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Test Report

Report Number:

F190124E1

Equipment under Test (EUT):

CET214

Applicant:

eologix sensor technology gmbh

Manufacturer:

eologix sensor technology gmbh

ilac-MRA

DAkkS 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 of Procedures for Compliance Testing of Unlicensed Wireless Devices

[2] **FCC CFR 47 Part 15**, Radio Frequency Devices

[3] **RSS-247 Issue 2 (February 2017)**, Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

[4] **RSS-Gen Issue 5 (April 2018)**, General Requirements for Compliance of Radio Apparatus

[5] **508074 D01 DTS Meas Guidance v04 (April 2017),** Guidance for performing compliance measurements on transmission systems (DTS) operating under section 15.247

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.

Tested and written by:	Wolfgang KASALOWSKY	W. Kasalowsky	25.11.2019
	Name	Signature	Date
Reviewed and approved by:	Bernd STEINER	B. Steiner	25.11.2019
	Name	Signature	Date

This test report is only valid in its original form.

Contents: Page

1 Identification 4
1.1 Applicant 4
1.2 Manufacturer 4
1.3 Test Laboratory 4
1.4 EUT (Equipment under Test) 5
1.5 Technical Data of Equipment 5
1.6 Dates 6
2 Operational States 7
3 Additional Information 7
4 Overview 7
5 Results 8
5.1 Duty cycle 8
5.1.1 Method of measurement 8
5.1.2 Test results 9
5.2 Maximum peak conducted output power 10
5.2.1 Method of measurement (radiated) 10
5.2.2 Test results (radiated) 11
5.3 Maximum conducted (average) output power 12
5.3.1 Method of measurement (radiated) 12
5.3.2 Test results 13
5.4 DTS Bandwidth / 99% Bandwidth 14
5.4.1 Method of measurement 14
5.4.2 Test results 15
5.5 Peak Power Spectral Density 17
5.5.1 Method of measurement (conducted) 17
5.5.2 Test results 18
5.6 Band-edge compliance 19
5.6.1 Method of measurement (band edges next to unrestricted bands (radiated)) 19
5.6.2 Test results (radiated) 20
5.7 Maximum unwanted emissions 21
5.7.1 Method of measurement (radiated emissions) 21
5.7.2 Test results (radiated emissions) 28
5.7.2.1 Preliminary radiated emission measurement 28
5.7.2.2 Final radiated emission measurement (9 kHz to 1 GHz) 30
5.7.2.3 Final radiated emission measurement (1 GHz to 12 GHz) 32
6 Test Equipment used for Tests 34
7 Test site Validation 36
8 Report History 36
9 List of Annexes 36

1 Identification

1.1 Applicant

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Applicant represented during the test by the following person:	-

1.2 Manufacturer

Name:	eologix sensor technology gmbh
Address:	Kratkystrasse. 2 8020 Graz
Country:	Austria
Name for contact purposes:	Dr. Michael MOSER
Phone:	+43 (0)316 931215 200
Fax:	+43 (0)676 897061 200
eMail address:	michael.moser@eologix.com
Manufacturer represented during the test by the following person:	-

1.3 Test Laboratory

The tests were carried out by: **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-17186-01-02 and D-PL-17186-01-05, FCC Test Firm Accreditation designation number DE0004, CAB Identifier DE0003 and ISED# 3469A.

1.4 EUT (Equipment under Test)

EUT	
Test object: *	Sensor for icing detection
Type / PMN: *	CET214
Modelname / HVIN:*	R2017d
Order number: *	CET214-US
Serial number: *	3193
PCB identifier: *	R2017d
Firmware version / FVIN: *	2018-C913-D203-10
FCC ID:*	2APYIR2017D203-10
IC: *	24932-R2017D20310
Lowest / highest internal frequency:*	DC to 913 MHz

* Declared by the applicant

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

1.5 Technical Data of Equipment

Technical Data	
Rated RF output power: *	+10 dBm
Number of channels: *	1
Channel spacing: *	none
Antenna type: *	Integrated antenna
Frequency range: *	913 MHz
Modulation: *	FSK
Bit rate of transmitter: *	250 kBit per second
Supply Voltage: *	2.2 to 3.1 V
Power Supply: *	Energy buffer charged by integrated photovoltaic cells. For testing: temporary external battery (two AAA batteries)
Temperature range: *	-40°C - +60°C

* Declared by the applicant

1.6 Dates

Date of receipt of test sample:	28.01.2019
Start of test:	15.02.2019
End of test:	26.02.2019

2 Operational States

The EUT is an autonomous sensor for icing detection and temperature measurement on the surface of wind turbine rotor blades. The EUT transmits the data to a receiving unit.

During all tests the EUT was supplied with 3 V DC by a temporary external battery (two AAA batteries).
The transmitter OFF time was decreased from 1.1 seconds in original mode to 9.2 ms for testing.
The transmitter ON time remains 2.3ms

3 Additional Information

The tested sample was not labelled with the final label version.

4 Overview

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	RSS-247 [3] or RSS-Gen, Issue 5 [4]	Status	Refer page
Maximum Peak Output Power	902 - 928	15.247 (b) (3), (4)	5.4 (d) [3]	Passed	9 et seq.
DTS Bandwidth	902 - 928	15.247 (a) (2)	5.2 (a) [3]	Passed	14 et seq.
Peak Power Spectral Density	902 - 928	15.247 (e)	5.2 (b) [3]	Passed	17 et seq.
Band edge compliance	902 - 928	15.247 (d) 15.205 (a) 15.209 (a)	5.5 [3] 8.9 [4], 8.10 [4]	Passed	19 et seq.
Radiated emissions (transmitter)	0.009 – 10,000	15.247 (d) 15.205 (a) 15.209 (a)	5.5 [3] 8.9 [4], 8.10 [4]	Passed	21 et seq.

5 Results

5.1 Duty cycle

5.1.1 Method of measurement

The measurement was performed as an measurement at a test fixture.

The method described in chapter 11.6. b) of document [1] or 6 b) of document [5] was used to perform the following test.

The following measurement technique was used:

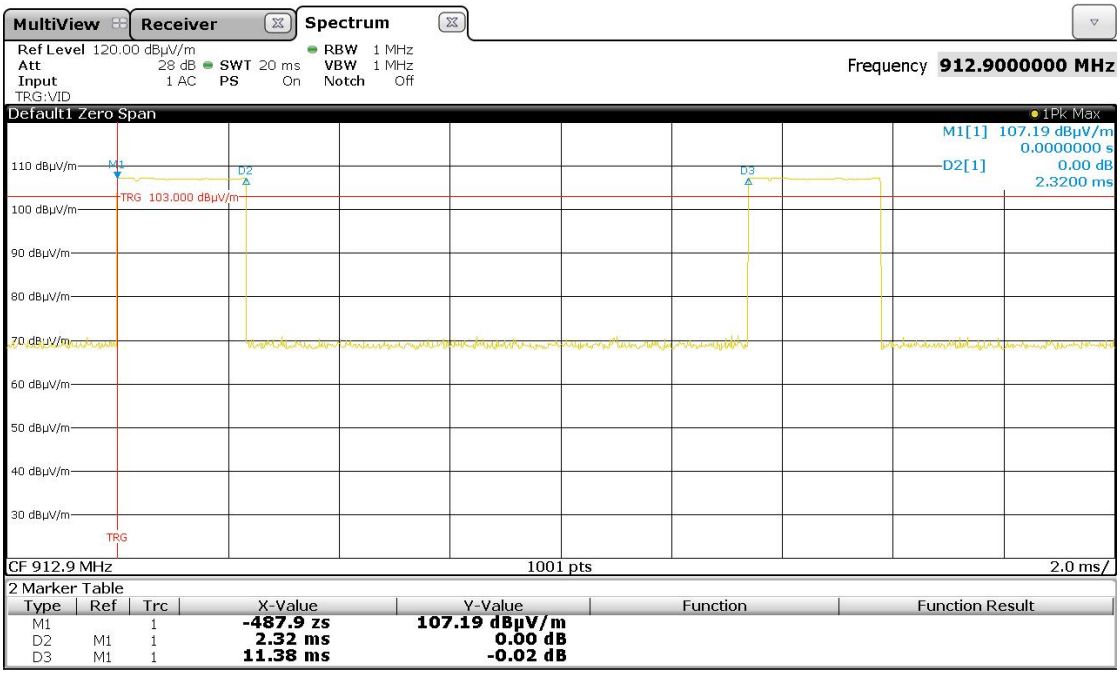
The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between two bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal.

- Set the center frequency of the instrument to the center frequency of the transmission.
- Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value.
- Set VBW ≥ RBW.
- Set detector = peak or average.
- The zero-span measurement method shall not be used unless both RBW and VBW are > 50/T and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if T ≤ 16.7 microseconds.)

5.1.2 Test results

Ambient temperature	21 °C
Relative humidity	25 %

Date	15.02.2019
Tested by	W.Kasalowsky



TX_on [µs]	TX_ges [µs]	RBW [MHz]	50/T [kHz]	50/T < RBW?
2320	11380	1	21.6	Yes

Sweep points	Sweep time [µs]	Meas points	Meas points >100?	Duty cycle %	DCCF [dB]
1001	20000	115	Yes	20.4	6.9

The DCCF (duty cycle correction factor) is calculated by:

$$DCCF = 10 * log_{10}\left(\frac{1}{Duty\ cycle}\right)$$

Therefore for average measurements a correction factor of 6.9 dB is used for all tests.

Test equipment (please refer to chapter 6 for details)
11

5.2 Maximum peak conducted output power

5.2.1 Method of measurement (radiated)

Procedure 11.9.1.1 in [1] was used for the following test.

The following procedure shall be used when an instrument with a resolution bandwidth that is greater than the DTS bandwidth is available to perform the measurement:

a) Set the RBW ≥ DTS bandwidth.
b) Set VBW ≥ [3 × RBW].
c) Set span ≥ [3 × RBW].
d) Sweep time = auto couple.
e) Detector = peak.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use peak marker function to determine the peak amplitude level.

The measured Electric field strength was corrected with the following correction factor:

Antenna Factor [dB/m] + Cable Attenuation [dB] - Amplifier Gain [dB] = correction factor [dB/m]

The formula in 11.12.2.2 e) in [1] was used to calculate the EIRP power:

$E = EIRP - 20\log(d) + 104.8$
$EIRP = E + 20\log(d) - 104.8$

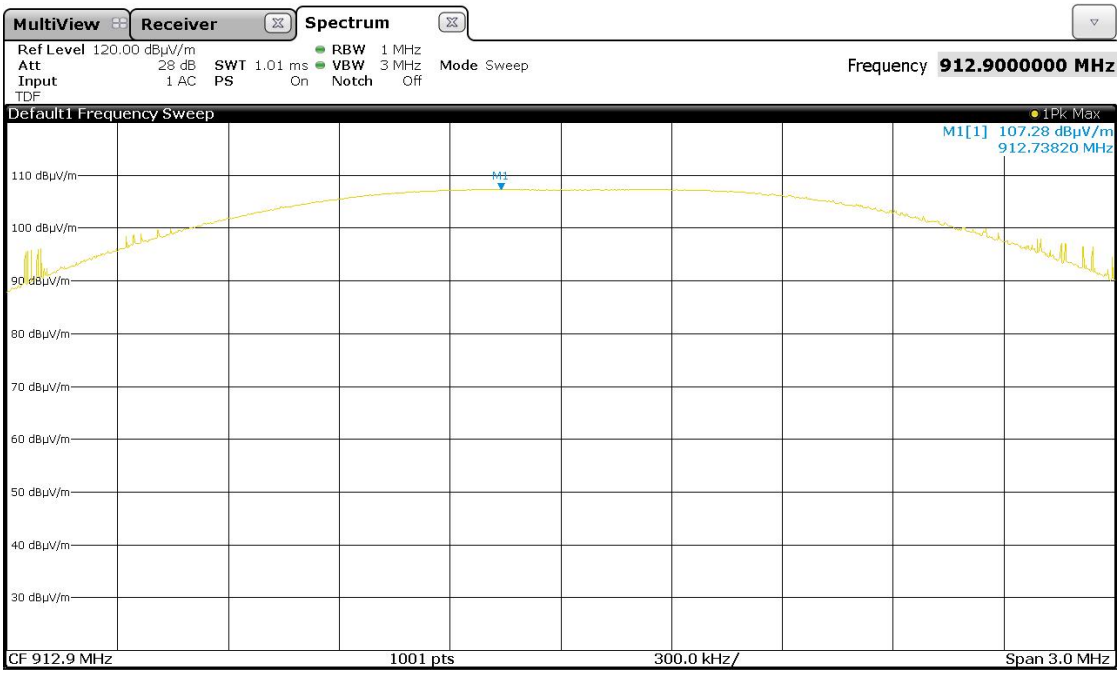
$MPOP = EIRP - G$

E is the electric field strength in dBµV/m
EIRP is the equivalent isotropically radiated power in dBm
d is the specified measurement distance in m
G is the antenna gain in dBi
MPOP is the maximum peak output power – measured antenna port conducted – in dBm

5.2.2 Test results (radiated)

Ambient temperature	21° C
Relative humidity	23 %

Date	15.02.2019
Tested by	W. Kasalowsky



Frequency [MHz]	Field strength @3m [dBµV/m]	EIRP [dBm]	Antenna gain [dBi]	MPOP [dBm]	Limit [dBm]
912.738	107.3	12.0	2.2	9.8	30

Test equipment (please refer to chapter 6 for details)
3 – 5, 7, 11, 12, 14, 16

5.3 Maximum conducted (average) output power

5.3.1 Method of measurement (radiated)

Method AVGSA-2 of [1] subclause 11.9.2.2.4 was used for the measurement:

- Measure the duty cycle (D) of the transmitter output signal.
- Set instrument center frequency to DTS channel center frequency.
- Set span to at least 1.5 times the OBW.
- Set RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
- Set VBW ≥ [3 × RBW].
- Detector = power averaging (rms).
- Ensure that the number of measurement points in the sweep ≥ [2 × span / RBW].
- Sweep time = auto couple.
- Do not use sweep triggering; allow sweep to “free run.”
- Employ trace averaging (rms) mode over a minimum of 100 traces.
- Use the peak marker function to determine the maximum amplitude level.
- Add [10 log (1 / D)], where D is the duty cycle measured in step a), to the measured PSD to compute the average PSD during the actual transmission time.
- If measured value exceeds requirement specified by regulatory agency, then reduce RBW (but no less than 3 kHz) and repeat.

The measured Electric field strength was corrected with the following correction factor:

Antenna Factor [dB/m] + Cable Attenuation [dB] - Amplifier Gain [dB] = correction factor [dB/m]

The formula in 11.12.2.2 e) in [1] was used to calculate the EIRP power:

$E = EIRP - 20\log(d) + 104.8$
$EIRP = E - 95.3$

$MPOP = EIRP - G + DCCF$

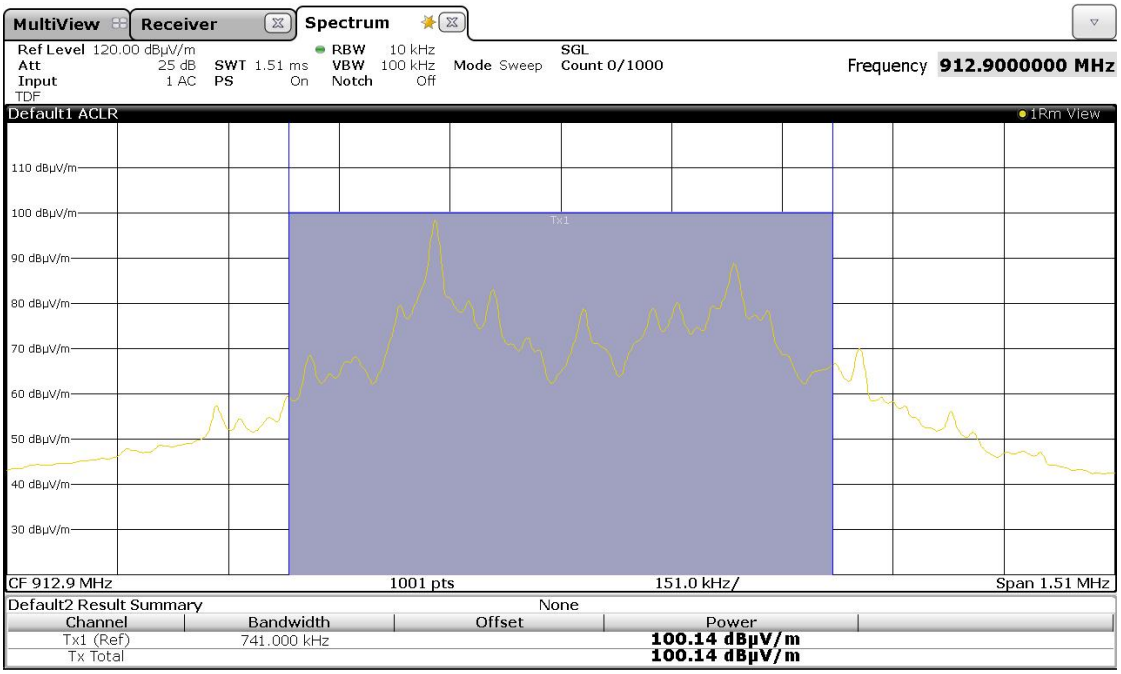
E	is the electric field strength in dBµV/m
EIRP	is the equivalent isotropically radiated power in dBm
d	is the specified measurement distance in m
G	is the antenna gain in dBi
MPOP	is the maximum peak output power – measured antenna port conducted – in dBm
DCCF	Duty cycle correction factor

This measurement was performed for calculation of the values for “Declaration of RF Exposure Compliance for Exemption from Routine Evaluation Limits”.

5.3.2 Test results

Ambient temperature	21° C
Relative humidity	23 %

Date	15.02.2019
Tested by	W. Kasalowsky



Frequency [MHz]	Measured field strength @3m [dBµV/m]	EIRP [dBm]	DCCF [dB]	Antenna gain [dBi]	MPOP [dBm]	Limit [dBm]
912.900	100.1	4.8	6.9	2.2	9.5	30

Test equipment (please refer to chapter 6 for details)
3 – 5, 7, 11, 12, 14, 16

5.4 DTS Bandwidth / 99% Bandwidth

5.4.1 Method of measurement

DTS Bandwidth:

The EUT was tested with a spectrum analyzer connected via a test fixture to the EUT.

The measurement procedure refers to part 11.8.1 of document [1].

- Set RBW = 100 kHz.
- Set the video bandwidth (VBW) ≥ 3 x RBW.
- Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Allow the trace to stabilize.
- Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

99 % Bandwidth:

The EUT was measured radiated in the anechoic chamber using the procedures described in 5.7.1.

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:

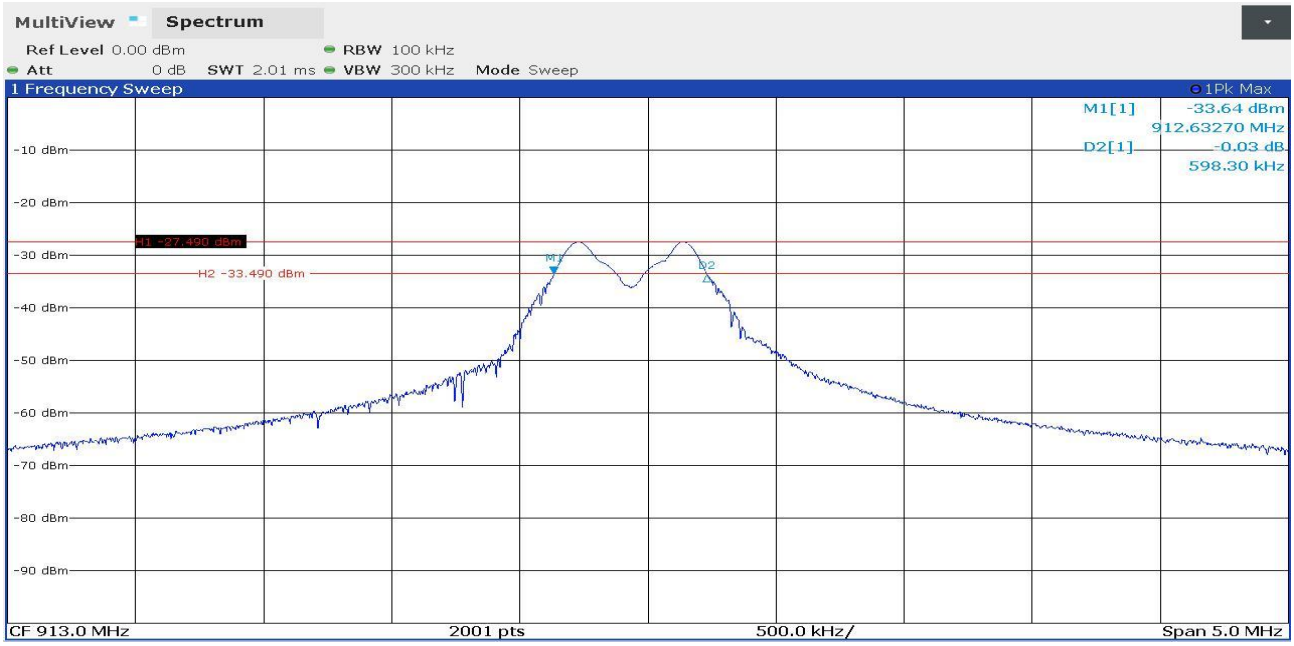
- The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.
- The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW, unless otherwise specified by the applicable requirement.
- 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.
- 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.
- 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 labelled. Tabular data maybe reported in addition to the plot(s).

5.4.2 Test results

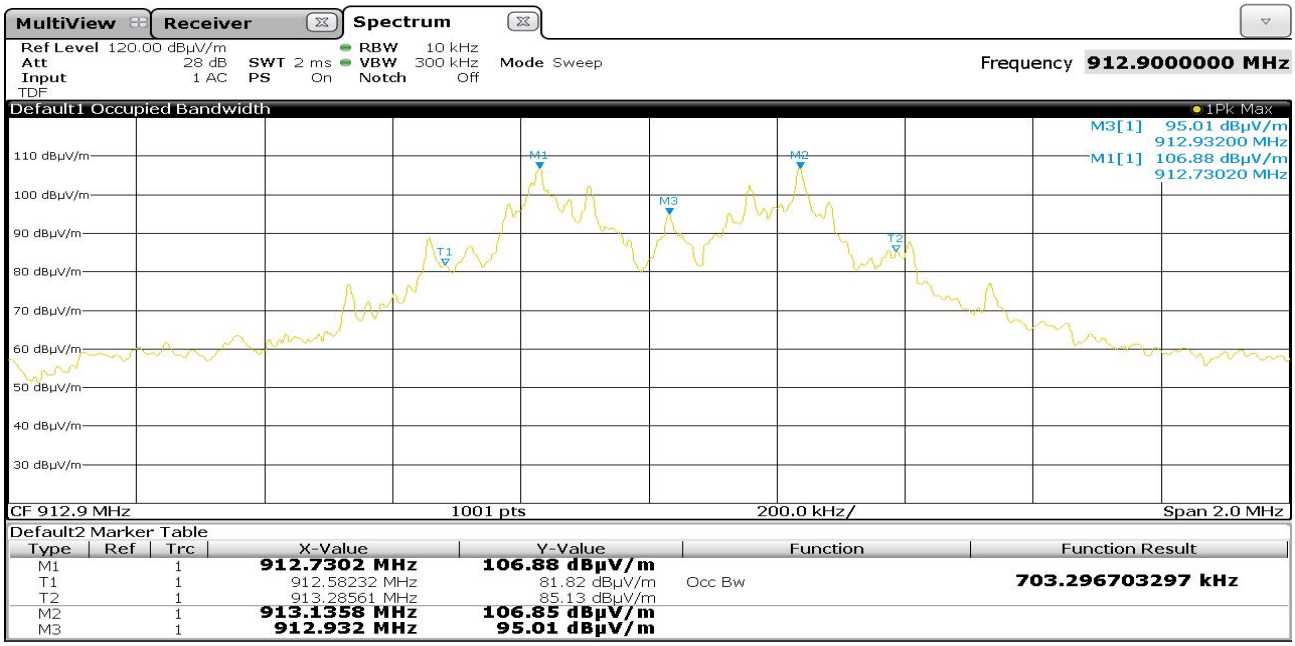
Ambient temperature	22 °C
Relative humidity	23 %

Date	06.02.2019
Tested by	W. Kasalowsky

DTS Bandwidth:



99 % Bandwidth:



Center Frequency [MHz]	Minimum 6-dB Bandwidth Limit [MHz]	6 dB Bandwidth [MHz]	99 % Bandwidth [MHz]	Result
912.730	0.5	0.598	0.703	Passed

Test equipment (please refer to chapter 6 for details)
6 dB BW: 1, 32 99% BW: 3 – 5, 7, 11, 12, 14, 16

5.5 Peak Power Spectral Density

5.5.1 Method of measurement (conducted)

The EUT was tested with a spectrum analyzer connected via a test fixture to the EUT.

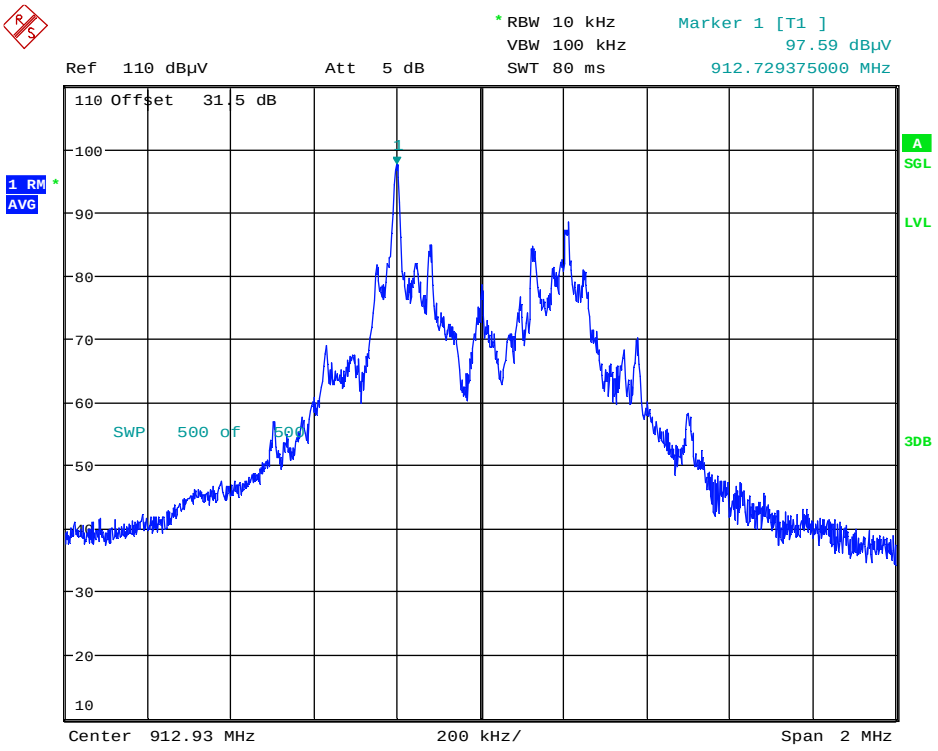
The measurement procedure refers to part 11.10.5 of document [1].

- Measure the duty cycle (D) of the transmitter output signal.
- Set instrument center frequency to DTS channel center frequency.
- Set span to at least 1.5 times the OBW.
- Set RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
- Set VBW ≥ [3 × RBW].
- Detector = power averaging (rms).
- Ensure that the number of measurement points in the sweep ≥ [2 × span / RBW].
- Sweep time = auto couple.
- Do not use sweep triggering; allow sweep to “free run.”
- Employ trace averaging (rms) mode over a minimum of 100 traces.
- Use the peak marker function to determine the maximum amplitude level.
- Add [10 log (1 / D)], where D is the duty cycle measured in step a), to the measured PSD to compute the average PSD during the actual transmission time.
- If measured value exceeds requirement specified by regulatory agency, then reduce RBW (but no less than 3 kHz) and repeat.

5.5.2 Test results

Ambient temperature	22 °C
Relative humidity	29 %

Date	19.02.2019
Tested by	W. Kasalowsky



Peak Frequency [MHz]	Field strength @3m [dBµV/m]	DCCF [dB]	EIRP [dBm / 10 kHz]	Antenna gain [dBi]	Conducted PSD [dBm / 10 kHz]	PSD Limit [dBm / 3 kHz]	Result
912.729	97.6	6.9	9.1	2.2	7.9	8	Passed

Test equipment (please refer to chapter 6 for details)
1, 32

5.6 Band-edge compliance

5.6.1 Method of measurement (band edges next to unrestricted bands (radiated))

For the measurement, the EUT was measured radiated in the anechoic chamber using the procedures described in 5.7.1.

The measurement procedure refers to part 11.11.2 and 11.11.3 of document [1].

Measurement Procedure Reference – Reference Level:

- RBW = 100 kHz.
- VBW ≥ 300 kHz.
- Set the span to ≥ 1.5 times the DTS Bandwidth.
- Detector = Peak.
- Sweep time = auto couple.
- Trace mode = max hold.
- Allow trace to fully stabilize.
- Use the peak marker function to determine the maximum amplitude level.

Measurement Procedure – Unwanted Emissions

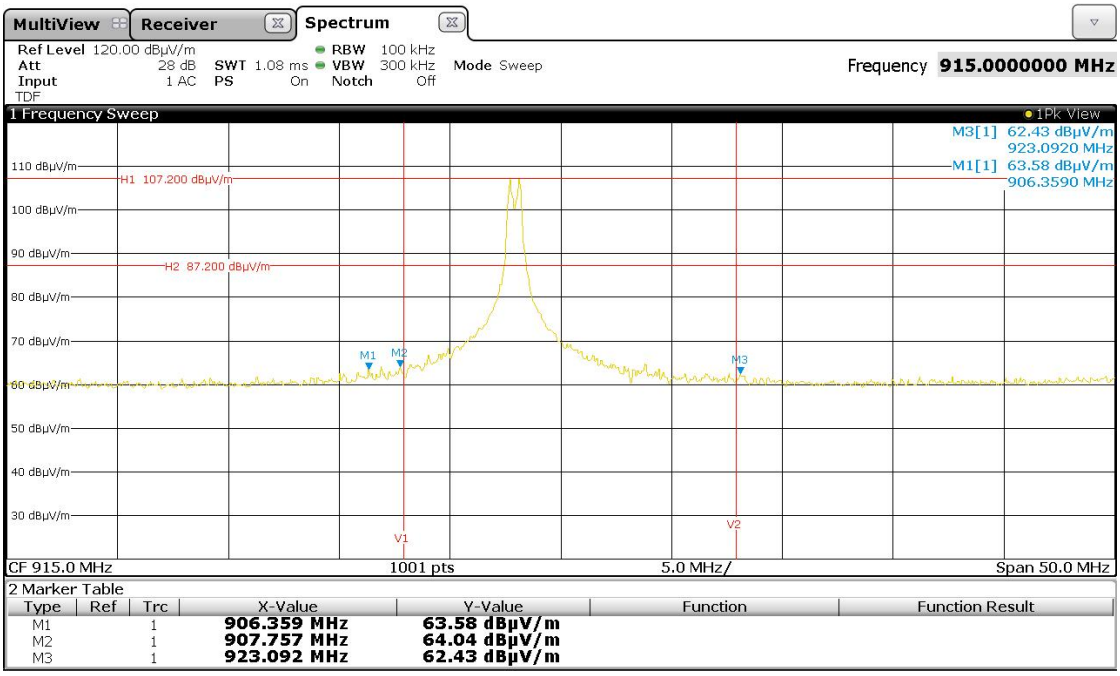
- Set the center frequency and span to encompass the frequency range to be measured.
- RBW = 100 kHz.
- VBW ≥ 300 kHz.
- Detector = Peak.
- Ensure that the number of measurement points ≥ span/RBW.
- Sweep time = auto couple.
- Trace Mode = max hold.
- Allow the trace to stabilize.
- Use the peak marker function to determine the maximum amplitude level.

The measurement procedure at the band edges was simplified by performing the measurement in just one plot. Both, the in-band-emission and the unwanted emission were be encompassed by the span. After trace stabilization, the maximum peak was be determined by a peak detector and the value was marked by a marker. A second maximum-peak-detector marker marks the highest emission in the unrestricted band next to the band edge.

5.6.2 Test results (radiated)

Ambient temperature	21 °C
Relative humidity	25 %

Date	15.02.2019
Tested by	W. Kasalowsky



Tx Frequency [MHz]	Emission Frequency [MHz]	Reference Level [dBµV/m]	Limit [dBµV/m]	Emission Level [dBµV/m]	Margin [dB]	Result
912.930	906.359	107.2	87.2	63.6	23.6	Passed
912.930	907.757	107.2	87.2	64.0	23.2	Passed
912.930	923.092	107.2	87.2	62.4	24.8	Passed
Measurement uncertainty		± 4.89 dB				

Test equipment (please refer to chapter 6 for details)
3 – 5, 7, 11, 12, 14, 16

5.7 Maximum unwanted emissions

5.7.1 Method of measurement (radiated emissions)

The radiated emission measurement is subdivided into five 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 height 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 above 1 GHz.
- A final measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range above 1 GHz.

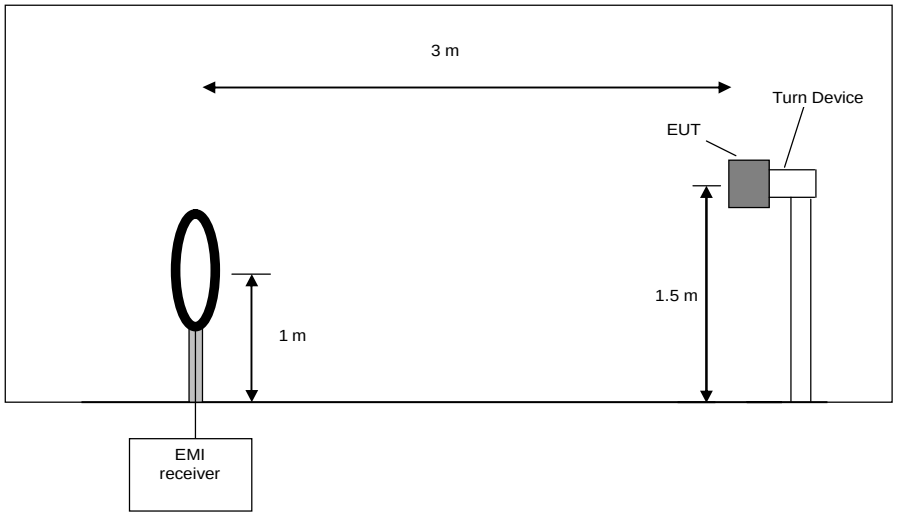
Preliminary measurement (9 kHz to 30 MHz):

In the first stage a preliminary measurement will be performed in a shielded room with a measuring distance of 3 meters. Table top devices will set up on a non-conducting turn device on the height of 1.5m. Floor-standing devices will be placed directly on the turntable/ground plane. The set-up 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 analyzer 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 analyzer 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:

Pre-scans were performed in the frequency range 9 kHz to 150 kHz and 150 kHz to 30 MHz.

Pre-scans were performed in the frequency range 30 MHz to 230 MHz and 230 MHz to 1 GHz.
The following procedure will be used:

1. Monitor the frequency range at horizontal polarization 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. Repeat 1) to 3) with the vertical polarization of the measuring antenna.
5. Make a hardcopy of the spectrum.
6. Repeat 1) to 5) with the EUT raised by an angle of 0° (45°, 90°) according to 6.6.5.4 in [1].
7. Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.

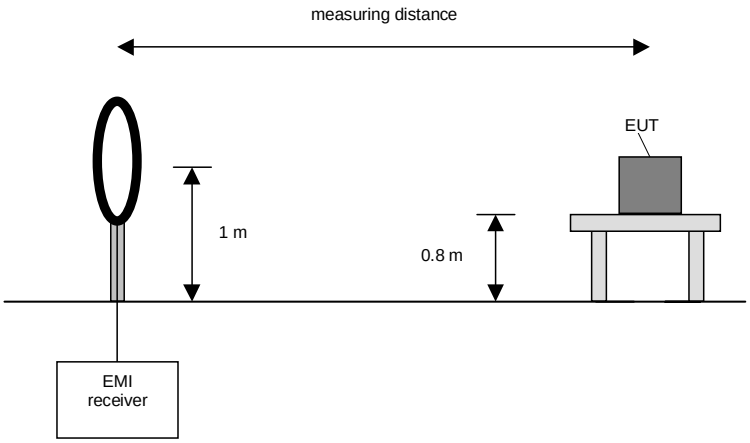
Final measurement (9 kHz to 30 MHz):

In the second stage a final measurement will be performed on an open area test site with no conducting ground plane in measuring distances of 3 m, 10 m and 30 m. In the case where larger measuring distances is required the results will be extrapolated based on the values measured on the closer distances according to Section 15.31 (f) (2) [2]. The final measurement will be performed with a EMI Receiver set to Quasi Peak detector except for the frequency bands 9 kHz to 90 kHz and 110 kHz to 490 kHz where an average detector will be used according Section 15.209 (d) [2].

On the frequencies, which were detected during the preliminary measurements, 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 (if the EUT is a module and might be used in a handheld equipment application).

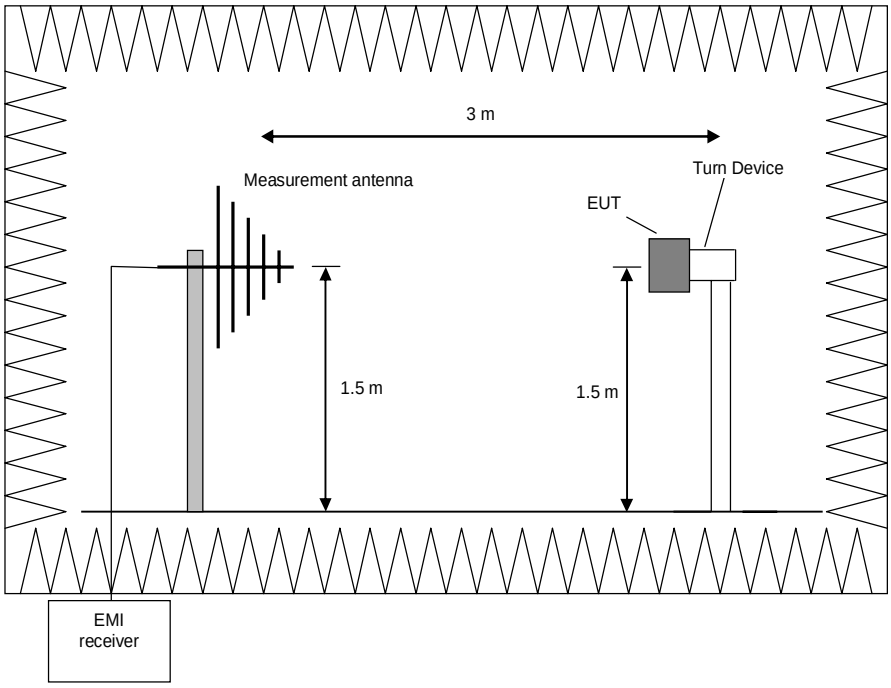
Preliminary measurement (30 MHz to 1 GHz)

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 turn device on the height of 1.5m. 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 polarization 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
30 MHz to 230 MHz	100 kHz
230 MHz to 1 GHz	100 kHz



Procedure preliminary measurement:

Pre-scans were performed in the frequency range 30 MHz to 230 MHz and 230 MHz to 1 GHz.
The following procedure will be used:

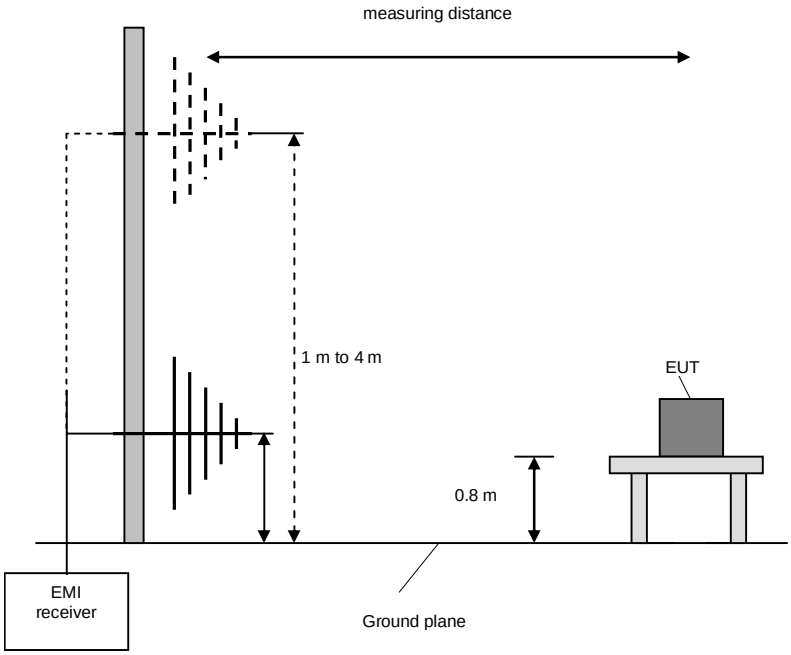
8. Monitor the frequency range at horizontal polarization and a EUT azimuth of 0 °.
9. Manipulate the system cables within the range to produce the maximum level of emission.
10. Rotate the EUT by 360 ° to maximize the detected signals.
11. Repeat 1) to 3) with the vertical polarization of the measuring antenna.
12. Make a hardcopy of the spectrum.
13. Repeat 1) to 5) with the EUT raised by an angle of 0° (45°, 90°) according to 6.6.5.4 in [1].
14. Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.

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 polarization 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 (because of EUT is a module and might be used in a handheld equipment application).

Preliminary and final measurement (1 GHz to 40 GHz)

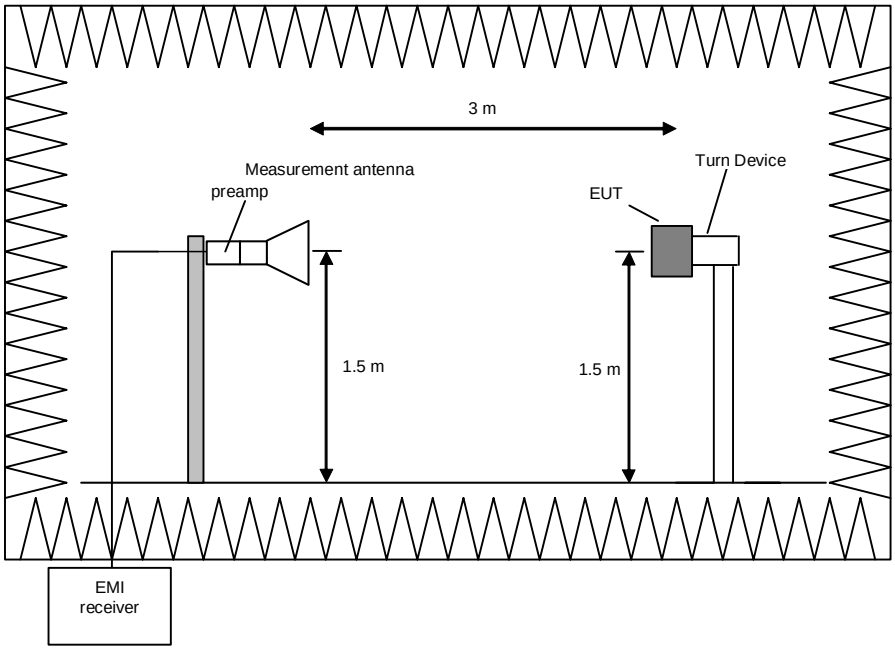
This measurement will be performed in a fully anechoic chamber. Table top devices will set up on a non-conducting turn device on the height of 1.5m. The set-up of the Equipment under test will be in accordance to [1].

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 analyzer set to MAX Hold mode and a resolution bandwidth of 100 kHz. The measurement will be performed in horizontal and vertical polarization 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	100 kHz
4 GHz to 12 GHz	100 kHz
12 GHz to 18 GHz	100 kHz
18 GHz to 25 / 26.5 GHz	100 kHz
26.5 GHz to 40 GHz	100 kHz



Procedure preliminary measurement:

Prescans were performed in the frequency range 1 to 40 GHz.
The following procedure will be used:

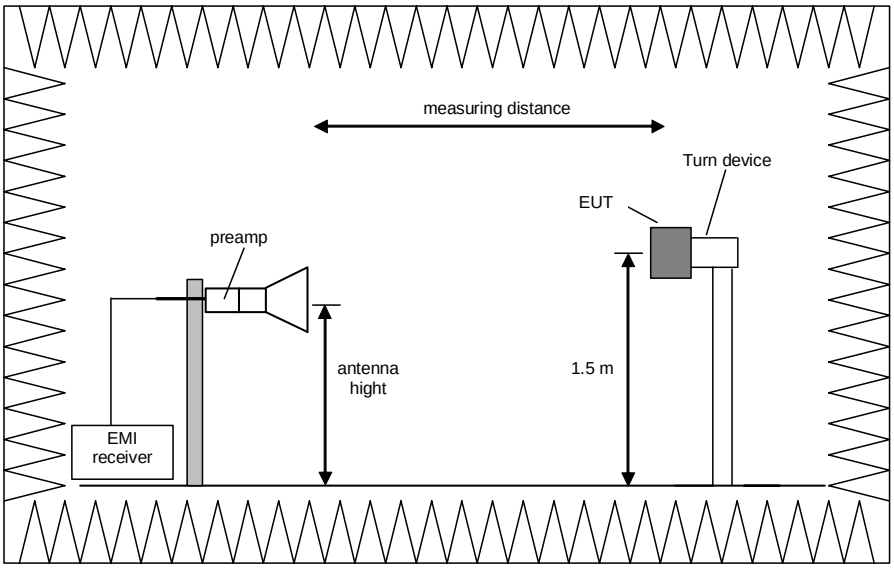
1. Monitor the frequency range at horizontal polarization and a EUT azimuth of 0 °.
2. Rotate the EUT by 360° to maximize the detected signals.
3. Repeat 1) to 2) with the vertical polarization of the measuring antenna.
4. Make a hardcopy of the spectrum.
5. Repeat 1) to 4) with the EUT raised by an 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 polarization, 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 40 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn 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 25 / 26.5 GHz	1 MHz
26.5 GHz to 40 GHz	1 MHz



Procedure of measurement:

The measurements were performed in the frequency ranges 1 GHz to 4 GHz, 4 GHz to 12 GHz, 12 GHz to 18 GHz, 18 GHz to 25 /26.5 GHz and 26.5 GHz to 40 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 polarization to the orientation with the highest emission for the first frequency identified in the preliminary measurements.
3) Set the spectrum analyzer to EMI mode with peak and average detector activated.
4) Rotate the turntable from 0° to 360° to find the TT Pos. 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.

5.7.2 Test results (radiated emissions)

5.7.2.1 Preliminary radiated emission measurement

Ambient temperature	21 °C
Relative humidity	25 %

Date	15.02.2019
Tested by	W. Kasalowsky

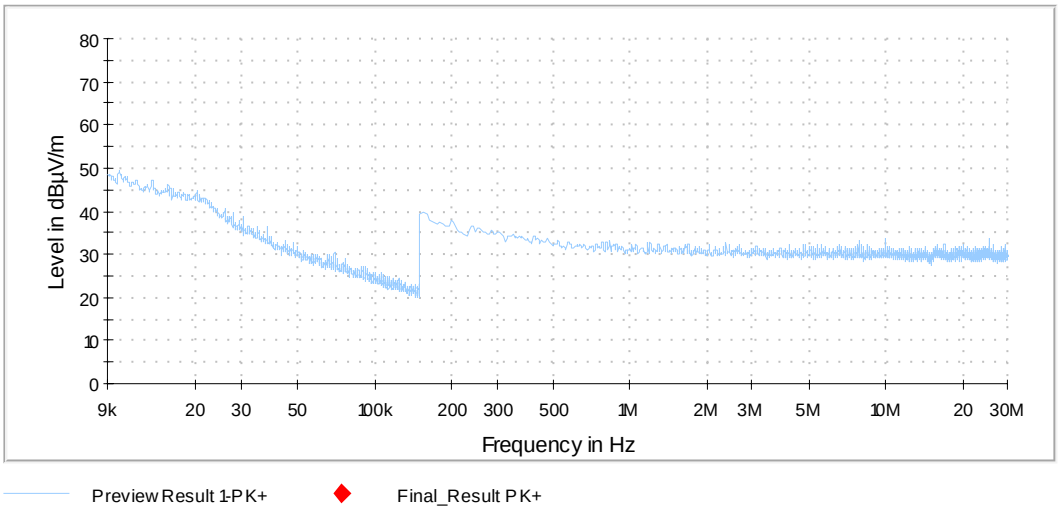
Position of EUT: The EUT was set-up on an EUT turn device of a height of 1.5 m. The distance between EUT and antenna was 3 m.

Cable guide: For detail information of test set-up and the cable guide refer to the pictures in Test setup Photo annex.

Test record: All results are shown in the following.

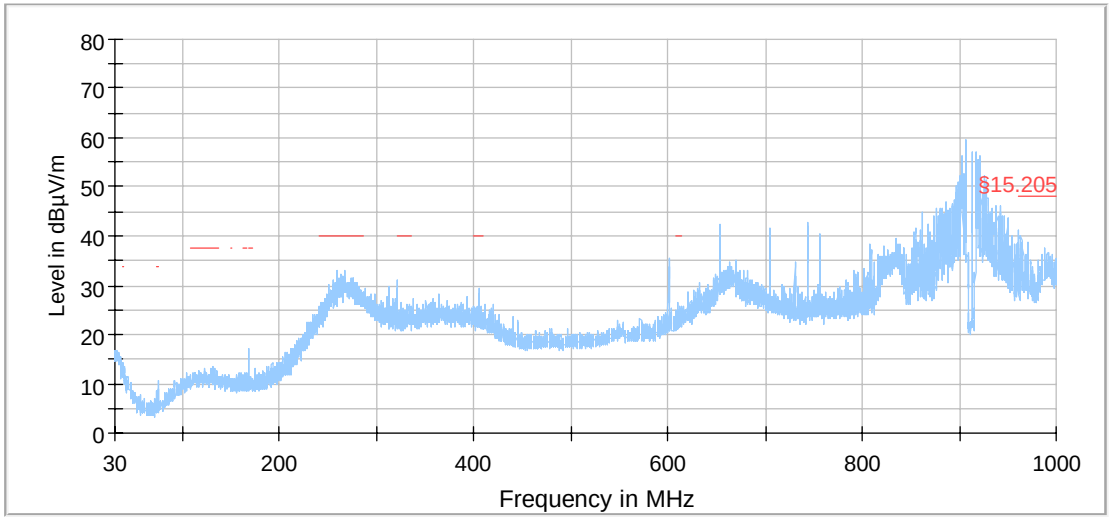
Supply voltage: During all measurements the EUT was powered with 3 V DC via a temporary connection.

Spurious emissions from 9 kHz to 30 MHz
(No significant emission, no final measurement)

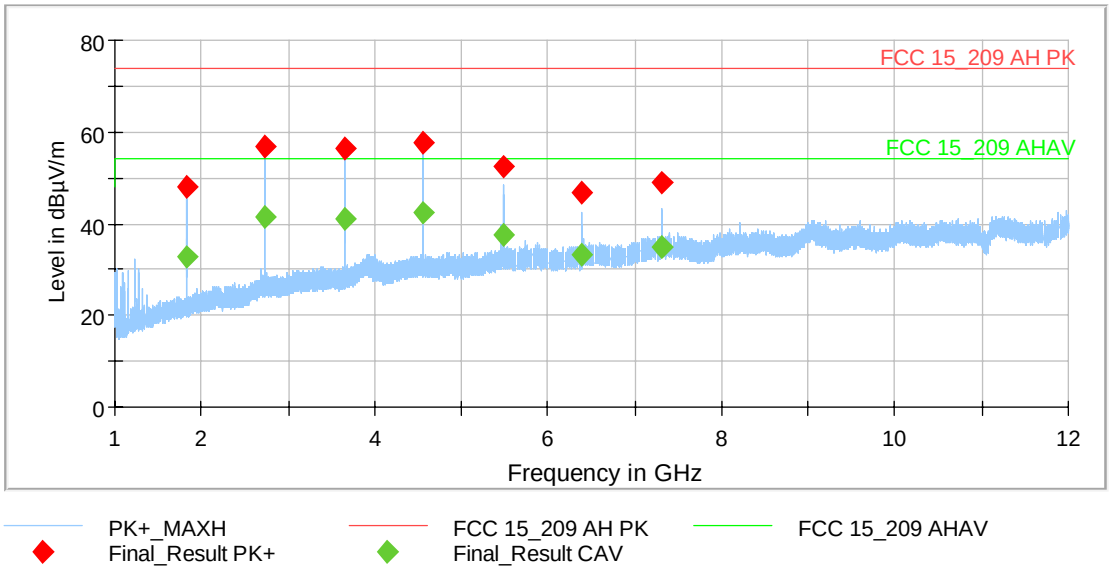


Test equipment (please refer to chapter 6 for details)
3 – 5, 7, 11, 14, 16, 17, 22

Spurious emissions from 30 MHz to 1 GHz:



Spurious emissions from 1 to 12 GHz:



Test equipment (please refer to chapter 6 for details)	
Preliminary measurements 30 MHz - 1 GHz	3 – 5, 11, 12, 14, 16, 22, 33
Preliminary measurements above 1 GHz	3 - 9, 16, 22, 28, 31

5.7.2.2 Final radiated emission measurement (9 kHz to 1 GHz)

Ambient temperature	22 °C
Relative humidity	23 %

Date	25.02.2019
Tested by	W. Kasalowsky

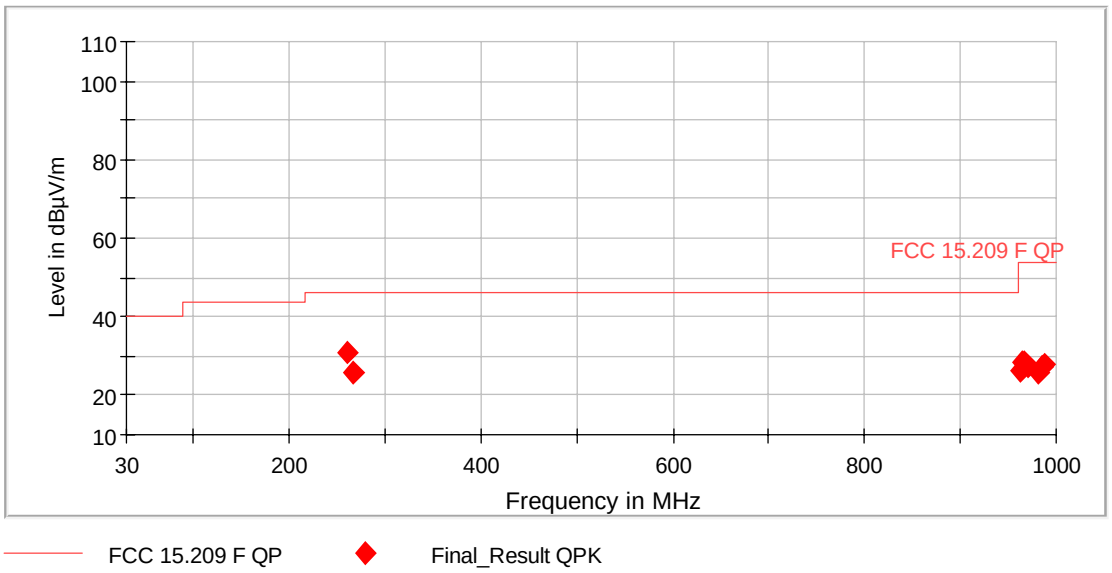
Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m. The distance between EUT and antenna was 3 m.

Cable guide: For detail information of test set-up and the cable guide refer to the pictures in test setup photos.

Test record: All results are shown in the following.

Supply voltage: During all measurements the EUT was powered with 3 V DC via a temporary connection.

The correction factor is calculated as Antenna Factor [dB] + Cable Attenuation [dB] - Amplifier Gain [dB]



Spurious Emissions 9kHz - 30 MHz								
Frequency [MHz]	Reading [dBµV]	Result* [dBµV/m]	Limit acc. 15.209 [dBµV/m]	Margin [dB]	Detector (acc. to §15.209 (d)	Antenna factor [dB/m]	Measuring Distance [m]	Distance correction factor** [dB]
No emission found. Therefore no final measurement was performed.								

Spurious Emissions (30 MHz - 1 GHz)								
Frequency [MHz]	QuasiPeak [dBµV/m]	Limit [dBµV/m]	Margin dB	Pol	Azimuth [°]	Height [cm]	Correction [dB]	Result
259.938500	30.97	46.00	15.03	V	318.0	176.0	22.0	Passed
266.777000	25.68	46.00	20.32	V	4.0	175.0	21.1	Passed
961.491000	26.12	54.00	27.88	V	4.0	152.0	35.7	Passed
963.867500	28.23	54.00	25.77	V	343.0	193.0	35.7	Passed
965.807500	28.35	54.00	25.65	V	358.0	198.0	35.7	Passed
971.094000	27.27	54.00	26.73	V	1.0	191.0	35.6	Passed
982.055000	25.82	54.00	28.18	V	358.0	199.0	35.5	Passed
985.304500	27.56	54.00	26.44	V	7.0	185.0	35.4	Passed
987.341500	28.03	54.00	25.97	V	346.0	189.0	35.4	Passed
Measurement uncertainty				± 4.78 dB				

Test equipment (please refer to chapter 6 for details)
18 - 24

5.7.2.3 Final radiated emission measurement (1 GHz to 12 GHz)

Ambient temperature	21 °C
Relative humidity	25 %

Date	15.02.2019
Tested by	W. Kasalowsky

Position of EUT: The EUT was set-up on a EUT turn device of a height of 1.5 m. The distance between EUT and antenna was 3 m.

Cable guide: For detail information of test set-up and the cable guide refer to the pictures in test setup photos.

Test record: All results are shown in the following.

Supply voltage: During all measurements the host of the EUT was powered with 5 V DC via an USB cable.

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

Additional information: For simplification all values were compared to the restricted band limits.
The result Peak/Average is the result of Reading [dBµV/m] – Correction factor [dB]

Spurious Emissions									
Duty cycle correction factor of 6.9 dB was applied for the Average reading									
Frequency	Max Peak	Average	Limit	Margin	Pol	Azimuth	Elevation	Correction	Result
[MHz]	[dBµV/m]	[dBµV/m]	[dBµV/m]	[dB]		[°]	[°]	[dB]	
1825.361	---	39.8	54.0	14.2	V	263.0	90.0	-13	Passed
1825.361	47.9	---	74.0	26.1	V	263.0	90.0	-13	Passed
2738.319	---	48.5	54.0	5.5	H	100.0	0.0	-8	Passed
2738.319	56.8	---	74.0	17.2	H	100.0	0.0	-8	Passed
3652.540	---	47.9	54.0	6.1	V	276.0	120.0	-6	Passed
3652.540	56.5	---	74.0	17.5	V	276.0	120.0	-6	Passed
4563.599	---	49.5	54.0	4.5	H	132.0	0.0	-3	Passed
4563.599	57.8	---	74.0	16.2	H	132.0	0.0	-3	Passed
5476.355	---	44.6	54.0	9.4	V	108.0	90.0	0	Passed
5476.355	52.5	---	74.0	21.5	V	108.0	90.0	0	Passed
6389.174	---	40.1	54.0	13.9	H	40.0	120.0	2	Passed
6389.174	46.8	---	74.0	27.2	H	40.0	120.0	2	Passed
7301.303	---	41.9	54.0	12.1	H	82.0	0.0	5	Passed
7301.303	49.1	---	74.0	24.9	H	82.0	0.0	5	Passed
Measurement uncertainty				+2.2 dB / -3.6 dB					

Test equipment (please refer to chapter 6 for details)
3 - 9, 16, 22, 28, 31

6 Test Equipment used for Tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal Due
1	Signal & Spectrum Analyzer	FSW43	Rohde & Schwarz	100586 & 100926	481720	15.03.2018	03.2020
2	Spectrum Analyzer	FSU46	Rohde & Schwarz	200125	480956	01.03.2018	03.2019
3	Antenna mast	AS615P	Deisel	615/310	480187	Calibration not necessary	
4	Fully anechoic chamber M20	B83117-E2439-T232	Albatross Projects	103	480303	Calibration not necessary	
5	Turntable	DS420 HE	Deisel	420/620/00	480315	Calibration not necessary	
6	RF-cable No.3	Sucoflex 106B	Suhner	0563/6B / Kabel 3	480670	Calibration not necessary	
7	Multiple Control Unit	MCU	Maturo GmbH	MCU/043/971107	480832	Calibration not necessary	
8	Antenna (Log.Per.)	HL050	Rohde & Schwarz	100438	481170	09.10.2017	10.2020
9	RF-Cable No. 40	Sucoflex 106B	Suhner	0708/6B / Kabel 40	481330	Calibration not necessary	
10	HF-Cable	Sucoflex 104	Huber+Suhner	517406	482391	Calibration not necessary	
11	EMI Receiver / Spectrum Analyzer	ESW44	Rohde & Schwarz	101635	482467	22.06.2017	06.2019
12	Antenna (Bilog)	CBL6112B	Schaffner EMV GmbH (-Chase)	2688	480328	19.06.2017	06.2020
13	Software	WMS32	Rohde & Schwarz		481800	Calibration not necessary	
14	RF-cable No.36	Sucoflex 106B	Suhner	0587/6B / Kabel 36	480865	Calibration not necessary	
15	HF-Cable	Sucoflex 104	Huber+Suhner	517402	482392	Calibration not necessary	
16	Positioner	TDF 1.5- 10Kg	Maturo	15920215	482034	Calibration not necessary	
17	Loop antenna	HFH2-Z2	Rohde & Schwarz	100417	481912	10.01.2019	01.2020
18	Open area test site M6	OATS M6	Phoenix Testlab	-	480085	Calibration not necessary	
19	Antenna mast	MA240-0	Inn-Co GmbH	MA240-0/030/6600603	480086	Calibration not necessary	
20	Turntable	DS412	Deisel	412/316	480087	Calibration not necessary	
21	Controller	HD100	Deisel	100/349	480139	Calibration not necessary	
22	Software	EMC32	Rohde & Schwarz	100061	481022	Calibration not necessary	
23	Antenna (Bilog)	CBL6111D	Schaffner Elektrotest GmbH / Teseq GmbH	25761	480894	19.10.2017	10.2020
24	EMI Measuring receiver	ESR7	Rohde & Schwarz	101939	482558	19.09.2017	09.2019
28	Preamplifier 100 MHz to 16 GHz	AFS6	Narda MITEQ	2011215	482333	10.07.2018	07.2020
31	High pass filter	WHKX12-935-1000-15000-40ST	Wainwright Instruments	12	482908	Calibration not necessary	
32	Test fixture	-	Phoenix Testlab	-	410160	Calibration not necessary	

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal Due
33	Tunable Band Reject Filter	WTRCT8-800-960-5-13-60EEK	Wainwright Instruments	2	482012	Calibration not necessary	

7 Test site Validation

Test equipment	PM. No.	Frequency range	Type of validation	According to	Val. Date	Val Due
OATS M6	480085	30 – 1000 MHz	NSA	ANSI C63.4-2014	25.10.2018	24.10.2020
Fully anechoic chamber M20	480303	1 -18 GHz	SVSWR	CISPR 16-1-4 Amd. 1	13.07.2018	12.07.2020

8 Report History

Report Number	Date	Comment
F190124E1	25.11.2019	Initial Test Report

9 List of Annexes

Annex A	Test Setup Photos	5 pages
Annex B	External Photos	2 pages
Annex C	Internal Photos	3 pages