



PHOENIX
TESTLAB

Königswinkel 10
32825 Blomberg, Germany
Phone: +49 (0) 52 35 / 95 00-0
Fax: +49 (0) 52 35 / 95 00-10
office@phoenix-testlab.de
www.phoenix-testlab.de

Test Report

Report Number:

F1900149E3

Equipment under Test (EUT):

NINA-B306 / NINA-B316

Applicant:

u-blox AG

Manufacturer:

u-blox AG



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] **558074 D01 15.247 Meas Guidance v05 (August 2018)**, GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES

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:	<u>Bernward ROHDE</u> Name	<u></u> Signature	<u>18.03.2019</u> Date
Reviewed and approved by:	<u>Bernd STEINER</u> Name	<u></u> Signature	<u>18.03.2019</u> Date

This test report is only valid in its original form.

Any reproduction of its contents in extracts without written permission of the accredited test laboratory PHOENIX TESTLAB GmbH is prohibited.

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.

Contents:	Page
1 Identification.....	5
1.1 Applicant.....	5
1.2 Manufacturer.....	5
1.3 Test Laboratory.....	5
1.4 EUT (Equipment under Test).....	6
1.5 Technical Data of Equipment.....	8
1.6 Dates.....	9
2 Operational States.....	10
2.1 Description of function of the EUT.....	10
2.2 The following states were defined as the operating conditions.....	10
2.3.1 Operation Modes/Power settings.....	11
2.3.2 Radio tests.....	11
3 Additional Information.....	12
4 Overview.....	12
5 Results.....	13
5.1 Duty cycle.....	13
5.2 Maximum peak output power.....	13
5.3 DTS Bandwidth / 99% Bandwidth.....	13
5.4 Peak Power Spectral Density.....	13
5.5 Band-edge compliance.....	13
5.6 Maximum unwanted emissions.....	13
5.6.1 Method of measurement (radiated emissions).....	13
5.6.1.1 Test results (radiated emissions).....	21
5.7 Conducted emissions on power supply lines (150 kHz to 30 MHz).....	28
6 Test Equipment used for Tests.....	29
7 Test site Validation.....	30
8 Report History.....	30
9 List of Annexes.....	30

1 Identification

1.1 Applicant

Name:	u-blox AG
Address:	Zürcherstr. 68, 8800 Thalwil
Country:	Switzerland
Name for contact purposes:	Mr. Filip KRUZELA
Phone:	+46 40 630 71 70
Fax:	N/A
eMail address:	Filip.Kruzela@u-blox.com
Applicant represented during the test by the following person:	-

1.2 Manufacturer

Name:	u-blox AG
Address:	Zürcherstr. 68, 8800 Thalwil
Country:	Switzerland
Name for contact purposes:	Mr. Filip KRUZELA
Phone:	+46 40 630 71 70
Fax:	N/A
eMail address:	Filip.Kruzela@u-blox.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-17186-01-05, FCC Test Firm Accreditation designation number DE0004, CAB Identifier DE0003 and ISED# 3469A.

1.4 EUT (Equipment under Test)

EUT	
Test object: *	Stand-alone radio module
Model series	NINA-B3
PMN / Model name: *	NINA-B306 (u-blox PCB trace Antenna) NINA-B316 (u-blox PCB trace Antenna)
FCC ID: *	XPYNINAB30 (NINA-B301, NINA-B302, NINA-B306) XPYNINAB31 (NINA-B311, NINA-B312, NINA-B316)
ISED Certification number: * IC: *	8595A-NINAB30 (NINA-B301, NINA-B302, NINA-B306) 8595A-NINAB31 (NINA-B311, NINA-B312, NINA-B316)
HVIN: *	NINA-B301, NINA-B302, NINA-B306 NINA-B311, NINA-B312, NINA-B316
HMN: *	N/A
FVIN: *	N/A
Serial number: *	D82CCF95780330C0500 NINA-B306 (labelled PT2-B306#2)
PCB identifier: *	N/A
Hardware version: *	05
Software version: *	Radio test modes nRF5_SDK_15.0.0_a53641a (radio_test_14may.hex)

* Declared by the applicant

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

Bluetooth LE frequencies				
Channel 00	RX	2402 MHz	TX	2402 MHz
Channel 19	RX	2440 MHz	TX	2440 MHz
Channel 39	RX	2480 MHz	TX	2480 MHz

IEEE 802.15.4 frequencies				
Channel 11	RX	2405 MHz	TX	2405 MHz
Channel 19	RX	2440 MHz	TX	2440 MHz
Channel 25	RX	2475 MHz	TX	2475 MHz

Proprietary frequencies				
Channel 0	RX	2402 MHz	TX	2402 MHz
Channel 38	RX	2440 MHz	TX	2440 MHz
Channel 78	RX	2480 MHz	TX	2480 MHz

Ancillary Equipment	
Cables (connected to the EUT):	USB 2.0 type A <-> USB 2.0 type B micro, ~0.2 m ^{*1} +2 m USB extension ^{*2}
Fiber optic converter:	Opto USB2.0, MK Messtechnik (PM. No. 482617) ^{*2}
Laptop PC:	Fujitsu Lifebook S751 (PM No. 201036) ^{*2}

^{*1} Provided by the applicant

^{*2} Provided by the laboratory

1.5 Technical Data of Equipment

General radio module						
Radio chip	Nordic Semiconductor nRF52840					
Antenna type: *	NINA-B306	(u-blox PCB Antenna)				
	NINA-B316	(u-blox PCB Antenna)				
Antenna name: *	u-blox PCB Antenna					
Antenna gain: *	Max +3 dBi					
Antenna connector: *	NINA-B306	(none)				
	NINA-B316	(none)				
Evaluation board: *	EVB-NINA-B3					
Power supply EUT: *	DC					
Supply voltage eval board: *	U _{nom} =	9 V	U _{min} =	5 V	U _{max} =	12 V
Supply voltage radio module: *	U _{nom} =	3.3	U _{min} =	1.7 V	U _{max} =	3.6 V
Temperature range: *	-40 °C to +85 °C					
Lowest / highest internal clock frequency: *	32.768 kHz to 2480 MHz					

* Declared by the applicant

Radio module	
Radio chip*	Nordic Semiconductor nRF52840
Power supply EUT: *	DC
Supply voltage radio module: *	U _{nom} = 3.3 U _{min} = 1.7 V U _{max} = 3.6 V
Fulfils specification: *	Bluetooth Low Energy; IEEE 802.15.4; Proprietary mode; NFC
Bluetooth Low Energy Conducted output power: *	Typical 8 dBm
Bluetooth Low Energy Type of modulation: *	GFSK (1 Mbit/s; 2 Mbit/s; 500 kbit/s; 125 kbit/s)
Bluetooth Low Energy Operating frequency range: *	2402 – 2480 MHz
Bluetooth Low Energy Number of channels: *	40 (2 MHz channel spacing)
IEEE 802.15.4 Conducted output power: *	Typical 8 dBm
IEEE 802.15.4 Type of modulation: *	O-QPSK (250 kbit/s)
IEEE 802.15.4 Operating frequency range: *	2405 – 2475 MHz
IEEE 802.15.4 Number of channels: *	15 (5 MHz channel spacing)
Proprietary mode Conducted output power: *	Typical 8 dBm
Proprietary mode Type of modulation: *	GFSK (1 Mbit/s; 2 Mbit/s)
Proprietary mode Operating frequency range: *	2402 – 2480 MHz
Proprietary mode Number of channels: *	79 (1 MHz spacing)
NFC Conducted output power: *	No transmitter, receiver only
NFC Type of modulation: *	receiver uses load modulation to “transmit” data (106 kbit/s)
NFC Operating frequency range: *	13.56 MHz
NFC Number of channels: *	1

* Declared by the applicant

1.6 Dates

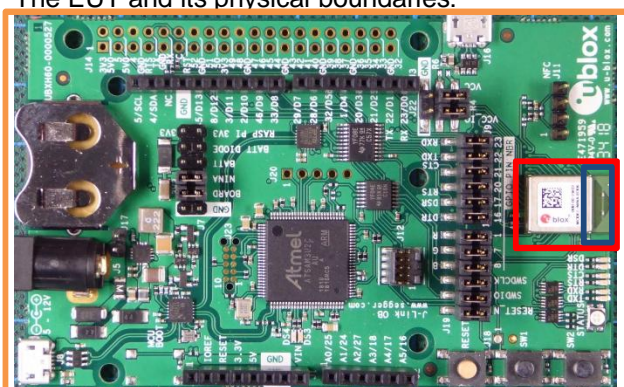
Date of receipt of test sample:	28.01.2019
Start of test:	29.01.2019
End of test:	02.02.2019

2 Operational States

2.1 Description of function of the EUT

NINA-B3 is a small size radio module intended for OEM integration utilizing Bluetooth 5, IEEE 802.15.4, 2.4 GHz proprietary mode and/or NFC. All 2.4 GHz RF-signals share the same RF-path thus it is not possible to transmit e.g. BLE, 802.15.4 and 2.4GH proprietary mode signals simultaneously.

The EUT and its physical boundaries:



- Evaluation board
- EUT (radio module NINA-B3)
- U-blox PCB Antenna

2.2 The following states were defined as the operating conditions

The NINA-B3 modules are set into a test mode, in which normal operation is not possible, but the full capabilities of the radio are unlocked and can be used in transmission tests. This mode is typically used during spurious emissions testing and requires special firmware to be enabled.

The applicable test firmware was loaded to the radio module:

Radio test modes	nRF5_SDK_15.0.0_a53641a (radio_test_14may.hex)
------------------	---

2.3.1 Operation Modes/Power settings

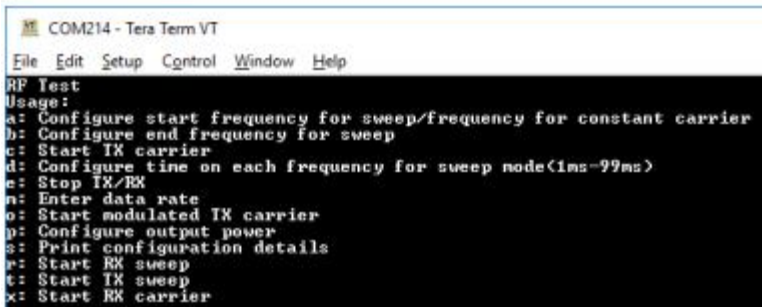
Operation mode #	Radio technology	Frequency [MHz]	Channel	Modulation / Mode	Data rate	Power setting
1	BLE	2402	0	GFSK	1 Mbit/s	+8 dBm
2	IEEE 802.15.4	2405	11	O-QPSK	250 kbit/s	+8 dBm
3	Prop	2402	0	GFSK	1 Mbit/s	+8 dBm

2.3.2 Radio tests

For the radio tests the following settings were used:

A connection to the EUT was established via USB cable.
 The USB connection was converted to a serial connection on the EUT.
 The following COM port settings were used with "tera term".
 Baud rate: 115200
 Data: 8 bit
 Parity: None
 Stop: 1 bit
 Flow control: None

The below shown interface was used to set the EUT in the applicable test-mode.



```

COM214 - Tera Term VT
File Edit Setup Control Window Help
RP Test
Usage:
a: Configure start frequency for sweep/frequency for constant carrier
b: Configure end frequency for sweep
c: Start TX carrier
d: Configure time on each frequency for sweep node(1ms-99ms)
e: Stop TX/RX
n: Enter data rate
o: Start modulated TX carrier
p: Configure output power
P: Print configuration details
r: Start RX sweep
t: Start TX sweep
x: Start RX carrier
  
```

3 Additional Information

This test report incorporates the limited tests with a further internal antenna (u-blox PCB Trace antenna). It contains just limited test cases with the goal to add a new antenna to an existing filing.

The complete radio test for BLE, IEEE 802.15.4 and proprietary mode are documented in test reports: F181014E7, F181014E8 and F181014E9 by PHOENIX TESTLAB GmbH.

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	2400.0 - 2483.5	15.247 (b) (3), (4)	5.4 (d) [3]	Verified*	---
DTS Bandwidth	2400.0 - 2483.5	15.247 (a) (2)	5.2 (a) [3]	not tested	---
Peak Power Spectral Density	2400.0 - 2483.5	15.247 (e)	5.2 (b) [3]	not tested	---
Band edge compliance	2400.0 - 2483.5	15.247 (d) 15.205 (a) 15.209 (a)	5.5 [3] 8.9 [4], 8.10 [4]	not tested	---
Radiated emissions (transmitter)	0.009 – 26,500	15.247 (d) 15.205 (a) 15.209 (a)	5.5 [3] 8.9 [4], 8.10 [4]	Passed	13 et seq.
Conducted emissions on supply line	0.15 - 30	15.207 (a)	8.8 [4]	not tested	---

* The Maximum Peak Output Power was verified and compared with the original results.

5 Results

5.1 Duty cycle

Not tested, see test-reports F181014E7, F181014E8 and F181014E9 by PHOENIX TESTLAB GmbH.

5.2 Maximum peak output power

The Maximum Peak output power was verified and compared with the results from the original filing. The results are similar to the original results within the measurement uncertainty. For detailed results see test-reports F181014E7, F181014E8 and F181014E9 by PHOENIX TESTLAB GmbH

5.3 DTS Bandwidth / 99% Bandwidth

Not tested, see test-reports F181014E7, F181014E8 and F181014E9 by PHOENIX TESTLAB GmbH.

5.4 Peak Power Spectral Density

Not tested, see test-reports F181014E7, F181014E8 and F181014E9 by PHOENIX TESTLAB GmbH.

5.5 Band-edge compliance

Not tested, see test-reports F181014E7, F181014E8 and F181014E9 by PHOENIX TESTLAB GmbH.

5.6 Maximum unwanted emissions

5.6.1 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 site 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 site 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.

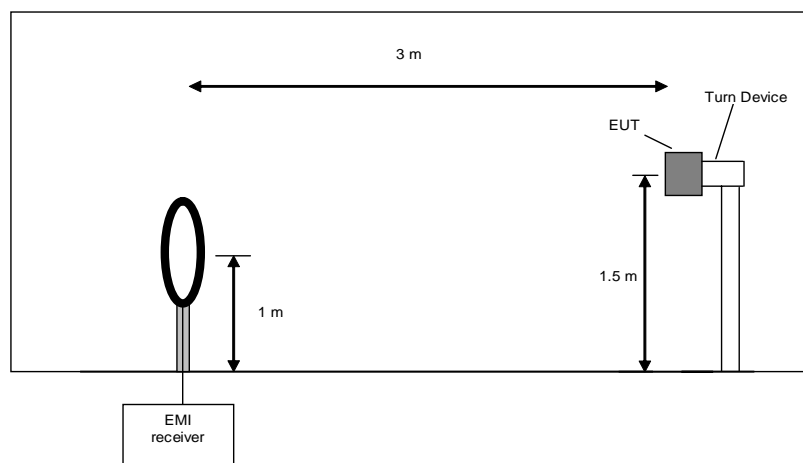
Preliminary measurement (9 kHz to 30 MHz):

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.

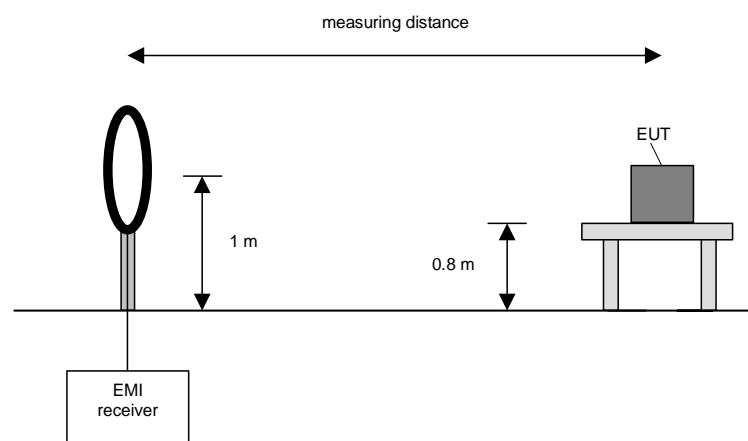
Final measurement (9 kHz to 30 MHz):

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).

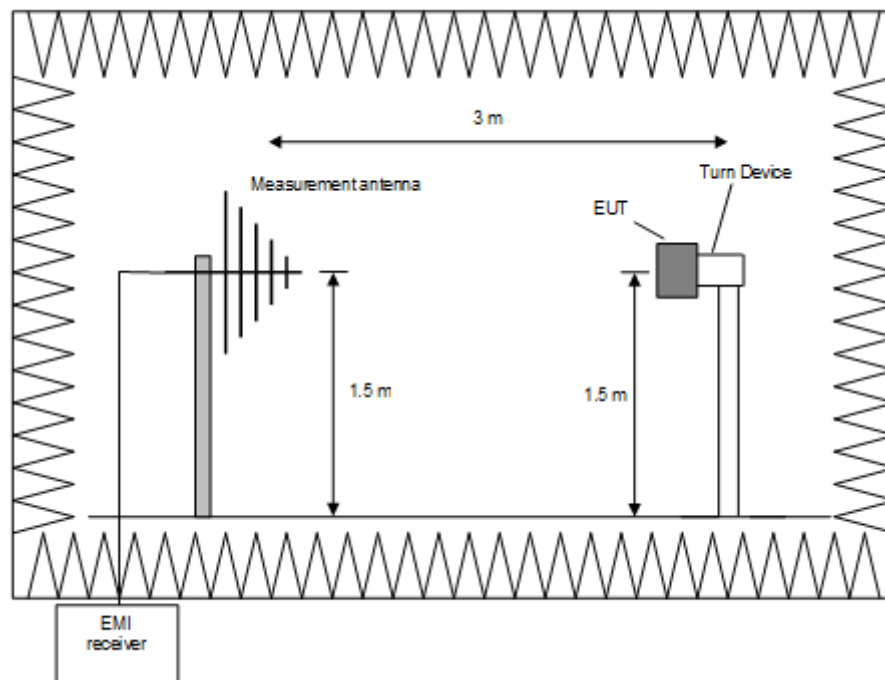
Preliminary measurement (30 MHz to 1 GHz)

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:

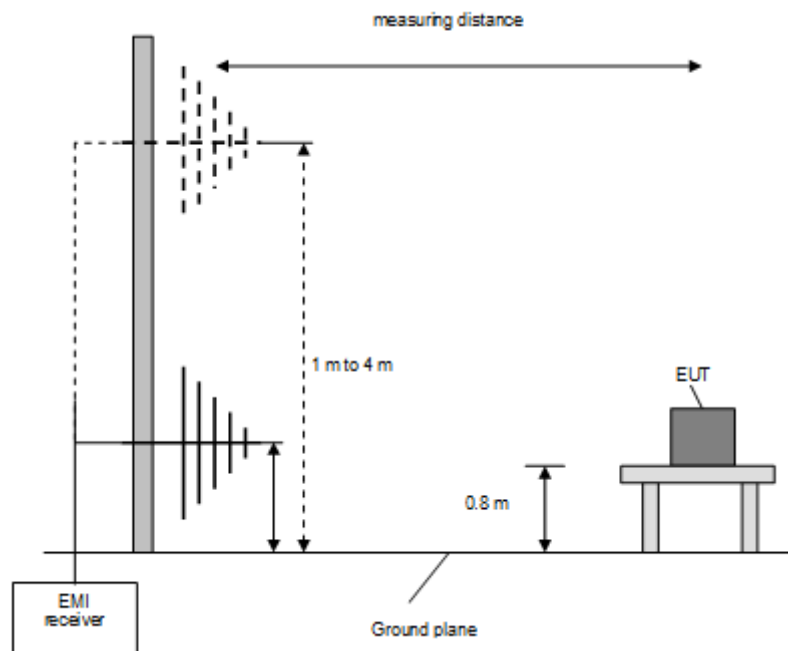
8. Monitor the frequency range at horizontal polarization and a EUT azimuth of 0°.
9. Manipulate the system cables within the range to produce the maximum level of emission.
10. Rotate the EUT by 360° to maximize the detected signals.
11. Repeat 1) to 3) with the vertical polarization of the measuring 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)

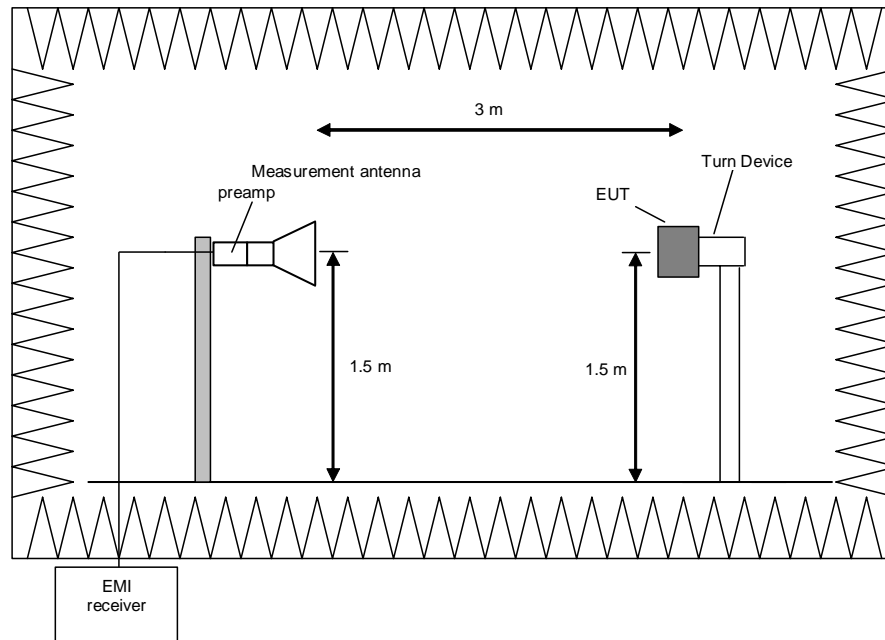
This measurement will be performed in a fully anechoic chamber. Table top devices will set up on a non-conducting turn device on the height of 1.5m. The set-up of the Equipment under test will be in accordance to [1].

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:

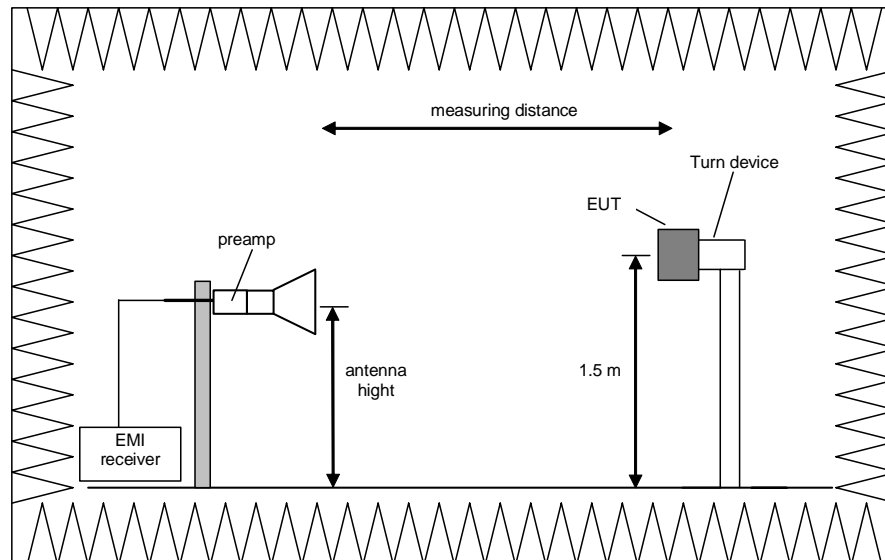
1. Monitor the frequency range at horizontal polarization and a EUT azimuth of 0 °.
2. Rotate the EUT by 360° to maximize the detected signals.
3. Repeat 1) to 2) with the vertical polarization of the measuring antenna.
4. Make a hardcopy of the spectrum.
5. Repeat 1) to 4) with the EUT raised by an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

5.6.1.1 Test results (radiated emissions)

5.6.1.1.1 Preliminary radiated emission measurement

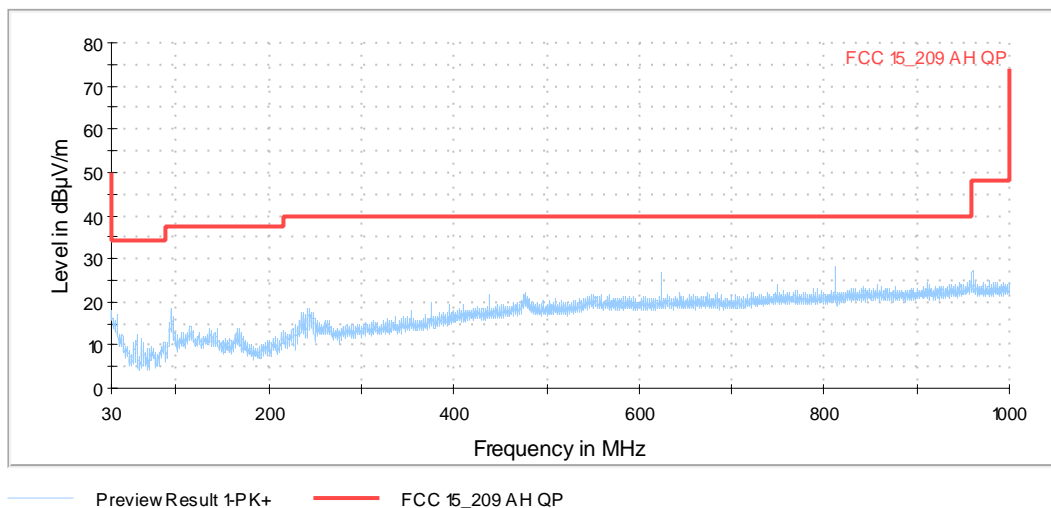
5.6.1.1.1.1 Emissions below 1 GHz

Ambient temperature	21.5 °C
Relative humidity	26 %

Date	29.01.2019
Tested by	B. Rohde

- 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 host of the EUT was powered with 5 V DC via an USB cable.
- Remark:** No measurement in the frequency range 9 kHz - 30 MHz was performed. No change in the spectrum from 30 – 1000 MHz compared to test-reports F181014E7, F181014E8 and F181014E9

Operation mode 1: Spurious emissions from 30 MHz – 1 GHz
(Preliminary plot)



Test equipment (please refer to chapter 6 for details)
1 – 3, 5, 9 – 12, 14

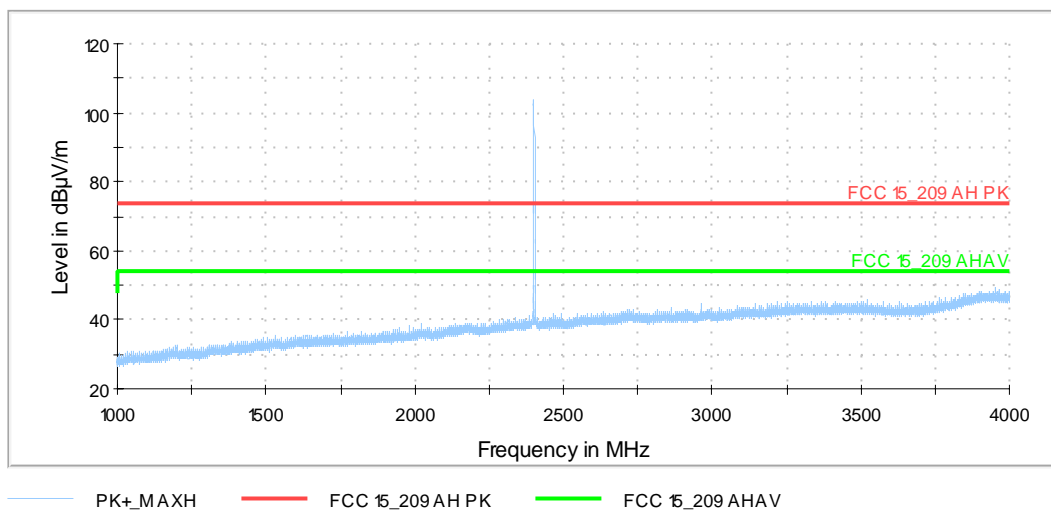
5.6.1.1.1.2 Emissions above 1 GHz

Ambient temperature	21.5 °C
Relative humidity	26 %

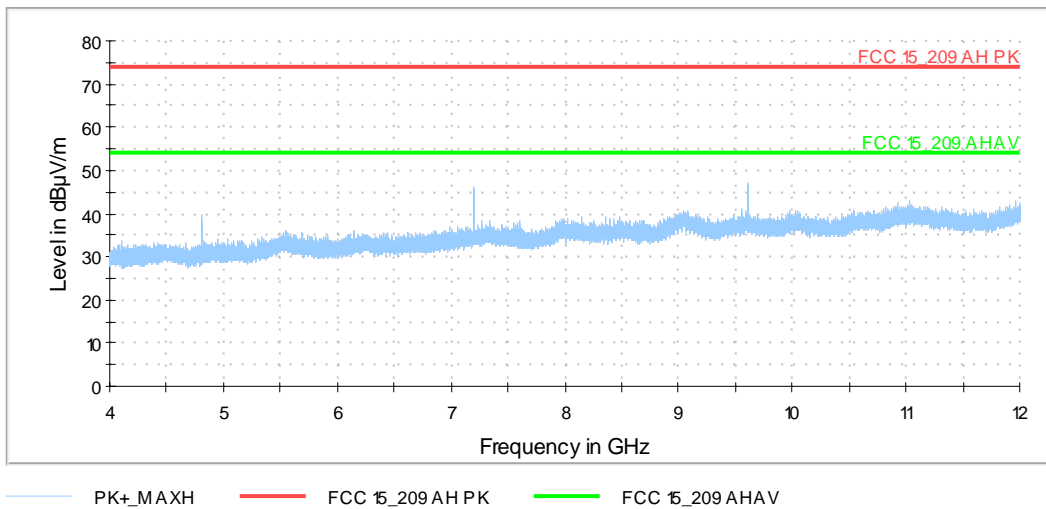
Date	29.01.2019
Tested by	B.Rohde

- 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 host of the EUT was powered with 5 V DC via an USB cable.
- Remark:

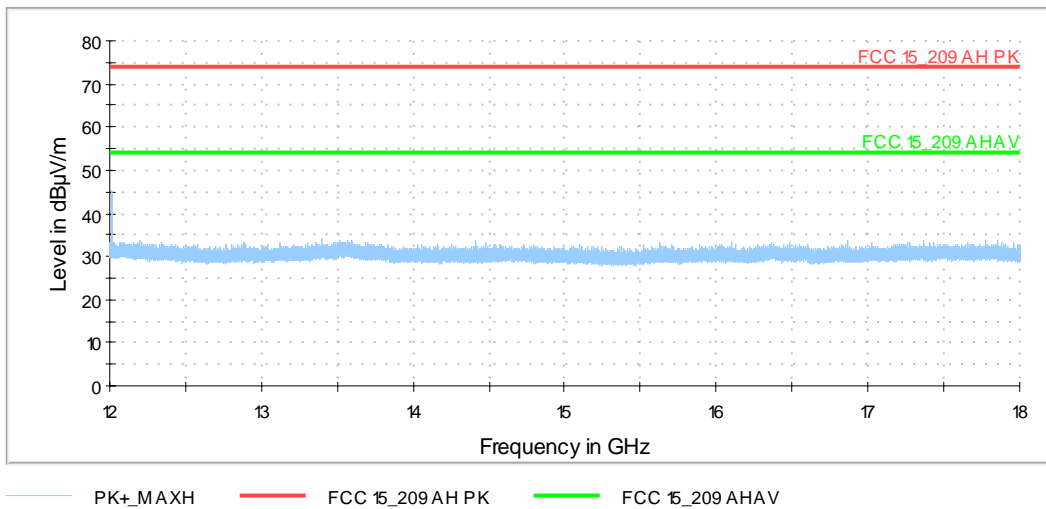
Operation mode 1: Spurious emissions from 1 – 4 GHz:
(Preliminary plot)



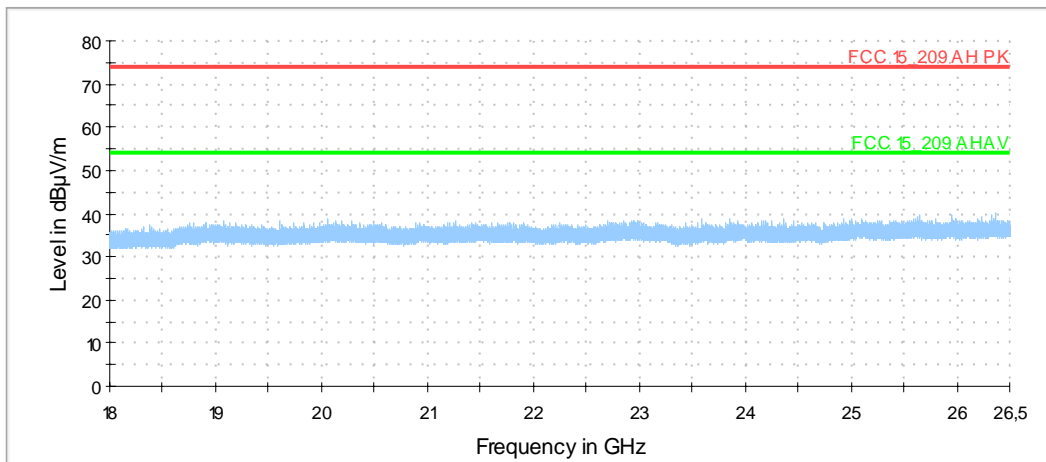
Operation mode 1: Spurious emissions from 4 - 12 GHz:
(Preliminary plot)



Operation mode 1: Spurious emissions from 12 - 18 GHz:
(Preliminary plot)



All modes: Spurious emissions from 18 – 26.5 GHz:
(Preliminary, no significant emission, no final measurement)



— PK+_MAXH — FCC 15_209 AHPK — FCC 15_209 AHAV

Test equipment (please refer to chapter 6 for details)
1 - 9, 11, 13 - 21

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

No final radiated emission measurement done, no change in the spectrum from 9 kHz – 1000 MHz compared to test-reports F181014E7, F181014E8 and F181014E9

5.6.1.1.3 Final radiated emission measurement (1 GHz to 25 GHz)

Ambient temperature	21.5 °C
Relative humidity	26 %

Date	29.01.2019 02.02.2019
Tested by	B. Rohde

- 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 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.

Operation mode 1

Spurious Emissions (Operation mode 1) 1 – 25 GHz									
Duty cycle correction factor of 0.25 dB was applied for the Average reading									
Frequency [MHz]	Max Peak [dB μ V/m]	Average [dB μ V/m]	Limit [dB μ V/m]	Margin dB	Pol	Azimuth [°]	Elevation [°]	Correction [dB]	Result
4803.511111	47.1	---	74	26.9	V	249	120	-2.0	Passed
4803.511111	---	37.4	54	16.6	V	249	120	-1.8	Passed
4804.488889	46.2	---	74	27.8	V	301	0	-2.0	Passed
4804.488889	---	36.0	54	18.0	V	301	0	-1.8	Passed
7205.288889	51.9	---	74	22.1	V	283	30	4.0	Passed
7205.288889	---	42.2	54	11.8	V	283	30	4.3	Passed
7206.666667	53.2	---	74	20.8	V	305	30	4.0	Passed
7206.666667	---	44.5	54	9.5	V	305	30	4.3	Passed
9607.111111	55.5	---	74	18.5	V	277	30	8.0	Passed
9607.111111	---	44.9	54	9.1	V	277	30	8.3	Passed
9609.111111	54.9	---	74	19.1	V	291	30	7.0	Passed
9609.111111	---	44.9	54	9.1	V	291	30	7.3	Passed
12008.940000	51.7	---	74	22.3	V	277	120	12.0	Passed
12008.940000	---	42.6	54	11.4	V	277	120	12.3	Passed
12011.400000	51.6	---	74	22.4	V	293	60	12.0	Passed
12011.400000	---	41.9	54	12.1	V	293	60	12.3	Passed
Measurement uncertainty				+2.2 dB / -3.6 dB					

Operation mode 2

Spurious Emissions (Operation mode 2) 1 – 25 GHz									
Duty cycle correction factor of 0 dB was applied for the Average reading									
Frequency [MHz]	Max Peak [dB μ V/m]	Average [dB μ V/m]	Limit [dB μ V/m]	Margin dB	Pol	Azimuth [°]	Elevation [°]	Correction [dB]	Result
9618.100000	55.2	---	74	18.8	V	320	30	7.0	Passed
9618.100000	---	45.5	54	8.5	V	320	30	7.0	Passed
9620.100000	53.5	---	74	20.5	V	278	30	7.0	Passed
9620.100000	---	37.9	54	16.1	V	278	30	7.0	Passed
9622.100000	55.5	---	74	18.5	V	282	30	7.0	Passed
9622.100000	---	45.6	54	8.4	V	282	30	7.0	Passed
12022.850000	51.2	---	74	22.8	V	296	120	12.1	Passed
12022.850000	---	42.6	54	11.4	V	296	120	12.1	Passed
12025.200000	49.6	---	74	24.4	V	286	150	12.1	Passed
12025.200000	---	31.7	54	22.3	V	286	150	12.1	Passed
12027.450000	50.6	---	74	23.4	V	295	60	12.1	Passed
12027.450000	---	41.9	54	12.1	V	295	60	12.1	Passed
Measurement uncertainty				+2.2 dB / -3.6 dB					

Operation mode 3

Spurious Emissions (Operation mode 3) 1 – 25 GHz									
Duty cycle correction factor of 0.26 dB was applied for the Average reading									
Frequency [MHz]	Max Peak [dB μ V/m]	Average [dB μ V/m]	Limit [dB μ V/m]	Margin dB	Pol	Azimuth [°]	Elevation [°]	Correction [dB]	Result
9607.500000	55.3	---	74	18.7	V	308	30	8.0	Passed
9607.500000	---	45.8	54	8.2	V	308	30	8.3	Passed
9608.800000	55.1	---	74	18.9	V	319	30	7.0	Passed
9608.800000	---	45.9	54	8.1	V	319	30	7.3	Passed
12009.250000	52.2	---	74	21.8	V	300	30	12.1	Passed
12009.250000	---	42.8	54	11.2	V	300	30	12.4	Passed
12010.900000	52.1	---	74	21.9	V	282	120	12.1	Passed
12010.900000	---	43.2	54	10.8	V	282	120	12.4	Passed
Measurement uncertainty				+2.2 dB / -3.6 dB					

Test equipment (please refer to chapter 6 for details)

1 - 9, 11, 13 - 21

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

Not tested, see test-reports F181014E7, F181014E8 and F181014E9 by PHOENIX TESTLAB GmbH.

6 Test Equipment used for Tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal Due
1	Antenna mast	AS615P	Deisel	615/310	480187	Calibration not necessary	
2	Fully anechoic chamber M20	B83117-E2439-T232	Albatross Projects	103	480303	Calibration not necessary	
3	Turntable	DS420 HE	Deisel	420/620/00	480315	Calibration not necessary	
4	RF-cable No.3	Sucoflex 106B	Suhner	0563/6B / Kabel 3	480670	Calibration not necessary	
5	Multiple Control Unit	MCU	Maturo GmbH	MCU/043/97110 7	480832	Calibration not necessary	
6	Antenna (Log.Per.)	HL050	Rohde & Schwarz	100438	481170	09.10.2017	10.2020
7	RF-Cable No. 40	Sucoflex 106B	Suhner	0708/6B / Kabel 40	481330	Calibration not necessary	
8	HF-Cable	Sucoflex 104	Huber+Suhner	517406	482391	Calibration not necessary	
9	EMI Receiver / Spectrum Analyzer	ESW44	Rohde & Schwarz	101635	482467	22.06.2017	06.2019
10	Antenna (Bilog)	CBL6112B	Schaffner EMV GmbH (-Chase)	2688	480328	19.06.2017	06.2020
11	Software	EMC32	Rohde & Schwarz		481800	Calibration not necessary	
12	RF-cable No.36	Sucoflex 106B	Suhner	0587/6B / Kabel 36	480865	Calibration not necessary	
13	HF-Cable	Sucoflex 104	Huber+Suhner	517402	482392	Calibration not necessary	
14	Positioners	TDF 1.5- 10Kg	Maturo	15920215	482034	Calibration not necessary	
15	standard gain horn antenna	18240-20	Flann Microwave	483	480294	Calibration not necessary	
16	standard gain horn antenna	20240-20	Flann Microwave	411	480297	Calibration not necessary	
17	Microwave cable 2m	Insulated Wire Inc.	Insulated Wire	KPS-1533-800-KPS	480302	Calibration not necessary	
18	Preamplifier 100 MHz - 13 GHz	JS3-00101200-23-5A	MITEQ Hauppauge N.Y.	681851	480337	14.03.2018	03.2020
19	Preamplifier 18 GHz - 26 GHz	JS4-18002600-20-5A	MITEQ Hauppauge N.Y.	658697	480342	14.03.2018	03.2020
20	Preamplifier 12 GHz - 18 GHz	JS3-12001800-16-5A	MITEQ Hauppauge N.Y.	571667	480343	14.03.2018	03.2020
21	High pass filter	WHKX4.0/18G-8SS	Wainwright Instruments GmbH	1	480587	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
Shielded chamber M4	480088	9 kHz – 30 MHz	GND-Plane	ANSI C63.4-2014	06.11.2018	05.11.2020

8 Report History

Report Number	Date	Comment
F190149E3	18.03.2019	Initial Test Report

9 List of Annexes

Annex A	Test Setup Photos	6 pages
Annex B	External Photos	4 pages