DAkkS Deutsche Akkreditierungsstelle D-PL-21375-01-03 D-PL-21375-01-04

INGENIEURBÜRO LENHARDT

Bundesnetzagentur BNetzA-CAB-21/21-21

Test Report

Test report no.: 20114752-19951-1
Date of issue: 2022-08-19

Test result: The test item **- passed - and complies** with below listed standards.

Applicant
Continental Automotive GmbH

Manufacturer
Continental Automotive GmbH

Test Item
E3HCP422

RF-Spectrum Testing according to:

FCC 47 CFR Part 15
Radio Frequency Devices (Subpart C)

RSS-Gen
General Requirements for Compliance of Radio Apparatus

Tested by (name, function, signature)	*Karsten Geraldy* *Head of Laboratory RF*	p. O. _____ signature
Approved by (name, function, signature)	*Andreas Bender* *Deputy Managing Director*	_____ signature

Applicant and Test item details	
Applicant	Continental Automotive GmbH Philipsstrasse 1 D-35576, Wetzlar, Germany Fon: +49 6441 3700 Fax:
Manufacturer	Continental Automotive GmbH Philipsstrasse 1 D-35576, Wetzlar, Germany
Test item description	Passive Start- and Entry-System (PASE), Remote Keyless Entry (RKE) and Immobilization
Model/Type reference	E3HCP422
FCC ID	KR5E3HCP422
IC	7812D-E3HCP422
HMN	N/A
PMN	E3HCP422
HVIN	C3
FVIN	Homologation_004 US
Frequency	125 kHz
Antenna	ferrite coil antennas
Power supply	9.0 V – 16.0 V DC via car battery
Temperature range	-40 °C – +85 °C

Disclaimer and Notes

The content of this test report relates to the mentioned test sample(s) only.
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Within this test report, a ☒ point / ☐ comma is used as a decimal separator.
If otherwise, a detailed note is added adjected to its use.

IBL-Lab GmbH does not take test samples. The sample used for testing is provided by the applicant.

Decision rule:
Decision rule based on simple acceptance without guard bands, binary statement, based on mutually agreed uncertainty tolerances with expansion factor k=2 according to ILAC-G8:09/2019

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2 GENERAL INFORMATION

2.1 Administrative details

Testing laboratory	**IBL-Lab GmbH** Heinrich-Hertz-Allee 7 66386 Sankt Ingbert / Germany Fon: +49 6894 38938-0 Fax: +49 6894 38938-99 URL: www.ib-lenhardt.de E-Mail: info@ib-lenhardt.de
Accreditation	The testing laboratory is accredited by Deutsche Akkreditierungsstelle GmbH (DAkkS) in compliance with DIN EN ISO/IEC 17025:2018. Scope of testing and registration number: • Electronics D-PL-21375-01-01 • Electromagnetic Compatibility D-PL-21375-01-02 • Electromagnetic Compatibility and Telecommunication (FCC requirements) D-PL-21375-01-03 • Telecommunication (TC) and Electromagnetic Compatibility (EMC) for Canadian Standards D-PL-21375-01-04 • ISED Company Number 27156 • Testing Laboratory CAB Identifier DE0020 • Telekommunikation (TK) D-PL-21375-01-05 Website DAkkS: https://www.dakks.de/ The Deutsche Akkreditierungsstelle GmbH (DAkkS) is also a signatory to ILAC Mutual Recognition Arrangement
Testing location	**IBL-Lab GmbH** Heinrich-Hertz-Allee 7 66386 St. Ingbert / Germany
Date of receipt of test samples	2021-07-05
Start – End of tests	2021-07-06 – 2021-07-09

2.2 Possible test case verdicts

Test sample meets the requirements	P (PASS)
Test sample does not meet the requirements	F (FAIL)
Test case does not apply to the test sample	N/A (Not applicable)
Test case not performed	N/P (Not performed)

2.3 Observations

No additional observations other than the reported observations within this test report have been made.

2.4 Opinions and interpretations

No appropriate opinions or interpretations according ISO/IEC 17025:2017 clause 7.8.7 are within this test report.

2.5 Revision History

-0 Initial Version

-1 Revision: corrected nominal voltage from 13.4 V to 13.5 V.

This test report **20114752-19951-1 replaces the previous test report 20114752-19951-0.**
Utilisation, publication and control of previous report editions is under responsibility of the applicant.

2.6 Further documents

List of further applicable documents belonging to the present test report:
– no additional documents –

3 ENVIRONMENTAL & TEST CONDITIONS

3.1 Environmental conditions

Temperature	20°C ± 5°C
Relative humidity	25-75% r.H.
Barometric Pressure	860-1060 mbar
Power supply	230 V AC ± 5%

3.2 Normal and extreme test conditions

	minimum	nominal	maximum
Temperature	-/- °C	20 °C	-/- °C
Relative humidity	-/-	45 % r.h.	-/-
Power supply	8.0 V DC	13.5 V DC	16.0 V DC

4 TEST STANDARDS AND REFERENCES

Test standard (accredited)	Description
FCC 47 CFR Part 15	Radio Frequency Devices (Subpart C)
RSS-Gen	General Requirements for Compliance of Radio Apparatus

Reference	Description
ANSI C63.4-2014	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10-2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

5 EQUIPMENT UNDER TEST (EUT)

5.1 Product description

Passive Start- and Entry-System (PASE), Remote Keyless Entry (RKE) and Immobilization

5.2 Description of test item

Model name*	E3HCP422
Serial number*	SME-RBG07.04.2100580074
PCB identifier*	A2C76712911
Hardware status*	C3
Software status*	Homologation_004 US

*: as declared by applicant

5.3 Technical data of test item

Operational frequency band*	125 kHz
Type of radio transmission*	Modulated carrier
Modulation type*	ASK (OOK)
Number of channels*	1
Channel bandwidth*	<30 kHz
Channel spacing*	n.a.
Antenna*	ferrite coil antennas
Power supply*	9.0 V – 16.0 V DC via car battery
Temperature range*	-40 °C – +85 °C

*: as declared by applicant

5.4 Additional information

Model differences	none
Additional application considerations to test a component or sub-assembly	none
Ancillaries tested with	none
Additional equipment used for testing	none

Equipment Under Test (EUT) is prepared by the applicant with switch box to setup different Tx polling telegrams / Immobilizer telegram.

5.5 Test instruction of manufacturer

5.2.3.1 Triggered LF telegram1

Precondition before start of each measurement: Power switch is off (red LED off)

Measurement procedure:

1. Select the mode

SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
1	0	0	1	0	0	0	0

2. Switch the power switch to on (red LED on)
3. The module starts to transmit the LF sequence periodically every 2000ms
4. Start the measurement
5. After measurement switch the power switch to off (red LED off")

Sequence:

Ant	Data transmission	Data transmission	CW trans-mission	CW trans-mission	CW trans-mission	CW trans-mission	CW trans-mission
	LF0	LF1	HFM1	HFM2	HFM3	HFM4	HFM5
1		WUP	HFM				
2	WUP0			HFM			
3					HFM		
4 long		WUP				HFM	
5 long	WUP						HFM

5.2.3.2 LF polling telegram 1

Precondition before start of each measurement: Power switch is off (red LED off)

Measurement procedure:

1. Select the mode

SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
1	0	0	1	0	0	0	1

2. Switch the power switch to on (red LED on)
3. The module starts to transmit the LF sequence periodically every 500ms
4. Start the measurement
5. After measurement switch the power switch to off (red LED off")

Ant	Data transmission	Data transmission	CW trans-mission	CW trans-mission	CW trans-mission	CW trans-mission	CW trans-mission
	LF0	LF1	HFM1	HFM2	HFM3	HFM4	HFM5
1		WUP	HFM				
2	WUP			HFM			
3					HFM		
4 long		WUP				HFM	
5 long	WUP						HFM

5.2.3.3 Transmission of LF immobilizer telegram

Precondition before start of each measurement: Power switch is off (red LED off)

Measurement procedure:

1. Select the mode

SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
1	1	1	0	0	0	0	0

2. Switch the power switch to on (red LED on)
3. The module starts to transmit the LF sequence periodically every 2000ms
4. Start the measurement
5. After measurement switch the power switch to off (red LED off")

Ant1

Reference:
Functional Description of Homologations board FBS HCP4, Description_Homologation_FBS_HCP4 (1).pdf, Date: 2021-06-25, Version: 1.4, Author: Rupert Schuster

6 SUMMARY OF TEST RESULTS

Test specification
FCC 47 CFR Part 15 RSS-Gen

Clause	Requirement / Test case	Test Conditions	Result / Remark	Verdict
§15.209 RSS-Gen	Radiated emission limits	Normal	< limit	P
RSS-Gen, 6.7	Occupied bandwidth	Normal	27.2 kHz	P

Notes
– none –

Comments and observations
– none –

7 TEST RESULTS

7.1 Field strength of emissions

Description / Limits

§15.209 (a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency	Field Strength	Measurement distance
0.009 – 0.490 MHz	2400/F[kHz] µV/m	300 m
0.490 – 1.705 MHz	24000/F[kHz] µV/m	30 m
1.705 – 30.0 MHz	30.0 µV/m / 29.5 dBµV/m	30 m
30 – 88 MHz	100 µV/m / 40.0 dBµV/m	3 m
88 – 216 MHz	150 µV/m / 43.5 dBµV/m	3 m
216 – 960 MHz	200 µV/m / 46.0 dBµV/m	3 m
960 – 100 000 MHz	500 µV/m / 54.0 dBµV/m	3 m

§15.209 (b) In the emission table above, the tighter limit applies at the band edges.

§15.209 (c) The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. For intentional radiators which operate under the provisions of other sections within this part and which are required to reduce their unwanted emissions to the limits specified in this table, the limits in this table are based on the frequency of the unwanted emission and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.

§15.209 (d) The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

Test procedure

§15.31 (m) Measurements on intentional radiators or receivers, other than TV broadcast receivers, shall be performed and, if required, reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in the following table:

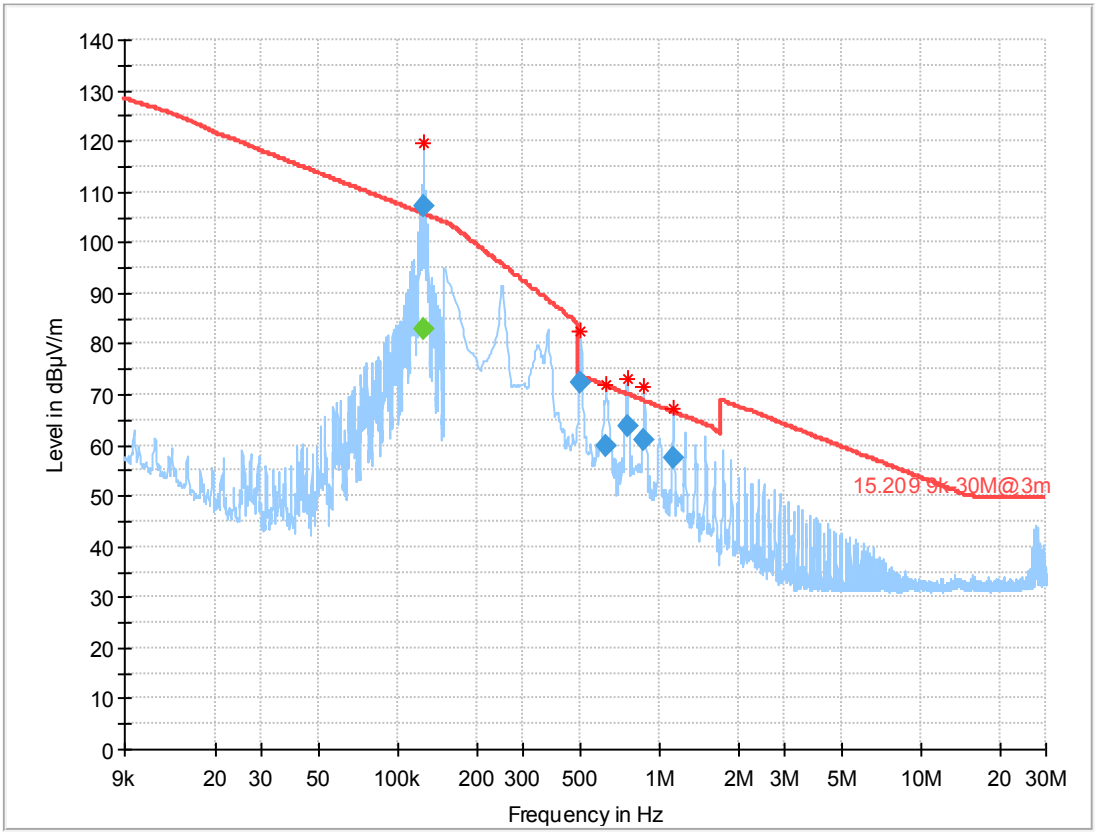
Frequency range	Number of frequencies	Location
< 1MHz bandwidth	1	middle
1 – 10 MHz bandwidth	2	1 near bottom and 1 near top
> 10 MHz bandwidth	3	1 near bottom / middle / top

§15.35 (a) On any frequency or frequencies below or equal to 1000 MHz, the limits shown are based on measuring equipment employing a CISPR quasi-peak detector function and related measurement bandwidths, unless otherwise specified. The specifications for the measuring instrumentation using the CISPR quasi-peak detector can be found in ANSI C63.4-2014, clause 4 (incorporated by reference, see §15.38). As an alternative to CISPR quasi-peak measurements, the responsible party, at its option, may demonstrate compliance with the emission limits using measuring equipment employing a peak detector function as long at the same bandwidth as indicated for CISPR quasi-peak measurements are employed.

Test setup: see 8.2 – 8.4

Test results:						
Channel / Mode	**Frequency [MHz]**	**Detector**	**Test distance [m]**	**Level [dBµV/m]**	**Limit [dBµV/m]**	**Margin [dB]**
Triggered LF	0.125	AVG	3	82.96	105.72	22.76
Polling	0.125	AVG	3	95.00	105.72	10.72
Immobilizer	0.125	AVG	3	82.41	105.72	23.31
Note: For more details see measurement plot on next pages.						

Plot no. 1: radiated emissions 9 kHz – 30 MHz, loop antenna, Triggered LF Telegram 1



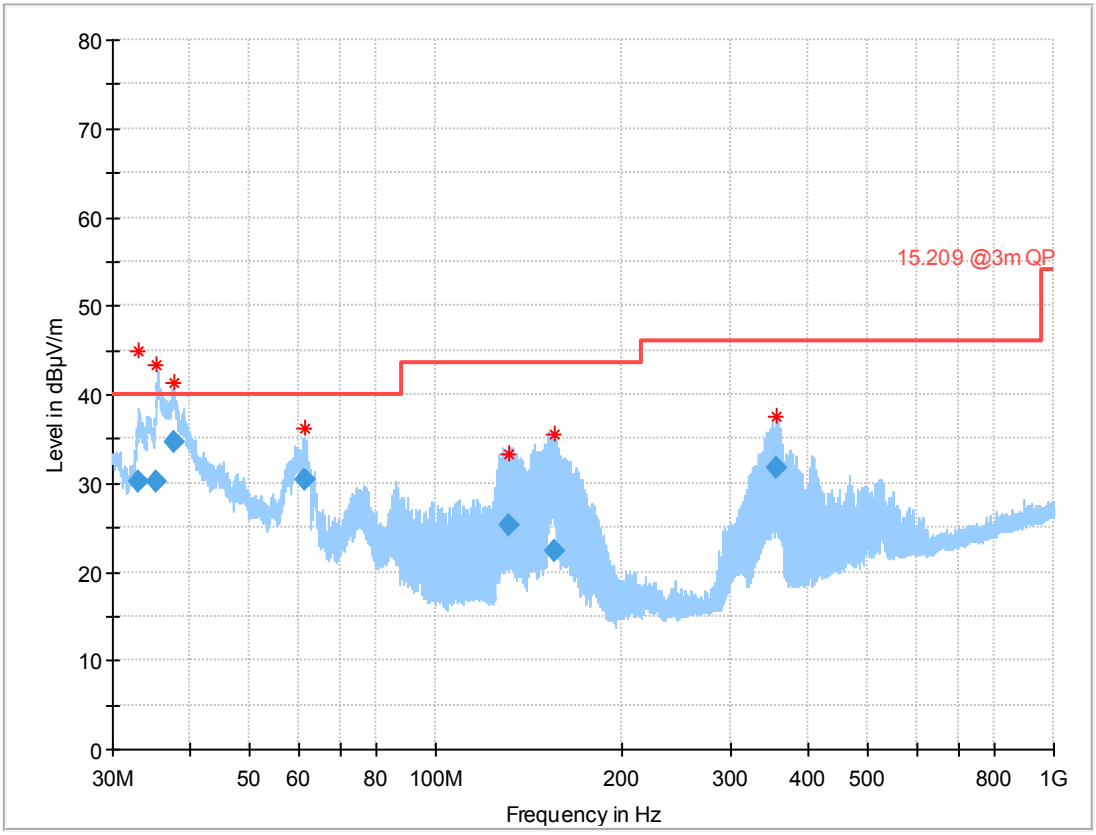
Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB)
0.125000	119.57	105.72	-13.85	---	---	H	-28.0	20.5
0.501000	82.32	73.60	-8.72	---	---	H	-30.0	20.4
0.624750	71.95	71.68	-0.27	---	---	H	-30.0	20.3
0.750750	72.98	70.11	-2.87	---	---	H	-28.0	20.3
0.874500	71.38	68.78	-2.60	---	---	H	-28.0	20.3
1.124250	67.07	66.58	-0.49	---	---	H	-28.0	20.3

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)
0.125000	---	82.96	105.72	22.76	20000.0	0.200	H	-28.0
0.125000	107.03	---	105.72	-1.31	20000.0	0.200	H	-28.0
0.501000	72.36	---	73.60	1.24	20000.0	9.000	H	-30.0
0.624750	59.66	---	71.71	12.05	20000.0	9.000	H	-30.0
0.750750	63.64	---	70.11	6.47	20000.0	9.000	H	-28.0
0.874500	61.07	---	68.78	7.71	20000.0	9.000	H	-28.0
1.124250	57.44	---	66.60	9.16	20000.0	9.000	H	-28.0

Plot no. 2: radiated emissions 30 MHz – 1 GHz, hor./vert. polarization, Triggered LF Telegram 1



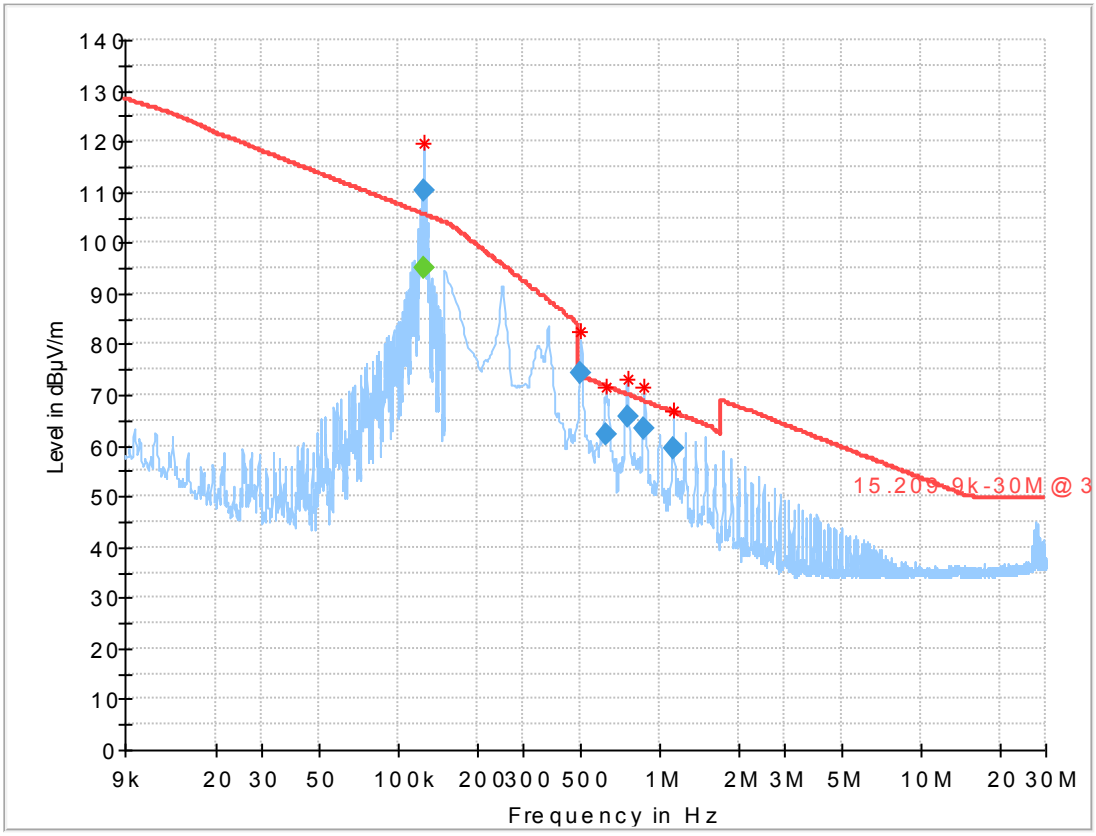
Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
33.125000	44.98	40.00	-4.98	---	---	123.0	V	120.0
35.375000	43.43	40.00	-3.43	---	---	100.0	V	29.0
37.750000	41.31	40.00	-1.31	---	---	100.0	V	317.0
61.500000	36.27	40.00	3.73	---	---	357.0	H	164.0
131.000000	33.23	43.50	10.27	---	---	173.0	H	300.0
155.250000	35.56	43.50	7.94	---	---	100.0	V	105.0
357.000000	37.62	46.00	8.38	---	---	247.0	H	47.0

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
33.125000	30.06	40.00	9.94	10000.0	120.000	123.0	V	120.0
35.375000	30.20	40.00	9.80	10000.0	120.000	100.0	V	29.0
37.750000	34.66	40.00	5.34	10000.0	120.000	100.0	V	317.0
61.500000	30.28	40.00	9.72	10000.0	120.000	357.0	H	164.0
131.000000	25.23	43.50	18.27	10000.0	120.000	173.0	H	300.0
155.250000	22.37	43.50	31.13	10000.0	120.000	100.0	V	105.0
357.000000	31.68	46.00	14.32	10000.0	120.000	247.0	H	47.0

Plot no. 3: radiated emissions 9 kHz – 30 MHz, loop antenna, LF Polling Telegram 1



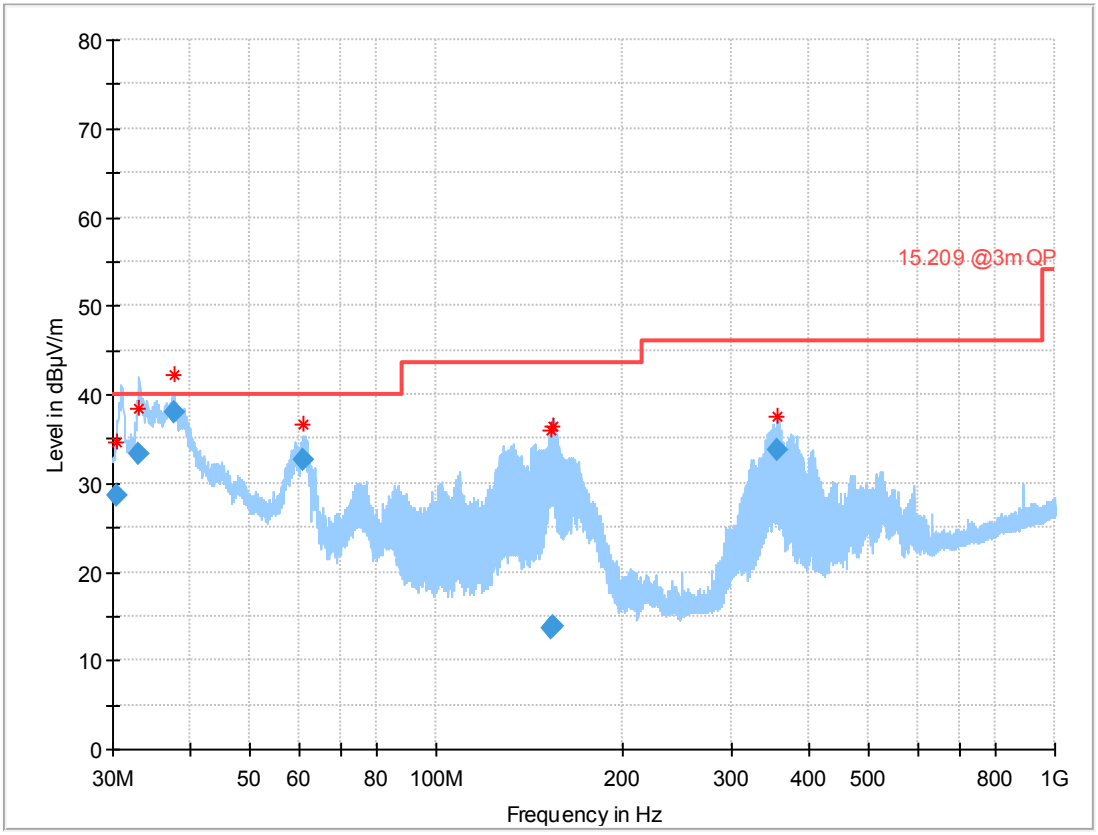
Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB)
0.125000	119.58	105.72	-13.86	---	---	H	-28.0	20.5
0.501000	82.34	73.60	-8.74	---	---	H	-30.0	20.4
0.624750	71.73	71.71	-0.02	---	---	H	-30.0	20.3
0.750750	73.11	70.11	-2.99	---	---	H	-28.0	20.3
0.874500	71.42	68.78	-2.64	---	---	H	-30.0	20.3
1.124250	66.97	66.58	-0.39	---	---	H	-28.0	20.3

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)
0.125000	---	95.00	105.72	10.72	20000.0	0.200	H	-28.0
0.125000	110.33	---	105.72	-4.61	20000.0	0.200	H	-28.0
0.501000	72.74	---	73.60	0.86	20000.0	9.000	H	-30.0
0.624750	62.25	---	71.71	9.46	20000.0	9.000	H	-30.0
0.750750	65.84	---	70.11	4.27	20000.0	9.000	H	-28.0
0.874500	63.49	---	68.78	5.29	20000.0	9.000	H	-30.0
1.124250	59.50	---	66.60	7.10	20000.0	9.000	H	-28.0

Plot no. 4: radiated emissions 30 MHz – 1 GHz, hor./vert. polarization, LF Polling Telegram 1



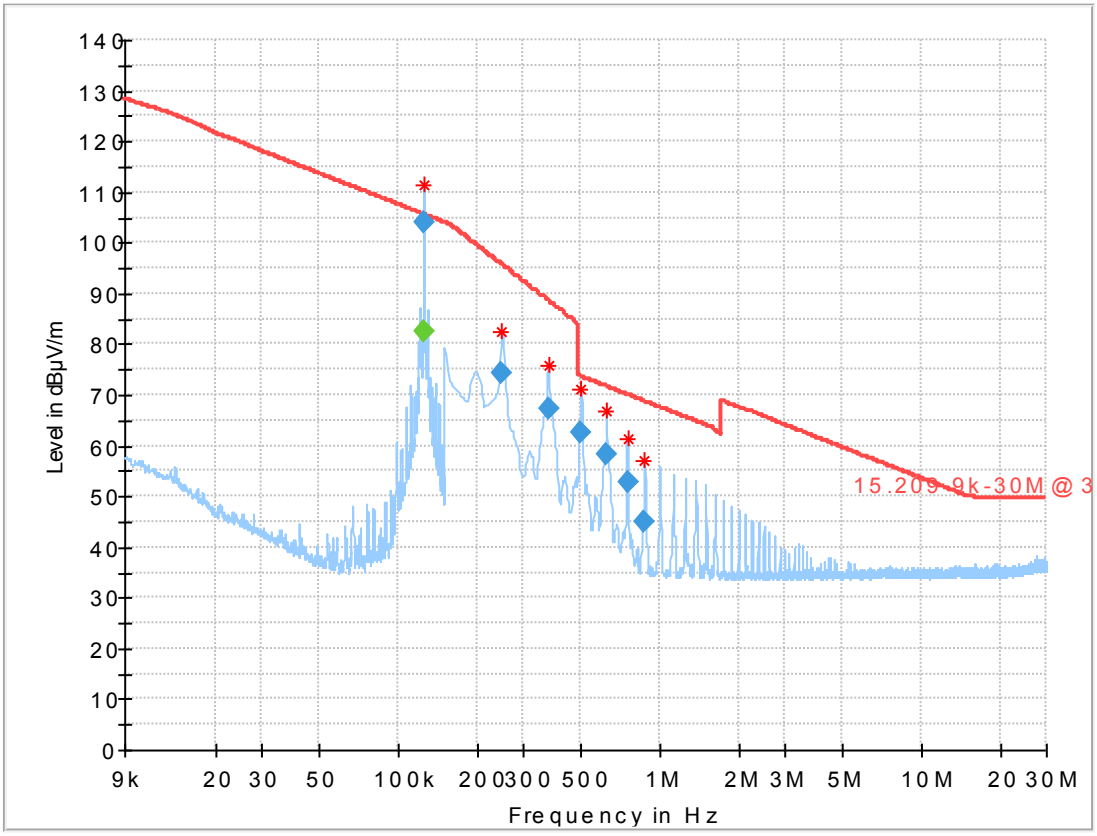
Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
30.500000	34.74	40.00	5.26	---	---	103.0	V	150.0
33.125000	38.49	40.00	1.51	---	---	100.0	V	164.0
37.750000	42.32	40.00	-2.32	---	---	103.0	V	316.0
60.875000	36.75	40.00	3.25	---	---	353.0	H	158.0
153.825000	35.88	43.50	7.62	---	---	103.0	V	97.0
154.325000	36.39	43.50	7.11	---	---	100.0	V	97.0
357.000000	37.44	46.00	8.56	---	---	261.0	H	46.0

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
30.500000	28.60	40.00	11.40	10000.0	120.000	103.0	V	150.0
33.125000	33.22	40.00	6.78	10000.0	120.000	100.0	V	164.0
37.750000	37.91	40.00	2.09	10000.0	120.000	103.0	V	316.0
60.875000	32.59	40.00	7.41	10000.0	120.000	353.0	H	158.0
153.825000	13.73	43.50	29.77	10000.0	120.000	103.0	V	97.0
154.325000	13.94	43.50	29.56	10000.0	120.000	100.0	V	97.0
357.000000	33.78	46.00	12.22	10000.0	120.000	261.0	H	46.0

Plot no. 5: radiated emissions 9 kHz – 30 MHz, loop antenna, LF Immobilizer Telegram



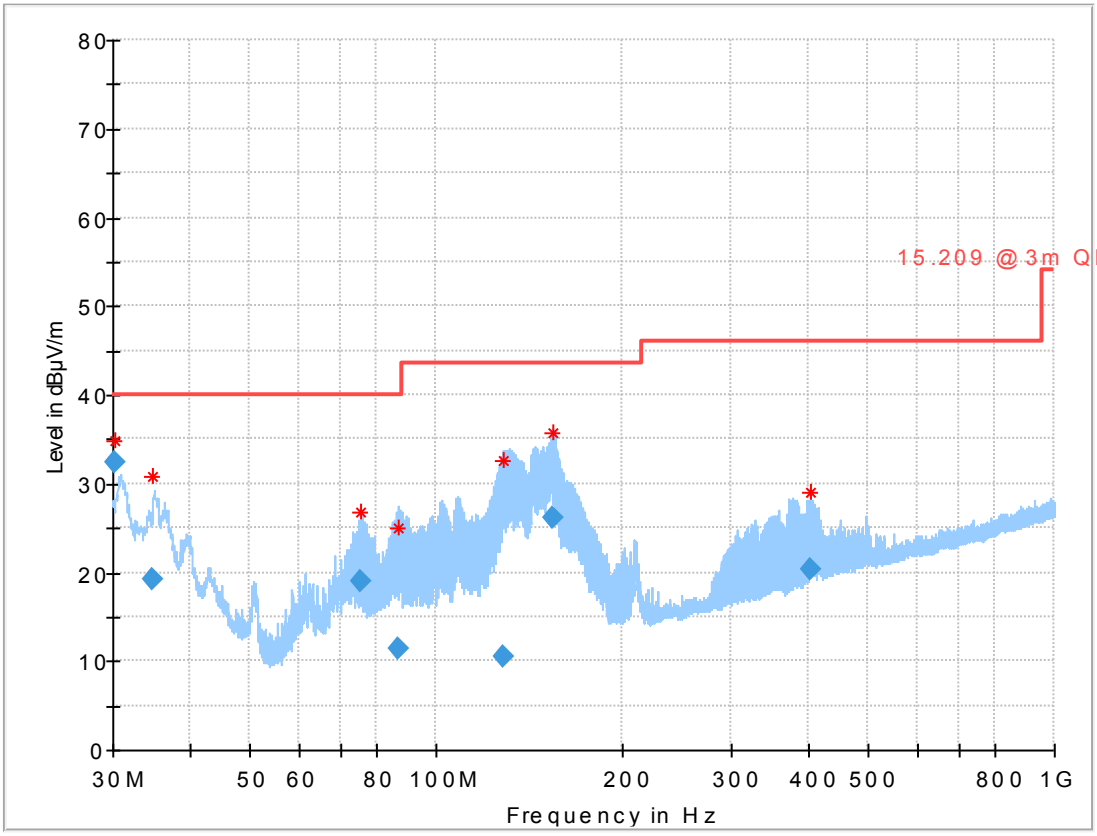
Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB)
0.125000	111.30	105.72	-5.58	---	---	H	242.0	20.5
0.249000	82.36	95.79	13.43	---	---	H	242.0	20.4
0.375000	75.99	88.68	12.69	---	---	H	242.0	20.4
0.501000	71.12	73.60	2.49	---	---	H	242.0	20.4
0.624750	66.68	71.71	5.02	---	---	H	242.0	20.3
0.750750	61.21	70.11	8.90	---	---	H	242.0	20.3
0.874500	57.12	68.78	11.66	---	---	H	242.0	20.3

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)
0.125000	104.12	---	105.72	1.60	20000.0	0.200	H	242.0
0.125000	---	82.41	105.72	23.31	20000.0	0.200	H	242.0
0.249000	74.26	---	95.79	21.53	20000.0	9.000	H	242.0
0.375000	67.22	---	88.68	21.46	20000.0	9.000	H	242.0
0.501000	62.67	---	73.60	10.93	20000.0	9.000	H	242.0
0.624750	58.24	---	71.71	13.47	20000.0	9.000	H	242.0
0.750750	52.63	---	70.11	17.48	20000.0	9.000	H	242.0
0.874500	44.95	---	68.78	23.83	20000.0	9.000	H	242.0

Plot no. 6: radiated emissions 30 MHz – 1 GHz, hor./vert. polarization, LF Immobilizer Telegram



Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
30.325000	34.81	40.00	5.19	---	---	103.0	V	255.0
34.825000	30.75	40.00	9.25	---	---	122.0	V	265.0
75.500000	26.89	40.00	13.11	---	---	226.0	H	164.0
86.875000	25.05	40.00	14.95	---	---	140.0	V	40.0
128.175000	32.72	43.50	10.78	---	---	315.0	H	293.0
154.500000	35.77	43.50	7.73	---	---	100.0	V	85.0
403.000000	29.04	46.00	16.96	---	---	227.0	H	265.0

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
30.325000	32.40	40.00	7.60	10000.0	120.000	103.0	V	255.0
34.825000	19.25	40.00	20.75	10000.0	120.000	122.0	V	265.0
75.500000	19.07	40.00	20.93	10000.0	120.000	226.0	H	164.0
86.875000	11.39	40.00	28.61	10000.0	120.000	140.0	V	40.0
128.175000	10.59	43.50	32.91	10000.0	120.000	315.0	H	293.0
154.500000	26.23	43.50	17.27	10000.0	120.000	100.0	V	85.0
403.000000	20.26	46.00	25.74	10000.0	120.000	227.0	H	265.0

7.2 Occupied bandwidth

Description

The occupied bandwidth or the “99% emission bandwidth” is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

In some cases, the “x dB bandwidth” is required, which is defined as the frequency range between two points, one at the lowest frequency below and one at the highest frequency above the carrier frequency, at which the maximum power level of the transmitted emission is attenuated x dB below the maximum in-band power level of the modulated signal, where the two points are on the outskirts of the in-band emission.

The following conditions shall be observed for measuring the occupied bandwidth and x dB bandwidth:

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.
- The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max Hold”) may be necessary to determine the occupied / x dB bandwidth if the device is not transmitting continuously.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.

For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).

Test procedure

ANSI C63.10, 6.9.3

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission.

The following procedure shall be used for measuring 99% power bandwidth:

a) The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.

b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW, unless otherwise specified by the applicable requirement.

c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.

d) Step a) through step c) might require iteration to adjust within the specified range.

e) Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.

f) Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth.

g) If the instrument does not have a 99% power bandwidth function, then the trace data points are recovered and directly summed in linear power terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% power bandwidth is the difference between these two frequencies.

h) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

Note
Measurements with the peak detector are also suitable to demonstrate compliance of an EUT, as long as the required resolution bandwidth is used, because peak detection will yield amplitudes equal to or greater than amplitudes measured with RMS detector. The measurement data from a spectrum analyser peak detector will represent the worst-case results (see ANSI C63.10).

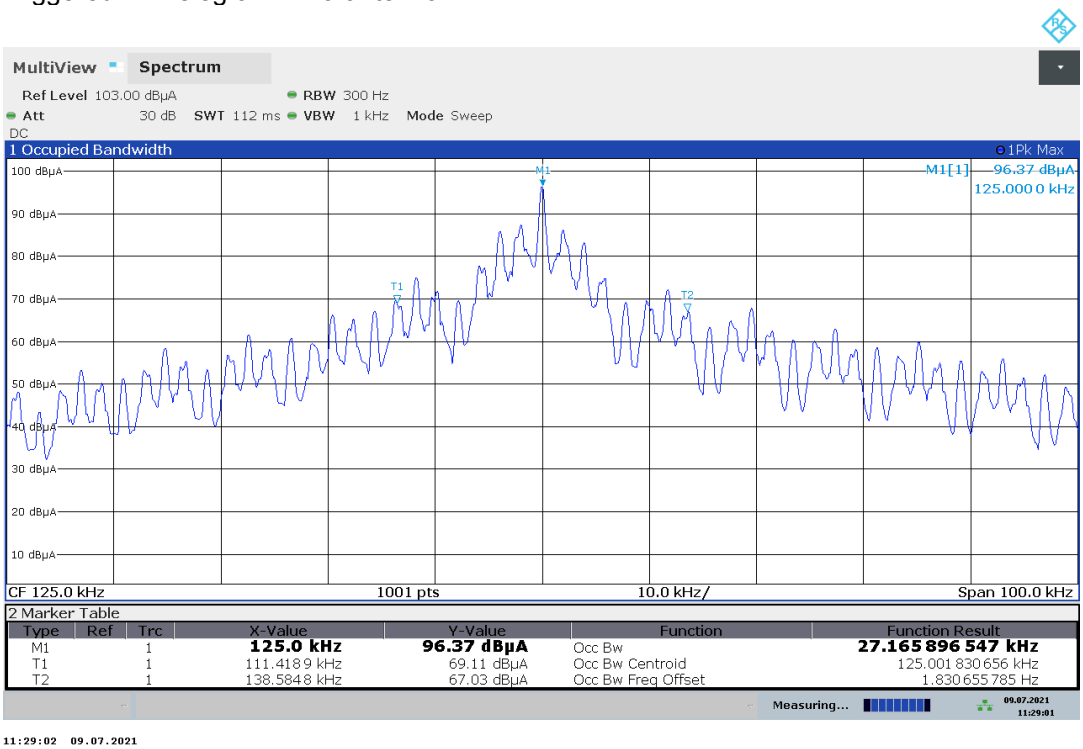
Test setup: see 8.2

Test results:

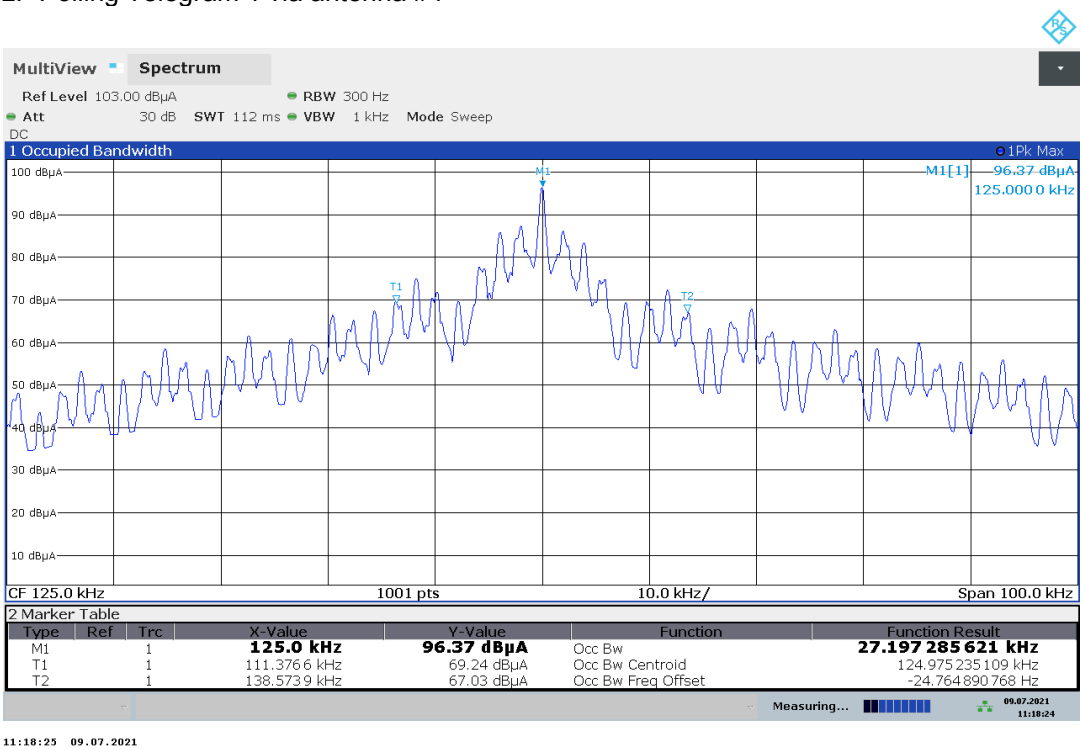
Mode	Min. Frequency F_L [kHz]	Max. frequency F_H [kHz]	Occupied bandwidth (99%) [kHz]
Triggered LF	111.4189	138.5848	27.1659
Polling	111.3766	138.5739	27.1973
Immobilizer	120.1324	130.0351	9.90265

Where: F_L = is the lower edge of the OBW
F_H = is the upper edge of the OBW

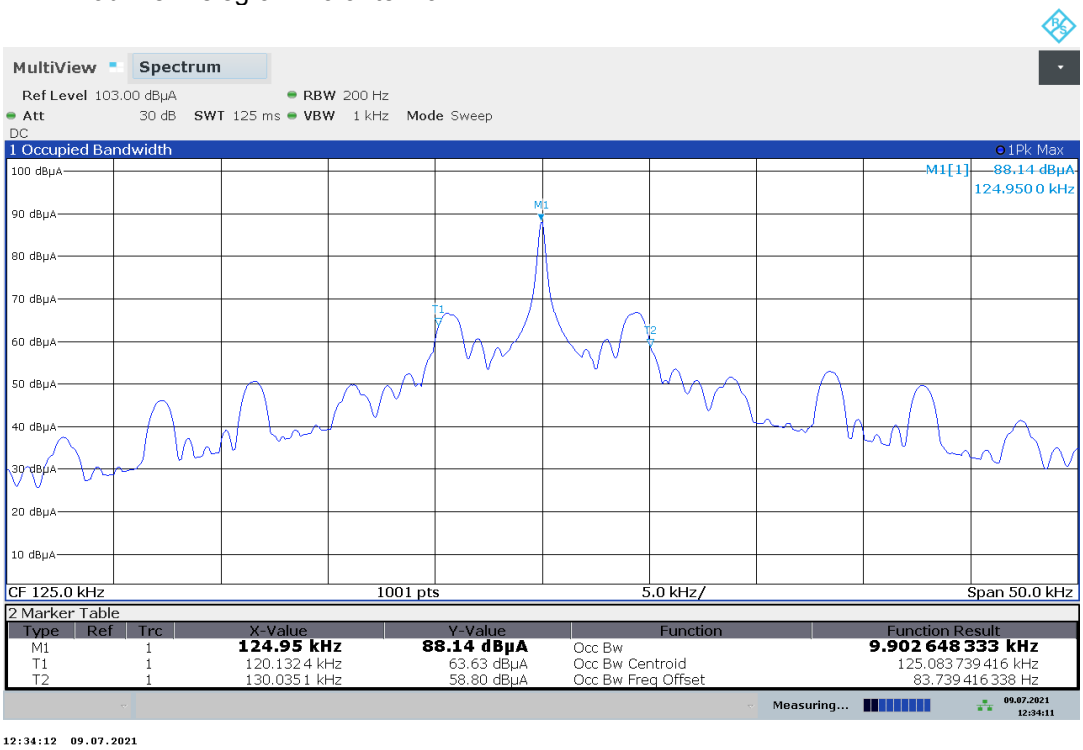
Plot No. 7: Triggered LF Telegram 1 via antenna #4



Plot No. 8: LF Polling Telegram 1 via antenna #4



Plot No. 9: LF Immobilizer Telegram via antenna #1



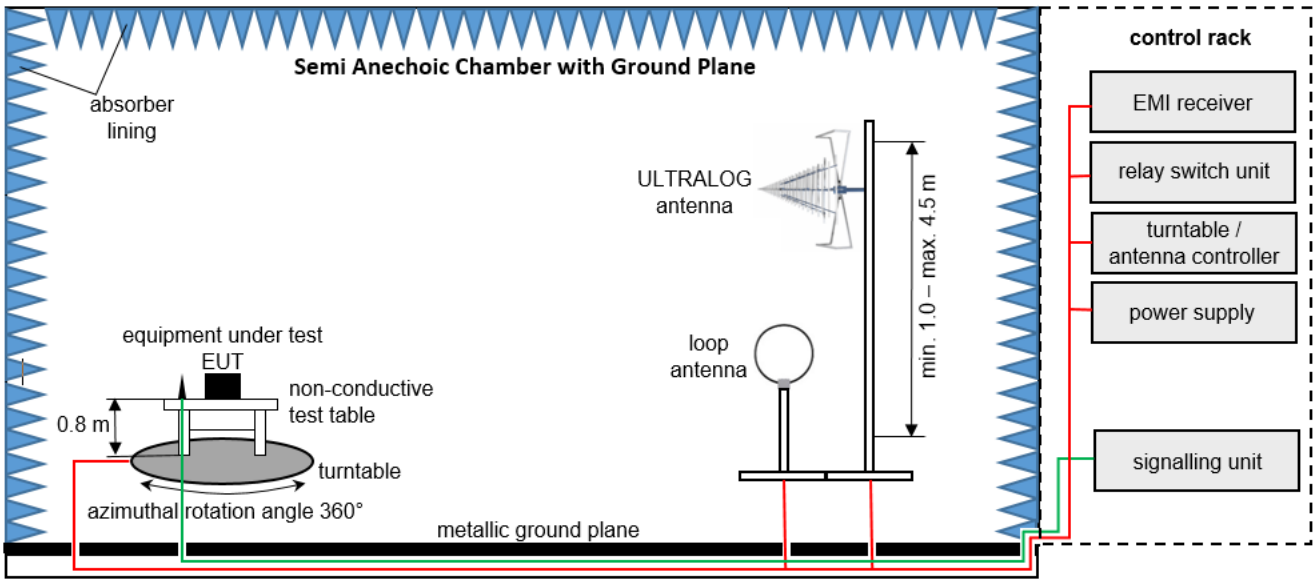
8 Test Setup Description

Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements with other calibrated test systems or effective verifications. Cyclically chamber inspections and range calibrations are performed. Where possible resp. necessary, RF generating and signaling equipment as well as measuring receivers and analyzers are connected to an external high-precision 10 MHz reference (GPS-based frequency standard).

In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

8.1 Semi Anechoic Chamber with Ground Plane

Radiated measurements are performed in vertical and horizontal plane in the frequency range 30 MHz to 1 GHz in a Semi Anechoic Chamber with a metallic ground plane. The EUT is positioned on a non-conductive test table with a height of 0.80 m above the metallic ground plane that covers the whole chamber. The receiving antennas conform to specification ANSI C63.10-2013, American National Standard for Testing Unlicensed Wireless Devices. These antennas can be moved over the height range between 1.0 m and 4.5 m in order to search for maximum field strength emitted from the EUT. The measurement distances between EUT and receiving antennas are indicated in the test setups for the various frequency ranges. For each measurement, the EUT is rotated in all three axes until the maximum field strength is received. The wanted and unwanted emissions are received by a spectrum analyzer where the detector modes and resolution bandwidths over various frequency ranges are set according to requirement ANSI C63.



Measurement distance: ULTRALOG antenna 5 meter; loop antenna 5 meter / 3 meter / 1 meter
EMC32 software version: 11.00.00

FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

Example calculation:
FS [dBµV/m] = 12.35 [dBµV/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dBµV/m] (35.69 µV/m)

List of test equipment used:

No.	Equipment	Manufacturer	Type	Serial No.	IBL No.	Kind of Calibration	Calibration
1	EMI Test Receiver	Rohde & Schwarz	ESW26	101517	LAB000363	K	2021-02-05 → 12M → 2022-02-05
2	Power Supply	Elektro-Automatik GmbH & Co. KG	EA-PSI 9080-40 T	2000230001	LAB000313	NE	–
3	Test table	innco systems GmbH	PT1208-080-RH	-	LAB000306	NE	–
4	Power Supply	Chroma	61604	616040005416	LAB000285	NE	–
5	Antenna	TTE Europe	62-HA20-A-SMF	-	LAB000282	K	2020-09-29 → 36M → 2023-09-29
6	Positioner	maturo GmbH	TD 1.5-10KG		LAB000258	NE	–
7	Compressed Air	Implotex	1-850-30	-	LAB000256	NE	–
8	Semi-Anechoic Chamber (SAC)	Albatross Projects GmbH	Babylon 5 (SAC 5)	20168.PRB	LAB000235	ZW	2020-08-24 → 12M → 2021-08-24
9	Measurement Software	Rohde & Schwarz	EMC32 V11.00.10		LAB000226	NE	–
10	Turntable	maturo GmbH	TT2.0-2t	TT2.0-2t/921	LAB000225	NE	–
11	Antenna Mast	maturo GmbH	CAM4.0-P	CAM4.0-P/316	LAB000224	NE	–
12	Controller	maturo GmbH	FCU 3.0	10082	LAB000222	NE	–
13	Power Supply	Elektro-Automatik GmbH & Co. KG	EA-PS 2042-10 B	2878350292	LAB000191	NE	–
14	Pre-Amplifier	Schwarzbeck Mess-Elektronik OHG	BBV 9718 C	84	LAB000169	NE	–
15	Antenna	Rohde & Schwarz	HF907	102899	LAB000151	K	2020-04-23 → 36M → 2023-04-23
16	Antenna	Rohde & Schwarz	HL562E	102005	LAB000150	K	2020-07-05 → 36M → 2023-07-05
17	Open Switch and Control Platform	Rohde & Schwarz	OSP200 Base Unit 2HU	101748	LAB000149	ZW	2020-07-07 → 12M → 2021-07-07
18	Antenna	Rohde & Schwarz	HL562E	102001	LAB000123	K	2020-07-05 → 36M → 2023-07-05
19	Antenna	Rohde & Schwarz	HFH2-Z2E - Active Loop Antenna	100954	LAB000108	K	2020-03-25 → 36M → 2023-03-25

9 Measurement procedures

9.1 Radiated spurious emissions from 9 kHz to 30 MHz

Test setup

- The EUT is set up according to its intended use, as described in the user manual or as defined by the manufacturer.
- In case of floor standing equipment, it is placed in the middle of the turn table.
  In case of tabletop equipment it is placed on a non-conductive table with a height of 80 cm.
- Additional equipment, cables, … necessary for testing, are positioned like under normal operation.
- Interface cables, e.g. power supply, network, … are connected to the connection box in the turn table.
- EUT is powered on and set into operation.

Pre-scan

- Turntable performs an azimuthal rotation from 0° to 315° in 45° steps.
- For each turntable step the EMI-receiver/spectrum analyser performs a positive-peak/max-hold sweep (=worst-case). Data is transferred to EMI-software and recorded. EMI-software will show the maximum level of all single sweeps as the final result for the pre-scan.

Final measurement

- Significant emissions found during the pre-scan will be maximized by the EMI-software by rotating the turntable from 0° to 360°.
- Loop antenna is rotated with special 3D adapter set to find maximum level of emissions.
- Plot of the pre-scan with frequencies of identified emissions including levels, correction factors, turn table position and settings of measuring equipment is recorded.

Distance correction (extrapolation)

- When performing measurements on test distances other than defined in the rules, the results shall be extrapolated to the specified distance by conservatively presuming that the field strength decays at 40 dB/decade of distance in the region closer than λ in m divided by 2π (i.e., λ/2π), and at 20 dB/decade of distance beyond that, using the measurement of a single point at the radial angle that produces the maximum emission.
  This correction is already included in the limit line of corresponding measurement plots.

Detailed requirements can be found in e.g. ANSI C63.4 / C63.10

9.2 Radiated spurious emissions from 30 MHz to 1 GHz

Test setup

- The EUT is set up according to its intended use, as described in the user manual or as defined by the manufacturer.
- In case of floor standing equipment, it is placed in the middle of the turn table.
  In case of tabletop equipment it is placed on a non-conductive table with a height of 80 cm.
- Additional equipment, cables, … necessary for testing, are positioned like under normal operation.
- Interface cables, e.g. power supply, network, … are connected to the connection box in the turn table.
- EUT is powered on and set into operation.

Pre-scan

- Turntable performs an azimuthal rotation from 0° to 315° in 45° steps.
- Antenna polarisation is changed (H-V / V-H) and antenna height is changed from 1 meter to 4 meters.
- For each turntable step / antenna polarisation / antenna height the EMI-receiver/spectrum analyser performs a positive-peak/max-hold sweep (=worst-case). Data is transferred to EMI-software and recorded. EMI-software will show the maximum level of all single sweeps as the final result for the pre-scan.

Final measurement

- Significant emissions found during the pre-scan will be maximized by the EMI-software based on evaluated data during the pre-scan by rotating the turntable and changing antenna height and polarisation.
- Final measurement will be performed with measuring equipment settings as defined in the applicable test standards (e.g. ANSI C6.4).
- Plot of the pre-scan with frequencies of identified emissions including levels, correction factors, turn table position, antenna polarisation and settings of measuring equipment is recorded.

Distance correction (extrapolation)

- When performing measurements on test distances other than defined in the rules, the results shall be extrapolated to the specified distance by conservatively presuming that the field strength decays at 20 dB/decade of distance beyond the region λ in m divided by 2π (i.e., λ/2π), using the measurement of a single point at the radial angle that produces the maximum emission.
  This correction is already included in the corresponding measurement plots.

Detailed requirements can be found in e.g. ANSI C63.4 / C63.10

10 MEASUREMENT UNCERTAINTIES

Radio frequency	≤ ± 10 ppm
Radiated emission	≤ ± 6 dB
Temperature	≤ ± 1 °C
Humidity	≤ ± 5 %
DC and low frequency voltages	≤ ± 3 %

The indicated expanded measurement uncertainty corresponds to the standard measurement uncertainty for the measurement results multiplied by the coverage factor k = 2. It was determined in accordance with EA-4/01 m:2013. The true value is located in the corresponding interval with a probability of 95 %.