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Test Report

Report Number:

F191161E3

Equipment under Test (EUT):

omlox Satellite

Applicant:

TRUMPF Werkzeugmaschinen GmbH + Co. KG

Manufacturer:

TRUMPF Werkzeugmaschinen GmbH + Co. KG

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

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	0.5.0	07.09.2020
	Name	Signature	Date
Reviewed and approved by:	Bernd STEINER	11.02.2021 12:58	07.09.2020
	Name	Signature	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 generalizations or conclusions drawn from these test results concerning further samples. Any modification of the tested samples is prohibited and leads to the invalidity of this test report. Each page necessarily contains the PHOENIX TESTLAB Logo and the TEST REPORT NUMBER.

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1 Identification

1.1 Applicant

Name:	TRUMPF Werkzeugmaschinen GmbH + Co. KG
Address:	Johann-Maus-Str. 2, 71254 Ditzingen
Country:	Germany
Name for contact purposes:	Mr. Guido Schönhardt
Phone:	07156-303-36117
Fax:	-
eMail Address:	Guido.schoenhardt@trumpf.com
Applicant represented during the test by the following person:	-

1.2 Manufacturer

Name:	TRUMPF Werkzeugmaschinen GmbH + Co. KG
Address:	Johann-Maus-Str. 2, 71254 Ditzingen
Country:	Germany
Name for contact purposes:	Mr. Guido Schönhardt
Phone:	07156-303-36117
Fax:	-
eMail Address:	Guido.schoenhardt@trumpf.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: *	Satellite for indoor localization
PMN / Model name: *	omlox Satellite
FCC ID: *	2AVYV-2554432-01
Serial number: *	204744040
PCB identifier: *	1901154A00102B90
Hardware version: *	Rev D
Software version: *	3.0.6

* 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

General technical data of EUT						
Power supply EUT: *	DC (by POE or USB)					
Supply voltage EUT POE: *	U_{nom}=	48.0 V_{DC}	U_{min}=	42.5 V_{DC}	U_{max}=	57.0 V_{DC}
Supply voltage EUT (USB): *	U_{nom}=	5.0 V_{DC}	U_{min}=	4.45 V_{DC}	U_{max}=	5.25 V_{DC}
Temperature range: *	-10 °C to +39 °C					
Lowest / highest internal clock frequency: *	32 kHz / 2480 MHz (in BLE mode)					

Identification	Connector		Length
	EUT	Ancillary	
USB	USB type C	USB type A	2.0 m
Ethernet	RJ45	RJ45	3.0 m

Remark:
USB was used during AC-Powerline emissions testing only
Ethernet was used for in all other testcases.

1.5.1 BLE Radio mode

Bluetooth® Low Energy radio mode		
Fulfils radio specification: *	BLE 4.2 (1 Mbit/s only)	
Radio chip: *	Nordic nRF52840	
Antenna type: *	Internal PCB antenna	
Antenna name: *	ANT2	
Antenna gain: *	2 dBi	
Antenna connector: *	none	
Conducted output power: *	BLE 1 Mbit/s	-1.3 dBm (Peak)
		-1.8 dBm (Average)
Type of modulation: *	BLE 1 Mbit/s	GFSK (1 Mbit/s)
Operating frequency range: *	BLE 1 Mbit/s	2402 – 2480 MHz
Number of channels: *	BLE 1 Mbit/s	40 (2 MHz channel spacing)

* as declared by the customer

Bluetooth® Low Energy frequencies				
Channel 0	RX	2402 MHz	TX	2402 MHz
Channel 1	RX	2404 MHz	TX	2404 MHz
…	…	…	…	…
Channel 19	RX	2440 MHz	TX	2440 MHz
…	…	…	…	…
Channel 38	RX	2478 MHz	TX	2478 MHz
Channel 39	RX	2480 MHz	TX	2480 MHz

1.5.2 Ancillary Equipment / Equipment used for testing

Equipment used for testing	
Cables*1	RJ45 Ethernet cable, length 3m (including POE) USB-A to USB-C cable, length 3m (used during AC-Powerline emissions testing only)
Laptop*1	Dell Inspiron 15 S/N: GB6H4P2
POE switch/injector:*1	PowerSine 3001

*1 Provided by the applicant
*2 Provided by the laboratory

1.6 Dates

Date of receipt of test sample:	13.09.2019
Start of test:	15.05.2020
End of test:	29.07.2020

2 Operational States

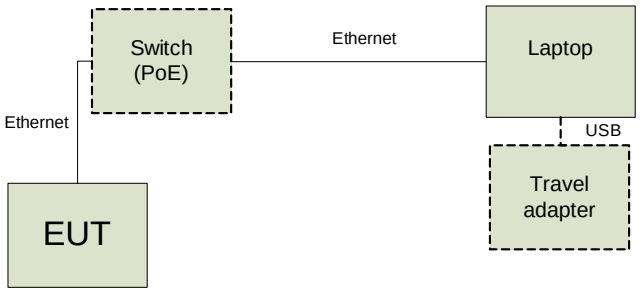
2.1 Description of function of the EUT

The EUT is intended to be used as transceiver for locating of machine tools inside a factory building. It will be fixed mounted inside the factory building. Therefore, it is defined as fixed indoor equipment.
All radiated tests were carried out with an unmodified test sample powered with 48 V_{DC} via PoE from a PoE switch. Because the EUT also could be supplied with 5.0 VDC via USB, the conducted emission measurement on the power supply line was additionally carried out with this kind of power supply.

2.2 The following states were defined as the operating conditions

2.2.1 Radio test

The system setup as follows:



2.2.2 Operation modes

Operation mode #	Radio technology	Frequency [MHz]	Channel / Band	Modulation / Mode	Data rate	TX / RX	Power setting
1	Bluetooth® LE	2402	0	GFSK	1 Mbit/s	TX	Not settable
2	Bluetooth® LE	2440	19	GFSK	1 Mbit/s	TX	Not settable
3	Bluetooth® LE	2480	39	GFSK	1 Mbit/s	TX	Not settable

The power was set by the applicant and could not be changed during the tests.

3 Additional Information

The EUT also contains a Wi-Fi, a ZigBee and a UWB transceiver. The results of these technologies are documented in the test reports F191161E2 and F191161E4 to F191161E5. The emissions of the digital part of the EUT are documented in the test report F191161E1. Object of this test report is the BLE part of the EUT only.

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

The tests were done with an unmodified sample.

4 Overview

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	Status	Refer page
Maximum peak conducted output power	2400.0 - 2483.5	15.247 (b) (3), (4)	Passed	14
Maximum conducted output power	2400.0 - 2483.5	15.247 (b) (3), (4)	Passed	14
DTS Bandwidth / 99% Bandwidth	2400.0 - 2483.5	15.247 (a) (2)	Passed	17
Peak Power Spectral Density	2400.0 - 2483.5	15.247 (e)	Passed	17
Average Power Spectral Density	2400.0 - 2483.5	15.247 (e)	Passed	17
Band edge compliance	2400.0 - 2483.5	15.247 (d) 15.205 (a) 15.209 (a)	Passed	23
Maximum unwanted emissions	0.009 – 26,500*	15.247 (d) 15.205 (a) 15.209 (a)	Passed	26
Conducted emissions on supply line	0.15 - 30	15.207 (a)	Passed	45
Antenna Requirement	-	15.203 15.247 (b)	Passed*[1]	-

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

5 Results

5.1 Duty cycle

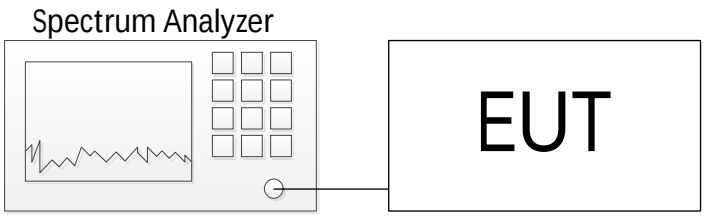
5.1.1 Method of measurement (conducted)

The EUT was measured conducted on a sample with an antenna connector, which was provided by the applicant.

Acceptable measurement configurations

According to [3] chapter 6 method b), which is equal to method described in chapter 11.6 b) of document [1] was used to perform the following test.

Test Setup:

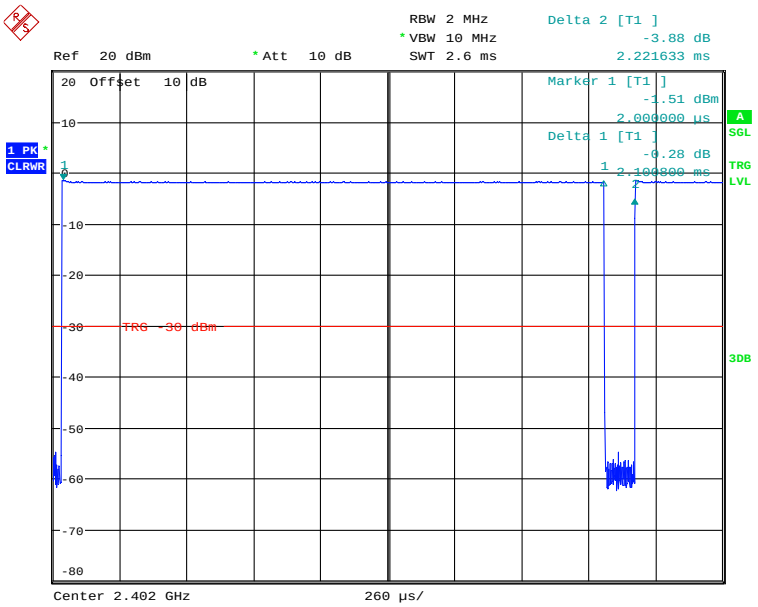


Only one representative plot is provided.

5.1.2 Test results

Ambient temperature	22 °C
Relative humidity	53 %

Date	24.07.2020
Tested by	B. ROHDE



Operation mode	TX_on [µs]	TX_ges [µs]	RBW [MHz]	50/T [kHz]	50/T < RBW?
BLE 1 Mbit/s	2101	2222	2	24	Yes

Operation mode	Sweep points	Sweep time [µs]	Meas points	Meas points >100?	Duty cycle %	DCCF [dB]
BLE 1 Mbit/s	10001	2600	8547	Yes	95	0.2

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 0.2 dB is used for all tests in test mode 1 -3.

Test equipment (please refer to chapter 6 for details)
28

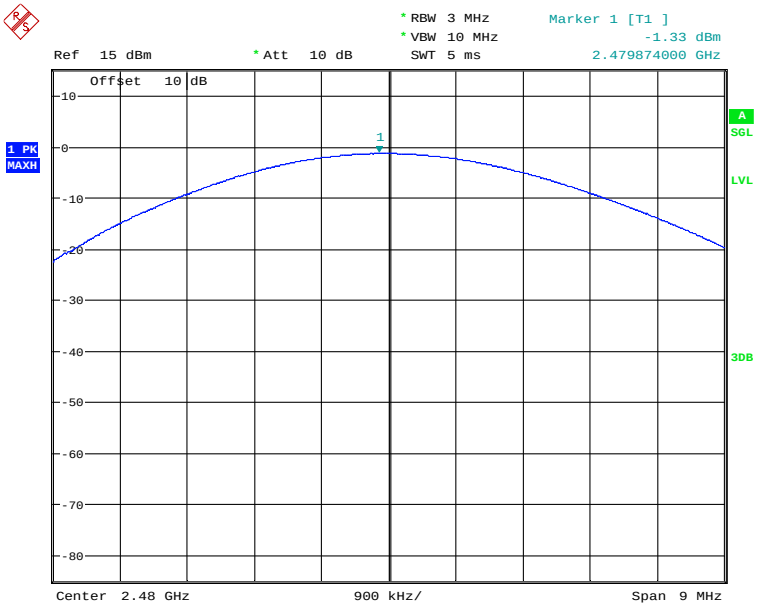
5.1 Maximum conducted output power

5.1.1 Test results

Ambient temperature	22 °C
Relative humidity	53 %

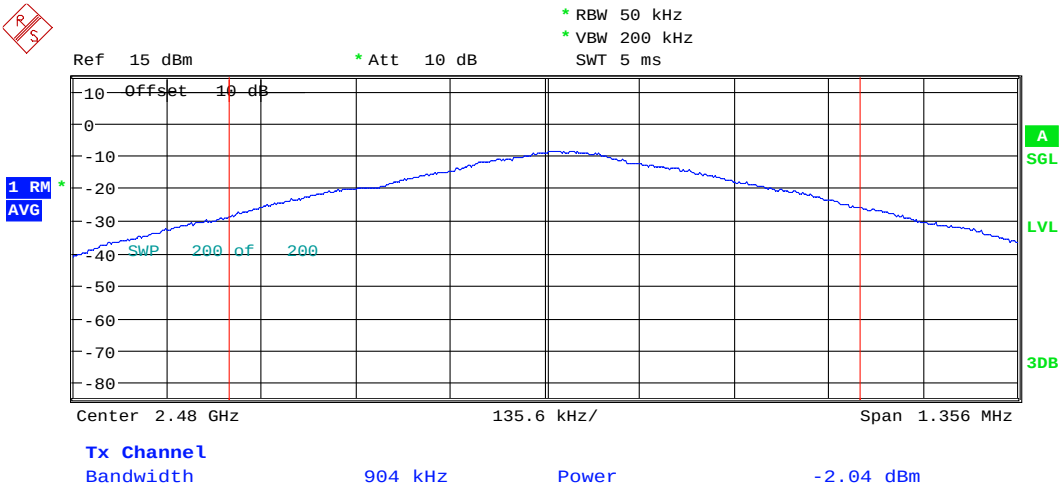
Date	24.07.2020
Tested by	B. ROHDE

Maximum *peak* conducted output power:



Operation mode	Result [dBm]	Limit [dBm]	Result
1	-1.4	30	Passed
2	-1.5	30	Passed
3	-1.3	30	Passed

Maximum *average* conducted output power:

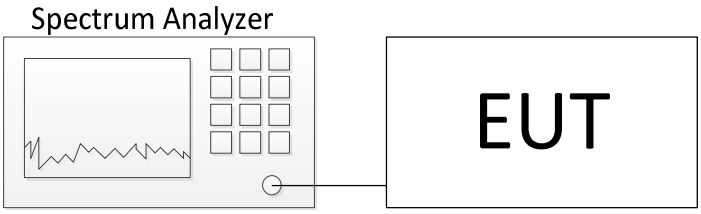


Operation mode	Reading [dBm]	DCCF [dB]	Result Incl. DCCF [dBm]	Limit [dBm]	Result
1	-2.2	0.2	-2.0	30	Passed
2	-2.3	0.2	-2.1	30	Passed
3	-2.0	0.2	-1.8	30	Passed

Test equipment (please refer to chapter 6 for details)
28

5.1.2 Method of measurement (conducted)

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.

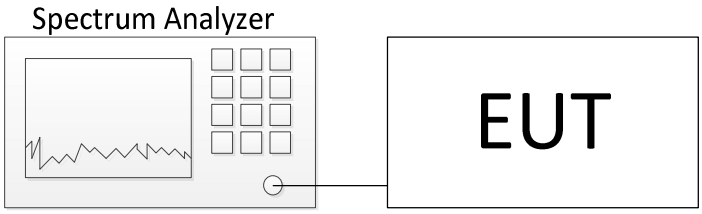
5.1 DTS Bandwidth / 99% Bandwidth

5.2 Power spectral density

5.2.1 Method of measurement (conducted)

The measurements were done conducted at the antenna connectors of both antennas.

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.

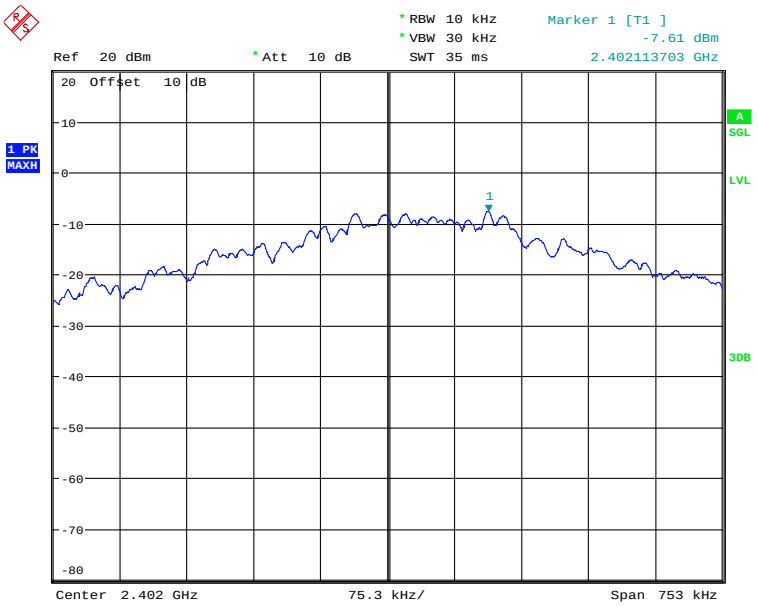
Only one representative plot for each measurement configuration is provided.

5.2.2 Test results

Ambient temperature	22 °C
Relative humidity	53 %

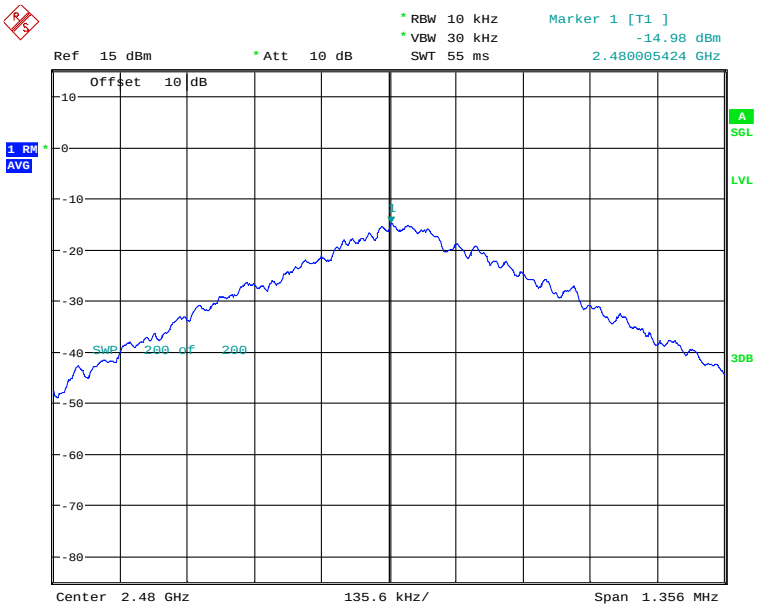
Date	24.07.2020
Tested by	B. ROHDE

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	2402.114	-7.6	8	Passed
2	2440.024	-7.7	8	Passed
3	2480.011	-7.6	8	Passed

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



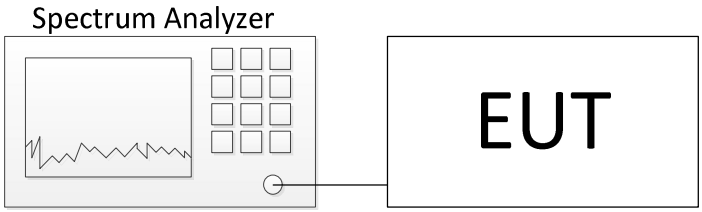
OP mode	Peak Frequency [MHz]	AvPSD [dBm / 10 kHz]	Result incl. DCCF [dBm / 10 kHz]	PSD Limit [dBm / 3 kHz]	Result
1	2402.037	-15.3	-15.1	8	Passed
2	2440.004	-14.7	-14.5	8	Passed
3	2480.005	-15.0	-14.8	8	Passed

Test equipment (please refer to chapter 6 for details)
28

5.2.3 Method of measurement (conducted)

The measurements were done conducted at the antenna connectors of both antennas.

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.

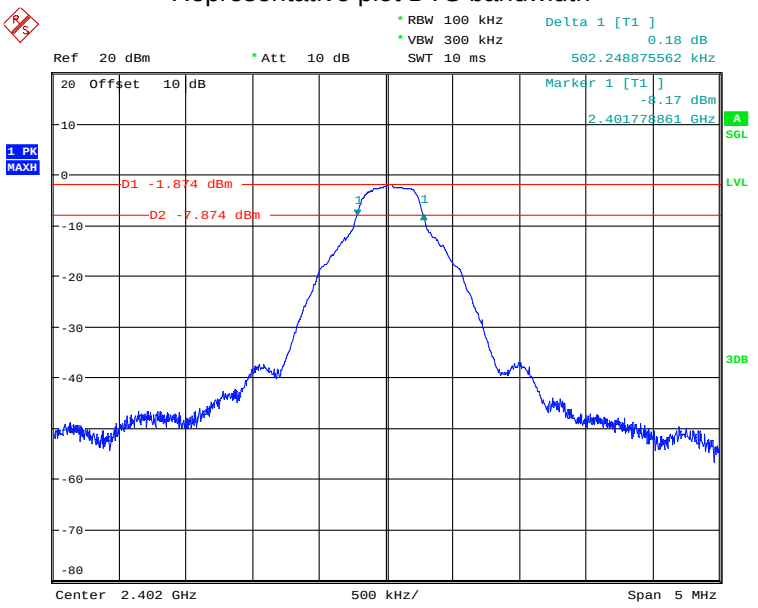
Only one representative plot for each measurement configuration is provided.

5.2.4 Test results

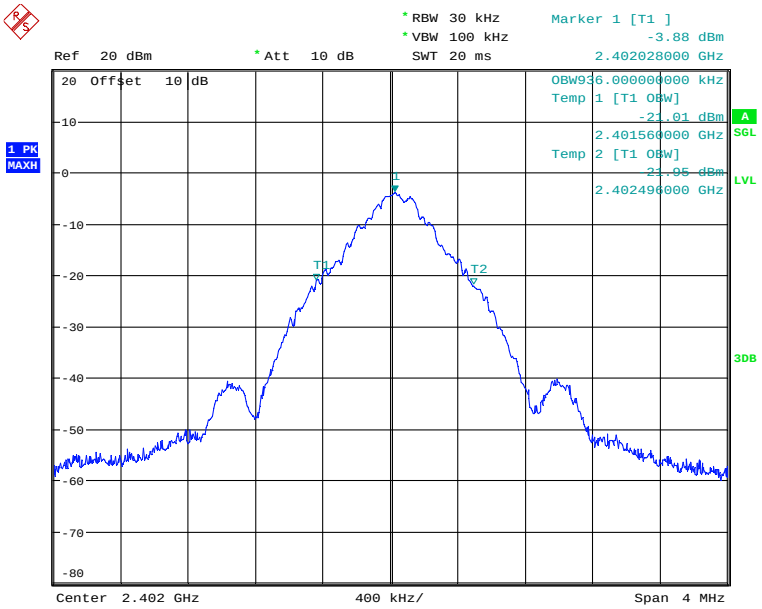
Ambient temperature	22 °C
Relative humidity	53 %

Date	24.07.2020
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	1 Mbit/s	2402	0.5	0.502	0.936	Passed
2	1 Mbit/s	2440	0.5	0.512	0.908	Passed
3	1 Mbit/s	2480	0.5	0.512	0.904	Passed

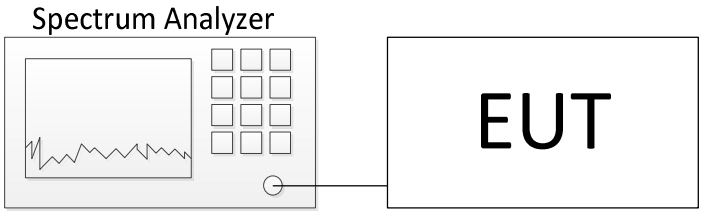
Test equipment (please refer to chapter 6 for details)
28

5.3 Band edge

5.3.1 Method of measurement (conducted)

The measurements were done conducted at the antenna connectors of both antennas.

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.

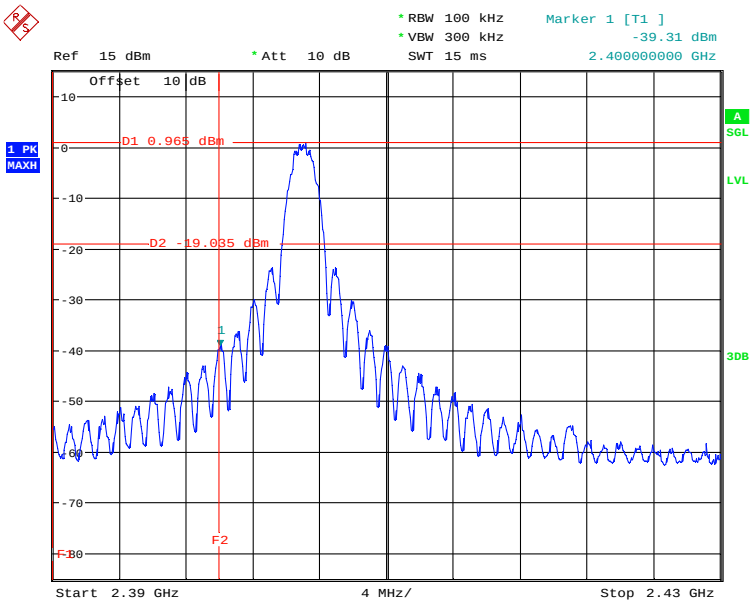
Only one representative plot is provided.

5.3.3 Test results

Ambient temperature	22 °C
Relative humidity	53 %

Date	24.07.2020
Tested by	B. ROHDE

Band-edge testing (unrestricted bands; conducted):



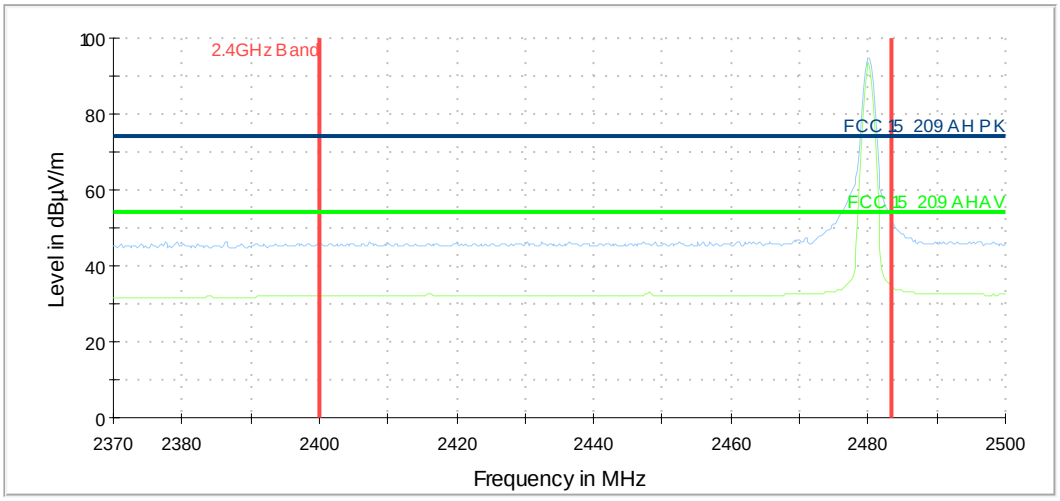
Operation mode	Data rate	Frequency [MHz]	Reference Level [dBm]	Limit [dBm]	Emission Level [dBm]	Margin [dB]	Result
1	250 kbps	2405	1.0	-19	-39.1	20.1	Passed

Test equipment (please refer to chapter 6 for details)
28

Ambient temperature	22 °C
Relative humidity	58 %

Date	02.06.2020
Tested by	B. ROHDE

Band-edge testing (restricted bands; radiated):



Frequency [MHz]	Result (Pk) [dBµV/m]	Result (Av) [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Readings [dBµV]	Correction [dB]	Height [cm]	Azimuth [deg]	Pol.	Result
2483.500000	51.5	---	74	22.5	16.9	34.6	186	123	V	Passed
2483.500000	---	34.5	54	19.5	-0.3	34.8	186	123	V	Passed
Measurement uncertainty					±5.5 dB					

The Average was corrected by the DCCF of 0.2

Test equipment (please refer to chapter 6 for details)
2, 9 - 15

5.4 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.

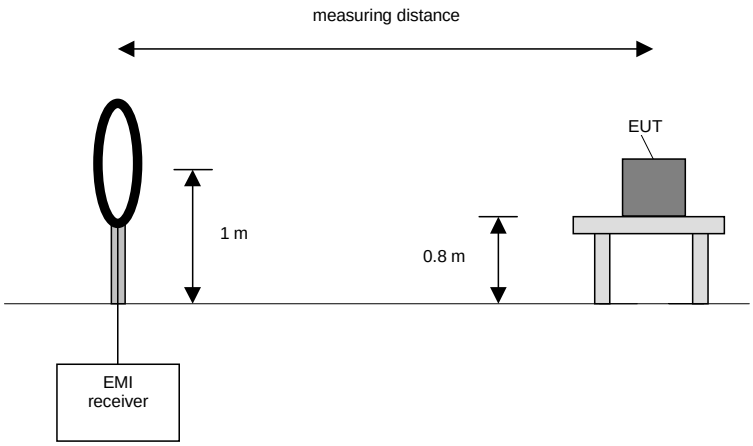
Preliminary measurement (9 kHz to 30 MHz):

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 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.

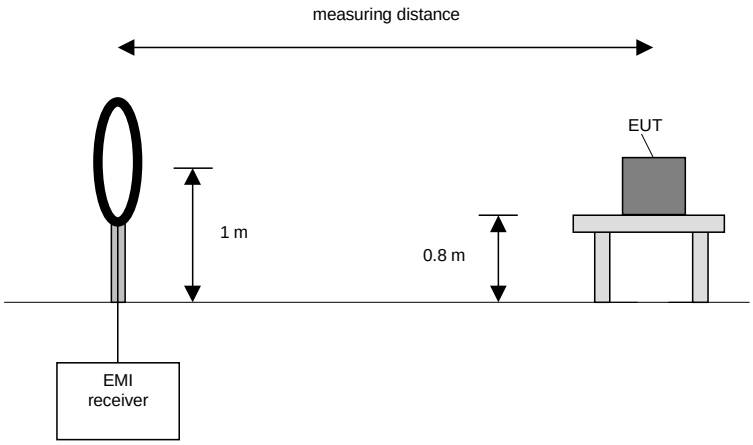
Final measurement (9 kHz to 30 MHz):

In the second stage a final measurement will be performed on an open area test site with no conducting ground plane in 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

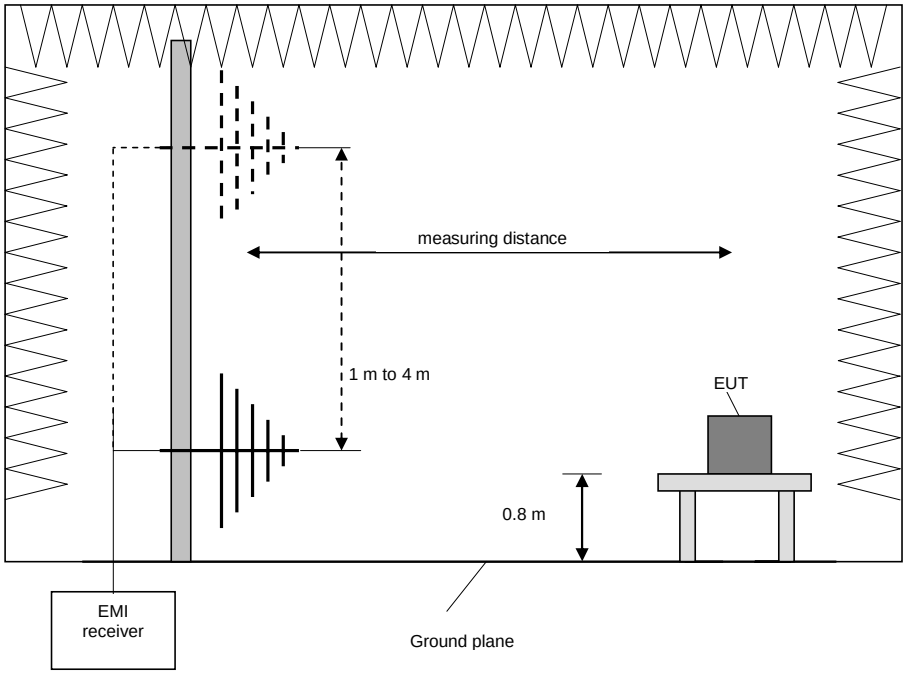


Preliminary and final measurement (30 MHz to 1 GHz)

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:

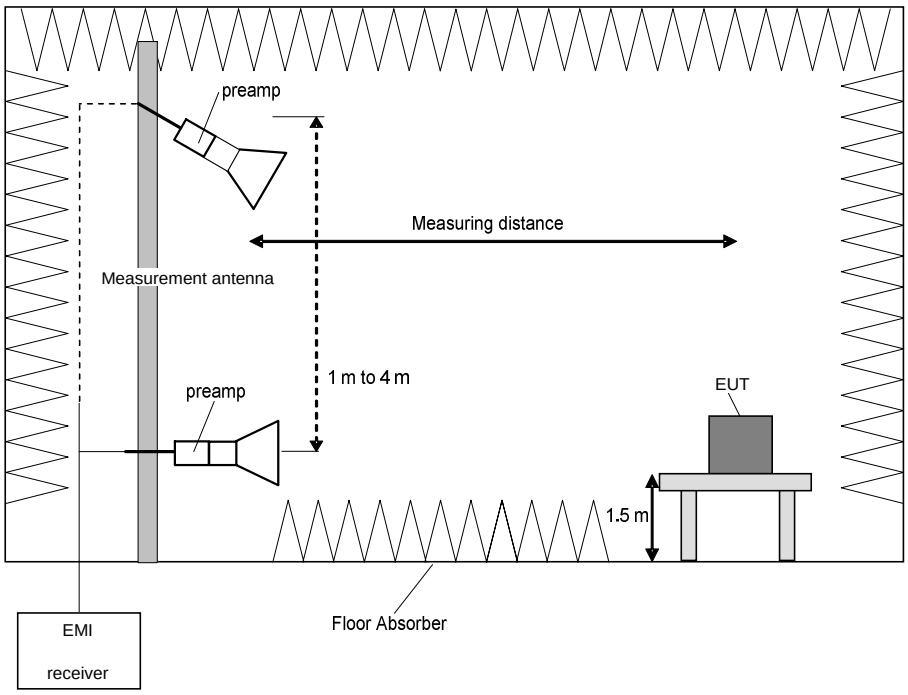
1. Select the highest frequency peaks to the limit for the final measurement.
2. The software will determine the exact peak frequencies by doing a partial scan with reduced step size with +/- 3 times the RBW of the pre-scan of the selected peaks.
3. If the EUT is portable or ceiling mounted, find the 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 (above 1 GHz)

The preliminary and final measurements were conducted in a semi-anechoic chamber with floor absorbers between EUT and measurement antenna.
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. For each height the angle of the antenna will be tilted so that the measurement antenna is always aiming at the EUT.

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	1 - 40 GHz	1 MHz	500 kHz	10 ms
Frequency peak search	+ / - 1 MHz	1 MHz	50 kHz	100 ms
Final measurement	1 - 40 GHz	1 MHz	-	10 x 100 ms



Procedure preliminary measurement:

The following procedure is used:

7. Set the measurement antenna to 1 m height.
8. Monitor the frequency range at vertical polarization and a EUT azimuth of 0 °.
9. Rotate the EUT by 360° to maximize the detected signals.
10. Repeat 1) to 2) with the vertical polarization of the measuring antenna.
11. Increase the height of the antenna for 0.5 m and repeat steps 2 – 4 until the final height of 4 m is reached.
12. 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:

8. Select the highest frequency peaks to the limit for the final measurement.
9. 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.
10. If the EUT is portable or ceiling mounted, find the worst case EUT orientation (x,y,z) for the final test.
11. 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.
12. 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.
13. The final measurement is performed at the worst-case antenna height and the worst-case turntable azimuth.
14. Steps 2 – 6 will be repeated for each frequency peak selected in step 1.

5.4.2 Test results (radiated)

5.4.2.1 Test results (9 kHz – 30 MHz)

Ambient temperature	23 °C
Relative humidity	62 %

Date	29.07.2020
Tested by	B. ROHDE

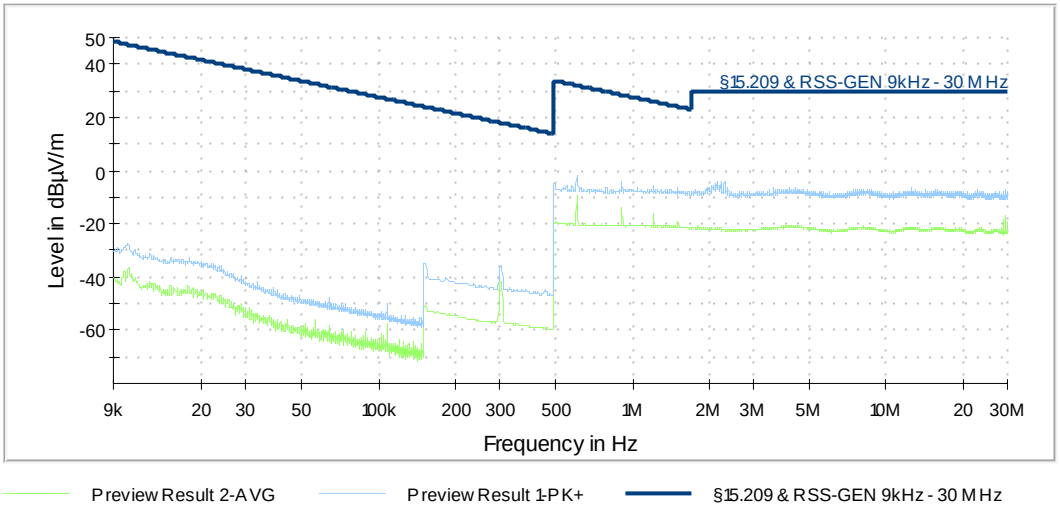
Position of EUT: For tests for f between 9 kHz and 30 MHz, the EUT was set-up on a table with a height of 80 cm. The distance between EUT and antenna was 3 m.

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

5.4.2.1.1.1 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).

5.4.2.1.1.2 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)
1 – 20, 27

5.4.2.2 Test results (30 MHz – 1 GHz)

Ambient temperature	21 °C
Relative humidity	70 %

Date	15.05.2020
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.

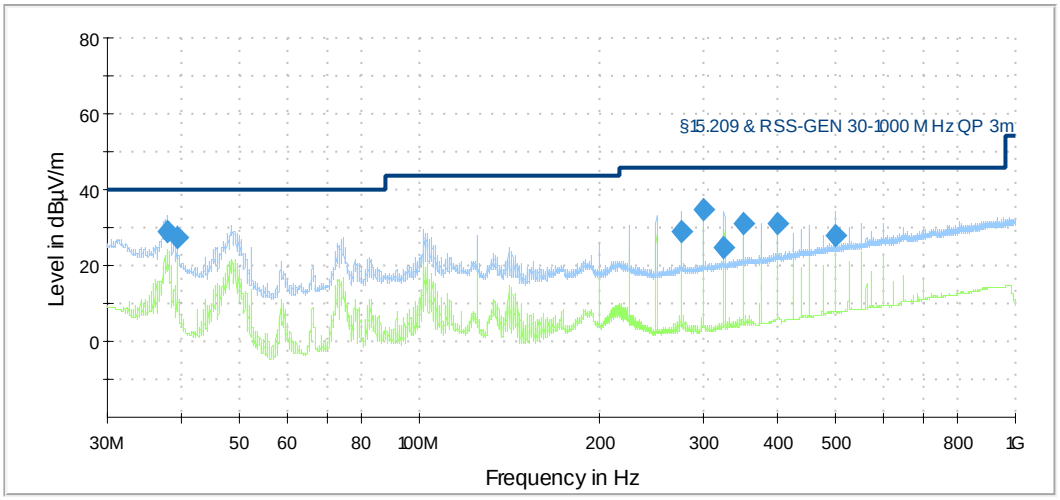
Cable guide: For detail information of test set-up and the cable guide refer to the pictures in the annex A in the test report.

Test record: Only one representative plot for each frequency range is submitted below.

Remark: -

5.4.2.2.1.1 Plots

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



5.4.2.2.1.2 Result table

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
37.740000	28.7	40	11.3	7.6	21.1	100	229	V	Passed
39.270000	27.3	40	12.7	7.1	20.3	100	317	V	Passed
275.010000	29.1	46.02	16.9	10.7	18.5	104	226	H	Passed
300.000000	34.6	46.02	11.4	15.3	19.3	105	224	H	Passed
325.020000	25.0	46.02	21.0	4.9	20.1	100	220	H	Passed
350.000000	31.2	46.02	14.8	10.3	20.9	102	108	H	Passed
399.990000	31.3	46.02	14.7	9.2	22.1	102	137	H	Passed
500.020000	28.0	46.02	18.0	3.5	24.6	122	84	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
275.030000	28.0	46.02	18.0	9.5	18.5	124	224	H	Passed
300.000000	34.8	46.02	11.2	15.5	19.3	102	221	H	Passed
324.990000	29.7	46.02	16.3	9.7	20.1	100	114	H	Passed
349.990000	30.7	46.02	15.3	9.8	20.9	104	110	H	Passed
400.000000	31.2	46.02	14.8	9.1	22.1	104	138	H	Passed
500.000000	29.0	46.02	17.0	4.5	24.6	107	93	V	Passed
841.480000	19.7	46.02	26.3	-9.7	29.4	252	195	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
37.770000	27.8	40	12.2	6.7	21.1	112	343	V	Passed
39.240000	25.7	40	14.3	5.4	20.3	100	325	V	Passed
275.000000	28.4	46.02	17.6	9.9	18.5	126	112	H	Passed
300.010000	34.8	46.02	11.2	15.4	19.3	102	215	H	Passed
325.030000	30.4	46.02	15.6	10.3	20.1	100	110	H	Passed
350.010000	30.8	46.02	15.2	9.9	20.9	102	114	H	Passed
400.010000	30.8	46.02	15.2	8.7	22.1	104	134	H	Passed
499.980000	28.2	46.02	17.8	3.7	24.6	106	85	V	Passed
Measurement uncertainty				±5.5 dB					

5.4.2.3 Test results (above 1 GHz)

Ambient temperature	22 °C
Relative humidity	58 %

Date	02.06.2020
Tested by	Y KHALEK

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.

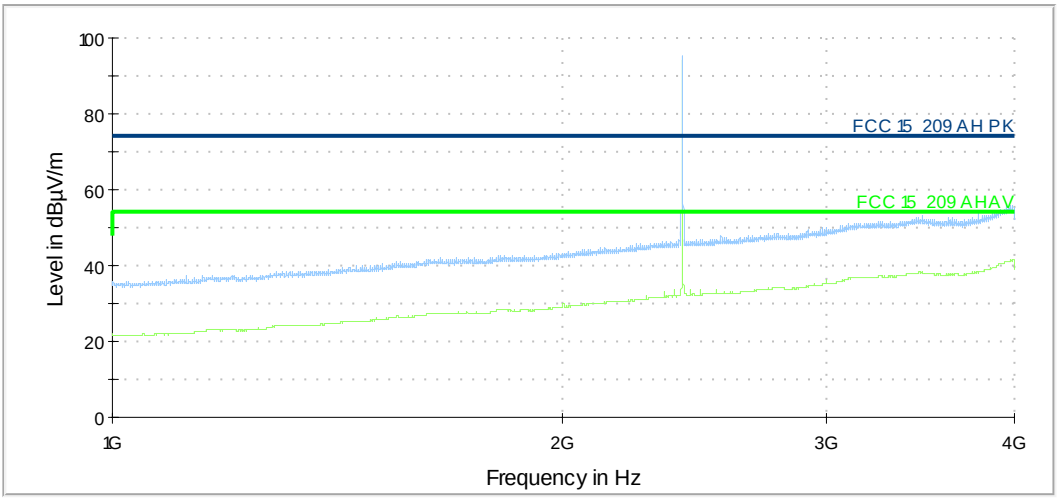
Test record: As shown below

Remark: If the measurement result was less than 20 dB from the limit, the highest noise emission was measured.

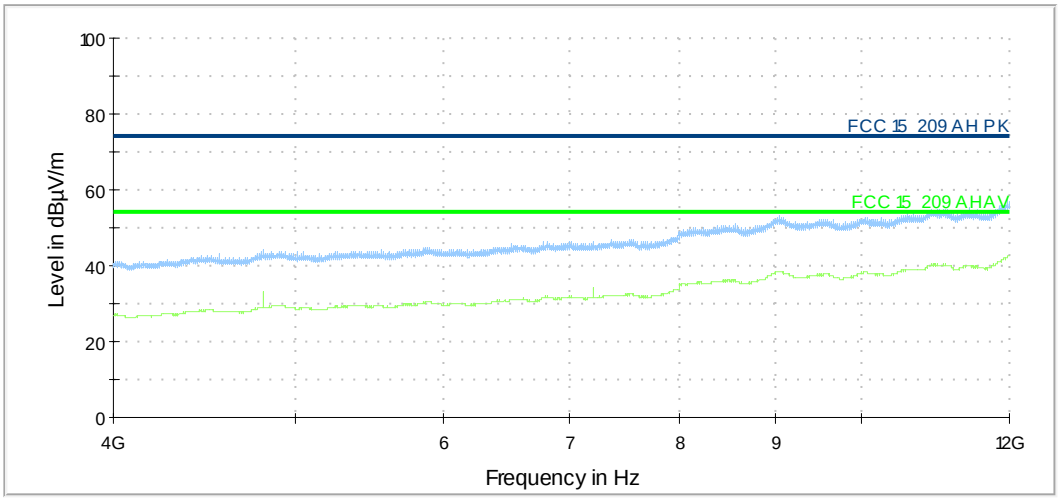
5.4.2.3.1 Operation mode 1

5.4.2.3.1.1 Plots

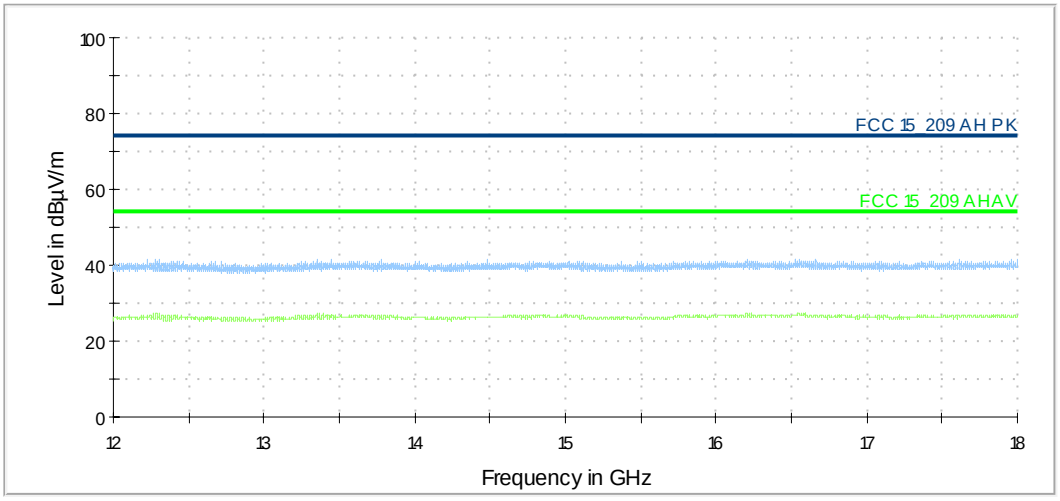
Spurious emissions from 1 GHz to 4 GHz (operation mode 1):



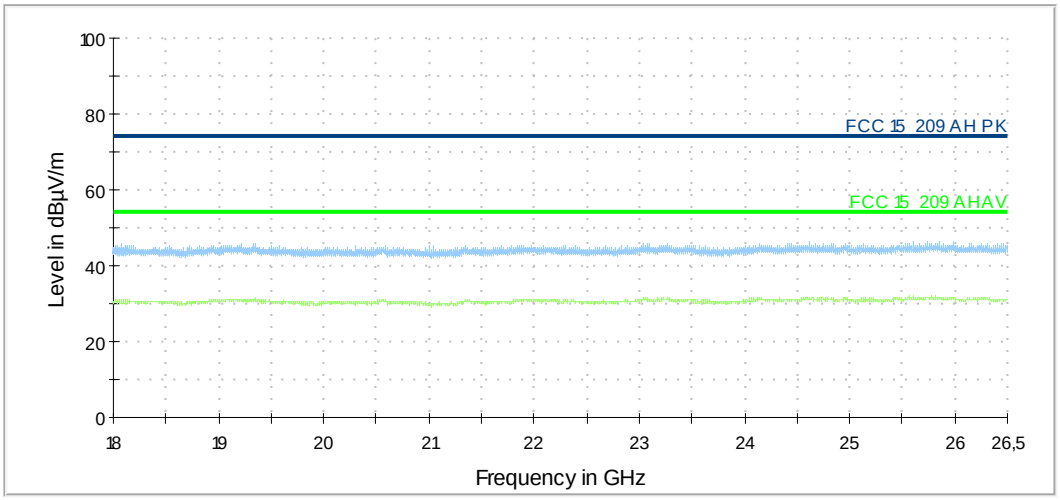
Spurious emissions from 4 GHz to 12 GHz (operation mode 1):



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



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



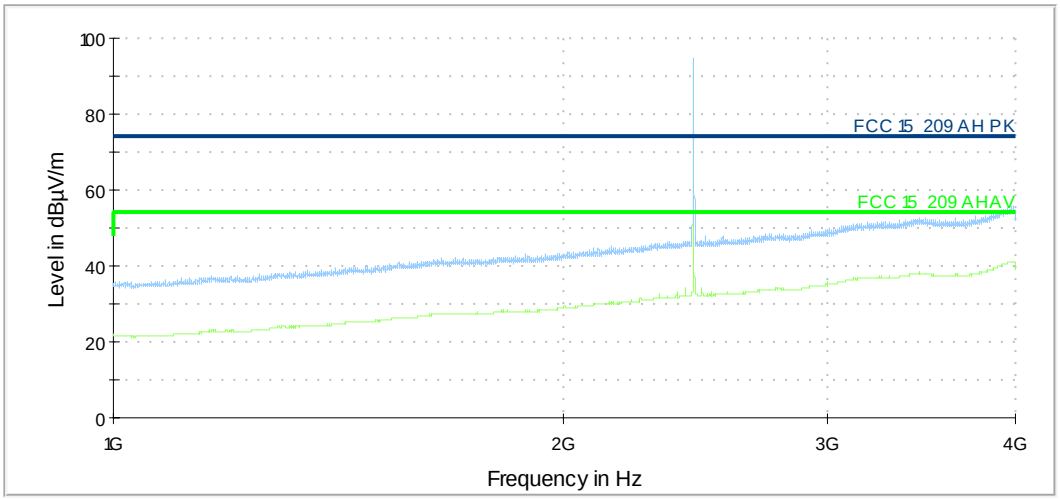
5.4.2.3.1.2 Result table

Frequency [MHz]	Result (Pk) [dBµV/m]	Result (Av) [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Readings [dBµV]	Correction [dB]	Height [cm]	Azimuth [deg]	Pol.	Result
2382.600000	45.0	---	74	29.0	10.7	34.5	202	151	H	Passed
2382.600000	---	33.3	54	20.7	-1.3	34.3	202	151	H	Passed
2402.200000	95.9	---	-	--	61.5	34.6	282	71	V	Fund.
2402.200000	---	95.0	-	--	60.4	34.4	282	71	V	Fund.
2483.700000	46.0	---	74	28.0	11.4	34.8	186	123	V	Passed
2483.700000	---	33.9	54	20.1	-0.9	34.6	186	123	V	Passed
3786.000000	---	39.8	54	14.2	0.9	38.7	139	140	H	Passed
3786.000000	51.5	---	74	22.5	12.8	38.9	139	140	H	Passed
3990.550000	55.7	---	74	18.3	15.4	40.5	171	196	H	Passed
3990.550000	---	42.8	54	11.2	2.3	40.3	171	196	H	Passed
11001.000000	49.9	---	74	24.1	29.2	20.9	204	97	V	Passed
11001.000000	---	37.9	54	16.1	17	20.7	204	97	V	Passed
11967.000000	50.8	---	74	23.2	29.1	21.9	128	287	H	Passed
11967.000000	---	39.2	54	14.8	17.3	21.7	128	287	H	Passed
Measurement uncertainty					±5.5 dB					

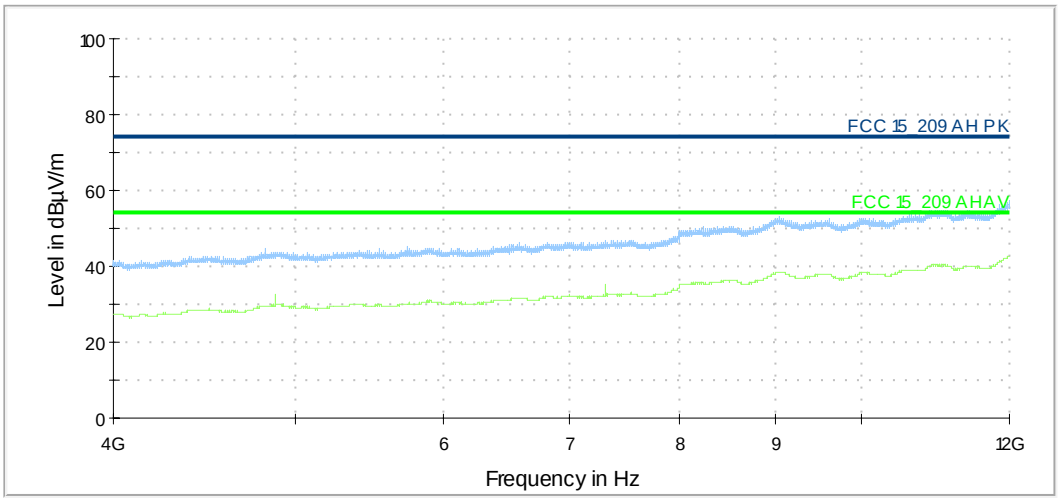
5.4.2.3.2 Operation mode 2

5.4.2.3.2.1 Plots

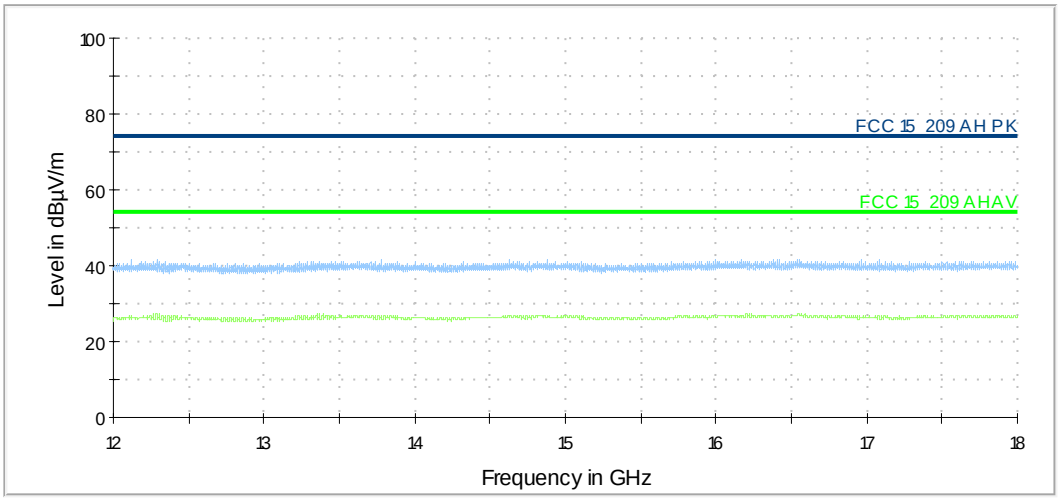
Spurious emissions from 1 GHz to 4 GHz (operation mode 2):



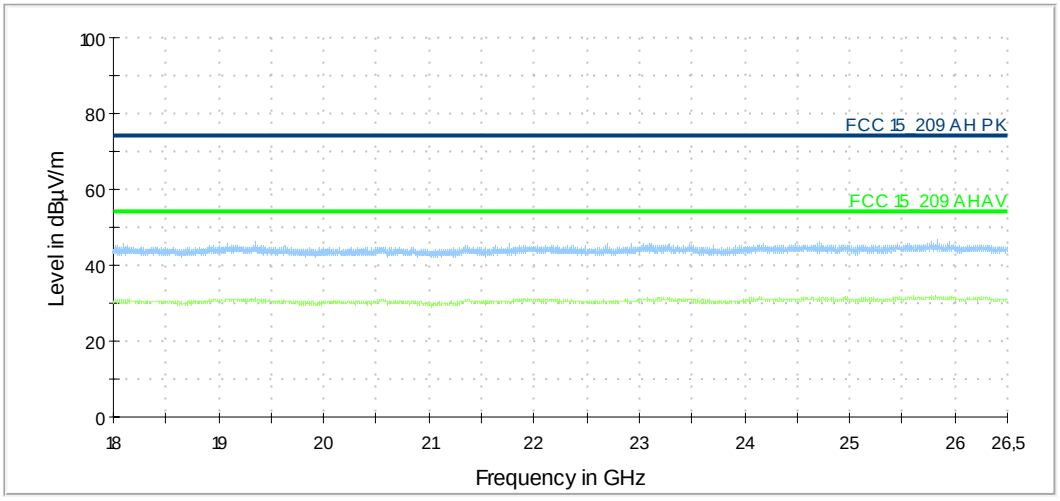
Spurious emissions from 4 GHz to 12 GHz (operation mode 2):



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



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



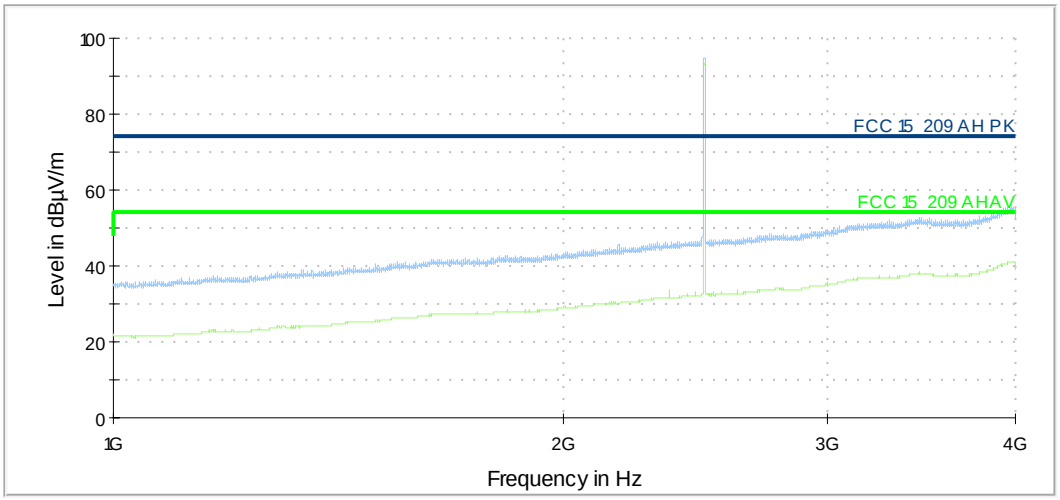
5.4.2.3.2.2 Result table

Frequency [MHz]	Result (Pk) [dBµV/m]	Result (Av) [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Readings [dBµV]	Correction [dB]	Height [cm]	Azimuth [deg]	Pol.	Result
2440.200000	94.7	---	-	-	60.1	34.8	350	67	V	Fund.
2440.200000	---	93.8	-	-	59	34.6	350	67	V	Fund.
3974.750000	55.0	---	74	19.0	14.7	40.5	383	236	H	Passed
3974.750000	---	42.7	54	11.3	2.2	40.3	383	236	H	Passed
11090.300000	---	38.0	54	16.0	17.2	20.6	273	298	H	Passed
11090.300000	49.6	---	74	24.4	29	20.8	273	298	H	Passed
11400.250000	---	37.6	54	16.4	16.7	20.6	103	5	V	Passed
11400.250000	49.4	---	74	24.6	28.7	20.8	103	5	V	Passed
11996.650000	51.5	---	74	22.5	29.5	22.1	250	257	H	Passed
11996.650000	---	39.5	54	14.5	17.4	21.9	250	257	H	Passed
Measurement uncertainty					±5.5 dB					

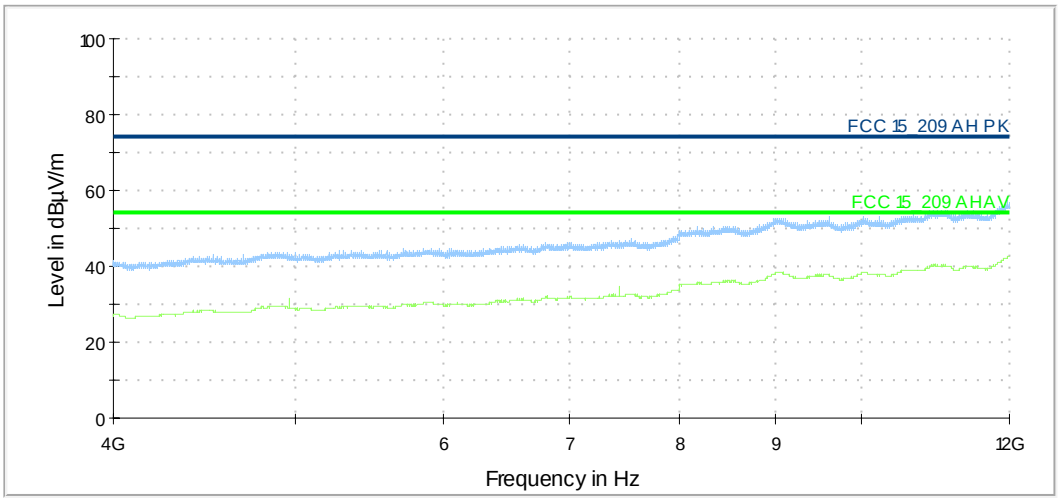
5.4.2.3.3 Operation mode 3

5.4.2.3.3.1 Plots

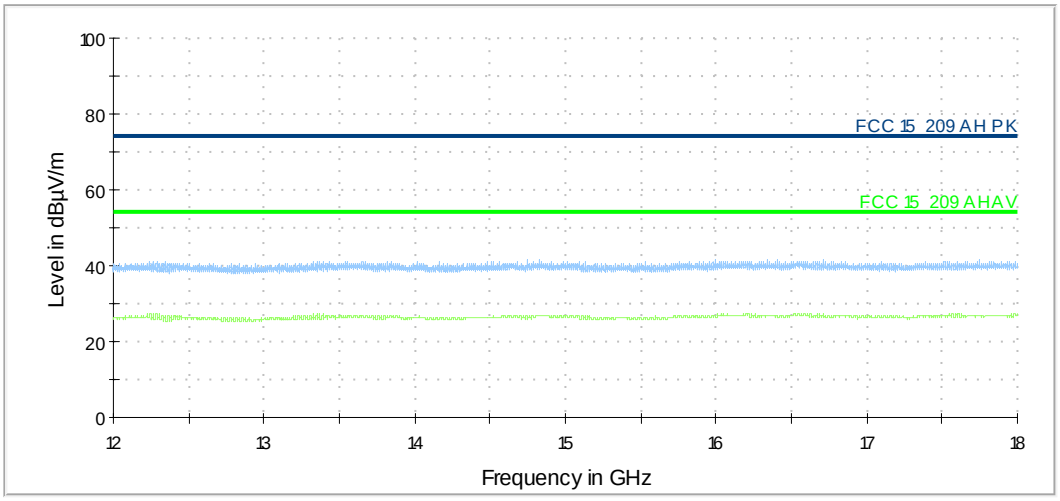
Spurious emissions from 1 GHz to 4 GHz (operation mode 3):



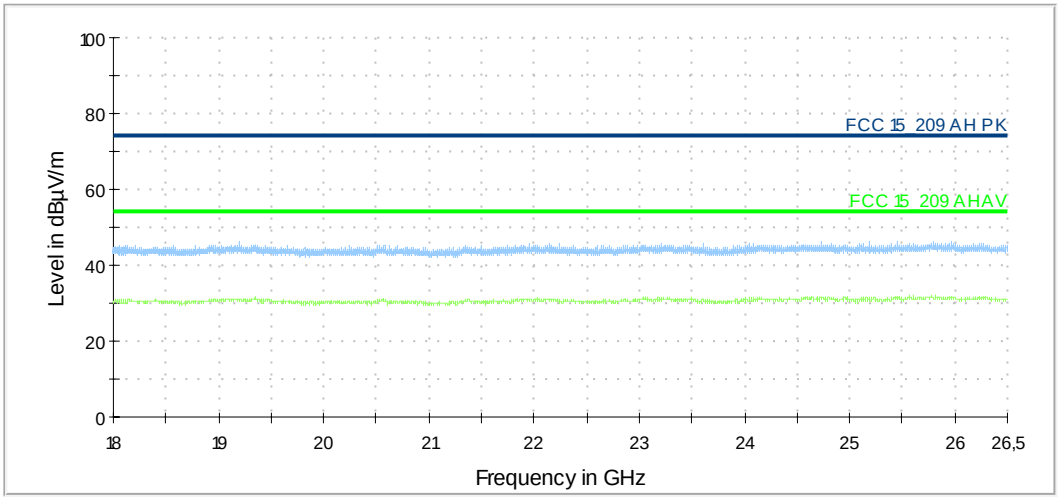
Spurious emissions from 4 GHz to 12 GHz (operation mode 3):



Spurious emissions from 12 GHz to 18 GHz (operation mode 3):



Spurious emissions from 18 GHz to 26.5 GHz (operation mode 3):



5.4.2.3.3.2 Result table

Frequency [MHz]	Result (Pk) [dBµV/m]	Result (Av) [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Readings [dBµV]	Correction [dB]	Height [cm]	Azimuth [deg]	Pol.	Result
2440.200000	94.7	---	-	-	60.1	34.8	350	67	V	Fund.
2440.200000	---	93.8	-	-	59	34.6	350	67	V	Fund.
3974.750000	55.0	---	74	19.0	14.7	40.5	383	236	H	Passed
3974.750000	---	42.7	54	11.3	2.2	40.3	383	236	H	Passed
11090.300000	---	38.0	54	16.0	17.2	20.6	273	298	H	Passed
11090.300000	49.6	---	74	24.4	29	20.8	273	298	H	Passed
11400.250000	---	37.6	54	16.4	16.7	20.6	103	5	V	Passed
11400.250000	49.4	---	74	24.6	28.7	20.8	103	5	V	Passed
11996.650000	51.5	---	74	22.5	29.5	22.1	250	257	H	Passed
11996.650000	---	39.5	54	14.5	17.4	21.9	250	257	H	Passed
Measurement uncertainty					±5.5 dB					

Test equipment (please refer to chapter 6 for details)
1 – 20, 27

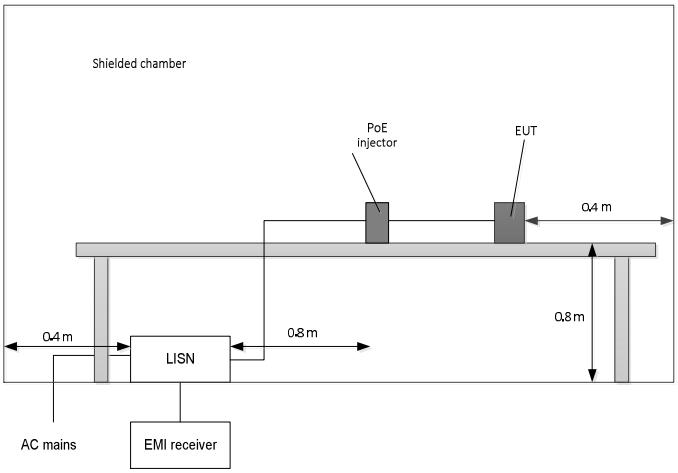
5.5 Conducted emissions on power supply lines (150 kHz to 30 MHz)

5.5.1 Method of measurement

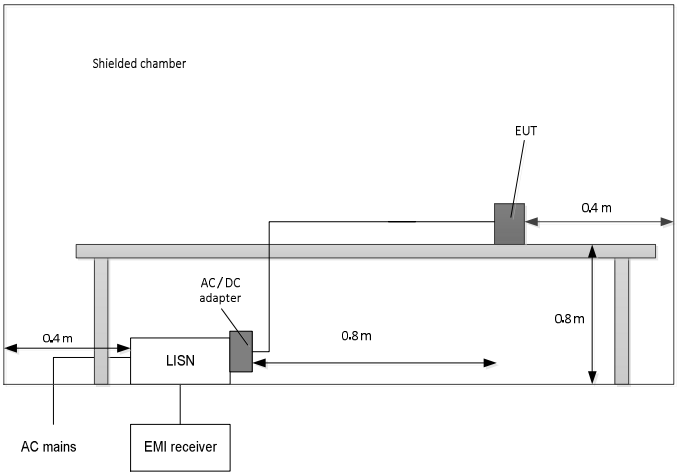
For details see ANSI C63.4 (2014) chapter 7.3.1.

Test setup:

Test setup for measurement with the EUT supplied via PoE:



Test setup for measurement with the EUT supplied via USB:



5.5.2 Test results

5.5.2.1 Test results with EUT supplied via PoE

Ambient temperature	21 °C
Relative humidity	71 %

Date	09.07.2020
Tested by	Y. KHALEK

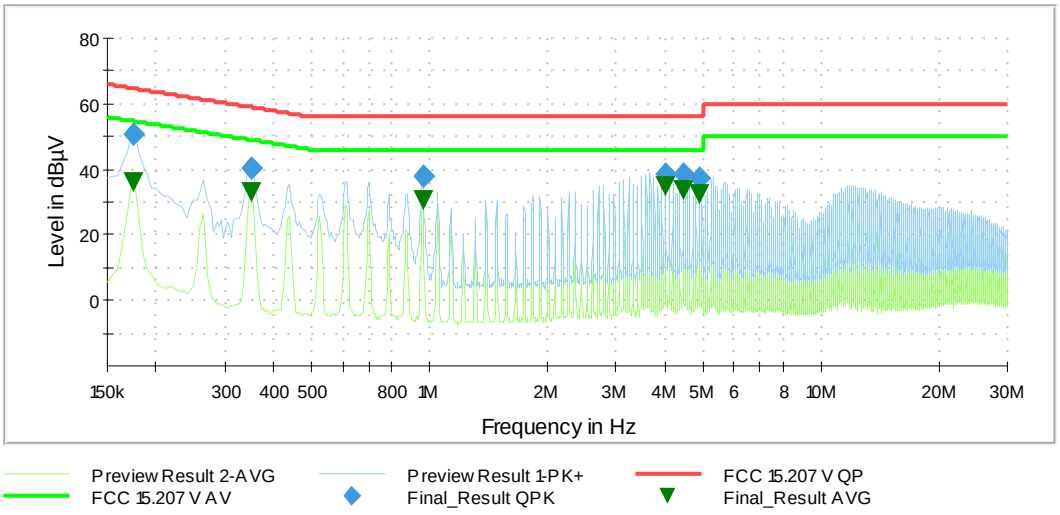
Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m.

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

Test record: All results are shown in the following.

Supply voltage: During this test the EUT was powered with 48 V_{DC} by the power injector PowerSine 3001, which was itself supplied with 120 V_{AC} / 60 Hz.

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



Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Transducer (dB)
0.174300	50.78	---	64.75	13.97	5000.0	9.000	N	GND	9.8
0.174300	---	35.91	54.75	18.85	5000.0	9.000	L1	GND	9.8
0.348900	---	32.79	48.99	16.19	5000.0	9.000	L1	FLO	9.9
0.348900	40.21	---	58.99	18.78	5000.0	9.000	L1	FLO	9.9
0.960000	---	30.44	46.00	15.56	5000.0	9.000	N	FLO	9.9
0.960000	37.72	---	56.00	18.28	5000.0	9.000	N	FLO	9.9
4.014600	---	34.60	46.00	11.40	5000.0	9.000	N	FLO	10.3
4.014600	38.77	---	56.00	17.23	5000.0	9.000	N	FLO	10.3
4.450200	38.30	---	56.00	17.70	5000.0	9.000	N	FLO	10.3
4.451100	---	33.62	46.00	12.38	5000.0	9.000	N	FLO	10.3
4.887600	37.55	---	56.00	18.45	5000.0	9.000	N	FLO	10.3
4.887600	---	32.35	46.00	13.65	5000.0	9.000	N	FLO	10.3
Measurement uncertainty				+2.76 dB / -2.76 dB					

5.5.2.2 Test results with EUT supplied via USB

Ambient temperature	21 °C
Relative humidity	71 %

Date	09.07.2020
Tested by	Y. KHALEK

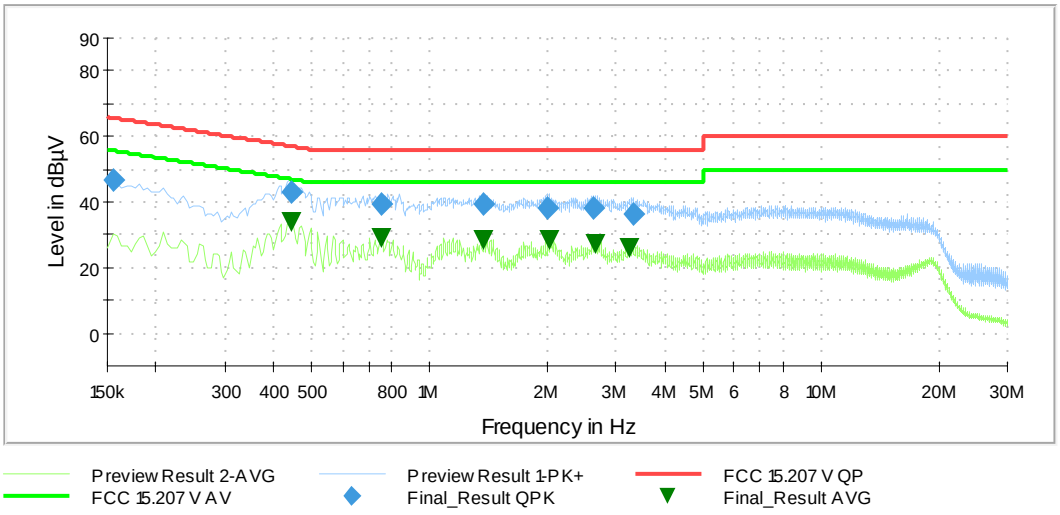
Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m.

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

Test record: All results are shown in the following.

Supply voltage: During this test the EUT was powered with 5.0 V_{DC} by the Samsung travel adapter EP-TA20EBE, which was itself supplied with 120 V_{AC} / 60 Hz.

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



Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Transducer (dB)
0.156300	46.91	---	65.66	18.75	5000.0	9.000	N	GND	9.8
0.441600	---	33.67	47.03	13.37	5000.0	9.000	L1	GND	9.9
0.444300	42.89	---	56.98	14.09	5000.0	9.000	L1	GND	9.9
0.753000	---	28.97	46.00	17.03	5000.0	9.000	L1	FLO	9.9
0.754800	39.61	---	56.00	16.39	5000.0	9.000	L1	GND	9.9
1.378500	---	28.71	46.00	17.29	5000.0	9.000	L1	GND	9.9
1.379400	39.24	---	56.00	16.76	5000.0	9.000	L1	GND	9.9
2.005800	38.32	---	56.00	17.68	5000.0	9.000	L1	FLO	10.1
2.027400	---	28.26	46.00	17.74	5000.0	9.000	L1	GND	10.1
2.630400	38.06	---	56.00	17.94	5000.0	9.000	L1	FLO	10.2
2.653800	---	27.36	46.00	18.64	5000.0	9.000	L1	GND	10.2
3.253200	---	25.76	46.00	20.24	5000.0	9.000	L1	GND	10.2
3.327000	36.38	---	56.00	19.62	5000.0	9.000	L1	GND	10.2
Measurement uncertainty				+2.76 dB / -2.76 dB					

Test equipment (please refer to chapter 6 for details)
21 - 26

6 Test Equipment used for Tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal Due
1	Low Noise Amplifier 100 MHz - 18 GHz	LNA-30-00101800-25-10P	Narda-Miteq	2110917	482967	18.02.2020	02.2022
2	Log Per Antenna	HL050	Rohde & Schwarz	4062.4063.02-100908	482977	13.08.2019	08.2022
3	Standard Gain Horn 20 dB, 12 GHz-18 GHz	18240-20	Flann	267220	483025	Calibration not necessary	
4	Low Noise Amplifier 18 GHz - 26.5 GHz	LNA-30-18002650-20-10P	Narda-Miteq	2110911	482969	17.02.2020	02.2022
5	Standard Gain Horn 20 dB, 18 GHz -26 GHz	20240-20	Flann	266399	483026	Calibration not necessary	
6	Low Noise Amplifier 26 MHz - 40 GHz	LNA-30-26004000-27-10P	Narda-Miteq	2110293	482970	17.02.2020	02.2022
7	Standard Gain Horn 20 dB, 26 GHz - 40 GHz	22240-20	Flann	266405	483027	Calibration not necessary	
8	Loop antenna	HFH2-Z2	Rohde & Schwarz	832609/014	480059	14.02.2020	02.2022
9	RF Switch Matrix	OSP220	Rohde & Schwarz		482976	Calibration not necessary	
10	Turntable	TT3.0-3t	Maturo	825/2612/.01	483224	Calibration not necessary	
11	Antennasupport	BAM 4.5-P-10kg	Maturo	222/2612.01	483225	Calibration not necessary	
12	Controller	NCD	Maturo	474/2612.01	483226	Calibration not necessary	
13	Semi Anechoic Chamber M276	SAC5-2	Albatross Projects	C62128-A540-A138-10-0006	483227	Calibration not necessary	
14	Measurment software	EMC32	Rohde & Schwarz	100970	482972	Calibration not necessary	
15	EMI Testreceiver	ESW44	Rohde & Schwarz	101828	482979	14.11.2019	11.2021
16	Preamplifier 12 GHz - 18 GHz	JS3-12001800-16-5A	MITEQ Hauppauge N.Y.	571667	480343	13.02.2020	02.2022
17	Antenna (Bilog)	CBL6111D	Schaffner Elektrotest GmbH / Teseq GmbH	25761	480894	19.10.2017	10.2020
18	Low Noise Amplifier 12 GHz - 18 GHz	LNA-30-12001800-13-10P	Narda-Miteq	2089798	482968	17.02.2020	02.2022
20	Loop antenna	HFH2-Z2	Rohde & Schwarz	100417	481912	05.02.2020	02.2021
21	Shielded chamber M4	-	Siemens	B83117-S1-X158	480088	Calibration not necessary	
22	EMI Receiver	ESIB 26	Rohde & Schwarz	1088.7490	481182	12.02.2020	02.2022
23	LISN	NSLK8128	Schwarzbeck	8128161	480138	11.02.2020	02.2022
24	Transient Limiter	CFL 9206A	Teseq	38268	481982	Calibration not necessary	
25	Software	EMC32	Rohde & Schwarz	100061	481022	Calibration not necessary	
26	AC source	AC6803A	Keysight	JPVJ002509	482350	Calibration not necessary	
27	Attenuator 6 dB	WA2-6	Weinschel	-	482794	Calibration not necessary	
28	Spektrum analyser	FSU46	Rohde & Schwarz	200125	480956	13.02.2020	02.2021

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
Semi anechoic chamber M276	483227	1 -18 GHz	SVSWR	CISPR 16-1-4 + Cor1:2010 + A1:2012 +A2:2017	19.09.2019	18.09.2021
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
F191161E3	07.09.2020	Initial Test Report
-	-	-
-	-	-

9 List of Annexes

Annex A Test Setup Photos 7 pages