PHOENIX TESTLAB

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Test Report

Report Number:

F201055E3

Equipment under Test (EUT):

TrackSense LyoPro Data logger

Applicant:

Ellab A/S

Manufacturer:

Ellab A/S

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] **558074 D01 15.247 Meas Guidance v05r02 (April 2019),** 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

[4] **RSS-247, Issue 2 (2017-02)** Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

[4] **RSS-Gen, Issue 5 (2019-03)** 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.

Tested and written by:	Bernward ROHDE Name	 Signature	12.10.2020 Date
Reviewed and approved by:	Paul NEUFELD Name	 Signature	12.10.2020 Date

This test report is only valid in its original form.

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

1.1 Applicant

Name:	Ellab A/S
Address:	Trollesmindealle 25, 3400 Hilleroed
Country:	Denmark
Name for contact purposes:	Mr. James JACOBSSON
Phone:	+45 4452 0515
Fax:	-
eMail Address:	jja@ellab.com
Applicant represented during the test by the following person:	-

1.2 Manufacturer

Name:	Ellab A/S
Address:	Trollesmindealle 25, 3400 Hilleroed
Country:	Denmark
Name for contact purposes:	Mr. James JACOBSSON
Phone:	+45 4452 0515
Fax:	-
eMail Address:	jja@ellab.com
Applicant 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 and D-PL-17186-01-06, FCC Test Firm Accreditation designation number DE0004, FCC Test Firm Registration Number 469623, CAB Identifier DE0003 and ISED# 3469A.

1.4 EUT (Equipment under Test)

EUT	
Test object: *	Wireless Data Logger for validation and monitoring
PMN / Model name: *	TrackSense LyoPro Data logger
FCC ID: *	XUS-LYODL1
IC: * ISED Certification number: *	8758A-LYODL1
Serial number: *	525649 (radiated) 525632 (conducted)
PCB identifier: *	n/a
Hardware version: * HVIN: *	66306000
Software version: * FVIN: *	n/a

* Declared by the applicant

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

1.5 Technical Data of Equipment

EUT data						
Power supply EUT: *	DC (by internal battery)					
Supply voltage EUT: *	U_{nom}=	3.6 V_{DC}	U_{min}=	2.6 V_{DC}	U_{max}=	3.8 V_{DC}
Temperature range: *	-60 °C to +121 °C (intended range for end customer)					
Ambient Temperature range: *	-65 °C to +140 °C					
Lowest / highest internal clock frequency: *	32.768 kHz / 2480 MHz (in IEEE802.15.4 mode)					

Ports / Connectors				
Identification			Length during test	Shielding (Yes / No)
	EUT	Ancillary		
None				

IEEE 802.15.4 radio mode		
Fulfils radio specification: *	IEEE 802.15.4	
Radio chip: *	Atmel AT86RF233	
Antenna type: *	Chip Antenna(Helical)	
Antenna name: *	AF216M2405001-T, TAIYO YUDEN	
Antenna gain: *	Peak: Average:	1.6 dBi (Typical) 0 dBi (@ omni plane)
Antenna connector: *	-	
Conducted output power: *	IEEE 802.15.4	1.7 dBm (Peak)
		0.5 dBm (Average)
Type of modulation: *	IEEE 802.15.4	O-QPSK (250 kbit/s)
Operating frequency range: *	IEEE 802.15.4	2405 – 2480 MHz
Number of channels: *	IEEE 802.15.4	16 (5 MHz channel spacing)

IEEE 802.15.4 frequencies				
Channel 11	RX	2405 MHz	TX	2405 MHz
Channel 12	RX	2410 MHz	TX	2410 MHz
Channel 13	RX	2415 MHz	TX	2415 MHz
Channel 14	RX	2420 MHz	TX	2420 MHz
Channel 15	RX	2425 MHz	TX	2425 MHz
Channel 16	RX	2430 MHz	TX	2430 MHz
Channel 17	RX	2435 MHz	TX	2435 MHz
Channel 18	RX	2440 MHz	TX	2440 MHz
Channel 19	RX	2445 MHz	TX	2445 MHz
Channel 20	RX	2450 MHz	TX	2450 MHz
Channel 21	RX	2455 MHz	TX	2455 MHz
Channel 22	RX	2460 MHz	TX	2460 MHz
Channel 23	RX	2465 MHz	TX	2465 MHz
Channel 24	RX	2470 MHz	TX	2470 MHz
Channel 25	RX	2475 MHz	TX	2475 MHz
Channel 26	RX	2480 MHz	TX	2480 MHz

1.5.1 Ancillary Equipment / Equipment used for testing

Equipment used for testing	
Programming Device *1	LYOPRO Reader station
Laptop for remote access: *1	Lenovo X1 carbon

*1 Provided by the applicant

1.6 Dates

Date of receipt of test sample:	06.08.2020
Start of test:	18.08.2020
End of test:	02.09.2020

2 Operational States

2.1 Description of function of the EUT

The EUT is intended to be used as wireless data logger for validation in various environments.

2.2 The following states were defined as the operating conditions

2.2.1 Radio test

During all test the EUT was supplied with 3.6V DC by the internal battery.
Test modes were applied via a Laptop with a special software as provided by the applicant (LYO Pro Link Test House Version, 0.0.0120.0). A normal mode link with a Reader station was established, then the test mode could by applied.

2.2.2 Operation modes

Operation mode #	Radio technology	Frequency [MHz]	Channel / Band	Modulation / Mode	Data rate	Power setting
1	IEEE 802.15.4	2405	11	O-QPSK	250 kbit/s	+4 dBm
2	IEEE 802.15.4	2440	18	O-QPSK	250 kbit/s	+4 dBm
3	IEEE 802.15.4	2480	26	O-QPSK	250 kbit/s	+4 dBm

The maximum output power of the Radio chip is +4 dBm (typical)

3 Additional Information

Object of this test report is the IEEE802.15.4 part of the EUT only.

The tested sample was not labeled as required by the FCC.

The radiated tests were done with an unmodified sample.
The conducted tests were done with a sample with a temporary SMA antenna connector.

4 Overview

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	RSS-247 [4] RSS-Gen [5]	Status	Refer page
Maximum peak conducted output power	2400.0 - 2483.5	15.247 (b) (3), (4)	5.4 (d) [4]	Passed	13
Maximum conducted output power	2400.0 - 2483.5	15.247 (b) (3), (4)	5.4 (d) [4]	Passed	13
DTS Bandwidth / 99% Bandwidth	2400.0 - 2483.5	15.247 (a) (2)	5.2 (a) [4]	Passed	16
Peak Power Spectral Density	2400.0 - 2483.5	15.247 (e)	5.2 (b) [4]	Passed	19
Average Power Spectral Density	2400.0 - 2483.5	15.247 (e)	5.2 (b) [4]	Passed	19
Band edge compliance	2400.0 - 2483.5	15.247 (d) 15.205 (a) 15.209 (a)	5.5 [4]	Passed	20
Maximum unwanted emissions	0.009 – 26,500*	15.247 (d) 15.205 (a) 15.209 (a)	8.9 [5]	Passed*	24
Antenna Requirement	-	15.203 15.247 (b)	5.4 (f) (ii) [4]	Passed*[1]	-

*[1] Fixed Antenna, gain below 6 dBi, no power reduction necessary.

5 Results

5.1 Duty cycle

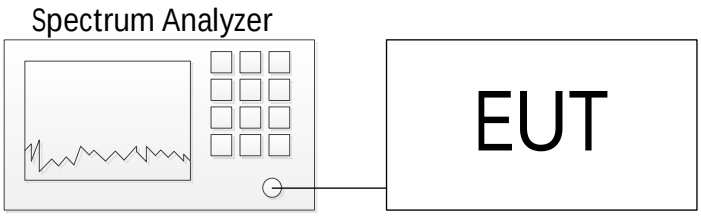
The duty cycle of the IEEE 802.15.4 part of the EUT was set to 100 %, therefore no duty cycle correction factor (DCCF) needs to be calculated.

5.1 Maximum conducted output power

5.1.1 Method of measurement (conducted)

The measurements were done conducted at the antenna connectors.

Test Setup:



Acceptable measurement configurations

See 8.3 of document [3] for details.

For the **Maximum *peak* conducted output power** the Procedure **11.9.1.1** in [1] was used.

For the **Maximum conducted *average* output power** the Procedure **11.9.2.2.4** in [1] was used.

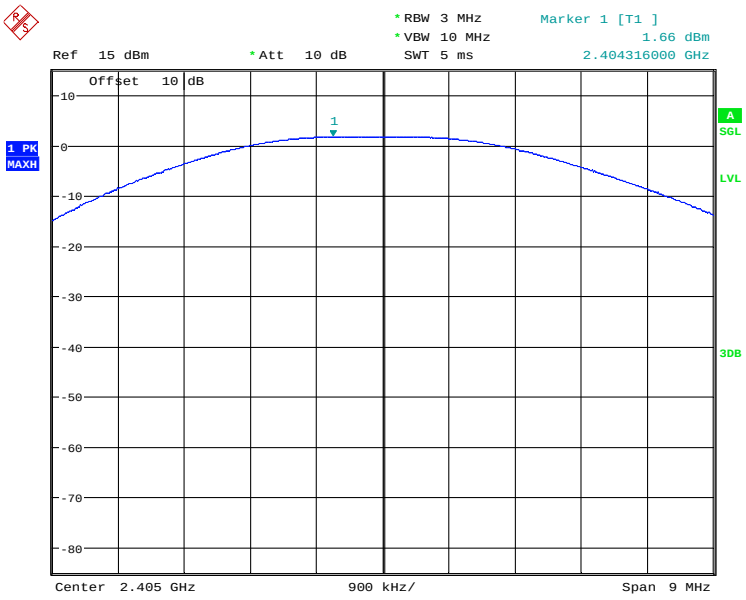
Only one representative plot for each measurement configuration is provided.

5.1.2 Test results

Ambient temperature	22 °C
Relative humidity	53 %

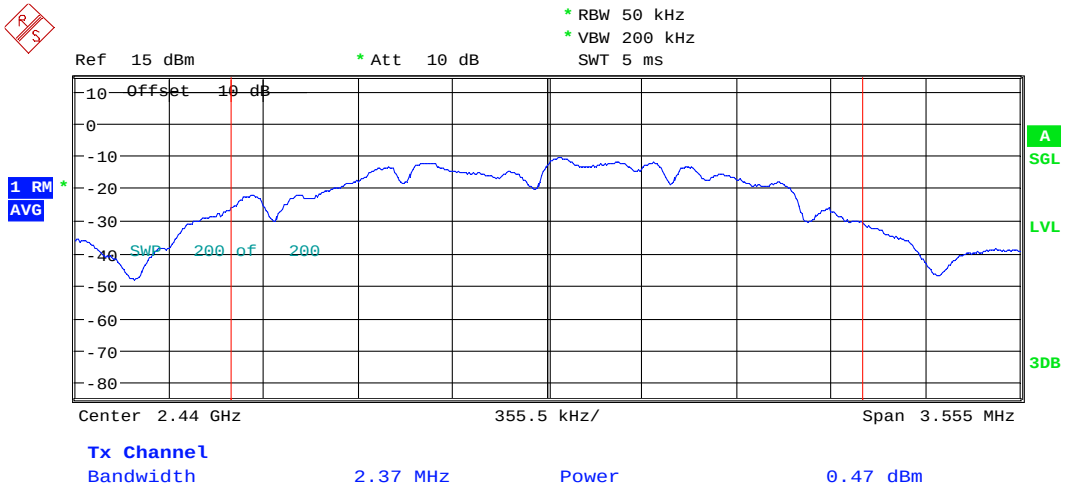
Date	02.09.2020
Tested by	B. ROHDE

Maximum *peak* conducted output power:



Operation mode	Reading [dBm]	Corr. Fact. [dB]	Result [dBm]	Limit [dBm]
1	1.7	0.0	1.7	30
2	1.0	0.0	1.0	30
3	0.7	0.0	0.7	30

Maximum *average* conducted output power:



Operation mode	Reading [dBm]	Corr. Fact. [dB]	Power [dBm]	DCCF [dB]	Power Incl. DCCF [dBm]	Result [dBm]	Limit [dBm]
1	0.2	0.0	0.2	0.0	0.2	0.2	30
2	0.5	0.0	0.5	0.0	0.5	0.5	30
3	0.0	0.0	0.0	0.0	0.0	0.0	30

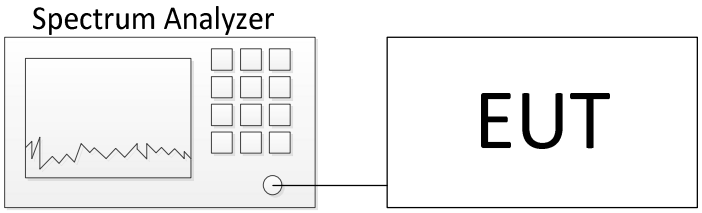
Test equipment (please refer to chapter 6 for details)
1

5.1 DTS Bandwidth / 99% Bandwidth

5.1.1 Method of measurement (conducted)

The measurements were done conducted at the antenna connector.

Test Setup:



Acceptable measurement configurations

See chapter 8.2 of document [3]

For the **DTS bandwidth** the Procedure **11.8.1** in [1] was used.

For the **Occupied bandwidth – 99% Bandwidth** the Procedure **6.9.3** in [1] was used.

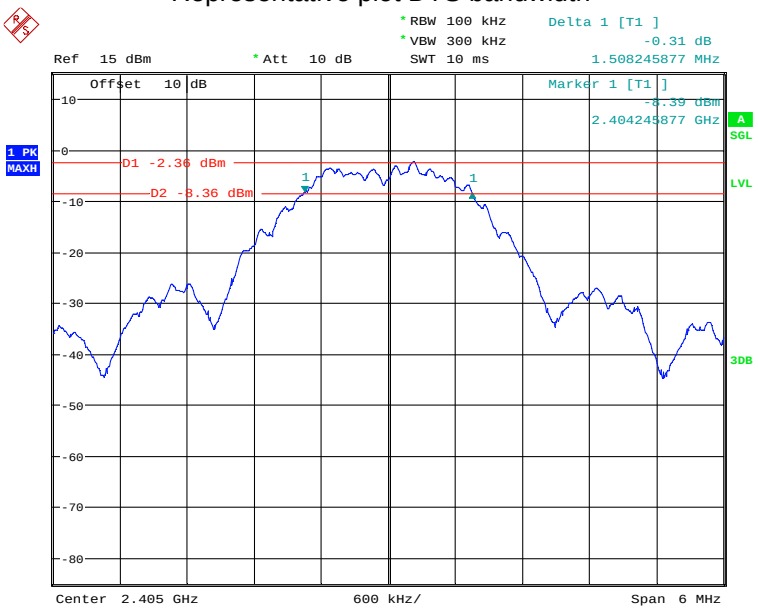
Only one representative plot for each measurement configuration is provided.

5.1.2 Test results

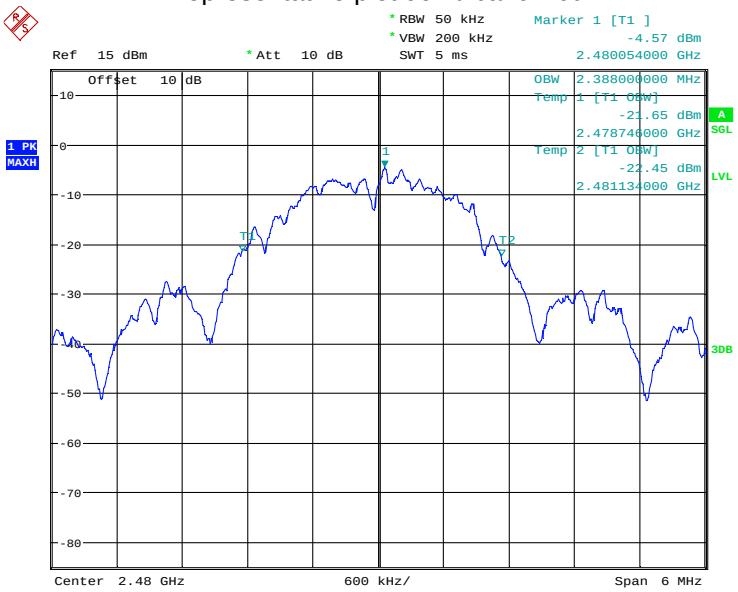
Ambient temperature	22 °C
Relative humidity	53 %

Date	02.09.2020
Tested by	B. ROHDE

Representative plot DTS bandwidth



Representative plot 99 % bandwidth



OP mode	Data rate	Center Frequency [MHz]	Minimum 6-dB Bandwidth Limit [MHz]	6 dB Bandwidth [MHz]	99 % Bandwidth [MHz]	Result
1	250 kbit/s	2405	0.5	1.508	2.346	Passed
2	250 kbit/s	2440	0.5	1.511	2.370	Passed
3	250 kbit/s	2480	0.5	1.529	2.388	Passed

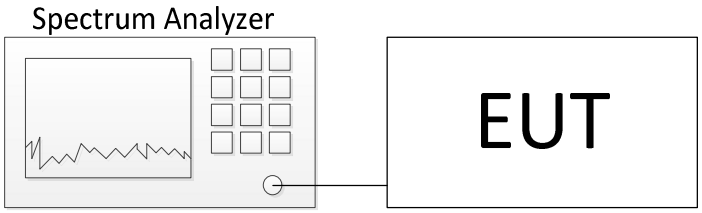
Test equipment (please refer to chapter 6 for details)
1

5.2 Power spectral density

5.2.1 Method of measurement (conducted)

The measurements were done conducted at the antenna connector.

Test Setup:



Acceptable measurement configurations

See chapter 8.4 of document [3]

For the **Maximum *peak* power spectral density level in the fundamental emission** the Procedure **11.10.2** in [1] was used.

For the **Maximum *average* power spectral density level in the fundamental emission** the Procedure **11.10.5** in [1] was used.

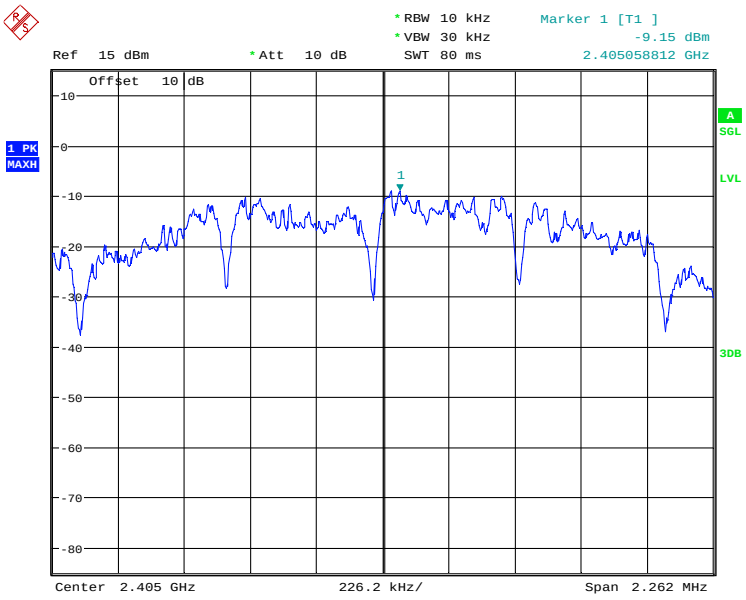
Only one representative plot for each measurement configuration is provided.

5.2.2 Test results

Ambient temperature	22 °C
Relative humidity	53 %

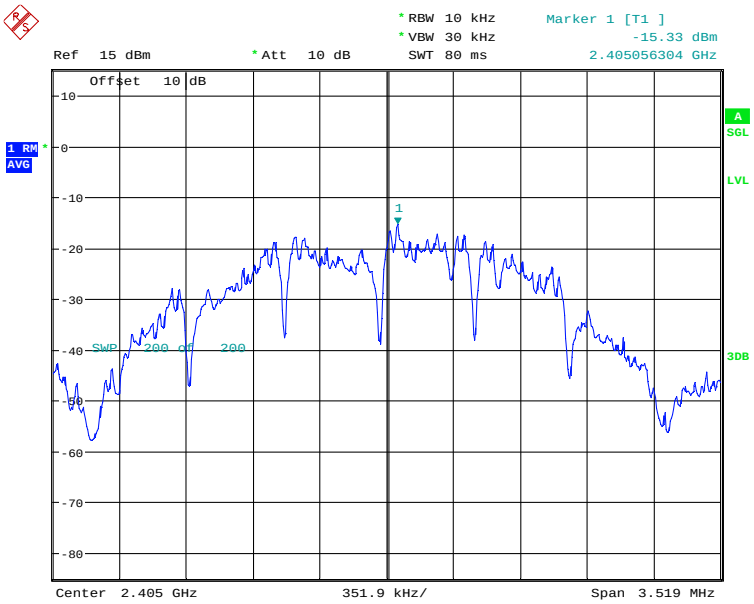
Date	02.09.2020
Tested by	B. ROHDE

Maximum *peak* power spectral density level in the fundamental emission:



OP mode	Peak Frequency [MHz]	PPSD [dBm / 10 kHz]	PSD Limit [dBm / 3 kHz]	Result
1	2405.059	-9.2	8	Passed
2	2440.057	-9.9	8	Passed
3	2480.057	-10.3	8	Passed

Maximum *average* power spectral density level in the fundamental emission:



OP mode	Peak Frequency [MHz]	PSD [dBm / 10 kHz]	Result incl. DCCF [dBm / 10 kHz]	PSD Limit [dBm / 3 kHz]	Result
1	2405.056	-15.3	-15.3	8	Passed
2	2440.057	-15.3	-15.3	8	Passed
3	2480.054	-15.9	-15.9	8	Passed

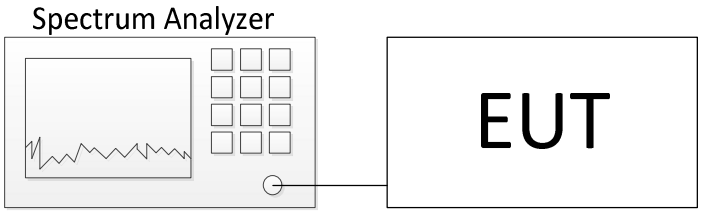
Test equipment (please refer to chapter 6 for details)
1

5.3 Band edge

5.3.1 Method of measurement (conducted)

The measurements were done conducted at the antenna connector.

Test Setup:



Acceptable measurement configurations

See chapter 8.7 of document [3].

For the **Band-edge testing (unrestricted bands)** the Procedure **6.10.4** in [1] was used, see remarks of #59, table A2 of document [1].

For the **Band-edge testing (restricted bands)** the tests were done radiated.

Only one representative plot is provided.

5.3.2 Method of measurement (radiated)

The EUT was measured radiated in an anechoic chamber. For test setup and measurement configuration see 5.4.1

For the **Band-edge testing (restricted bands)** the 15.209 limits apply.

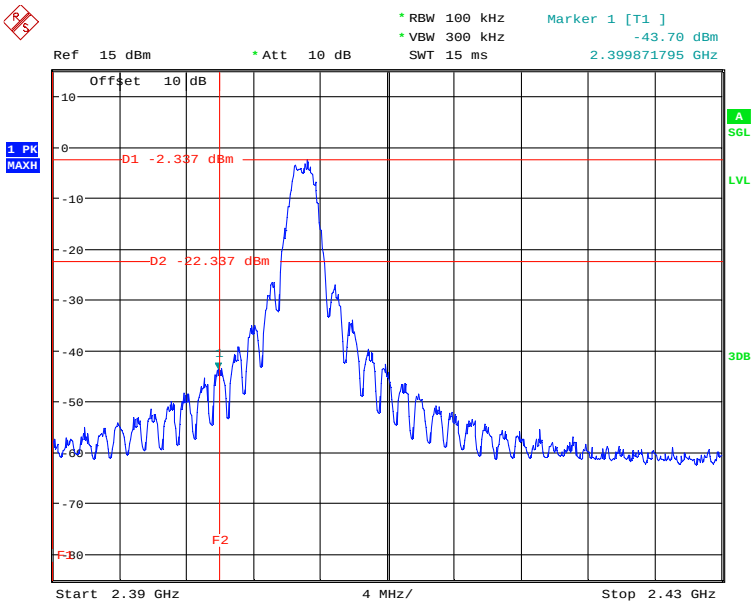
Only one representative plot is provided.

5.3.3 Test results

5.3.3.1 Band-edge testing (unrestricted bands; conducted):

Ambient temperature	22 °C
Relative humidity	53 %

Date	02.09.2020
Tested by	B. ROHDE



Operation mode	Data rate	Frequency [MHz]	Reference Level [dBm]	Limit [dBm]	Emission Level [dBm]	Margin [dB]	Result
1	250 kbit/s	2399.872	-2.3	-22.3	-43.7	21.4	Passed

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

5.3.3.2 Band-edge testing (restricted bands; radiated):

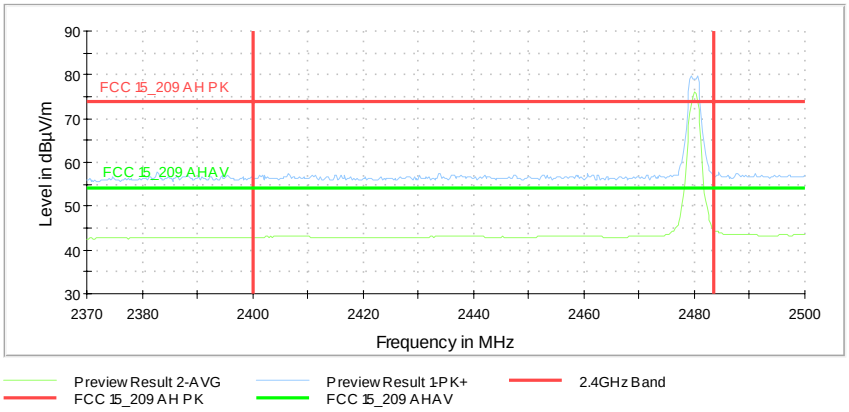
Ambient temperature	22 °C
Relative humidity	42 %

Date	02.06.2020
Tested by	B. ROHDE

Operation mode 1:

Not tested, no emissions in the restricted band

Operation mode 3:



Frequency [MHz]	Result (Pk) [dBµV/m]	Result (Av) [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Readings [dBµV]	Correction [dB]	Elevation [deg]	Azimuth [deg]	Pol.	Result
2483.500000	47.5	---	74	26.5	14.1	33.4	150	100	V	Passed
2483.500000	---	34.8	54	19.2	1.4	33.4	150	100	V	Passed
Measurement uncertainty					±5.5 dB					

Test equipment (please refer to chapter 6 for details)
2 - 11

5.4 Maximum unwanted emissions Maximum unwanted emissions

5.4.1 Method of measurement (radiated)

The radiated emission measurement is subdivided into six stages.

- A preliminary measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 9 kHz to 30 MHz.
- 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 preliminary and final measurement carried out in a semi anechoic chamber with a varying antenna height in the frequency range 30 MHz to 1 GHz.
- A preliminary and final measurement carried out in a semi anechoic chamber with ground absorbers with a varying antenna height in the frequency range above 1 GHz.

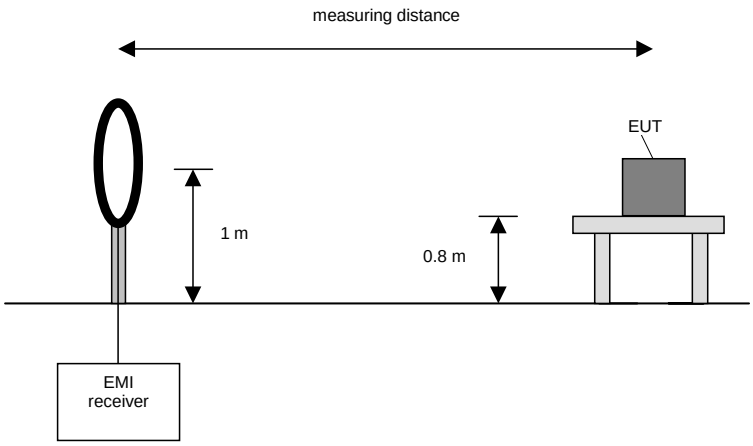
Preliminary measurement (9 kHz to 30 MHz):

In the first stage a preliminary measurement will be performed in a shielded room with a measuring distance of 3 meters. Tabletop devices will set up on a non-conducting turn device on the height of 0.8 m. 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 find 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	9 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 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.

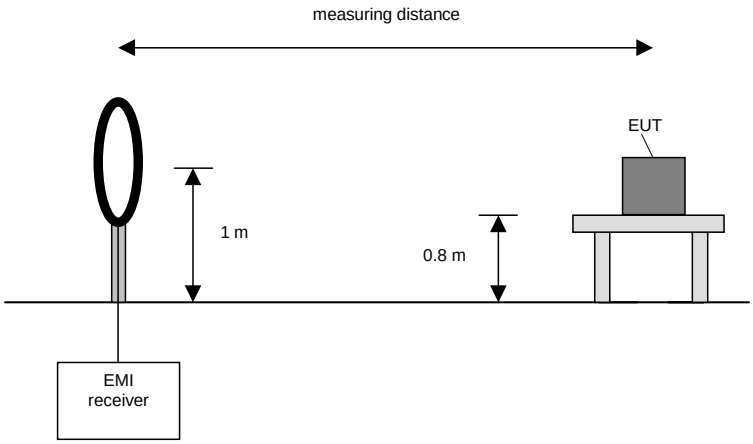
Final measurement (9 kHz to 30 MHz):

In the second stage a final measurement will be performed on an open area test site with no conducting ground plane in a measuring distances of 3 m, 10 m and 30 m. In the case where larger measuring distances are 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

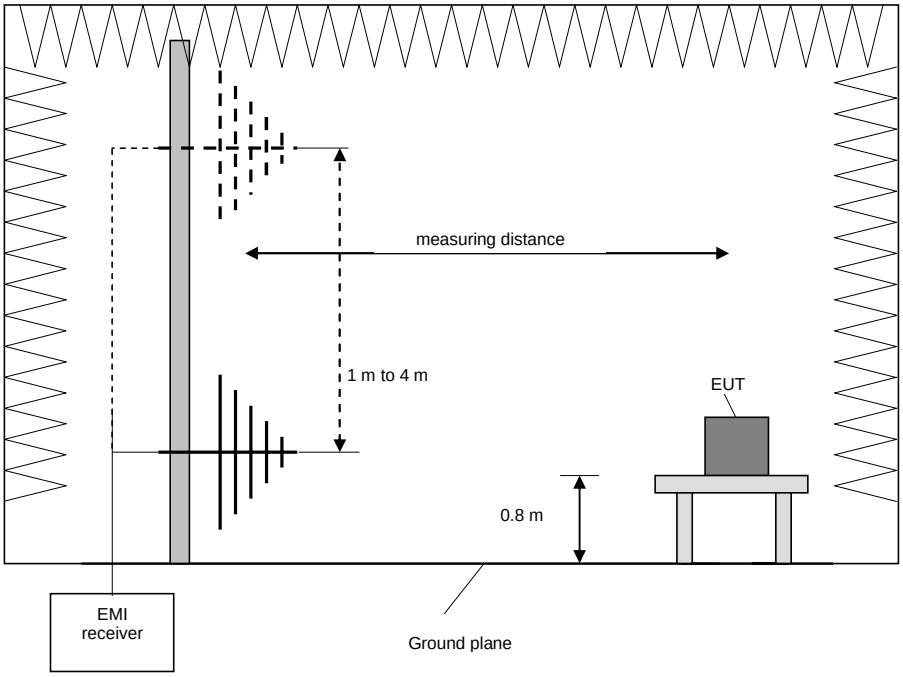


Preliminary and final measurement (30 MHz to 1 GHz)

The preliminary and final measurements were conducted in a semi-anechoic chamber with a metal ground plane. During the 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:

Test	Frequency range	Resolution bandwidth	Step size	Measurement time
Preliminary measurement	30 MHz to 1 GHz	120 kHz	40 kHz	100 ms
Frequency peak search	3 x RBW	120 kHz	10 kHz	1000 ms
Final measurement	30 MHz to 1 GHz	120 kHz	-	5 x 1000 ms



Procedure preliminary measurement:

The following procedure is used:

1. Set the measurement antenna to 1 m height.
2. Monitor the frequency range at vertical polarization and a EUT azimuth of 0 °.
3. Rotate the EUT by 360° to maximize the detected signals.
4. Repeat 1) to 2) with the vertical polarization of the measuring antenna.
5. Increase the height of the antenna for 0.5 m and repeat steps 2 – 4 until the final height of 4 m is reached.
6. The highest values for each frequency will be saved by the software, including the antenna height, measurement antenna polarization and turntable azimuth for the highest value.

Procedure final measurement:

The following procedure is used:

1. Select the highest frequency peaks to the limit for the final measurement.
2. The software will determine the exact peak frequencies by doing a partial scan with reduced step size with +/- 3 times the RBW of the pre-scan of the selected peaks.
3. If the EUT is portable or ceiling mounted, find the worst case EUT orientation (x,y,z) for the final test.
4. The worst measurement antenna height is found by the measurement software by varying the measurement antenna height by +/- 0.5 m from the worst-case value obtained in the preliminary measurement, and to monitor the emission level.
5. The worst azimuth turntable position is found by varying the turntable azimuth by +/- 30° from the worst-case value obtained in the preliminary measurement, and to monitor the emission level.
6. The final measurement is performed at the worst-case antenna height and the worst-case turntable azimuth.
7. Steps 2 – 6 will be repeated for each frequency peak selected in step 1.

Preliminary and final measurement (1 GHz to 40 GHz)

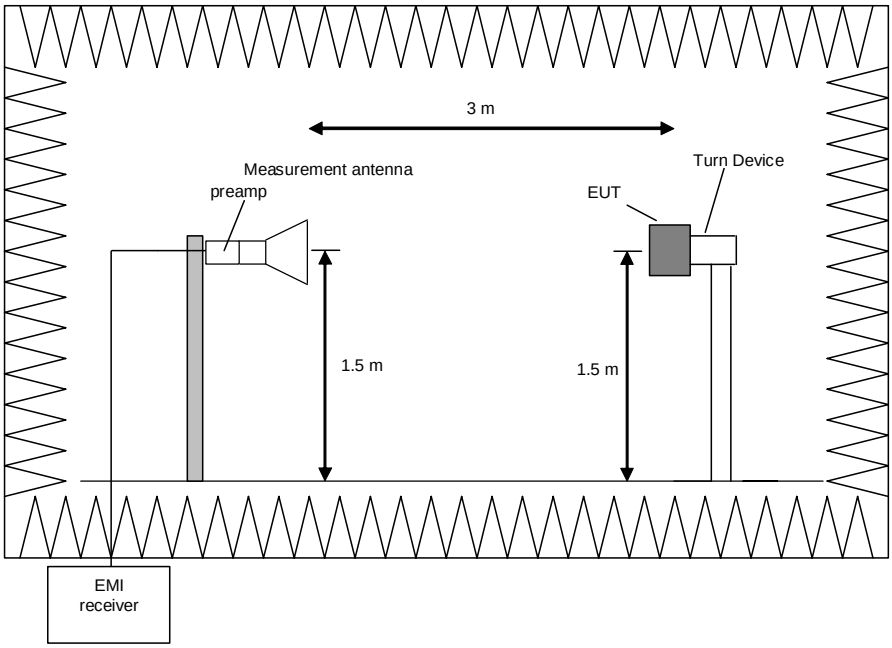
This measurement will be performed in a fully anechoic chamber. Table top devices will set up on a non-conducting turn device on the height of 1.5m. The set-up of the Equipment under test will be in accordance to [1].

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 analyser set to MAX Hold mode and a resolution bandwidth of 1 MHz. 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 25 / 26.5 GHz	1 MHz
26.5 GHz to 40 GHz	1 MHz



Procedure preliminary measurement:

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

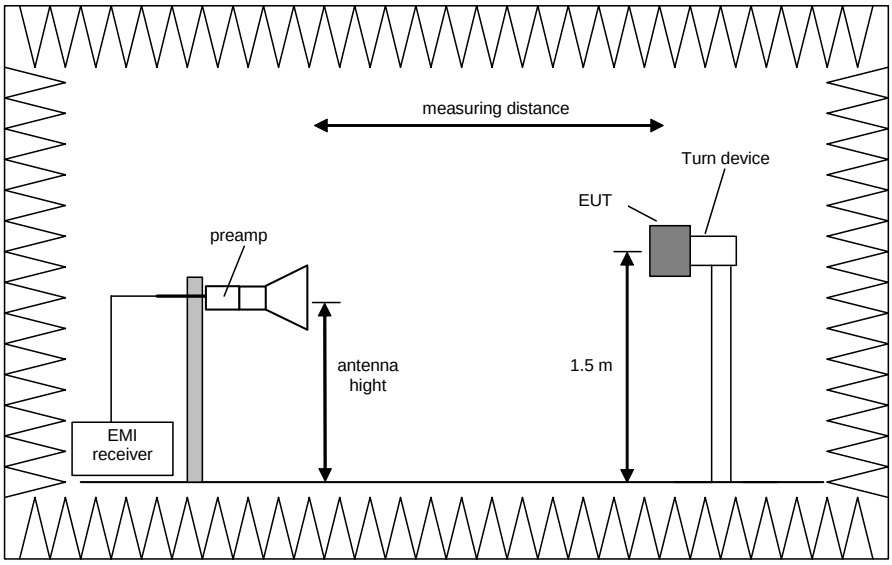
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Rotate the EUT by 360° to maximize the detected signals.
3. Repeat 1) to 2) with the vertical polarisation of the measuring antenna.
4. Make a hardcopy of the spectrum.
5. Repeat 1) to 4) with the EUT raised by an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

5.4.2 Test results (radiated)

5.4.2.1 Test results (9 kHz – 30 MHz)

Ambient temperature	23 °C
Relative humidity	70 %

Date	18.08.2020
Tested by	B. ROHDE

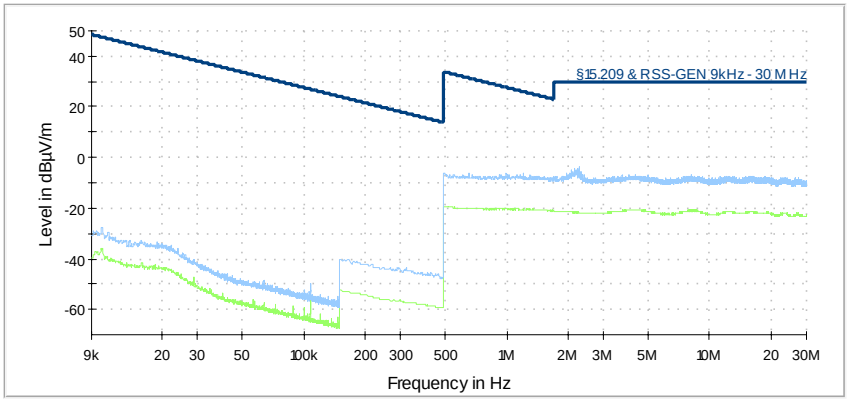
Position of EUT: For tests for f between 9 kHz and 30 MHz, the EUT was set-up on a table with a height of 80 cm. The distance between EUT and antenna was 3 m.

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

Test record: The measurement value was already corrected by 40 dB/decade as described in §15.31 (f) (2) regarding to the measurement distance as requested in §15.209

5.4.2.1.1 Plots

9k-30M: Spurious emissions from 9 kHz to 30 MHz



Remark: In the shown plot a distance correction factor was added to the measurement results to account for the different measuring distances according to standard (9 kHz to 490 kHz @ 300 m; 490 kHz to 30 MHz @ 30 m).

5.4.2.1.2 Result table

All emissions are more the 20 dB from the limit, so no final measurement was conducted.

Test equipment (please refer to chapter 6 for details)
12 - 19

5.4.2.2 Test results (30 MHz – 1 GHz)

Ambient temperature	23 °C
Relative humidity	70 %

Date	18.08.2020
Tested by	B. ROHDE

Position of EUT: The EUT was set-up on a table with a height of 80 cm. The distance between EUT and antenna was 3 m.

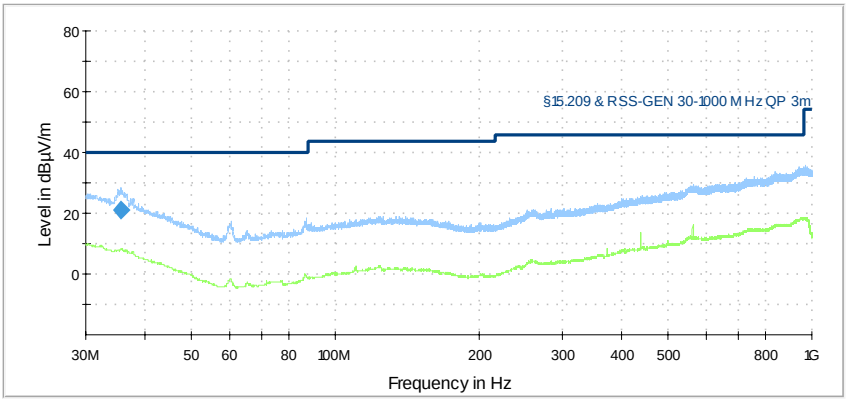
Cable guide: For detail information of test set-up and the cable guide refer to the pictures in the annex A in the test report.

Test record: Only the worst-case plot is submitted below.

Remark: -

5.4.2.2.1 Plots

Spurious emissions from 30 MHz to 1 GHz (operation mode 1):



5.4.2.2.2 Result tables

Result table (operation mode 1):

Frequency [MHz]	Result [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Readings [dBµV]	Correction [dB/m]	Height [cm]	Azimuth [deg]	Pol.	Result
35.640000	20.8	40	19.2	-4.0	24.8	102	197	V	Passed
Measurement uncertainty				±5.5 dB					

Result table (operation mode 2):

Frequency [MHz]	Result [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Readings [dBµV]	Correction [dB/m]	Height [cm]	Azimuth [deg]	Pol.	Result
35.700000	20.7	40	19.3	-4.1	24.8	109	246	V	Passed
Measurement uncertainty				±5.5 dB					

Result table (operation mode 3):

Frequency [MHz]	Result [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Readings [dBµV]	Correction [dB/m]	Height [cm]	Azimuth [deg]	Pol.	Result
35.88000	19.2	40	20.8	-5.4	24.8	102	212	V	Passed
Measurement uncertainty				±5.5 dB					

All other emissions were more than 20 dB from the limit.
Highest noise ~34 dBµV/m @ 970MHz

Test equipment (please refer to chapter 6 for details)
13 - 20

5.4.2.3 Test results (above 1 GHz)

Ambient temperature	23 °C
Relative humidity	61 %

Date	29.08.2020
Tested by	B. ROHDE

Position of EUT: For tests for f between 1 GHz and the 10th harmonic, the EUT was set-up on a table with a height of 150 cm. The distance between EUT and antenna was 3 m.

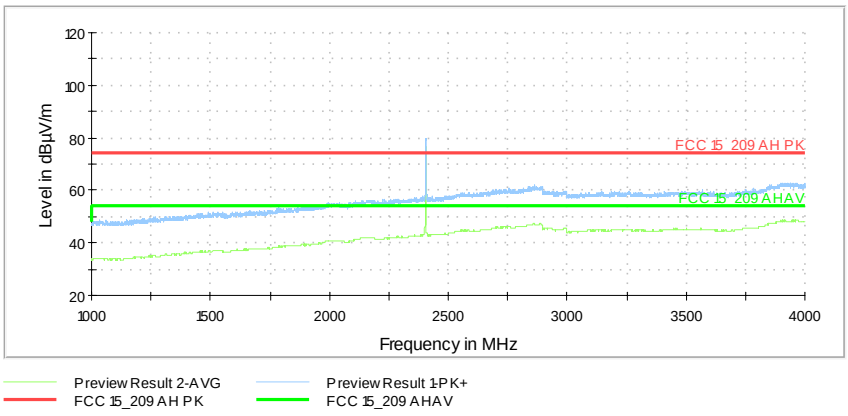
Cable guide: For detail information of test set-up and the cable guide refer to the pictures in the annex A in the test report.

Test record: Only the worst-case plot for each frequency range is submitted below.

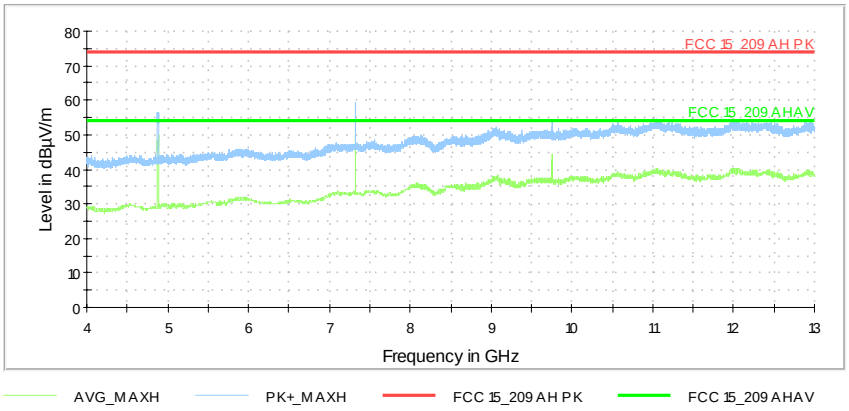
Remark: -

5.4.2.3.1 Plots

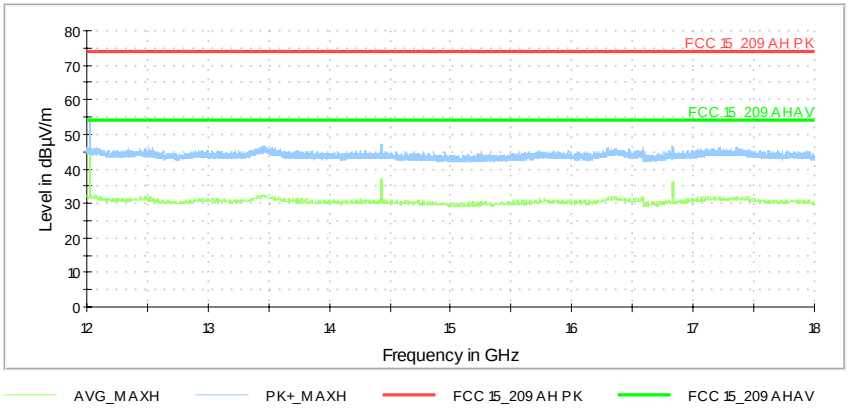
Spurious emissions from 1 GHz to 4 GHz (operation mode 1):



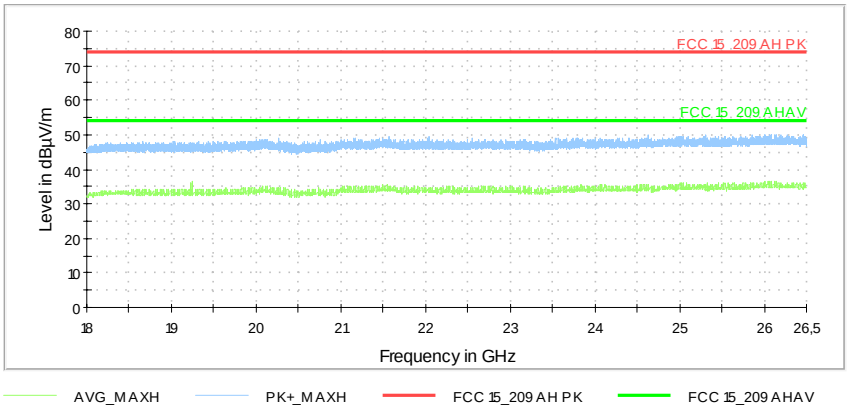
Spurious emissions from 4 GHz to 12 GHz (operation mode 2):



Spurious emissions from 12 GHz to 18 GHz (operation mode 1):



Spurious emissions from 18 GHz to 26.5 GHz (operation mode 1):



5.4.2.3.2 Result tables

Result table operation mode 1:

Frequency [MHz]	MaxPeak [dBµV/m]	Average [dBµV/m]	Limit [dBµV/m]	Margin (dB)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)	Result
2404.500000	---	74.0	-	-	H	150	120	33.3	Fund.
2404.500000	80.2	---	-	-	H	150	120	33.3	Fund.
2405.000000	---	77.0	-	-	H	150	120	33.3	Fund.
2405.000000	79.5	---	-	-	H	150	120	33.3	Fund.
2405.500000	---	74.5	-	-	H	181	120	33.3	Fund.
2405.500000	79.9	---	-	-	H	181	120	33.3	Fund.
4881.000000	---	50.5	54	3.5	V	70	90	-1.8	Passed
4881.000000	57.0	---	74	17.0	V	70	90	-1.8	Passed
7321.250000	---	52.7	54	1.3	H	278	150	4.6	Passed
7321.250000	59.6	---	74	14.4	H	278	150	4.6	Passed
9761.750000	---	43.1	54	10.9	V	72	60	6.9	Passed
9761.750000	52.9	---	74	21.1	V	72	60	6.9	Passed
12027.250000	---	45.6	54	8.4	V	107	90	12.1	Passed
12027.250000	53.4	---	74	20.6	V	107	90	12.1	Passed
14432.750000	---	37.2	54	16.8	H	40	120	11.5	Passed
14432.750000	47.1	---	74	26.9	H	40	120	11.5	Passed
16838.000000	---	36.6	54	17.4	H	253	0	10.6	Passed
16838.000000	46.4	---	74	27.6	H	253	0	10.6	Passed
Measurement uncertainty			+/- 4.79 dB						

Result table operation mode 2:

Frequency [MHz]	MaxPeak [dBµV/m]	Average [dBµV/m]	Limit [dBµV/m]	Margin (dB)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)	Result
2439.500000	---	73.6	-	-	H	180	120	33.5	Fund.
2439.500000	79.8	---	-	-	H	180	120	33.5	Fund.
2440.000000	---	76.4	-	-	H	180	120	33.5	Fund.
2440.000000	79.1	---	-	-	H	180	120	33.5	Fund.
2440.500000	---	74.3	-	-	H	179	120	33.5	Fund.
2440.500000	79.6	---	-	-	H	179	120	33.5	Fund.
4881.000000	---	50.0	54	4.0	V	68	90	-1.8	Passed
4881.000000	56.6	---	74	17.4	V	68	90	-1.8	Passed
7321.250000	---	52.8	54	1.2	H	283	150	4.6	Passed
7321.250000	59.6	---	74	14.4	H	283	150	4.6	Passed
9761.750000	---	43.7	54	10.3	V	76	60	6.9	Passed
9761.750000	52.9	---	74	21.1	V	76	60	6.9	Passed
Measurement uncertainty			+/- 4.79 dB						

Result table operation mode 3:

Frequency [MHz]	MaxPeak [dBµV/m]	Average [dBµV/m]	Limit [dBµV/m]	Margin (dB)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)	Result
2479.500000	---	73.5	-	-	V	212	30	33.4	Fund.
2479.500000	79.7	---	-	-	V	212	30	33.4	Fund.
2480.000000	---	76.3	-	-	V	211	30	33.4	Fund.
2480.000000	79.0	---	-	-	V	211	30	33.4	Fund.
2480.500000	---	74.4	-	-	V	211	30	33.4	Fund.
2480.500000	79.8	---	-	-	V	211	30	33.4	Fund.
4961.000000	---	50.1	54	3.9	H	256	0	-2.0	Passed
4961.000000	56.7	---	74	17.3	H	256	0	-2.0	Passed
7441.500000	---	44.6	54	9.4	H	276	150	5.0	Passed
7441.500000	53.3	---	74	20.7	H	276	150	5.0	Passed
9921.750000	---	40.2	54	13.8	V	76	60	7.3	Passed
9921.750000	51.1	---	74	22.9	V	76	60	7.3	Passed
12402.250000	---	35.8	54	18.2	V	248	0	12.1	Passed
12402.250000	45.9	---	74	28.1	V	248	0	12.1	Passed
Measurement uncertainty			+/- 4.79 dB						

Test equipment (please refer to chapter 6 for details)
2 - 11, 21 - 27

6 Test Equipment used for Tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal Due
1	Spectrum Analyser	FSU46	Rohde & Schwarz	200125	480956	13.02.2020	02.2021
2	Antenna (Log.Per.)	HL050	Rohde & Schwarz	100438	481170	09.10.2017	10.2020
3	RF-Cable No. 40	Sucoflex 106B	Suhner	0708/6B / Kabel 40	481330	Calibration not necessary	
4	EMI Receiver / Spectrum Analyser	ESW44	Rohde & Schwarz	101635	482467	18.02.2020	02.2022
5	Software	WMS32	Rohde & Schwarz		481800	Calibration not necessary	
6	Positioners	TDF 1.5- 10Kg	Maturo	15920215	482034	Calibration not necessary	
7	Turntable	DS420 HE	Deisel	420/620/00	480315	Calibration not necessary	
8	Fully anechoic chamber M20	B83117-E2439-T232	Albatross Projects	103	480303	Calibration not necessary	
9	Antenna mast	AS615P	Deisel	615/310	480187	Calibration not necessary	
10	Multiple Control Unit	MCU	Maturo GmbH	MCU/043/971107	480832	Calibration not necessary	
11	RF-cable No.38	Sucoflex 106B	Suhner	0709/6B / Kabel 38	481328	Calibration not necessary	
12	Loop antenna	HFH2-Z2	Rohde & Schwarz	100417	481912	05.02.2020	02.2021
13	RF Switch Matrix	OSP220	Rohde & Schwarz		482976	Calibration not necessary	
14	Turntable	TT3.0-3t	Maturo	825/2612/.01	483224	Calibration not necessary	
15	Antennasupport	BAM 4.5-P-10kg	Maturo	222/2612.01	483225	Calibration not necessary	
16	Controller	NCD	Maturo	474/2612.01	483226	Calibration not necessary	
17	Semi Anechoic Chamber M276	SAC5-2	Albatross Projects	C62128-A540-A138-10-0006	483227	Calibration not necessary	
18	Measuring software EMC32 M276	EMC32	Rohde & Schwarz	100970	482972	Calibration not necessary	
19	EMI Testreceiver	ESW44	Rohde & Schwarz	101828	482979	14.11.2019	11.2021
20	Antenna (Bilog)	CBL6111D	Schaffner Elektrotest GmbH	25761	480984	19.10.2017	10.2020
21	Standard gain horn antenna	18240-20	Flann Microwave	483	480294	Calibration not necessary	
22	Preamplifier 12 GHz - 18 GHz	JS3-12001800-16-5A	MITEQ Hauppauge N.Y.	571667	480343	13.02.2020	02.2022
23	standard gain horn antenna	20240-20	Flann Microwave	411	480297	Calibration not necessary	
24	Preamplifier 18 GHz - 26 GHz	JS4-18002600-20-5A	MITEQ Hauppauge N.Y.	658697	480342	13.02.2020	02.2022
25	High pass Filter	WHKX4.0/18G-8SS	Wainwright Instruments GmbH	1	480587	Calibration not necessary	
26	Microwave cable 2m	Insulated Wire Inc.	Insulated Wire	KPS-1533-800-KPS	480302	Calibration not necessary	
27	Preamplifier 100 MHz - 16 GHz	AFS6-00101600-23-10P-6-R	Narda MITEQ	2011215	482333	13.02.2020	02.2022

7 Test site Validation

Test equipment	PM. No.	Frequency range	Type of validation	According to	Val. Date	Val Due
Semi anechoic chamber M276	483227	30 – 1000 MHz	NSA	ANSI C63.4-2017	19.09.2019	18.09.2021
Fully anechoic chamber M20	480303	1 -18 GHz	SVSWR	CISPR 16-1-4 + Cor1:2010 + A1:2012 +A2:2017	24.08.2020	23.08.2022

8 Report History

Report Number	Date	Comment
F201055E3	12.10.2020	Initial Test Report
-	-	-
-	-	-

9 List of Annexes

Annex A	Test Setup Photos	9 pages
Annex B	External Photos	5 pages
Annex C	Internal Photos	7 pages