

Test Report

Report Number:

F212055E1

Equipment under Test (EUT):

**Infrared and radar motion detector
CDL2-A15G**

Applicant:

Bosch Security System, Inc.

Manufacturer:

Bosch Security Systems - Sistemas de Segurança, S.A.



Deutsche
Akkreditierungsstelle
D-PL-17186-01-01
D-PL-17186-01-02
D-PL-17186-01-03

References

- [1] **ANSI C63.10-2013**, American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services
- [2] **FCC CFR 47 Part 15**, Radio Frequency Devices
- [3] **RSS-210 Issue 10 December 2019**, Licence-Exempt Radio Apparatus: Category I Equipment
- [4] **RSS-Gen Issue 5 February 2021 Amendment 2**, General Requirements for Compliance of Radio Apparatus

TEST RESULT

The requirements of the tests performed as shown in the overview (clause 4) were fulfilled by the equipment under test. The complete test results are presented in the following.
“Passed” indicates that the equipment under test conforms with the relevant limits of the testing standard without taking any measurement uncertainty into account as stated in clause 1.3 of ANSI C63.10 (2013). However, the measurement uncertainty is calculated and shown in this test report.

Tested and
written by:

Signature

Reviewed and
approved by:

Signature

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The test results herein refer only to the tested sample. PHOENIX TESTLAB GmbH is not responsible for any generalisations or conclusions drawn from these test results concerning further samples. Any modification of the tested samples is prohibited and leads to the invalidity of this test report. Each page necessarily contains the PHOENIX TESTLAB Logo and the TEST REPORT NUMBER.

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1 Identification

1.1 Applicant

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Applicant represented during the test by the following person:	---

1.2 Manufacturer

Name:	Bosch Security Systems - Sistemas de Segurança, S.A.
Address:	EN109/IC1, Zona Industrial de Ovar Lugar da Pardala - S. João de Ovar 3880-728 Ovar
Country:	Portugal
Name for contact purposes:	Mr. Antonio PEREIRA
Phone:	+351 256 596 - 110
eMail Address:	AntonioMaria.Pereira@pt.bosch.com
Manufacturer represented during the test by the following person:	---

1.3 Test laboratory

The tests were carried out at: **PHOENIX TESTLAB GmbH**
Königswinkel 10
32825 Blomberg
Germany

Accredited by Deutsche Akkreditierungsstelle GmbH (DAkkS) in compliance with DIN EN ISO/IEC 17025 under Reg. No. D-PL-17186-01-05 and D-PL-17186-01-06, FCC Test Firm Designation Number DE0004, FCC Test Firm Registration Number 469623, CAB Identifier DE0003 and ISED# 3469A.

1.4 EUT (Equipment Under Test)

Test object: *	Infrared and radar motion detector
PMN: *	CDL2
HVIN: *	CDL2-A15G
FCC ID: *	T3X-CDL2
IC: *	1249A-CDL2
Serial number: *	042207917618010007
PCB identifier: *	F01U381125_03
Software version / FVIN: *	V0.7
Lowest internal frequency: *	32 MHz

*: Declared by the applicant.

Note: PHOENIX TESTLAB GmbH does not take samples. The samples used for tests are provided exclusively by the applicant.

Remark: All tests were performed on one sample as described above

1.5 Technical data of equipment

Duty cycle: *	<0.5 %		
Rated RF output power: *	<20 mW (e.i.r.p.)		
Antenna type:	Integral patch antenna		
Operating frequency range: *	10.500 GHz to 10.550 GHz		
Modulation: *	Pulsed CW		
Bit rate of transmitter: *	N/A		
Supply Voltage (EUT): *	$U_{Nom} = 12.0 V_{DC}$	$U_{Min} = 9.0 V_{DC}$	$U_{Max} = 15.0 V_{DC}$
Power Supply: *	External		
Temperature range: *	-25 °C to +55 °C		
Ancillaries to be tested with:	None		
Equipment used for testing:	AC/DC adaptor type enercell CAT.NO. 273-316** for conducted emission on supply lines		

*: Declared by the applicant.

***: Provided by the laboratory.

Ports/Connectors

Identification	Connector type		Length *
	EUT	Ancillary	
DC in and relays outputs	8-pole terminal block	-	2.0 m
-	-	-	-
-	-	-	-

*: Length during test

1.6 Dates

Date of receipt of test sample:	28.10.2021
Start of test:	09.12.2021
End of test:	13.12.2021

2 Operational states

The EUT is an infrared and radar movement detector intended to be used in indoor alarm applications. All tests were carried out with an unmodified test sample, operating in normal operation mode (infrared and radar detection active).

The EUT was supplied with 12.0 V_{DC} by an external power supply during all tests.

All tests were carried out in normal position of the EUT as it is stated in the installation instruction.

3 Additional information

The tested sample was not labeled with the final label.

4 Overview

Application	Frequency range	FCC 47 CFR Part 15 section [2]	RSS-Gen [4] and RSS 210 [3]	Status	Refer page
Bandwidth	10.500 GHz to 10.550 GHz	15.215 (c)	6.7 [4]	Passed	8 et seq.
Band edge compliance	10.500 GHz to 10.550 GHz	15.215 (c)	-	Passed	11 et seq.
Field strength of fundamental	10.500 GHz to 10.550 GHz	15.245 (b)	F.1 (a) [3]	Passed	14 et seq.
Field strength of harmonics	Up to 60 GHz	15.245 (b) (1) (ii)	F.1 (b) [3] F.1 (c) (ii) [3]	Passed	14 et seq.
Emissions outside the specified bands	10 MHz to 60 GHz	15.205 (a), 15.209 (a), 15.245 (3)	8.9 [4] 8.10 [4] F.1 (e) [3]	Passed	14 et seq.
Conducted emissions	150 kHz to 30 MHz	15.207	8.8 [4]	Passed	28 et seq.
Antenna requirement	-	15.203		Passed *	-

*: Integrated antenna only, requirement fulfilled.

5 Test results

5.1 Bandwidth

5.1.1 Method of measurement (bandwidth)

The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable. If the EUT is not equipped with an antenna connector, a temporary antenna connector has to be installed or a test fixture shall be used. The EUT has to be switched on, the transmitter shall work with its maximum data rate.

The following spectrum analyser settings shall be used:

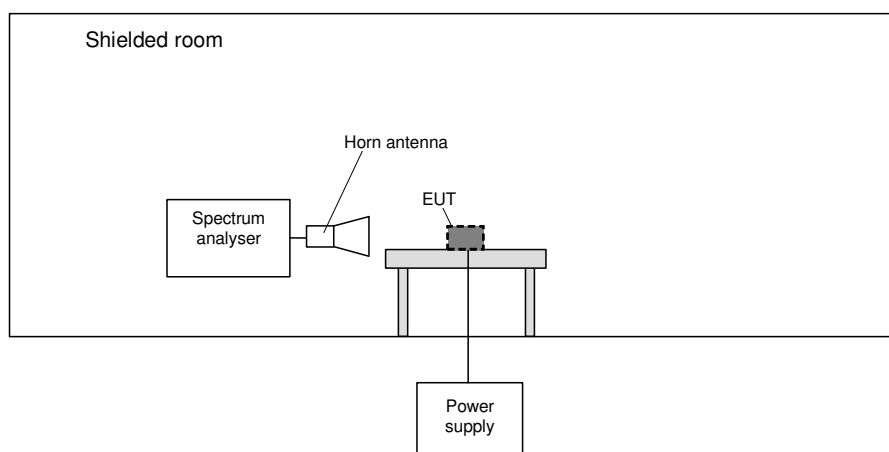
- Span: App. 2 to 3 times the 20 dB bandwidth, centred on the actual channel.
- Resolution bandwidth: App. 1 % of the emission bandwidth.
- Video bandwidth: equal or greater than the RBW.
- Sweep: Auto.
- Detector function: peak.
- Trace mode: Max hold.

20 dB bandwidth:

After trace stabilisation the marker shall be set on the signal peak. The first display line has to be set on this value. The second display line has to be set 20 dB below the first line (or the peak marker). The frequency lines shall be set on the intersection points between the second display line and the measured curve.

99 % bandwidth:

After trace stabilisation the marker shall be set on the signal peak. Use the 99 % bandwidth functionality of the spectrum analyser to integrate the requested bandwidth.



5.2 Test results (20 dB bandwidth)

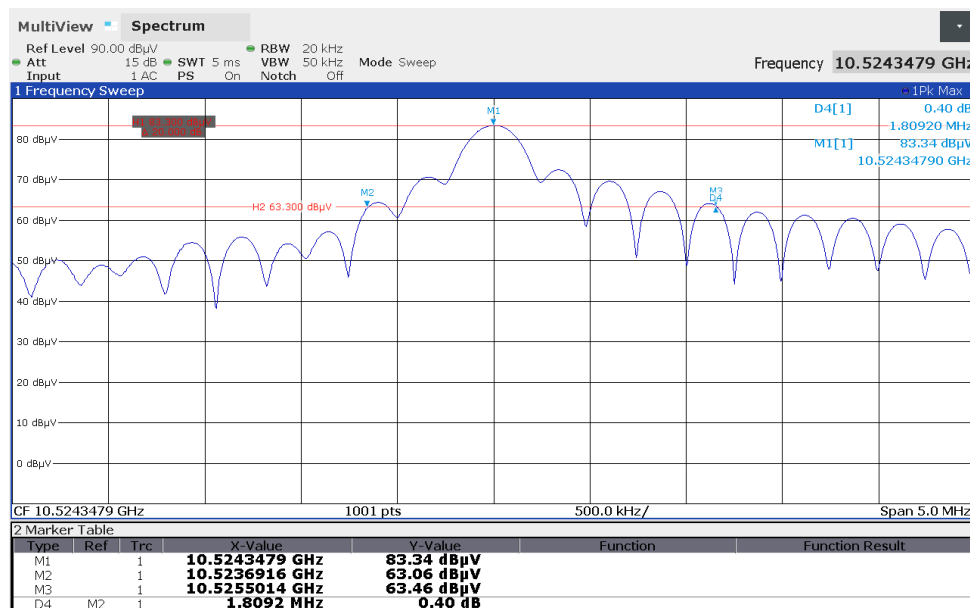
Ambient temperature:	21 °C
Relative humidity:	26 %

Date:	09.12.2021
Tested by:	Thomas KÜHN

Position of EUT: The EUT was set-up 3 m in front of the measuring antenna

Supply voltage: 12 V_{DC} by an external power supply.

212055_1.png: 20 dB bandwidth:



F _L	Limit F _L	F _U	Limit F _U	20 dB Bandwidth	Test result
10.523692 GHz	10.500 GHz	10.525501 GHz	10.550 GHz	1.809 MHz	Passed

Test equipment (please refer to chapter 6 for details)
15 – 20, 22 – 24, 26

5.2.1 Test results (99 % bandwidth)

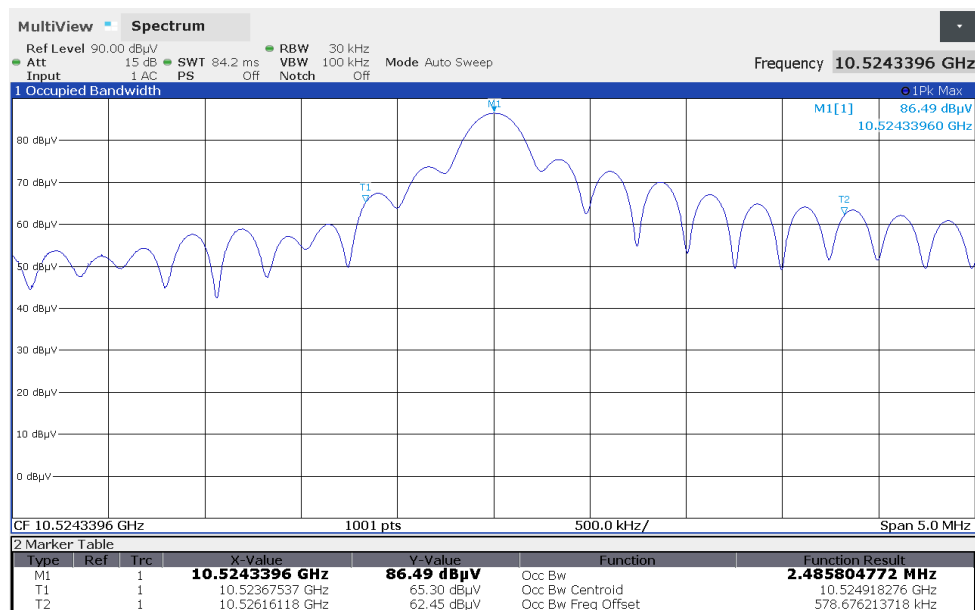
Ambient temperature:	21 °C
Relative humidity:	26 %

Date:	09.12.2021
Tested by:	Thomas KÜHN

Position of EUT: The EUT was set-up 3 m in front of the measuring antenna

Supply voltage: 12 V_{DC} by an external power supply.

212055_2.png: 99 % bandwidth:



F _L	Limit F _L	F _U	Limit F _U	99 % Bandwidth	Test result
10.523675 GHz	10.500 GHz	10.526161 GHz	10.550 GHz	2.486 MHz	Passed

Test equipment (please refer to chapter 6 for details)
15 – 20, 22 – 24, 26

5.3 Band-edge compliance

5.3.1 Method of measurement (band-edge compliance)

The same test set-up as used for the final radiated emission measurement shall be used.
The measurements shall be carried out with using a resolution bandwidth of 100 kHz.

The following spectrum analyser settings shall be used:

- Span: Wide enough to capture the peak level of the emission on the channel closest to the band-edge, as well as any modulation products, which fall outside the assigned frequency band.
- Resolution bandwidth: 100 kHz.
- Video bandwidth: $\geq$ the resolution bandwidth.
- Sweep: Auto.
- Detector function: Peak.
- Trace mode: Max hold.

After trace stabilisation the marker shall be set on the signal peak. The display line has to be set 50 dB below the peak marker. The frequency line shall be set on the edge of the assigned frequency band. Set the second marker on the emission at the band-edge, or on the highest modulation product outside of the band, if this level is higher than that at the band-edge. This frequency shall be measured with the EMI receiver as described in subclause 5.3.1 of this test report, but 100 kHz resolution bandwidth shall be used.

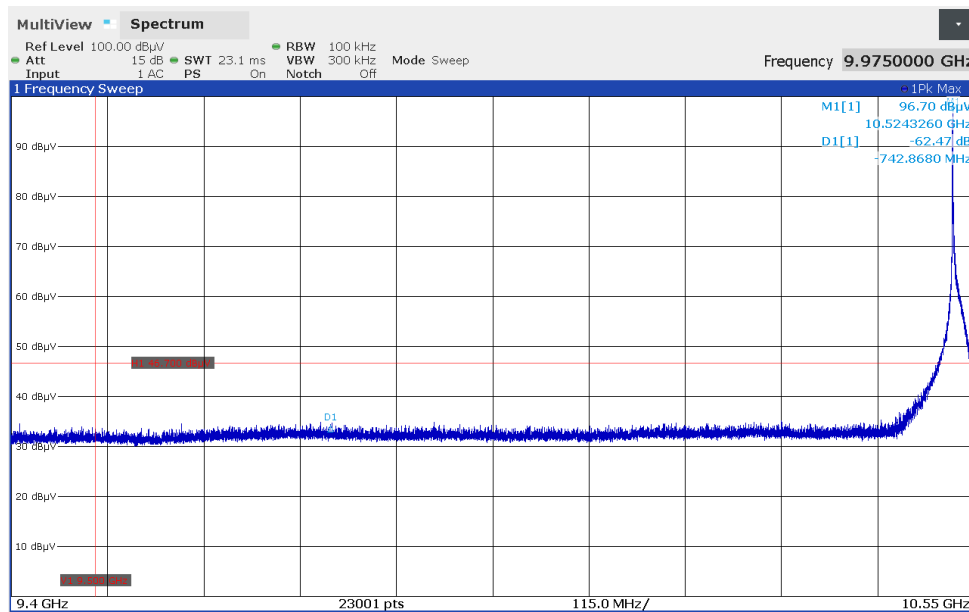
The measurement will be performed at the lower and upper end of the assigned frequency band.

5.3.2 Test results (band-edge compliance)

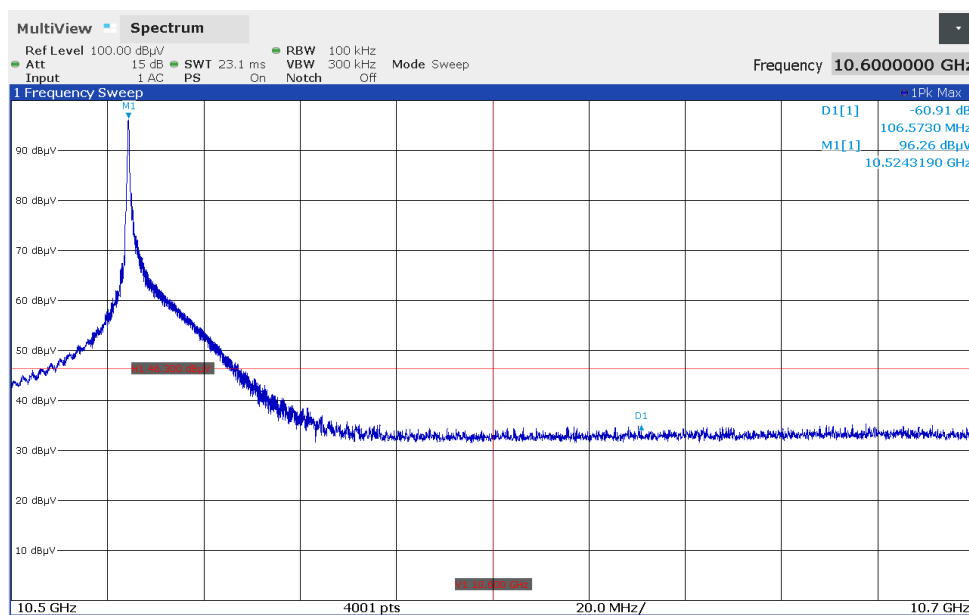
Ambient temperature:	21 °C
Relative humidity:	26 %

Date:	09.12.2021
Tested by:	Thomas KÜHN

212055 4.png: Band-edge compliance, lower band edge:



212055 3.png: Band-edge compliance, upper band edge:



The plots on the page before are showing the band-edge compliance for the lower and upper band-edge. The Marker 1 represents the highest level within the assigned frequency band. The delta marker shows the difference to this peak. The display line 1 (H1) represents the -50 dB offset to this highest level and shows the compliance with FCC 47 CFR Part 15.245 (b) (3). The frequency line 1 (V1) shows the edge of the assigned frequency.

The following calculations were used:

Correction [dB] = Antenna factor [dBm/m] – Preamplifier gain [dB] + Cable attenuation [dB]

Result [dBμV/m] = reading [dBμV] + correction [dB]

Band-edge compliance (lower band edge)							
Result measured with the peak detector:							
Frequency [GHz]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Readings [dBμV]	Correction [dB]	Restr. Band	Test result
9.781158	41.7	74.0	32.3	34.2	7.5	No	Passed
Result measured with the average detector:							
Frequency [GHz]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Readings [dBμV]	Correction [dB]	Restr. Band	Test result
9.781158	-9.9	54.0	63.9	-17.4	7.5	No	Passed

Band-edge compliance (upper band edge)							
Result measured with the peak detector:							
Frequency [GHz]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Readings [dBμV]	Correction [dB]	Restr. Band	Test result
10.063089	42.9	74.0	31.1	35.4	7.5	Yes	Passed
Result measured with the average detector:							
Frequency [GHz]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Readings [dBμV]	Correction [dB]	Restr. Band	Test result
10.063089	-8.7	54.0	62.7	-16.2	7.5	Yes	Passed

Test equipment (please refer to chapter 6 for details)
15 – 20, 22 – 24, 26

5.4 Radiated emissions

5.4.1 Method of measurement (radiated emissions)

The radiated emission measurement is subdivided into 5 stages.

- A preliminary measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 9 kHz to 1 GHz.
- A final measurement carried out on an outdoor test side without reflecting ground plane and a fixed antenna height in the frequency range 9 kHz to 30 MHz.
- A final measurement carried out on an open area test side with reflecting ground plane and various antenna heights in the frequency range 30 MHz to 1 GHz.
- A preliminary measurement carried out in a fully anechoic chamber with a variable antenna distance and height in the frequency range 1 GHz to 110 GHz.
- A final measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 1 GHz to 110 GHz.

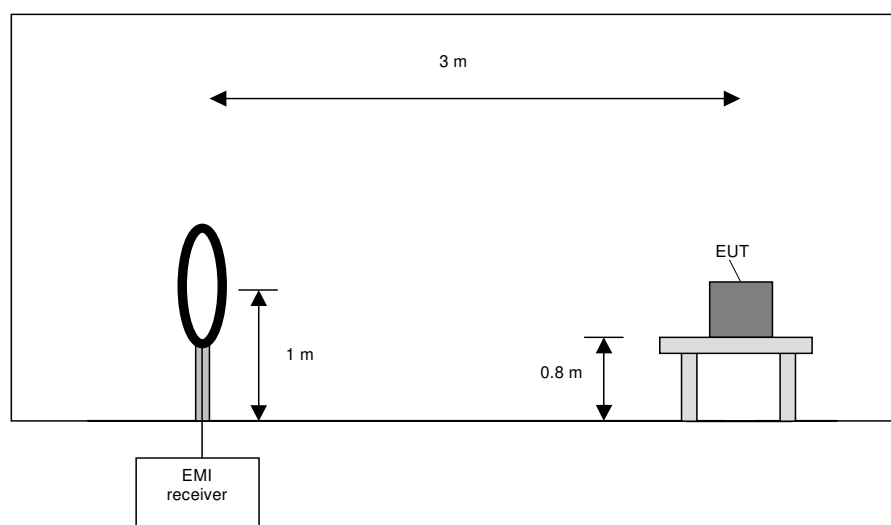
Preliminary measurement (9 kHz to 30 MHz):

In the first stage a preliminary measurement will be performed in a shielded room with a measuring distance of 3 meters. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The setup of the Equipment under test will be in accordance to [1].

The frequency range 9 kHz to 30 MHz will be monitored with a spectrum analyser while the system and its cables will be manipulated to find out the configuration with the maximum emission levels if applicable. The EMI Receiver will be set to MAX Hold mode. The EUT and the measuring antenna will be rotated around their vertical axis to found the maximum emissions.

The resolution bandwidth of the spectrum analyser will be set to the following values:

Frequency range	Resolution bandwidth
9 kHz to 150 kHz	200 Hz
150 kHz to 30 MHz	10 kHz



Preliminary measurement procedure:

Prescans were performed in the frequency range 9 kHz to 150 kHz and 150 kHz to 30 MHz.

The following procedure will be used:

- 1) Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
- 2) Manipulate the system cables within the range to produce the maximum level of emission.
- 3) Rotate the EUT by 360 ° to maximize the detected signals.
- 4) Make a hardcopy of the spectrum.
- 5) Measure the frequencies of highest detected emission with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
- 6) Repeat steps 1) to 5) with the other orthogonal axes of the EUT (only if the EUT is a module or is used in a handheld application).
- 7) Rotate the measuring antenna and repeat steps 1) to 5).

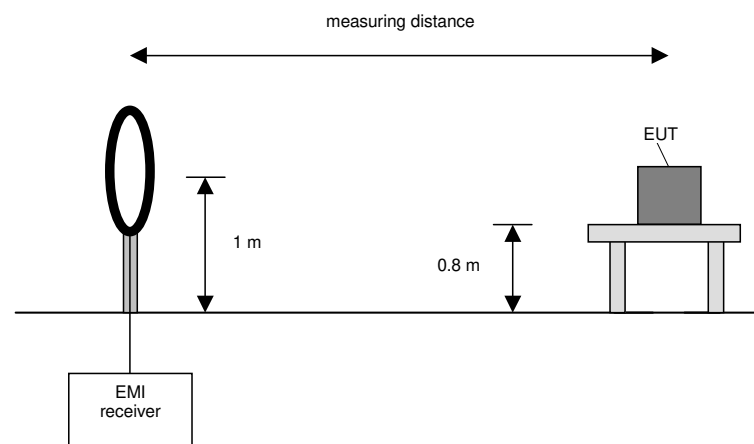
Final measurement (9 kHz to 30 MHz):

In the second stage a final measurement will be performed on an open area test site with no conducting ground plane in a measuring distances of 3 m, 10 m and 30 m whichever is appropriate. In the case where larger measuring distances were required the results will be extrapolated based on the values measured on the closer distances according to [2]. The final measurement will be performed with a EMI Receiver set to Quasi Peak detector except for the frequency bands 30 kHz to 90 kHz and 110 kHz to 490 kHz where an average detector will be used according to [2].

On the during the preliminary measurement detected frequencies the final measurement will be performed while rotating the EUT and the measuring antenna in the range of 0 ° to 360 ° around their vertical axis until the maximum value is found.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
9 kHz to 150 kHz	200 Hz
150 kHz to 30 MHz	9 kHz



Final measurement procedure:

The following procedure will be used:

- 1) Monitor the frequency range with the measuring antenna at vertical orientation parallel to the EUT at an azimuth of 0 °.
- 2) Rotate the EUT by 360 ° to maximize the detected signals and note the azimuth and orientation.
- 3) Rotate the measuring antenna to find the maximum and note the value.
- 4) Rotate the measuring antenna and repeat steps 1) to 3) until the maximum value is found.
- 5) Repeat steps 1) to 4) with the other orthogonal axes of the EUT (only if the EUT is a module or is used in a handheld application).

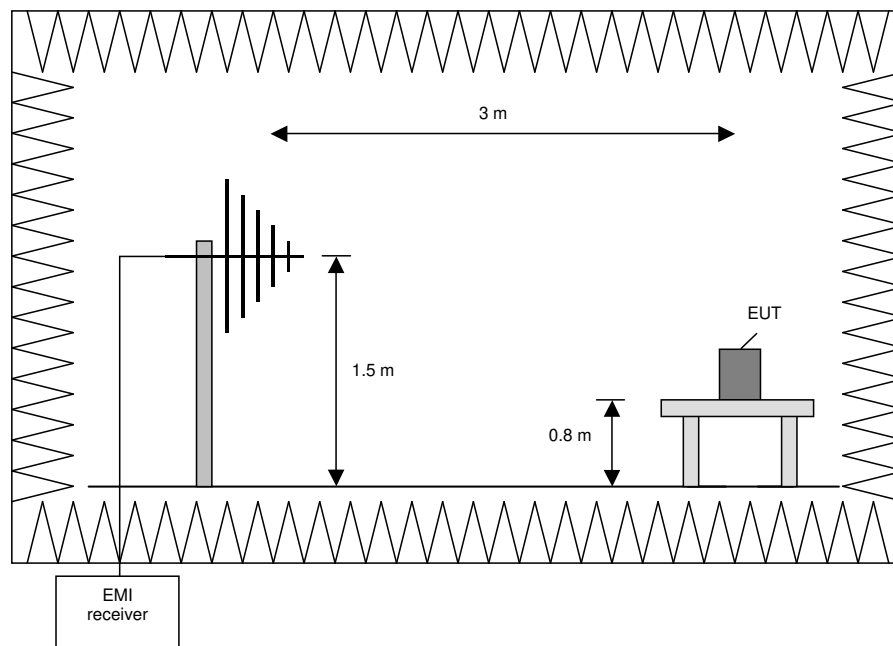
Preliminary measurement (30 MHz to 1 GHz)

In the first stage a preliminary measurement will be performed in a fully anechoic chamber with a measuring distance of 3 meter. Table top devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The setup of the Equipment under test will be in accordance to [1].

The frequency range 30 MHz to 1 GHz will be measured with an EMI Receiver set to MAX Hold mode and a resolution bandwidth of 100 kHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
30 MHz to 1 GHz	100 kHz



Procedure preliminary measurement:

Prescans were performed in the frequency range 30 MHz to 1 GHz.

The following procedure will be used:

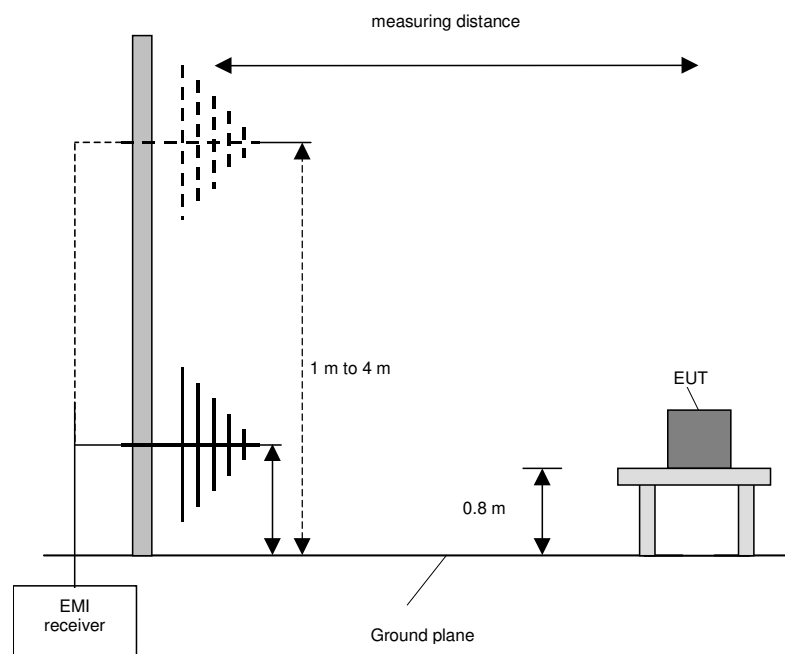
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Manipulate the system cables within the range to produce the maximum level of emission.
3. Rotate the EUT by 360 ° to maximize the detected signals.
4. Make a hardcopy of the spectrum.
5. Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
6. Repeat 1) to 4) with the other orthogonal axes of the EUT (only if the EUT is a module or is used in a handheld application).
7. Repeat 1) to 5) with the vertical polarisation of the measuring antenna.

Final measurement (30 MHz to 1 GHz)

A final measurement on an open area test site will be performed on selected frequencies found in the preliminary measurement. During this test the EUT will be rotated in the range of 0 ° to 360 °, the measuring antenna will be set to horizontal and vertical polarisation and raised and lowered in the range from 1 m to 4 m to find the maximum level of emissions.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
30 MHz to 1 GHz	120 kHz



Procedure final measurement:

The following procedure will be used:

- 1) Measure on the selected frequencies at an antenna height of 1 m and a EUT azimuth of 23 °.
- 2) Move the antenna from 1 m to 4 m and note the maximum value at each frequency.
- 3) Rotate the EUT by 45 ° and repeat 2) until an azimuth of 337 ° is reached.
- 4) Repeat 1) to 3) for the other orthogonal antenna polarization.
- 5) Move the antenna and the turntable to the position where the maximum value is detected.
- 6) Measure while moving the antenna slowly +/- 1 m.
- 7) Set the antenna to the position where the maximum value is found.
- 8) Measure while moving the turntable +/- 45 °.
- 9) Set the turntable to the azimuth where the maximum value is found.
- 10) Measure with Final detector (QP and AV) and note the value.
- 11) Repeat 5) to 10) for each frequency.
- 12) Repeat 1) to 11) for each orthogonal axes of the EUT (only if the EUT is a module or is used in a handheld application).

Preliminary and final measurement (1 GHz to 110 GHz)

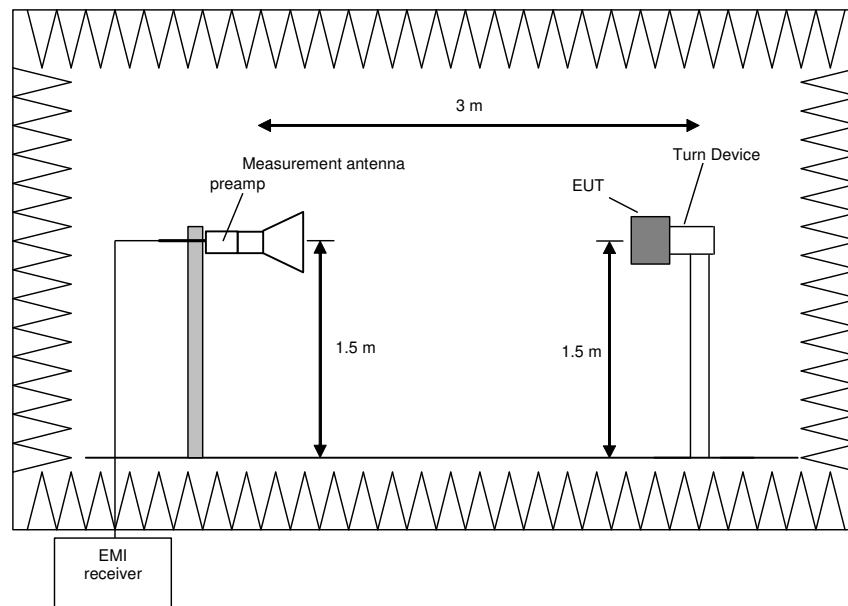
This measurement will be performed in a fully anechoic chamber. Table top devices will set up on a non-conducting turn device on the height of 1.5 m. The set-up of the Equipment under test will be in accordance to [1].

Preliminary measurement (1 GHz to 40 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The spectrum analyser set to MAX Hold mode and a resolution bandwidth of 100 kHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °. This measurement is repeated after raising the EUT in 30 ° steps according 6.6.5.4 in [1].

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
1 GHz to 4 GHz	1 MHz
4 GHz to 12 GHz	1 MHz
12 GHz to 18 GHz	1 MHz
18 GHz to 26.5 GHz	1 MHz
26.5 GHz to 40 GHz	1 MHz
40 GHz to 60 GHz	1 MHz
50 GHz to 75 GHz	1 MHz
75 GHz to 110 GHz	1 MHz



Procedure preliminary measurement:

Prescans were performed in the frequency range 1 to 40 GHz.

The following procedure will be used:

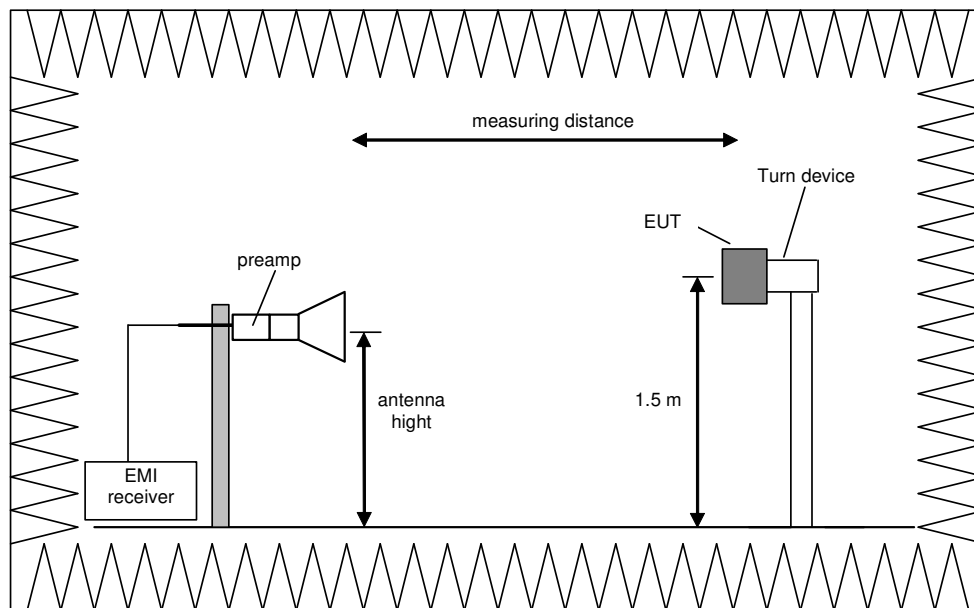
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Rotate the EUT by 360° to maximize the detected signals.
3. Repeat 1) to 2) with the vertical polarisation of the measuring antenna.
4. Make a hardcopy of the spectrum.
5. Repeat 1) to 4) with the EUT raised by an angle of 30° (60°, 90°, 120° and 150°) according to 6.6.5.4 in [1].
6. Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
7. The measurement antenna polarisation, with the according EUT position (Turntable and Turn device) which produces the highest emission for each frequency will be used for the final measurement. The six closest values to the applicable limit will be used for the final measurement.

Final measurement (1 GHz to 110 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used antenna. The EMI Receiver set to peak and average mode and a resolution bandwidth of 1 MHz. The measurement will be performed by rotating the turntable through 0 to 360° in the worst-case EUT orientation which was obtained during the preliminary measurements.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
1 GHz to 4 GHz	1 MHz
4 GHz to 12 GHz	1 MHz
12 GHz to 18 GHz	1 MHz
18 GHz to 26.5 GHz	1 MHz
26.5 GHz to 40 GHz	1 MHz
40 GHz to 60 GHz	1 MHz
50 GHz to 75 GHz	1 MHz
75 GHz to 110 GHz	1 MHz



Procedure of measurement:

The measurements were performed in the frequency range 1 GHz to 110 GHz.

The following procedure will be used:

- 1) Set the turntable and the turn device to obtain the worst-case emission for the first frequency identified in the preliminary measurements.
- 2) Set the measurement antenna polarisation to the orientation with the highest emission for the first frequency identified in the preliminary measurements.
- 3) Set the spectrum analyser to EMI mode with peak and average detector activated.
- 4) Rotate the turntable from 0° to 360° to find the EUT angle that produces the highest emissions.
- 5) Note the highest displayed peak and average values
- 6) Repeat the steps 1) to 5) for each frequency detected during the preliminary measurements.

5.4.3 Test results (radiated emissions)

5.4.3.1 Preliminary radiated emission measurement (10 MHz to 110 GHz)

Ambient temperature:	22 °C
Relative humidity:	26 %

Date:	10.12.2021
Tested by:	Thomas KÜHN

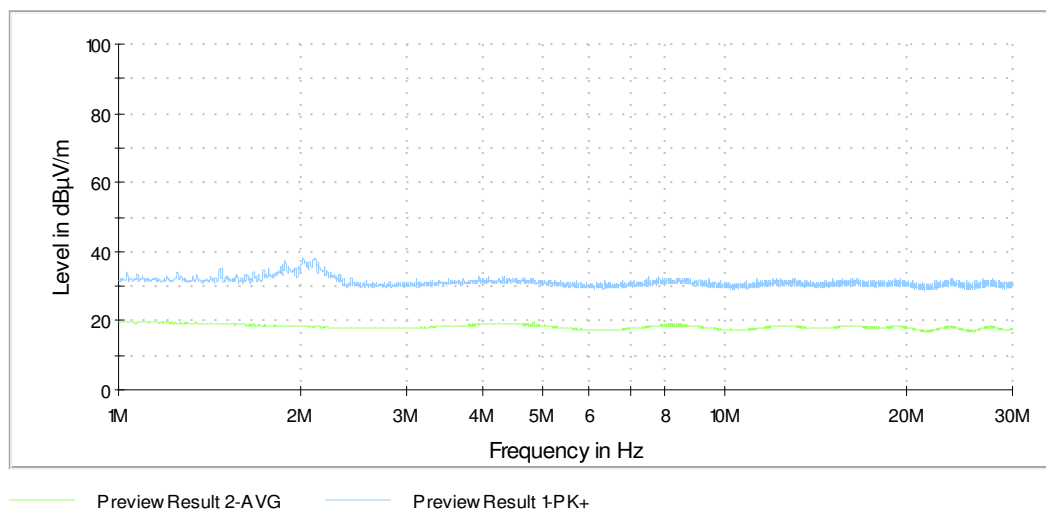
Position of EUT: The EUT was set-up on a non-conducting table of a height of 1.5 m (1 GHz to 40 GHz) and 80 cm (below 1 GHz and 40 GHz to 60 GHz). The distance between EUT and the antenna was 3 m (below 1 GHz and 1 GHz to 12 GHz), 1 m (12 GHz to 40 GHz) and 30 cm (40 GHz to 60 GHz).

Cable guide: For further information refer to the pictures in annex A of this test report.

Test record: The test was carried out in normal operation mode of the EUT.

Supply voltage: During all measurements the EUT was supplied with 12 V_{DC} by an external power supply.

Radiated emissions from 1 MHz to 30 MHz:

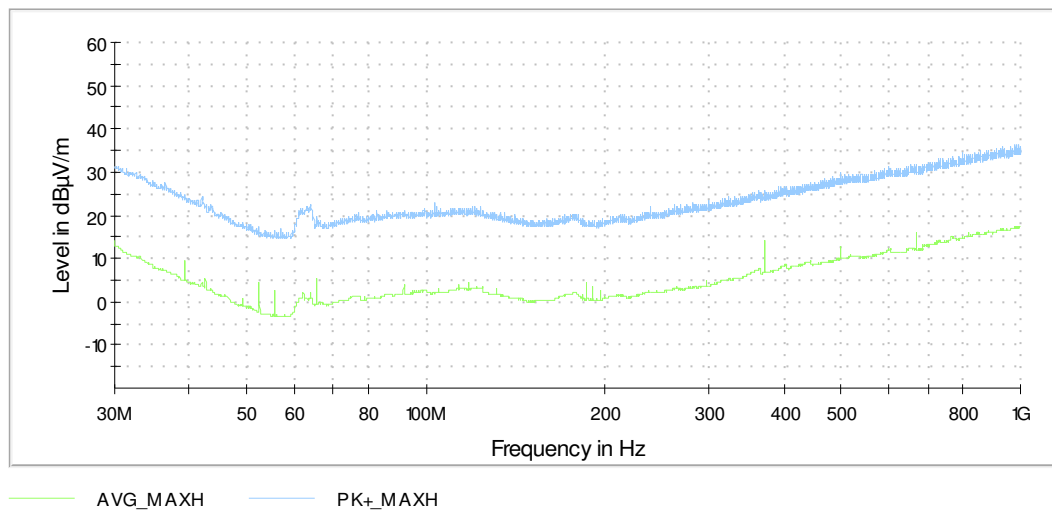


No emissions above the noise floor of the measurement system (max. 38.5 dBµV/m (measured with peak detector at 3 m distance)) found during the preliminary measurement. So no final measurements on the outdoor test site were carried out.

Test equipment (please refer to chapter 6 for details)

5 – 35

Radiated emissions from 30 MHz to 1000 MHz:

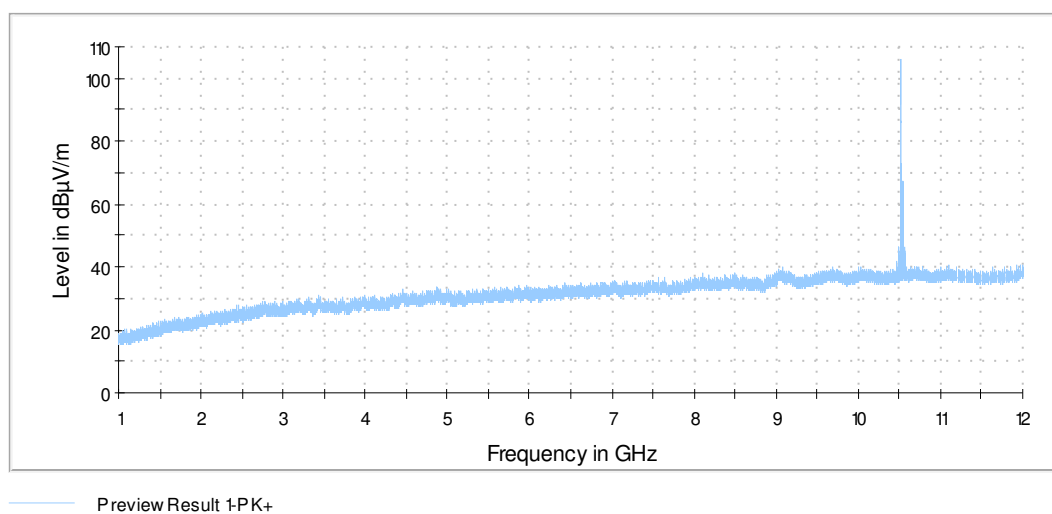


The following frequencies were found during the preliminary radiated emission measurement:

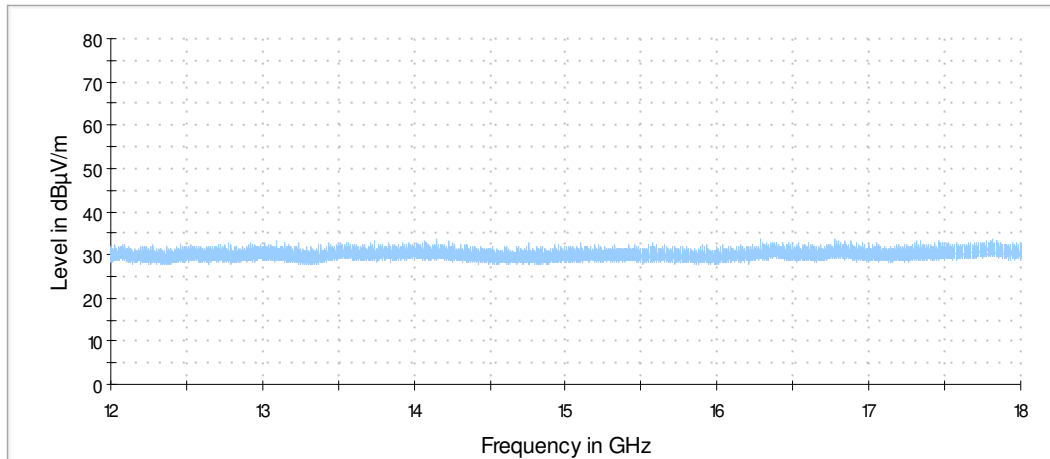
- 30.270 MHz, 64.020 MHz, 65.610 MHz, 103.770 MHz, 371.270 MHz, and 931.780 MHz.

These frequencies have to be measured on the open area test site. The result is presented in the following.

Radiated emissions from 1 GHz to 12 GHz:

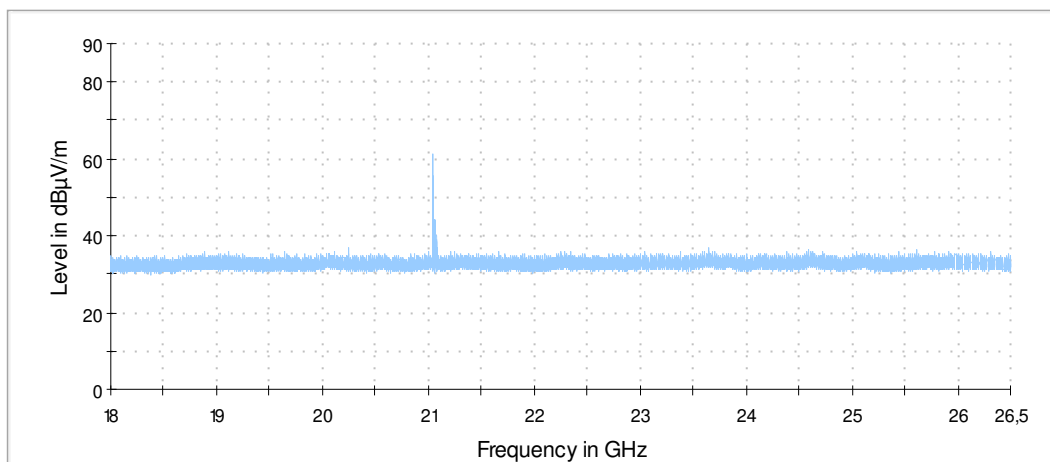


Radiated emissions from 12 GHz to 18 GHz:



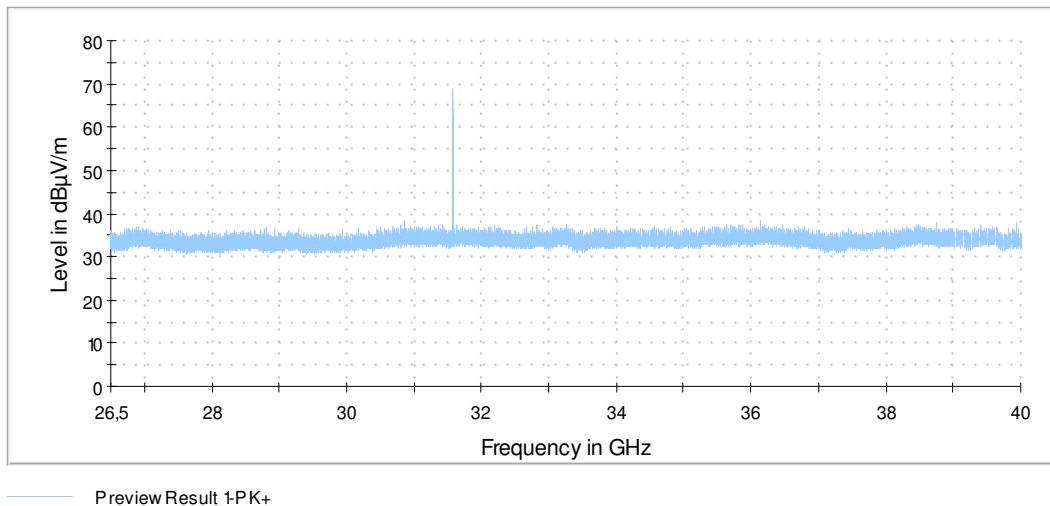
Preview Result 1-PK+

Radiated emissions from 18 GHz to 26.5 GHz:

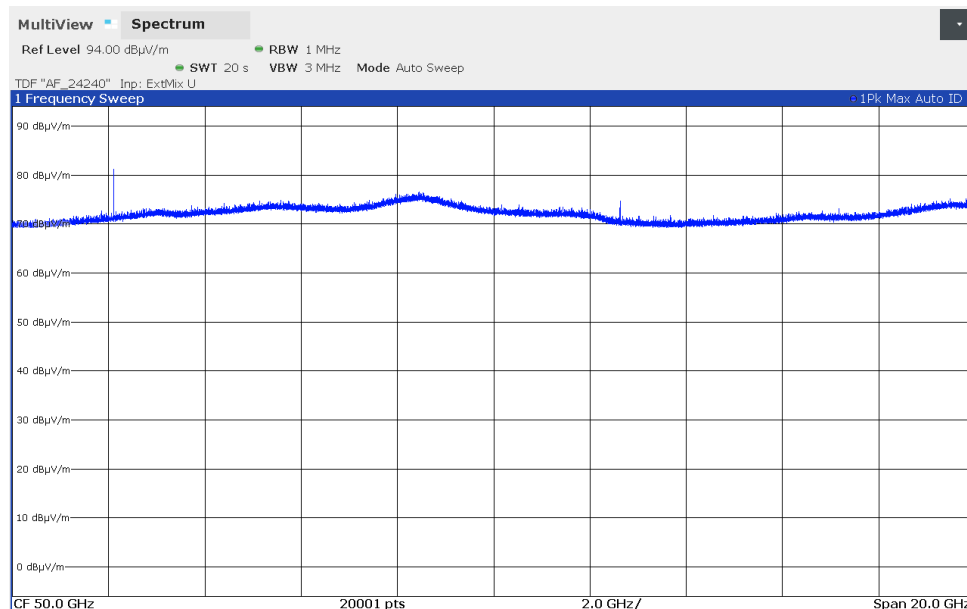


Preview Result 1-PK+

Radiated emissions from 26.5 GHz to 40 GHz:



181709 11.wmf: Radiated emissions from 40 GHz to 60 GHz:



The following fundamental frequency was found during the preliminary radiated emission measurement:

- 10.524 GHz.

The following harmonic emission frequencies were found during the preliminary radiated emission measurement:

- 21.048 GHz, 31.572 GHz, 40.096 GHz and 52.620 GHz.

The following other emission was found during the preliminary radiated emission measurement:

- 9.071 GHz.

These frequencies have to be measured in a final measurement. The results were presented in the following.

5.4.3.2 Final radiated emission measurement (9 kHz to 30 MHz)

No emissions above the noise floor of the measurement system (max. 38.5 dB μ V/m (measured with peak detector at 3 m distance)) found during the preliminary measurement. So, no final measurements on the open area test site were carried out.

5.4.3.3 Final radiated emission measurement (30 MHz to 1 GHz)

Ambient temperature:	22 °C
Relative humidity:	35 %

Date:	13.12.2021
Tested by:	Thomas KÜHN

Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m. The distance between EUT and antenna was 3 m.

Test record: All results are shown in the following.

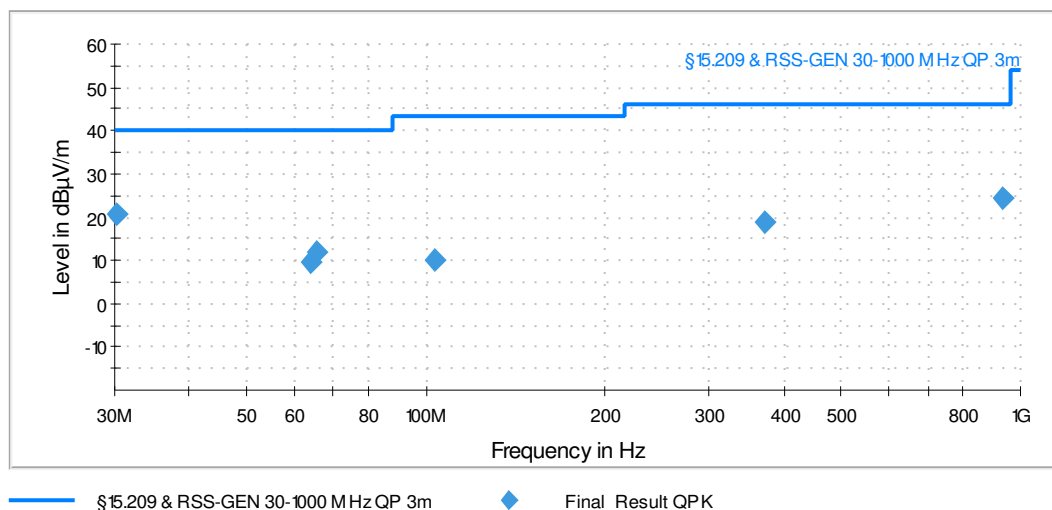
Supply voltage: 12.0 V_{DC} by an external power supply.

Test results: The test results were calculated with the following formula:

$$\text{Result [dB}\mu\text{V/m]} = \text{reading [dB}\mu\text{V]} + \text{level correction [dB]}$$

$$\text{Level correction [dB]} = + \text{cable loss [dB]} + \text{antenna factor [dB/m]} - \text{Preamp [dB]}$$

The measured points and the limit line in the following diagram refer to the standard measurement of the emitted interference in compliance with the above-mentioned standard. The measured points marked with "◆" are the measured results of the standard subsequent measurement on the semi anechoic chamber.



The results of the standard subsequent measurement inside the semi anechoic chamber are indicated in the table below. The limits as well as the measured results (levels) refer to the above-mentioned standard while taking account of the specified requirements for a 3 m measuring distance.

The measurement time with the quasi-peak measuring detector is 1 second.

Result measured with the quasi-peak detector:

(These values were marked in the diagram by an ♦)

Spurious emissions inside restricted bands										
Frequency MHz	Result dBμV/m	Limit dBμV/m	Margin dB	Readings dBμV	Level correction [dB]	Height cm	Azimuth deg	Pol.	Restricted band	Test result
30.270	20.6	40.0	19.4	-5.2	25.8	175	213	Hor.	No	Passed
64.020	9.5	40.0	30.5	-3.8	13.3	255	68	Vert.	No	Passed
65.610	12.0	40.0	28.0	-1.7	13.7	229	-21	Vert.	No	Passed
103.770	9.9	43.5	33.7	-7.7	17.6	217	-21	Hor.	No	Passed
371.270	19.1	46.0	27.0	-2.1	21.2	182	265	Vert.	No	Passed
931.780	24.6	46.0	21.5	-5.5	30.1	109	146	Vert.	No	Passed

Test equipment (please refer to chapter 6 for details)

5 – 12, 24, 26

5.4.3.4 Final radiated emission measurement (1 GHz to 60 GHz)

Ambient temperature:	22 °C
Relative humidity:	26 %

Date:	10.12.2021
Tested by:	Thomas KÜHN

Position of EUT: The EUT was set-up on a non-conducting table of a height of 1.5 m (1 GHz to 40 GHz) and 80 cm (below 1 GHz and 40 GHz to 60 GHz). The distance between EUT and the antenna was 3 m (below 1 GHz and 1 GHz to 12 GHz), 1 m (12 GHz to 40 GHz) and 30 cm (40 GHz to 60 GHz).

Test record: All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied with 12.0 V_{DC}.

Resolution bandwidth: For all measurements a resolution bandwidth of 1 MHz was used.

Test results: The test results were calculated with the following formulas:

Result [dBμV/m] = reading [dBμV] + level correction [dB] + measuring distance correction factor [dB]

Level correction [dB] = + cable loss [dB] + antenna factor [dB/m] – Preamp [dB]

Result measured with the peak detector:

Frequency [GHz]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Reading [dBμV]	Pol.	Azimuth [deg]	Elevation [deg]	Level correction [dB]	Dist. [m]	Dist. corr. [dB] *	Test result
9.071	56.6	74.0	17.4	47.4	Vert.	313	0.0	9.2	3	---	Passed
10.524 ***	104.0	148.0	44.0	96.5	Vert.	246	150	7.5	3	---	Passed
21.048 ****	75.7	97.5	21.8	80.9	Vert.	183	94	4.8	1	-10	Passed
31.572 ****	76.3	97.5	21.2	79.0	Vert.	154	120	7.3	1	-10	Passed
40.096 ****	63.5	97.5	34.0	83.5 **	Vert.	-5	10	---	0.3	-20	Passed
52.620 ****	67.8	97.5	29.7	77.8 **	Vert.	-10.3	90	---	0.3	-20	Passed

*: Measuring distance correction factor calculated with 20 dB / decade

**: Reading in dBμV/m at the measurement distance

***: Wanted signal, no spurious

****: Harmonic emission.

Result measured with the average detector:

Frequency [GHz]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Reading [dBμV]	Pol.	Azimuth [deg]	Elevation [deg]	Level correction [dB]	Dist. [m]	Dist. corr. [dB] *	Test result
9.071	44.2	54.0	9.8	35.0	Vert.	313	0.0	9.2	3	---	Passed
10.524 ***	52.4	128.0	75.6	44.9	Vert.	246	150	7.5	3	---	Passed
21.048	29.7	77.5	47.8	34.9	Vert.	183	94	4.8	1	-10	Passed
31.572	31.7	77.5	45.8	34.4	Vert.	154	120	7.3	1	-10	Passed
40.096	40.7	77.5	36.8	60.7	Vert.	-5	10	---	0.3	-20	Passed
52.620	39.6	77.5	37.9	59.6	Vert.	-10.3	90	---	0.3	-20	Passed

*: Measuring distance correction factor calculated with 20 dB / decade

**: Reading in dBμV/m at the measurement distance

***: Wanted signal, no spurious

****: Harmonic emission.

Test equipment (please refer to chapter 6 for details)

15 – 20, 22 – 24, 26, 28 – 32, 34, 35

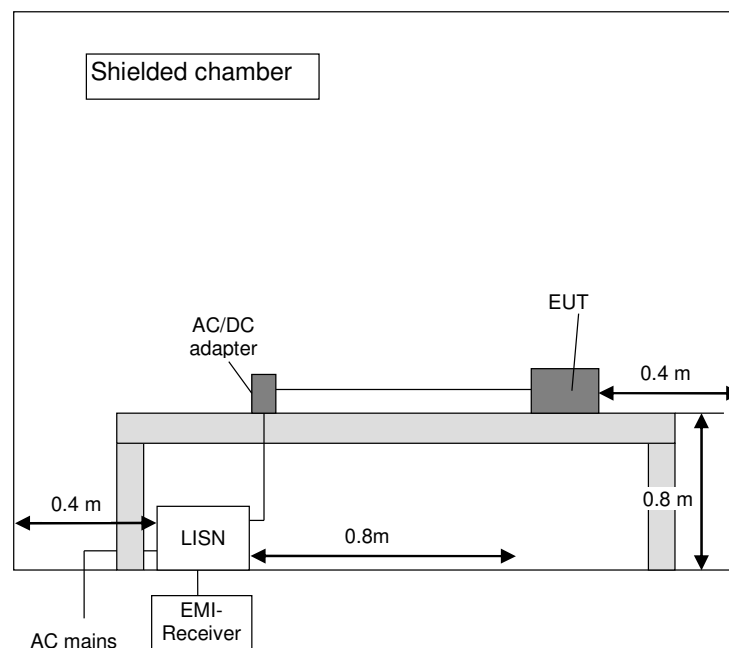
5.5 Conducted emissions on power supply lines (150 kHz to 30 MHz)

5.5.1 Method of measurement

This test will be carried out in a shielded chamber. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm above the ground plane. Floor-standing devices will be placed directly on the ground plane. The setup of the Equipment under test will be in accordance to [1].

The frequency range 150 kHz to 30 MHz will be measured with an EMI Receiver set to MAX Hold mode with peak and average detector and a resolution bandwidth of 9 kHz. A scan will be carried out on the phase (or plus pole in case of DC powered devices) of the AC mains network. If levels detected 10 dB below the appropriate limit, this emission will be measured with the average and quasi-peak detector on all lines.

Frequency range	Resolution bandwidth
150 kHz to 30 MHz	9 kHz



5.5.2 Test results (conducted emissions on power supply lines)

Ambient temperature:	21 °C
Relative humidity:	29 %

Date:	09.12.2021
Tested by:	Thomas KÜHN

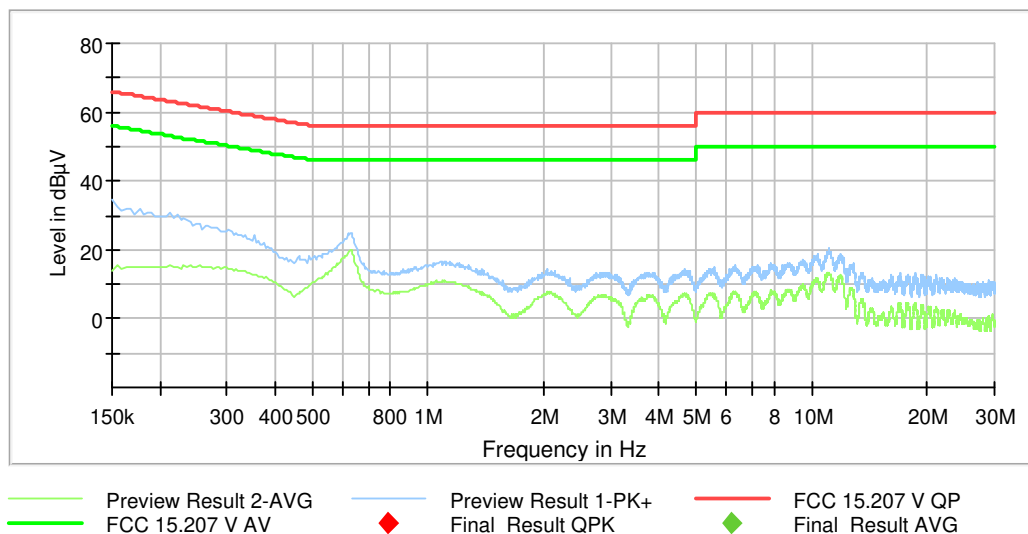
Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m.

Cable guide: The cable of the EUT was fixed on the non-conducting table. For further information of the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following.

Supply voltage: The EUT was supplied with 12 V_{DC} by an AC/DC adaptor type enercell CAT.NO. 273-316, which was connected to an AC mains network with 120 VAC / 60 Hz.

The curves in the diagram only represent for each frequency point the maximum measured value of all preliminary measurements, which were made for each power supply line. The top measured curve represents the peak measurement and the bottom measured curve the average measurement. The quasi-peak measured points are marked by an "◆" and the average measured points by a "◆".



Test: Passed

Test equipment (please refer to chapter 6 for details)

1 – 4

6 Test equipment and ancillaries used for tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. due
1	Shielded chamber M4	-	Siemens AG	B83117-S1-X158	480088	Calibration not necessary	
2	EMI Receiver	ESIB 26	Rohde & Schwarz	1088.7490	481182	12.02.2020	02.2022
3	LISN	NSLK8128	Schwarzbeck	8128161	480138	11.02.2020	02.2022
4	Transient Limiter	CFL 9206A	Teseq GmbH	38268	481982	Calibration not necessary	
5	Semi anechoic chamber M276	SAC5-2	Albatross Projects	C62128-A540-A138-10-0006	483227	Calibration not necessary	
6	RF Switch Matrix	OSP220	Rohde & Schwarz	-	482976	Calibration not necessary	
7	Turntable	TT3.0-3t	Maturo	825/2612/.01	483224	Calibration not necessary	
8	Controller	NCD	Maturo	474/2612.01	483226	Calibration not necessary	
9	Antenna support	BAM 4.5-P-10kg	Maturo	222/2612.01	483225	Calibration not necessary	
10	System software EMC32 M276	EMC32	Rohde & Schwarz	100970	482972	Calibration not necessary	
11	Antenna (Bilog)	HL562E	Rohde & Schwarz	101079	482978	18.03.2021	03.2024
12	Log.-Per. Antenna	HL050	Rohde & Schwarz	100908	482977	13.08.2019	08.2022
13	EMI Test receiver ESW	ESW44	Rohde & Schwarz	101819	483149	07.09.2020	09.2022
14	Cable C417	Sucoflex 118	Huber+Suhner	500654/118	-	Calibration not necessary	
15	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303	Calibration not necessary	
16	EMI Receiver / Spectrum Analyser	ESW44	Rohde & Schwarz	101635	482467	18.02.2020	02.2022
17	Controller	MCU	Maturo	MCU/043/971107	480832	Calibration not necessary	
18	Turntable	DS420HE	Deisel	420/620/80	480315	Calibration not necessary	
19	Antenna support	AS615P	Deisel	615/310	480187	Calibration not necessary	
20	Antenna	3115 A	EMCO	9609-4918	480183	23.02.2021	20.2024
21	RF-cable No. 36	Sucoflex 106B	Suhner	0587/6B	480865	Calibration not necessary	
22	RF-cable No. 38	Sucoflex 106B	Suhner	500218/6B	482415	Calibration not necessary	
23	Preamplifier 100 MHz – 16 GHz	AFS6-00101600-23-10P-6-R	MITEQ	2011215	482333	13.02.2020	02.2022
24	Power supply	TOE 8752	Toellner	31566	480010	Calibration not necessary	
25	Loop antenna	HFH2-Z2	Rohde & Schwarz	100417	481912	25.02.2021	02.2022
26	Multimeter	971A	Hewlett Packard	JP39009358	480721	17.02.2021	02.2022
27	Standard Gain Horn 11.9 GHz – 18 GHz	18240-20	Flann Microwave	483	480294	Calibration not necessary	

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. due
28	Standard Gain Horn 17.9 GHz – 26.7 GHz	20240-20	Flann Microwave	410	480296	Calibration not necessary	
29	Standard Gain Horn 26.4 GHz – 40.1 GHz	22240-20	Flann Microwave	469	480299	Calibration not necessary	
30	Harmonic mixer 40 GHz - 60 GHz	FS-Z60	Radiometer Physics	100980	482708	31.03.2021	03.2022
31	Standard Gain Horn 40 GHz - 60 GHz	24240-20	Flann	263442	482858	Calibration not necessary	
32	RF-cable 2 m	KPS-1533- 800-KPS	Insulated Wire	-	480302	Calibration not necessary	
33	Preamplifier 12 GHz - 18 GHz	JS3- 12001800- 16-5A	MITEQ	571667	480343	13.02.2020	02.2022
34	Preamplifier 18 GHz - 26 GHz	JS4- 18002600- 20-5A	MITEQ	658697	480342	13.02.2020	02.2022
35	Preamplifier 26 GHz - 40 GHz	JDM2- 26004000- 25-10P	MITEQ	128746	482806	17.02.2020	02.2022

7 Test site Validation

Test equipment	PM. No.	Frequency range	Type of validation	According to	Val. Date	Val Due
Shielded chamber M4	480088	---	Groundplane resistance	ANSI C63.4-2014	12.05.2020	05.2022
Fully anechoic chamber M20	480303	1 – 18 GHz	SVSWR	CISPR 16-1-4 Amd. 1	18.08.2020	08.2022
Semi anechoic chamber M276	483227	30 – 1000 MHz	NSA	ANSI C63.4-2014	03.03.2021	03.2023

8 Measurement uncertainties

Measurement uncertainties	
Description	U _{Lab}
Bandwidth measurement	9.0×10^{-8}
RF frequency	$\pm 4.5 \times 10^{-8}$
RF power	+0.66 dB / -0.72 dB
Conducted spurious emissions	± 2.3 dB
Radiated spurious emissions	± 5.1 dB

9 Report history

Report Number	Date	Comment
F212055E1	20,12,2021	Document created

10 List of annexes

Annex A	Test setup photos	9 pages
Annex B	External EUT photos	5 pages
Annex C	Internal EUT photos	5 pages