 + 15,13 log (F / 75)	E = 43

Vehicle emission limit value

Broadband type approval limit – 3 m

Quasi-peak detector – bandwidth 120 kHz



Polarization: **Horizontal**

Scan Table

Scan Start	30.000000000 MHz
Scan Stop	1.000000000 GHz
Scan Type	TD Scan
Transducer	Antenna 3143B new cal + cable

Detector Trace 1: Quasi Peak

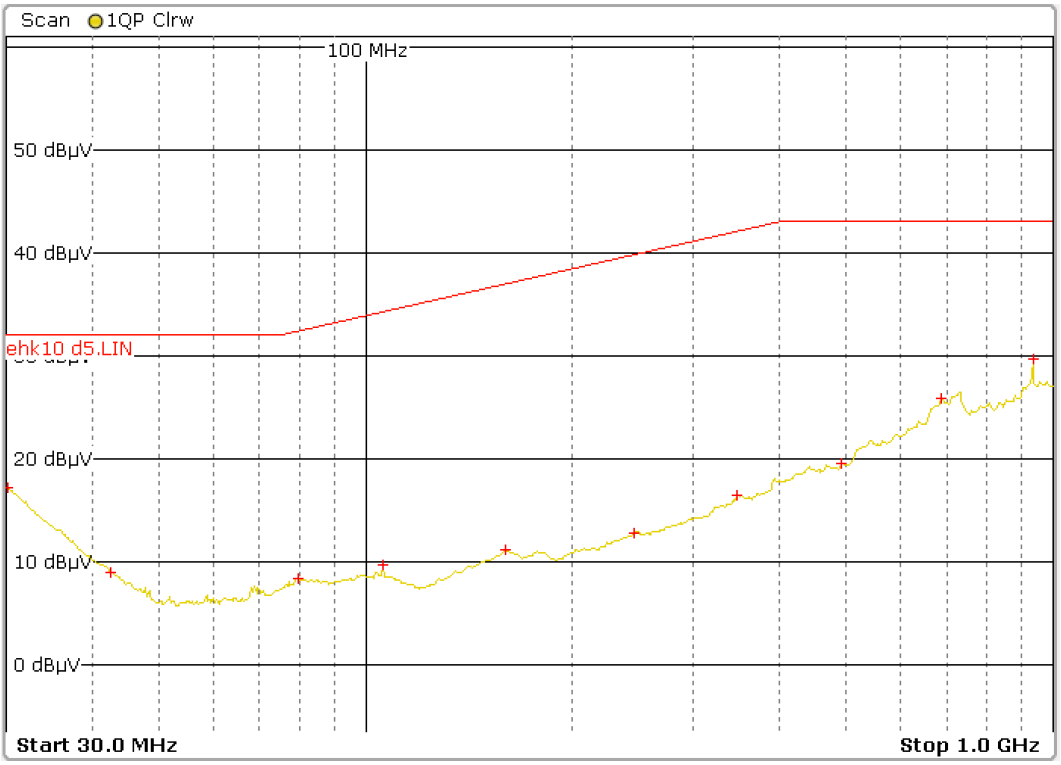
Start Frequency	Stop Frequency	Step Size	RBW	Meas Time	RF Atten	Preamp	Input
30.000 MHz	1.000 GHz	30.000 kHz	120.0 kHz	500.0 µs	10.0 dB	20.0 dB	INPUT1

Peak List

Margin	30.0 dB
Peaks	25

Trace	Frequency	Level (dBµV)	Detector	Delta Limit/dB
1	30.090000000 MHz	17.24	Quasi Peak	-14.76
1	42.660000000 MHz	9.01	Quasi Peak	-22.99
1	79.770000000 MHz	8.31	Quasi Peak	-24.10
1	105.900000000 MHz	9.67	Quasi Peak	-24.60
1	160.020000000 MHz	11.09	Quasi Peak	-25.89
1	245.880000000 MHz	12.81	Quasi Peak	-26.99
1	347.640000000 MHz	16.44	Quasi Peak	-25.64
1	493.080000000 MHz	19.50	Quasi Peak	-23.50
1	686.100000000 MHz	25.83	Quasi Peak	-17.17
1	938.190000000 MHz	29.67	Quasi Peak	-13.33

Scan Diagram



Result of measurement: PASS

Polarization: **Vertical**

Scan Table

Scan Start	30.000000000 MHz
Scan Stop	1.000000000 GHz
Scan Type	TD Scan
Transducer	Antenna 3143B new cal + cable

Detector Trace 1: Quasi Peak

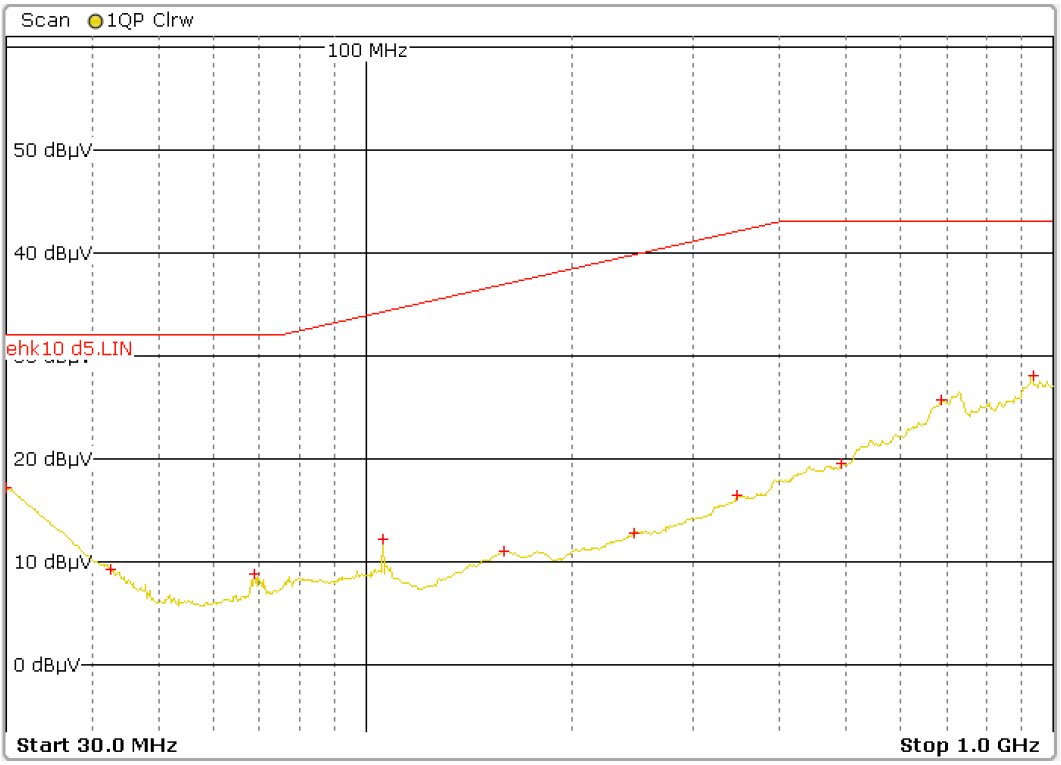
Start Frequency	Stop Frequency	Step Size	RBW	Meas Time	RF Atten	Preamp	Input
30.000 MHz	1.000 GHz	30.000 kHz	120.0 kHz	500.0 µs	10.0 dB	20.0 dB	INPUT1

Peak List

Margin	30.0 dB
Peaks	25

Trace	Frequency	Level (dBµV)	Detector	Delta Limit/dB
1	30.000000000 MHz	17.16	Quasi Peak	-14.84
1	42.630000000 MHz	9.22	Quasi Peak	-22.78
1	69.000000000 MHz	8.83	Quasi Peak	-23.17
1	105.900000000 MHz	12.18	Quasi Peak	-22.09
1	159.300000000 MHz	11.05	Quasi Peak	-25.90
1	245.700000000 MHz	12.80	Quasi Peak	-27.00
1	345.990000000 MHz	16.41	Quasi Peak	-25.64
1	492.030000000 MHz	19.49	Quasi Peak	-23.51
1	687.570000000 MHz	25.75	Quasi Peak	-17.25
1	938.250000000 MHz	28.10	Quasi Peak	-14.90

Scan Diagram



Result of measurement: PASS

6.3 Broadband electromagnetic interference generated by EMP

General description:

Measuring method

The electromagnetic radiation generated by the EMP representative of its type shall be measured by the method described in annex 7.

Broadband limit values for EMP type approval
When measured by the method described in Annex 7, the limits are 62 to 52 dBµV / m in the frequency range 30 to 75 MHz (this limit decreases from 30 MHz on a logarithmic scale) and 52 to 63 dBµV / m in the frequency range from 75 to 400 MHz (this limit value increases from 75 MHz at the logarithmic frequency scale, as shown in Appendix 6). In the frequency band from 400 to 1 000 MHz, the limit value is constant, namely 63 dBµV / m.

The values measured on the EMP representative of its type, expressed in dBµV / m, shall be lower than the type-approval limits.

Limit values:

Frequency range / Detector (MHz)	**Average dB** (µV/m) measure distance 3 m	**Quasi peak dB** (µV/m) measure distance 3 m
30 – 75	---	62 – 52
75 – 400	---	52 – 63
400 – 1 000	---	63

You can see also in supplement D6 and in EHK 10

ANNEX 6

Electrical/electronic subassembly

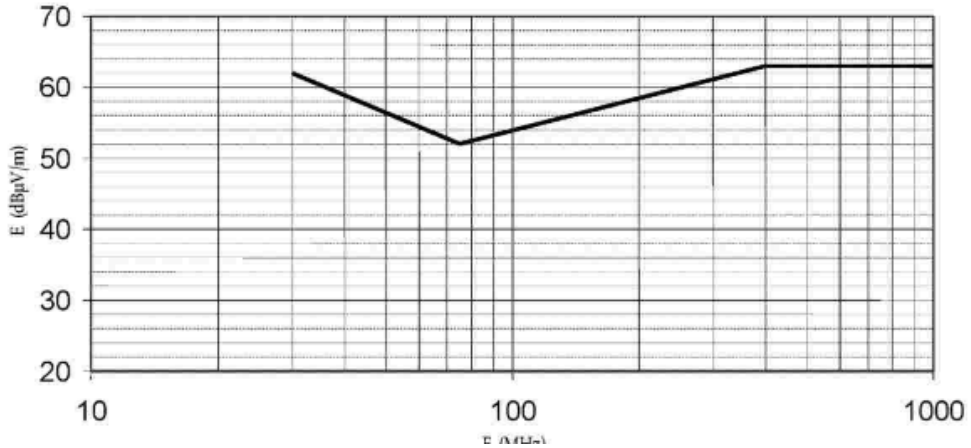
Broadband reference limits

Limit value E (dBµV/m) for frequency F (MHz)		
30 – 75 MHz	75 – 400 MHz	400 – 1 000 MHz
E = 62 – 25,13 log (F / 30)	E = 52 + 15,13 log (F / 75)	E = 63

Radiated EMP emission limit value

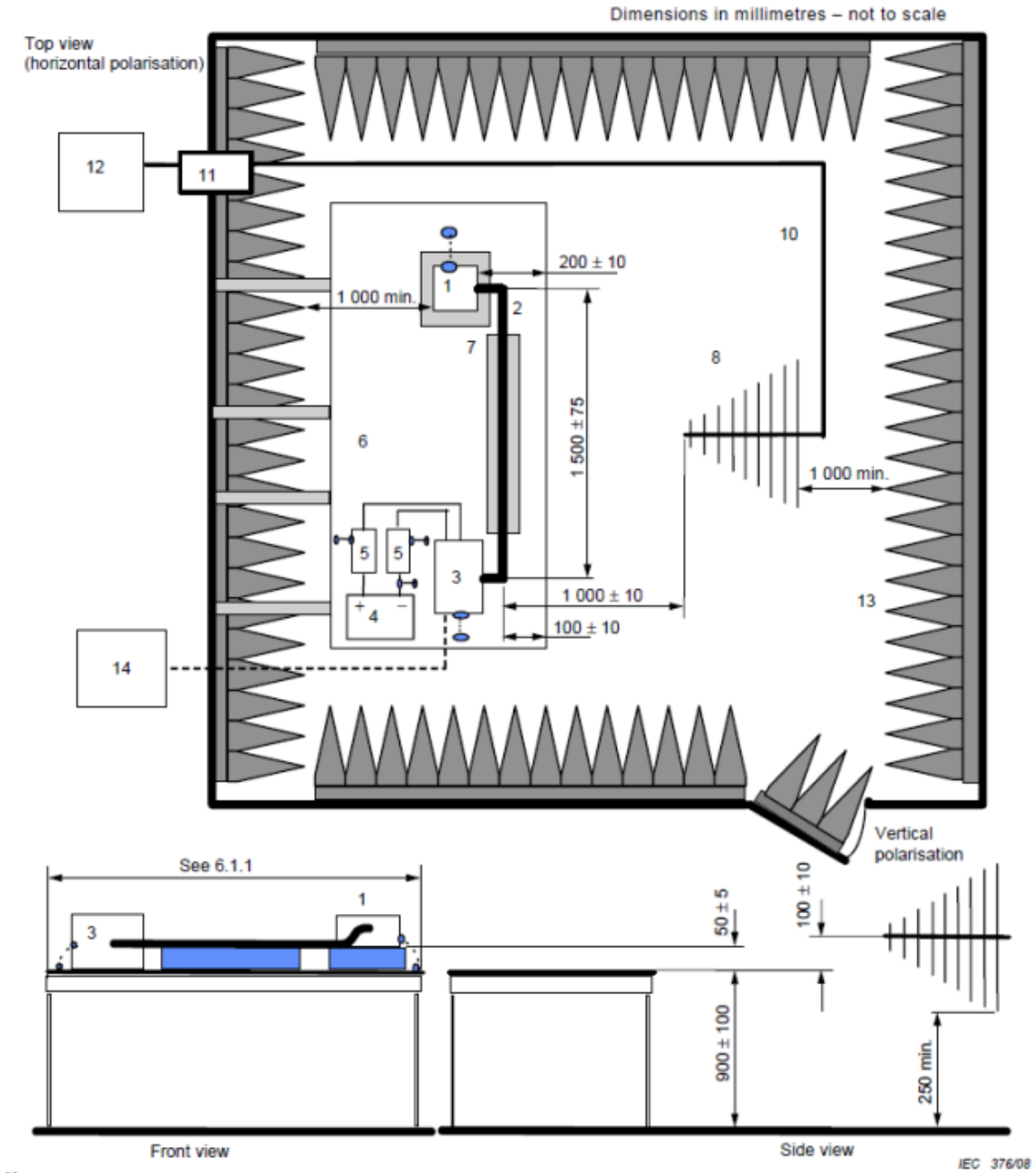
Broadband type approval limit – 1 m

Quasi-peak detector – bandwidth 120 kHz



Test method: The test method shall be in accordance with CISPR 25, ALSE.

CISPR 25 © IEC:2008



Key

1 EUT (grounded locally if required in test plan)
2 Test harness
3 Load simulator (placement and ground connection according to 6.4.2.5)
4 Power supply (location optional)
5 Artificial network (AN)
6 Ground plane (bonded to shielded enclosure)
7 Low relative permittivity support ($\varepsilon_r \leq 1{,}4$)
8 Log-periodic antenna
10 High-quality coaxial cable e.g. double-shielded (50 Ω)
11 Bulkhead connector
12 Measuring instrument
13 RF absorber material
14 Stimulation and monitoring system

Figure 14 – Example of test set-up – log-periodic antenna

Polarization: **Horizontal**

Scan Table

Scan Start	30.000000000 MHz
Scan Stop	1.000000000 GHz
Scan Type	TD Scan
Transducer	Antenna 3143B new cal + cable

Detector Trace 1: Quasi Peak

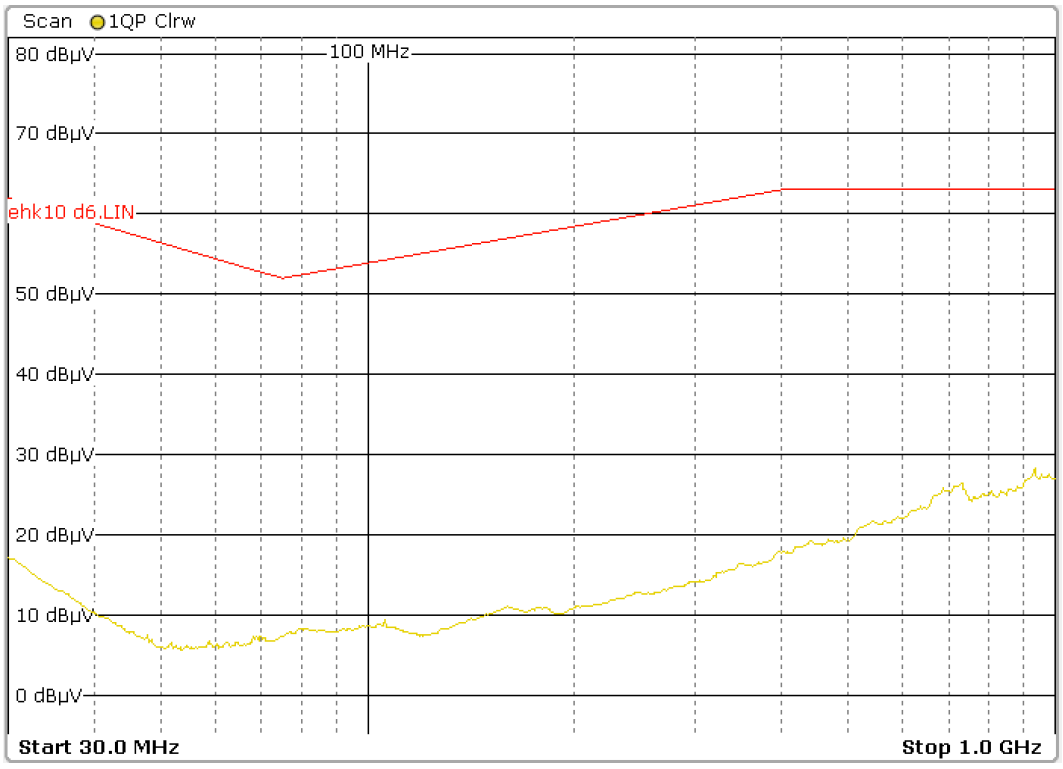
Start Frequency	Stop Frequency	Step Size	RBW	Meas Time	RF Atten	Preamp	Input
30.000 MHz	1.000 GHz	30.000 kHz	120.0 kHz	500.0 µs	10.0 dB	20.0 dB	INPUT1

Peak List

Margin	30.0 dB
Peaks	25

Trace	Frequency	Level (dBµV)	Phase	Detector	Delta Limit/dB

Scan Diagram



Result of measurement: PASS

Polarization: **Vertical**

Scan Table

Scan Start	30.000000000 MHz
Scan Stop	1.000000000 GHz
Scan Type	TD Scan
Transducer	Antenna 3143B new cal + cable

Detector Trace 1: Quasi Peak

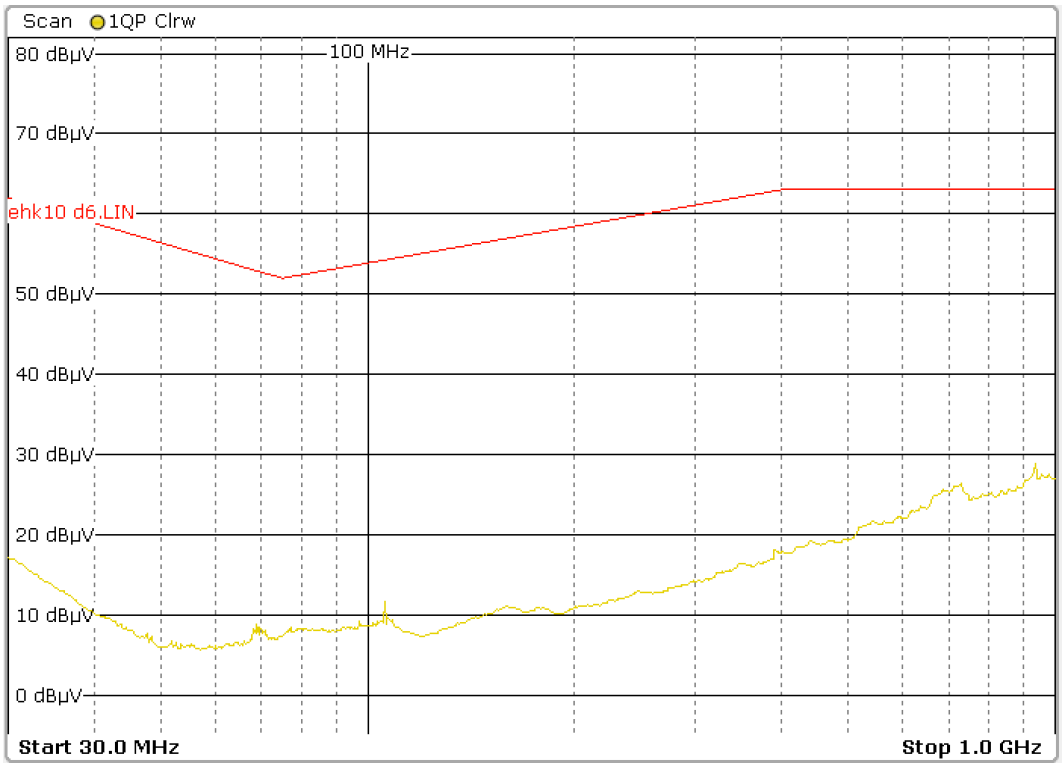
Start Frequency	Stop Frequency	Step Size	RBW	Meas Time	RF Atten	Preamp	Input
30.000 MHz	1.000 GHz	30.000 kHz	120.0 kHz	500.0 µs	10.0 dB	20.0 dB	INPUT1

Peak List

Margin	30.0 dB
Peaks	25

Trace	Frequency	Level (dBµV)	Phase	Detector	Delta Limit/dB

Scan Diagram



Result of measurement: PASS

6.4 Narrowband electromagnetic interference generated by EMP

General description:

Measuring method

The electromagnetic radiation generated by the EMP representative of its type shall be measured by the method described in annex 8.

Narrowband limit values for EMP type – approval
When measured by the method described in Annex 8, the limits are 52 to 42 dBµV / m in the frequency range 30 to 75 MHz (this limit decreases from 30 MHz on a logarithmic scale) and 42 to 53 dBµV / m in the frequency range from 75 to 400 MHz (this limit value increases from 75 MHz on the logarithmic frequency scale, as shown in Appendix 7. In the frequency band 400 to 1 000 MHz, the limit value is constant at 53 dBµV / m.

The values measured on the EMP representative of its type, expressed in dBµV / m, shall be lower than the type-approval limits.

Limit values:

Frequency range / Detector (MHz)	**Average dB** (µV/m) measure distance 3 m	**Quasi peak dB** (µV/m) measure distance 3 m
30 – 75	52 – 42	---
75 – 400	42 – 53	---
400 – 1 000	53	---

You can see also in supplement D7 and in EHK 10

ANNEX 7

Electrical/electronic subassembly

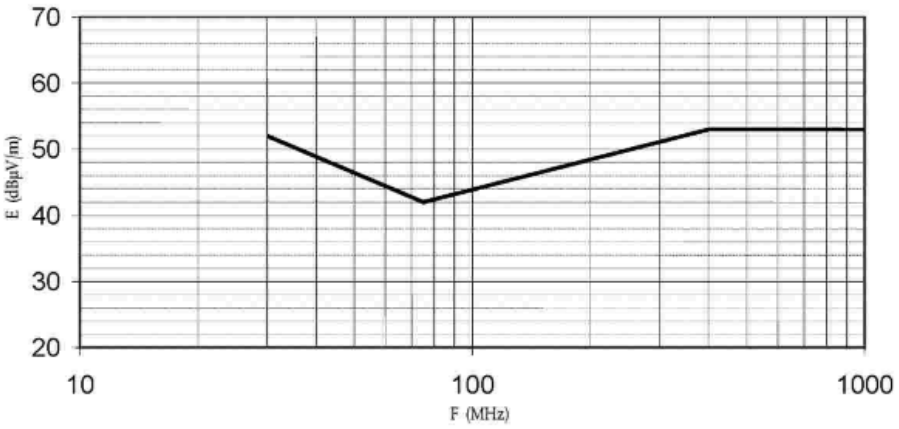
Narrowband reference limits

Limit value E (dBµV/m) for frequency F (MHz)		
30 – 75 MHz	75 – 400 MHz	400 – 1 000 MHz
E = 52 – 25,13 log (F / 30)	E = 42 + 15,13 log (F / 75)	E = 53

Radiated EMP emission limit value

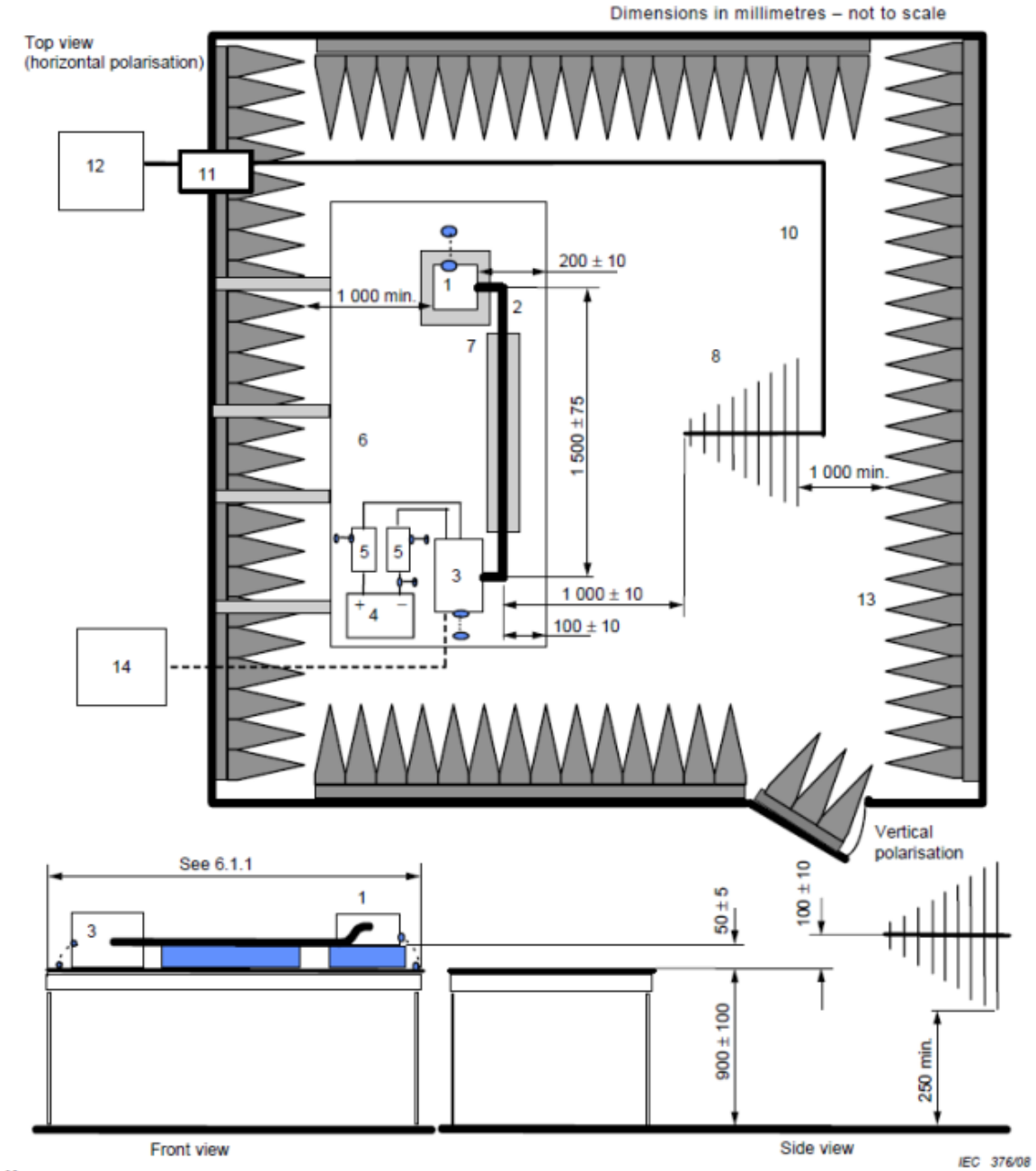
Broadband type approval limit – 1 m

Mean value detector - bandwidth 120 kHz



Test method:
The test method shall be in accordance with CISPR 25, ALSE.

CISPR 25 © IEC:2008



Key

1 EUT (grounded locally if required in test plan)
2 Test harness
3 Load simulator (placement and ground connection according to 6.4.2.5)
4 Power supply (location optional)
5 Artificial network (AN)
6 Ground plane (bonded to shielded enclosure)
7 Low relative permittivity support ($\varepsilon_r \leq 1{,}4$)
8 Log-periodic antenna
10 High-quality coaxial cable e.g. double-shielded (50 Ω)
11 Bulkhead connector
12 Measuring instrument
13 RF absorber material
14 Stimulation and monitoring system

Figure 14 – Example of test set-up – log-periodic antenna

Polarization: **Horizontal**

Scan Table

Scan Start	30.000000000 MHz
Scan Stop	1.000000000 GHz
Scan Type	TD Scan
Transducer	Antenna 3143B new cal + cable

Detector Trace 1: Quasi Peak

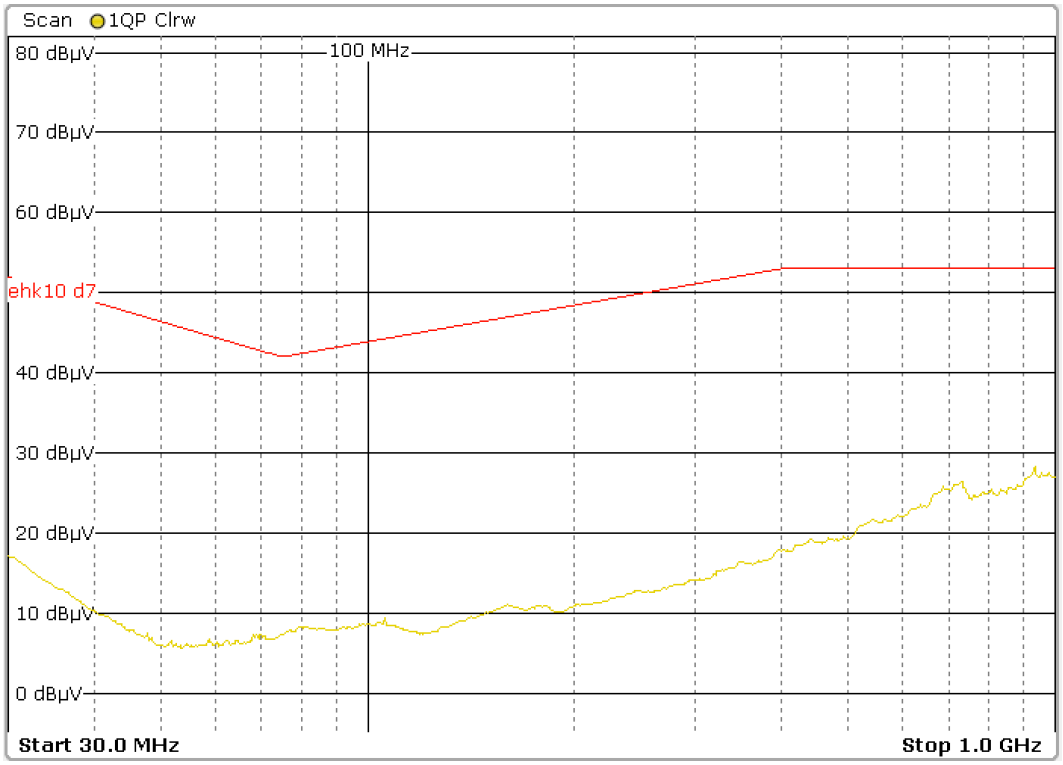
Start Frequency	Stop Frequency	Step Size	RBW	Meas Time	RF Atten	Preamp	Input
30.000 MHz	1.000 GHz	30.000 kHz	120.0 kHz	500.0 µs	10.0 dB	20.0 dB	INPUT1

Peak List

Margin	30.0 dB
Peaks	25

Trace	Frequency	Level (dBµV)	Phase	Detector	Delta Limit/dB

Scan Diagram



Result of measurement: PASS

Polarization: **Vertical**

Scan Table

Scan Start	30.000000000 MHz
Scan Stop	1.000000000 GHz
Scan Type	TD Scan
Transducer	Antenna 3143B new cal + cable

Detector Trace 1: Quasi Peak

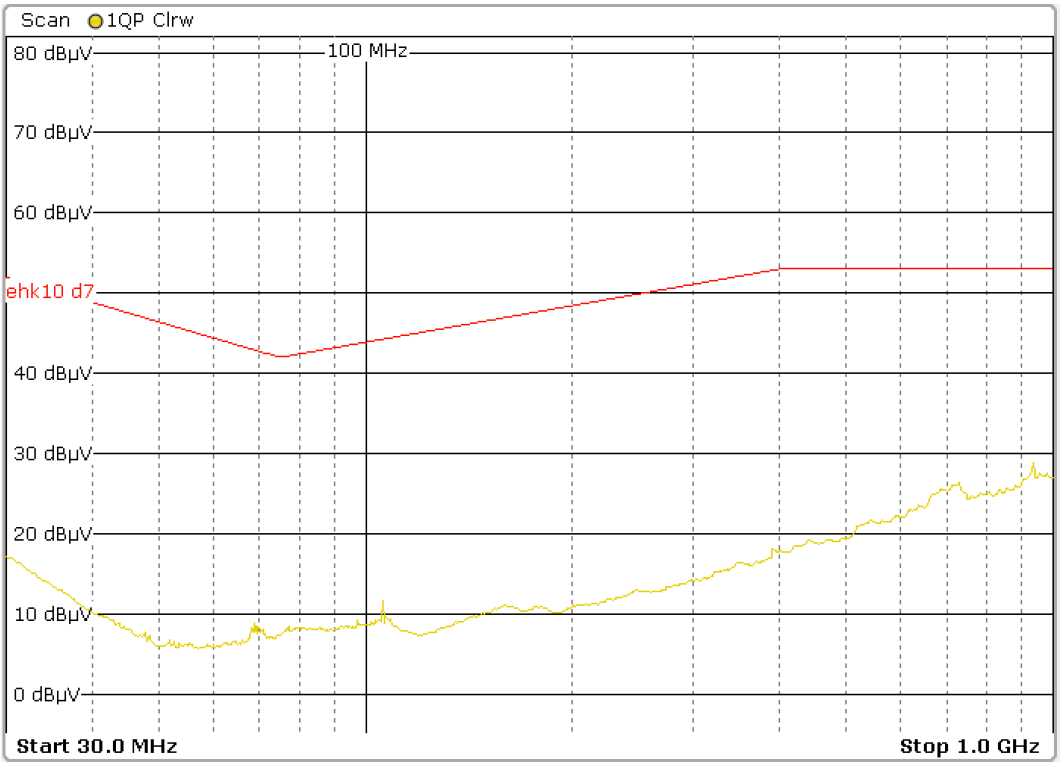
Start Frequency	Stop Frequency	Step Size	RBW	Meas Time	RF Atten	Preamp	Input
30.000 MHz	1.000 GHz	30.000 kHz	120.0 kHz	500.0 µs	10.0 dB	20.0 dB	INPUT1

Peak List

Margin	30.0 dB
Peaks	25

Trace	Frequency	Level (dBµV)	Phase	Detector	Delta Limit/dB

Scan Diagram



Result of measurement: PASS

7 IMMUNITY TESTS DESCRIPTION AND RESULTS

7.1 Resistance of vehicles to electromagnetic radiation

General description:

Test method

The immunity to electromagnetic radiation of the vehicle type shall be tested by the method described in Annex 6.

Immunity limits for vehicle type-approval

When tested by the method described in Annex 6, the field strength shall be 30 V / m (rms) in 90% of the frequency range 20 to 2 000 MHz and at least 25 V / m (rms) in the entire frequency range 20 to 2 000 MHz.

A representative vehicle type shall be considered satisfactory from the point of view of immunity if the performance of the "immunity-related functions" is not reduced during the tests performed according to Annex 6.

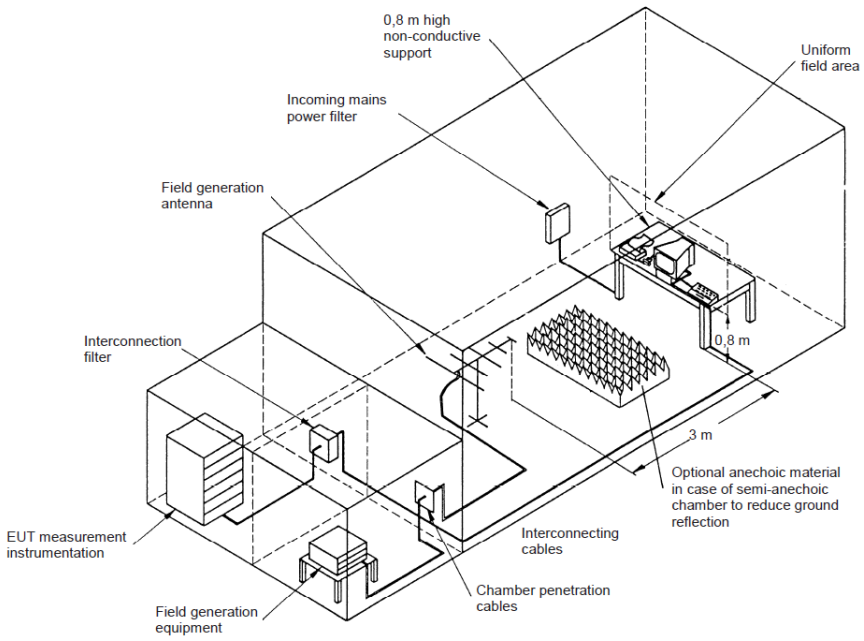
Frequency range, dwell times

It is measured in the frequency range 20 to 2 000 MHz with individual frequency steps according to ISO 11452-1, 3rd edition 2005.

Test signal modulation:

AM (amplitude modulation), 1 kHz modulation frequency and 80% modulation depth in the 20-800 MHz frequency range;

PM (pulse modulation), during the time „t“ equal to 577 µs the carrier frequency is transmitted, in the remaining time until the period of 4,600 µs the carrier frequency is switched off, the carrier frequency is in the range 800 – 2 000 MHz



Example of suitable test facility

Result of test

Test specifications:

Frequency – range	:	20 MHz – 800 MHz
Field strength	:	30 V/m
Distance of antenna – EUT	:	2,0 m
Modulation	:	AM : 80 % / sinusoidal: 1 000 Hz
Frequency step / dwell time	:	1 % / 3 sec.
Polarization of antenna	:	Horizontal & vertical

Frequency (MHz)	Antenna polarization	Field strength	Position	Fulfill the criteria
20 ÷ 800	Vertical	30 V/m	Front	PASS
20 ÷ 800	Horizontal	30 V/m	Front	PASS
20 ÷ 800	Vertical	30 V/m	Behind	PASS
20 ÷ 800	Horizontal	30 V/m	Behind	PASS
20 ÷ 800	Vertical	30 V/m	Left	PASS
20 ÷ 800	Horizontal	30 V/m	Left	PASS
20 ÷ 800	Vertical	30 V/m	Right	PASS
20 ÷ 800	Horizontal	30 V/m	Right	PASS

Remarks: No failure according to the performance criteria in the used standard was observed during or after the test.

Test specifications:

Frequency – range	:	800 MHz – 2 000 MHz
Field strength	:	30 V/m
Distance of antenna – EUT	:	2 m
Modulation	:	PM
Frequency step/dwell time	:	one period = 4.6 ms; t_{on} = 0,557 ms t_{off} = 4,6 - 0,557 ms
Polarization of antenna	:	Horizontal & vertical

Frequency (MHz)	Antenna polarization	Field strength	Position	Fulfill the criteria
800 ÷ 2000	Vertical	30 V/m	Front	PASS
800 ÷ 2000	Horizontal	30 V/m	Front	PASS
800 ÷ 2000	Vertical	30 V/m	Behind	PASS
800 ÷ 2000	Horizontal	30 V/m	Behind	PASS
800 ÷ 2000	Vertical	30 V/m	Left	PASS
800 ÷ 2000	Horizontal	30 V/m	Left	PASS
800 ÷ 2000	Vertical	30 V/m	Right	PASS
800 ÷ 2000	Horizontal	30 V/m	Right	PASS

Remarks: No failure according the to performance criteria in the used standard was observed during or after the test.

7.2 Resistance to transient disturbances on power lines

General description:

These tests are applicable to radio and ancillary equipment intended for vehicular use.
These tests shall be performed on nominal 12 V and 24 V_{DC} supply voltage input ports of mobile radio and ancillary equipment, which are also intended for mobile use in vehicles.
These tests shall be performed on a representative configuration of the mobile radio equipment, the associated ancillary equipment, or a representative configuration of the combination of radio and ancillary equipment.
These tests assess the ability of the EUT to operate as intended in the event of transients and surges present on their DC power input ports in a vehicular environment.

Test method:

The test method shall be in accordance with ISO 7637-2 for 12 V_{DC} and 24 V_{DC} powered equipment.
The test method shall be in accordance with ISO 7637-2, applying pulses 1, 2a, 2b, 3a, 3b, and 4, using immunity test level III. For the purpose of EMC testing it is sufficient to apply pulses 1, 2a, 2b and 4, 10 times each, and apply the test pulses 3a and 3b for 20 minutes each.

test pulse severity levels for nominal 12 V system

Test pulse[a]	Selected test level[b]	Test pulse severity level, U_S[cd] V			Min. number of pulses or test time	Burst cycle/ pulse repetition time	
		IV	III	I / II		min.	max.
1		–150	–112	–75	500 pulses	0,5 s	[e]
2a		+112	+55	+37	500 pulses	0,2 s	5 s
2b		+10	+10	+10	10 pulses	0,5 s	5 s
3a		–220	–165	–112	1 h	90 ms	100 ms
3b		+150	+112	+75	1 h	90 ms	100 ms

[a] Test pulses as in 5.6.

[b] Values agreed between vehicle manufacturer and equipment supplier.

[c] The amplitudes are the values of U_s as defined for each test pulse in 5.6.

[d] The former levels I and II are revised because they did not ensure sufficient immunity in subsequent road vehicles' design.

[e] The maximum pulse repetition time shall be chosen such that it is the minimum time for the DUT to be correctly initialized before the application of the next pulse and shall be $\geqslant$0,5 s.

For EUT was used severity level III

test pulse severity levels for nominal 24 V system

Test pulse[a]	Selected test level[b]	Test pulse severity level, U_s[cd] V			Min. number of pulses or test time	Burst cycle/ pulse repetition time	
		IV	III	I / II		min.	max.
1		–600	–450	–300	500 pulses	0,5 s	[e]
2a		+112	+55	+37	500 pulses	0,2 s	5 s
2b		+20	+20	+20	10 pulses	0,5 s	5 s
3a		–300	–220	–150	1 h	90 ms	100 ms
3b		+300	+220	+150	1 h	90 ms	100 ms

[a] Test pulses as in 5.6.

[b] Values agreed between vehicle manufacturer and equipment supplier.

[c] The amplitudes are the values of U_s as defined for each test pulse in 5.6.

[d] The former levels I and II are revised because they did not ensure sufficient immunity in subsequent road vehicles' design.

[e] The maximum pulse repetition time shall be chosen such that it is the minimum time for the DUT to be correctly initialized before the application of the next pulse and shall be $\geqslant$0,5 s.

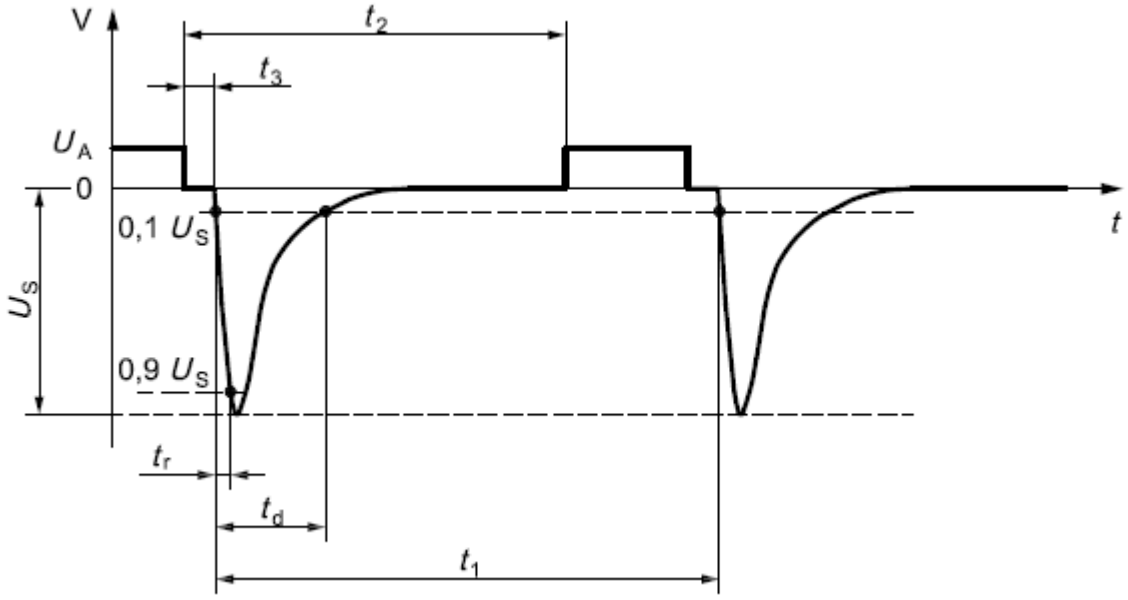
For EUT was used severity level III

Performance criteria:

For transmitters, pulse 3a and 3b the performance criteria for continuous phenomena for transmitters shall apply.
For pulse 1, 2a, 2b, and 4 the performance criteria for transient phenomena for transmitter shall apply, with the exception that a communication link need not to be maintained during the EMC exposure and may have to be re-established.
For receivers, pulse 3a and 3b the performance criteria for continuous phenomena for receivers shall apply.
For pulse 1, 2a, 2b, and 4 the performance criteria for transient phenomena for receivers shall apply, with the exception that a communication link need not to be maintained during the EMC exposure and may have to be re-established.
For ancillary equipment the pass/failure criteria supplied by the manufacturer shall apply, unless the ancillary equipment is tested in connection with the radio equipment in which case the corresponding performance criteria above shall apply.

Measurement data:

Pulse 1



Parameters	Nominal 12 V system	Nominal 24 V system
U_s	–75 V to –150 V	–300 V to –600 V
R_i	10 Ω	50 Ω
t_d	2 ms	1 ms
t_r	$(1\ ^{0}_{-0,5})$ µs	$(3\ ^{0}_{-1,5})$ µs
t_1[a]	⩾0,5 s	
t_2	200 ms	
t_3[b]	<100 µs	

[a] t_1 shall be chosen such that it is the minimum time for the DUT to be correctly initialized before the application of the next pulse and shall be ⩾0,5 s.

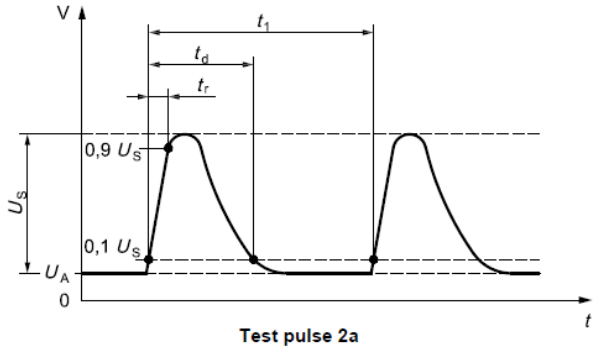
[b] t_3 is the smallest possible time necessary between the disconnection of the supply source and the application of the pulse.

At 24 V power supply, were used pulses with: U_s -450 V time.

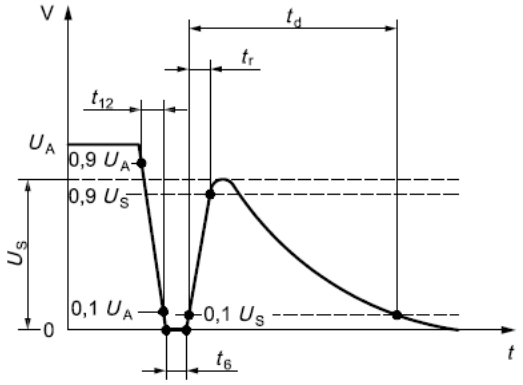
As a source of power and pulses with the parameters defined in the table above was used DC power source and Set to testing of immunity to the Transients and surges in the vehicular environment.
To verify the shape of the signal was used oscilloscope.

During and after the test the EUT was operated as intended, no loss function.

Pulse 2a and 2b



Test pulse 2a



Test pulse 2b

Parameters for test pulse 2a

Parameters	Nominal 12 V and 24 V system
U_s	+37 V to +112 V
R_i	2 Ω
t_d	0,05 ms
t_r	$(1\ ^{0}_{-0,5})$ µs
t_1[a]	0,2 s to 5 s

[a] The repetition time t_1 can be short depending on the switching. The use of a short repetition time reduces the test time.

Parameters for test pulse 2b

Parameters	Nominal 12 V system	Nominal 24 V system
U_s	10 V	20 V
R_i	0 Ω to 0,05 Ω	
t_d	0,2 s to 2 s	
t_{12}	1 ms ± 0,5 ms	
t_r	1 ms ± 0,5 ms	
t_6	1 ms ± 0,5 ms	

At 24 V power supply, were used pulses 2a with: U_s +55 V 10 time.

As a source of power and pulses with the parameters defined in the table above was used signal generator Spitzenberger PAS 5000
To verify the shape of the signal was used oscilloscope.

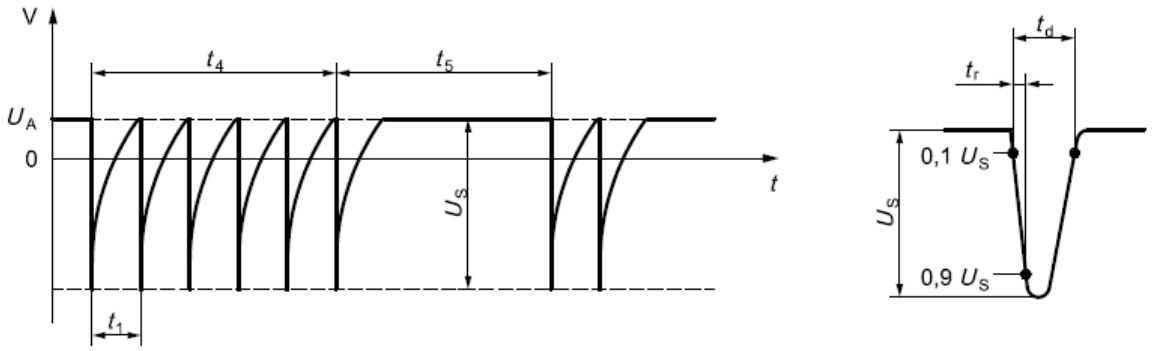
During and after the test the EUT was operated as intended, no loss function.

At 24 V power supply, were used pulses 2b with: U_s +20 V 10 time.

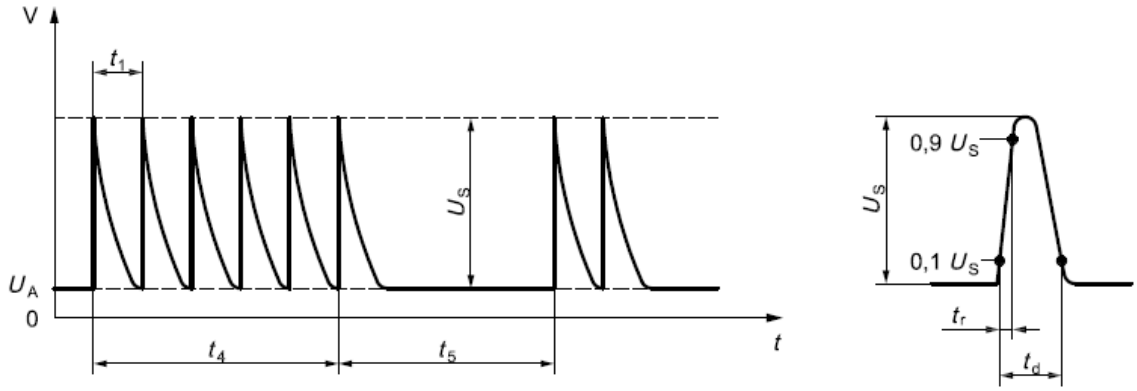
As a source of power and pulses with the parameters defined in the table above was used signal generator Spitzenberger PAS 5000
To verify the shape of the signal was used oscilloscope.

During and after the test the EUT was operated as intended, no loss function.

Pulse 3a and 3b



Test pulse 3a



Test pulse 3b

Parameters for test pulse 3a

Parameters	Nominal 12 V system	Nominal 24 V system
U_s	–112 V to –220 V	–150 V to –300 V
R_i	50 Ω	
t_d	150 ns ± 45 ns	
t_r	5 ns ± 1,5 ns	
t_1	100 µs	
t_4	10 ms	
t_5	90 ms	

Parameters for test pulse 3b

Parameters	Nominal 12 V system	Nominal 24 V system
U_s	+75 V to +150 V	+150 V to +300 V
R_i	50 Ω	
t_d	150 ns ± 45 ns	
t_r	5 ns ± 1,5 ns	
t_1	100 µs	
t_4	10 ms	
t_5	90 ms	

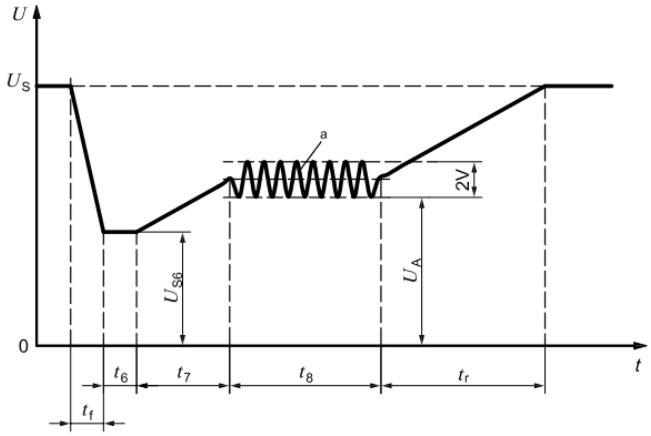
At 24 V power supply, were used pulses 3a with: Us -220 V 20 min per coupling polarity (total 60 min).

As a source of power and pulses with the parameters defined in the table above was used DC power source and Compact NX Generator AMETEK CTS NX5.
To verify the shape of the signal was used oscilloscope.
During and after the test the EUT was operated as intended, no loss function.

At 24 V power supply, were used pulses 3b with: Us -220 V 20 min per coupling polarity (total 60 min)

As a source of power and pulses with the parameters defined in the table above was used DC power source and Compact NX Generator AMETEK CTS NX5.
To verify the shape of the signal was used oscilloscope.
During and after the test the EUT was operated as intended, no loss function.

Pulse 4 – Starting profile



Key

t	time
U	test voltage
t_f	falling slope
t_r	rising slope
t_6, t_7, t_8	duration parameters (in accordance with Table 3)
U_A	supply voltage for generator in operation (see ISO 16750-1)
U_S	supply voltage
U_{S6}	supply voltage at t_6
a	$f = 2$ Hz.

Starting profile values for systems with 12 V nominal voltage (U_N)

Parameter		Level			
		I	II	III	IV
Voltage V	U_{S6}	8 (–0,2)	4,5 (–0,2)	3 (–0,2)	6 (–0,2)
	U_S	9,5 (–0,2)	6,5 (–0,2)	5 (–0,2)	6,5 (–0,2)
Duration ms	t_f	5 (± 0,5)	5 (± 0,5)	5 (± 0,5)	5 (± 0,5)
	t_6	15 (±1,5)	15 (± 1,5)	15 (± 1,5)	15 (± 1,5)
	t_7	50 (± 5)	50 (± 5)	50 (± 5)	50 (± 5)
	t_8	1 000 (± 100)	10 000 (± 1 000)	1 000 (± 100)	10 000 (± 1 000)
	t_r	40 (± 4)	100 (± 10)	100 (± 10)	100 (± 10)

Values systems with 24 V nominal voltage (U_N)

Parameter		Level		
		I	II	III
Voltage V	U_{S6}	10 (–0,2)	8 (–0,2)	6 (–0,2)
	U_S	20 (–0,2)	15 (–0,2)	10 (–0,2)
Duration ms	t_f	10 (± 1)	10 (± 1)	10 (± 1)
	t_6	50 (± 5)	50 (± 5)	50 (± 5)
	t_7	50 (± 5)	50 (± 5)	50 (± 5)
	t_8	1 000 (± 100)	1 000 (± 100)	1 000 (± 100)
	t_r	40 (± 4)	100 (± 10)	40 (± 10)

At 24 V power supply, were used pulses for level III.

As a source of power and pulses with the parameters defined in the table above was used signal generator Spitzenberger PAS 5000
To verify the shape of the signal was used oscilloscope.

During and after the test the EUT was operated as intended, no loss function.

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8 PHOTOGRAPHS FROM TESTING SITE

END OF TEST REPORT