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Test Report

Report Number:

F191161E5

Equipment under Test (EUT):

IEEE802.11 WLAN Module inside dedicated host device TRUMPF “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

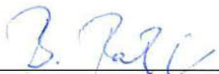
[1] **ANSI C63.10-2013**, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

[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		21.12.2020
	Name	Signature	Date
Reviewed and approved by:	Bernd STEINER		21.12.2020
	Name	Signature	Date

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

Contents: Page

1 Identification

1.1 Applicant

Name:	TRUMPF Werkzeugmaschinen GmbH + Co. KG
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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 Dedicated host device

EUTs dedicated host device	
Test object: *	Satellite for indoor localization
PMN / Model name: *	omlox Satellite
FCC ID: *	2AVYV-2554432-01
Serial number: *	204744042
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 and Host Device

General technical EUT data – host device						
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 / 2462 MHz (In WLAN 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.

1.6 EUT (Equipment under Test)

IEEE 802.11 WLAN mode						
Fulfils radio specification: *	IEEE 802.11 WLAN b/g/n (HT20/HT40)					
Radio module: *	WL18MODGB, Texas Instruments					
FCC ID: *	2AVYV-2547263-01					
Antenna type: *	Inverted F PCB antenna					
Antenna name: *	ANT1					
Antenna gain: *	2 dBi					
Antenna connector: *	n/a					
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}
Conducted output power: *	IEEE 802.11 b	17.96 dBm (from original filing)				
	IEEE 802.11 g	20.59 dBm (from original filing)				
	IEEE 802.11 n20	20.56 dBm (from original filing)				
	IEEE 802.11 n40	20.22 dBm (from original filing)				
Type of modulation: *	IEEE 802.11 b	DSSS (DBPSK, DQPSK, CCK) (1/2/5.5/11 Mbit/s)				
	IEEE 802.11 g	OFDM (BPSK, QPSK, 16-QAM, 64-QAM) (6/9/12/18/24/36/48/54 Mbit/s)				
	IEEE 802.11 n20	OFDM (BPSK, QPSK, 16-QAM, 64-QAM) (up to 72.2 Mbit/s)				
	IEEE 802.11 n40	OFDM (BPSK, QPSK, 16-QAM, 64-QAM) (up to 150 Mbit/s)				
Operating frequency range: *	IEEE 802.11 b	2412 – 2462 MHz				
	IEEE 802.11 g	2412 – 2462 MHz				
	IEEE 802.11 n20	2412 – 2462 MHz				
	IEEE 802.11 n40	2422 – 2452 MHz				
Number of channels: *	IEEE 802.11 b	11 (5 MHz channel spacing)				
	IEEE 802.11 g	11 (5 MHz channel spacing)				
	IEEE 802.11 n20	11 (5 MHz channel spacing)				
	IEEE 802.11 n40	7 (5 MHz channel spacing)				

* Declared by the applicant

IEEE 802.11 b/g/n20 frequencies				
Channel 01	RX	2412 MHz	TX	2412 MHz
Channel 02	RX	2417 MHz	TX	2417 MHz
Channel 03	RX	2422 MHz	TX	2422 MHz
Channel 04	RX	2427 MHz	TX	2427 MHz
Channel 05	RX	2432 MHz	TX	2432 MHz
Channel 06	RX	2437 MHz	TX	2437 MHz
Channel 07	RX	2442 MHz	TX	2442 MHz
Channel 08	RX	2447 MHz	TX	2447 MHz
Channel 09	RX	2452 MHz	TX	2452 MHz
Channel 10	RX	2457 MHz	TX	2457 MHz
Channel 11	RX	2462 MHz	TX	2462 MHz

IEEE 802.11 n40 frequencies				
Channel 03	RX	2422 MHz	TX	2422 MHz
Channel 04	RX	2427 MHz	TX	2427 MHz
Channel 05	RX	2432 MHz	TX	2432 MHz
Channel 06	RX	2437 MHz	TX	2437 MHz
Channel 07	RX	2442 MHz	TX	2442 MHz
Channel 08	RX	2447 MHz	TX	2447 MHz
Channel 09	RX	2452 MHz	TX	2452 MHz

1.6.1 Ancillary Equipment / Equipment used for testing

Equipment used for testing	
Cables*[1]	RJ45 Ethernet cable, length 3m (including POE)
Laptop*[1]	Dell Inspiron 15 S/N: GB6H4P2
POE switch:*[1]	PowerSine 3001
USB Power adaptor: *[1]	Samsung travel adapter EP-TA20EBE

*[1] Provided by the applicant

1.7 Dates

Date of receipt of test sample:	07.05.2020
Start of test:	15.05.2020
End of test:	12.06.2020

2 Operational States

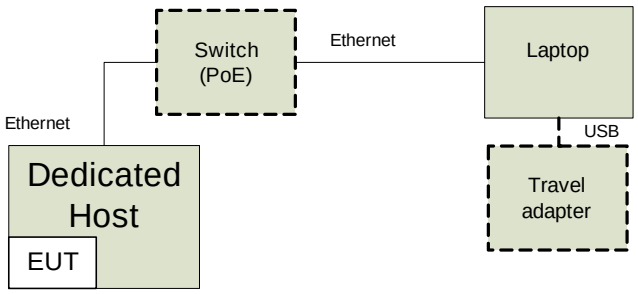
2.1 Description of function of the EUT

The EUT is an already certified WLAN Module that is integrated in a dedicated host

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]	Data rate	Power setting
1	IEEE 802.11 b	2412	1 Mbps	Not settable
2	IEEE 802.11 b	2437	1 Mbps	Not settable
3	IEEE 802.11 b	2462	1 Mbps	Not settable
4	IEEE 802.11 g	2437	6 Mbps	Not settable
5	IEEE 802.11 n20	2462	MCS0	Not settable

As pre-tests have shown, IEEE 802.11n (40 MHz) mode is not the worst case, no final measurements were conducted in that mode

Power settings were done by the customer

3 Additional Information

The dedicated host also contains a Bluetooth Low Energy, a ZigBee and a UWB transceiver. The results of these technologies are documented in the test reports F191161E2 to F191161E4. The emissions of the digital part of the dedicated host are documented in the test report F191161E1.

This test report incorporates only limited test-cases for the WiFi 2.4 GHz. Purpose of this report is to show compliance of the EUT in a dedicated host device.

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)	Verified*1	-
Maximum conducted output power	2400.0 - 2483.5	15.247 (b) (3), (4)	Verified*1	-
DTS Bandwidth / 99% Bandwidth	2400.0 - 2483.5	15.247 (a) (2)	Not tested*2	-
Peak Power Spectral Density	2400.0 - 2483.5	15.247 (e)	Not tested*2	-
Average Power Spectral Density	2400.0 - 2483.5	15.247 (e)	Not tested*2	-
Band edge compliance	2400.0 - 2483.5	15.247 (d) 15.205 (a) 15.209 (a)	Verified*3	15
Maximum unwanted emissions	0.009 – 26,000	15.247 (d) 15.205 (a) 15.209 (a)	Passed*4	18
Conducted emissions on supply line	0.15 - 30	15.207 (a)	Passed	36

*1 Limited verification done, results below the results of the original filing
*2 Not tested, for detailed results see original filing
*3 Limited testcases done, for details see original filing
*4 Worst cases were taken from original filing, limited testcases for each frequency rage.

5 Results

5.1 Duty cycle

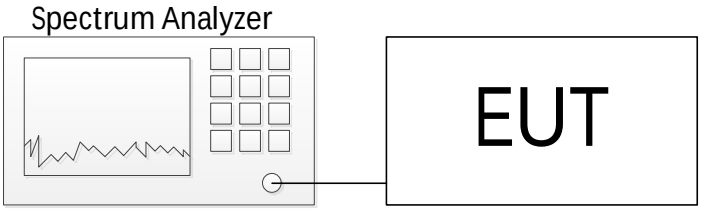
5.1.1 Method of measurement (conducted)

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

Acceptable measurement configurations

According to [5] 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:

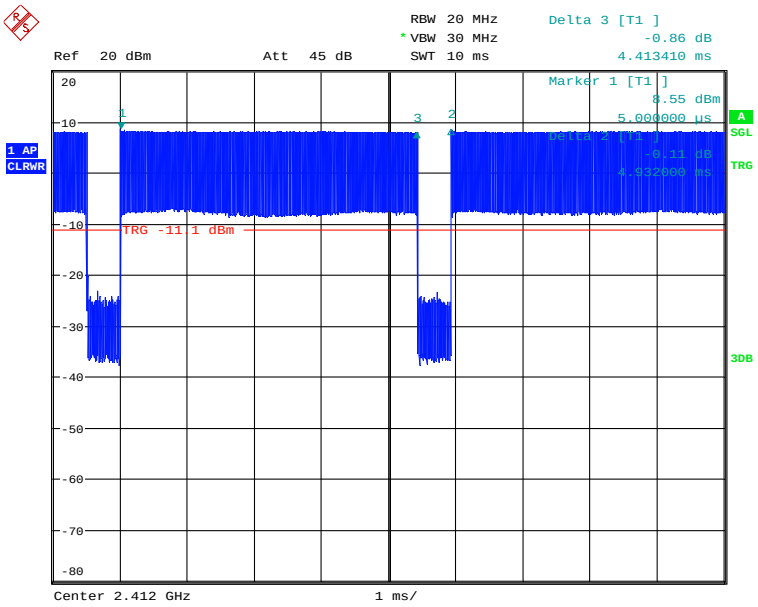


Only one representative plot is provided.

5.1.2 Test results

Ambient temperature	22 °C
Relative humidity	52 %

Date	20.5.2020
Tested by	B. ROHDE



Operation mode	TX_on [µs]	TX_ges [µs]	RBW [MHz]	50/T [kHz]	50/T < RBW?
b mode 1 Mbps	4413	4932	20	11	Yes
g mode 6 Mbps	4048	4465	20	12	Yes
n20 mode MCS0	4503	4808	20	11	Yes

Operation mode	Sweep points	Sweep time [µs]	Meas points	Meas points >100?	Duty cycle %	DCCF [dB]
b mode 1 Mbps	10001	10000	8949	Yes	89	0.48
g mode 6 Mbps	10001	10000	9067	Yes	91	0.43
n20 mode MCS0	10001	10000	9367	Yes	94	0.28

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 0.48 dB is used for all tests in b mode.
Therefore, for average measurements a correction factor of 0.43 dB is used for all tests in g mode.
Therefore, for average measurements a correction factor of 0.28 dB is used for all tests in n20 mode.
No tests in n40 mode were conducted, so no DCCF measurement was conducted.

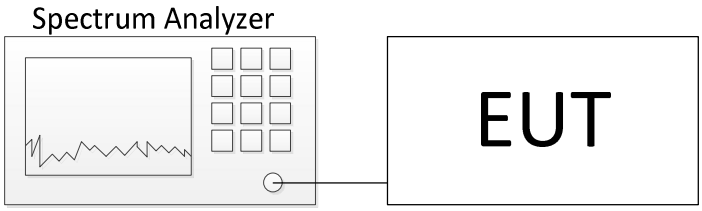
Test equipment (please refer to chapter 6 for details)
1

5.1 Band edge

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.

Test Setup:



Acceptable measurement configurations

See chapter 8.7 of document [5].

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)** was done radiated.

5.1.2 Method of measurement (radiated)

The EUT was measured radiated in an anechoic chamber. For test setup and measurement configuration see 5.2.1

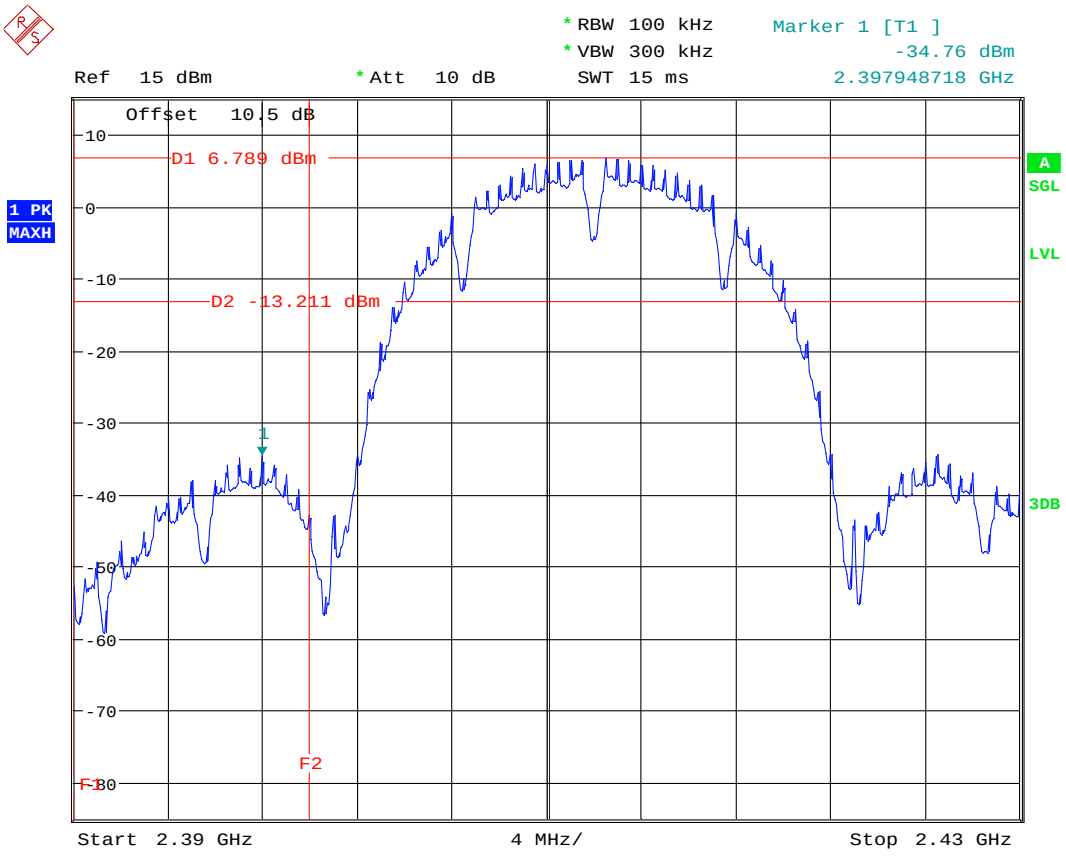
For the **Band-edge testing (restricted bands)** the 15.209 limits apply.

5.1.3 Test results

Ambient temperature	22 °C
Relative humidity	53 %

Date	24.07.2020
Tested by	B. ROHDE

Band-edge testing (unrestricted bands; conducted):



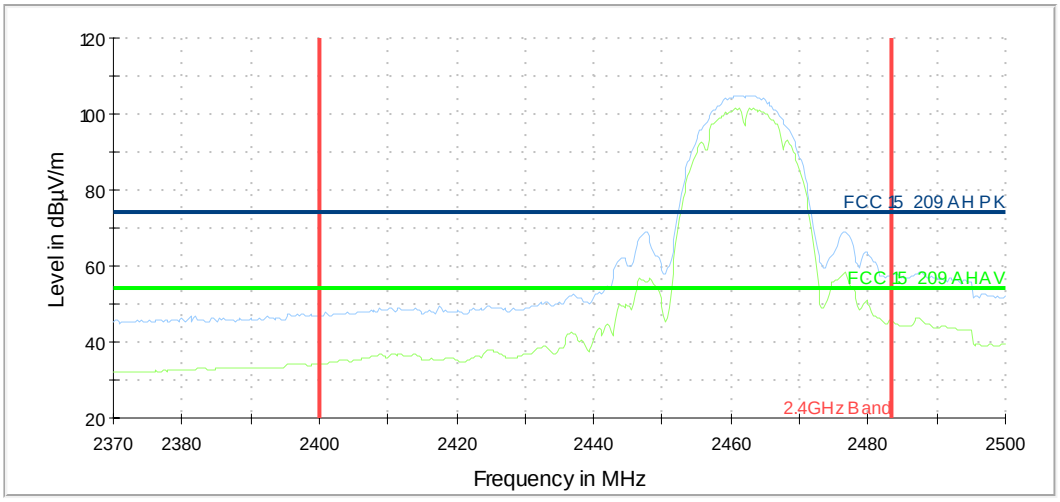
Operation mode	Data rate	Frequency [MHz]	Reference Level [dBm]	Limit [dBm]	Emission Level [dBm]	Margin [dB]	Result
1	1 Mbps	2412	6.8	-13.2	-34.8	21.6	Passed

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

Band-edge testing (restricted bands; radiated):

Ambient temperature	22 °C
Relative humidity	58 %

Date	02.06.2020
Tested by	B. ROHDE



(Operation mode 3)

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
2485.500000	57.5	---	74	16.5	22.9	34.6	197	237	V	Passed
2485.500000	---	45.9	54	8.1	10.8	35.1	197	237	V	Passed
Measurement uncertainty					±5.5 dB					

Test equipment (please refer to chapter 6 for details)
1 - 12

5.2 Maximum unwanted emissions

5.2.1 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.

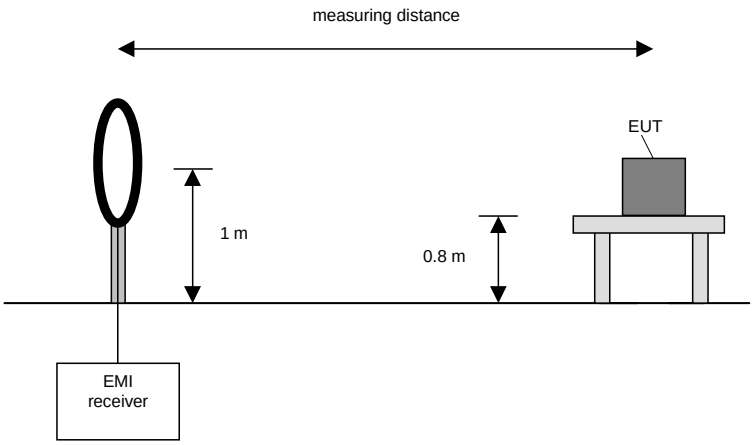
Preliminary measurement (9 kHz to 30 MHz):

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.

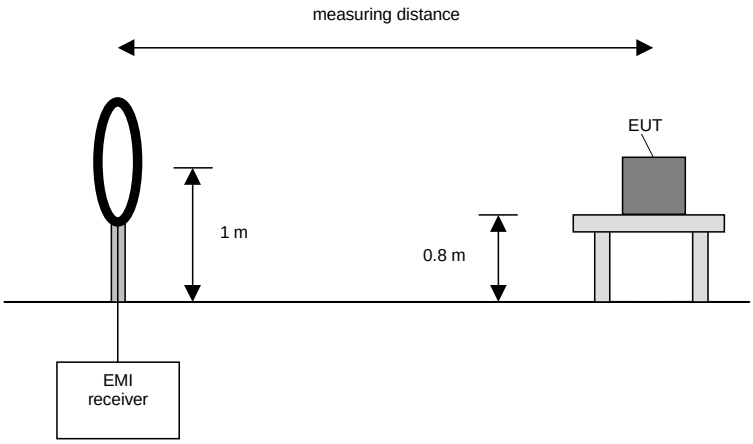
Final measurement (9 kHz to 30 MHz):

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

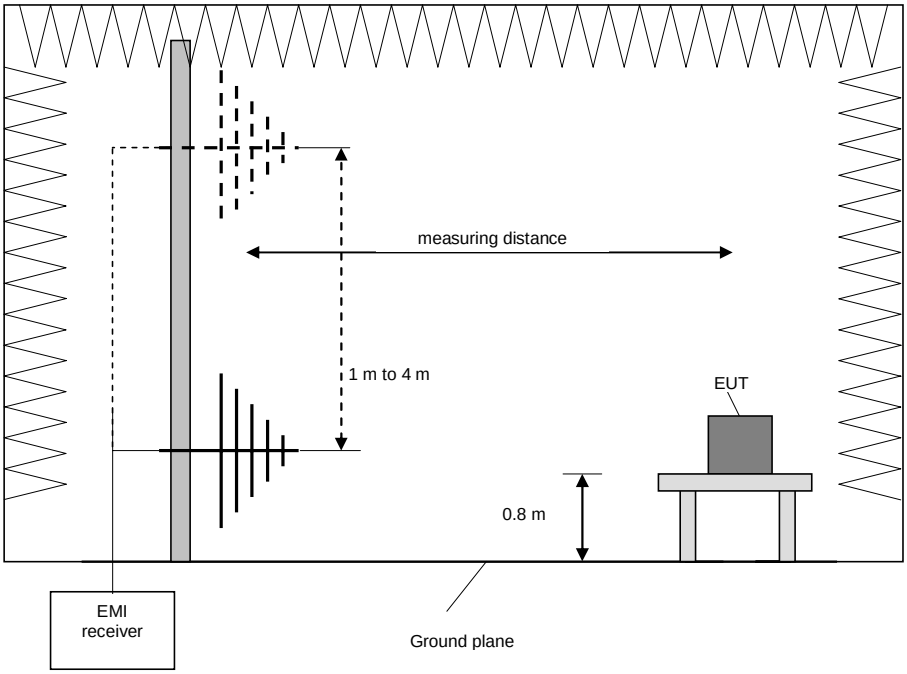


Preliminary and final measurement (30 MHz to 1 GHz)

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:

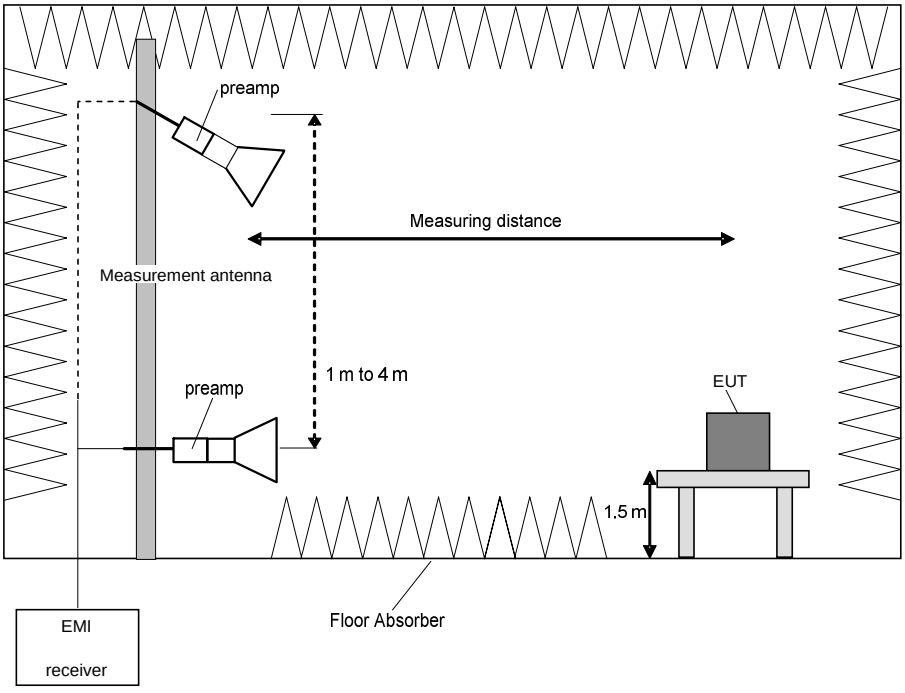
1. Select the highest frequency peaks to the limit for the final measurement.
2. The software will determine the exact peak frequencies by doing a partial scan with reduced step size with +/- 3 times the RBW of the pre-scan of the selected peaks.
3. If the EUT is portable or ceiling mounted, find the 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 - 12 GHz	1 MHz	500 kHz	10 ms
Frequency peak search	+ / - 1 MHz	1 MHz	50 kHz	100 ms
Final measurement	1 - 12 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.

5.2.2 Test results (radiated)

5.2.2.1 Test results (9 kHz – 30 MHz)

Ambient temperature	21 °C
Relative humidity	71 %

Date	29.07.2020
Tested by	B. ROHDE

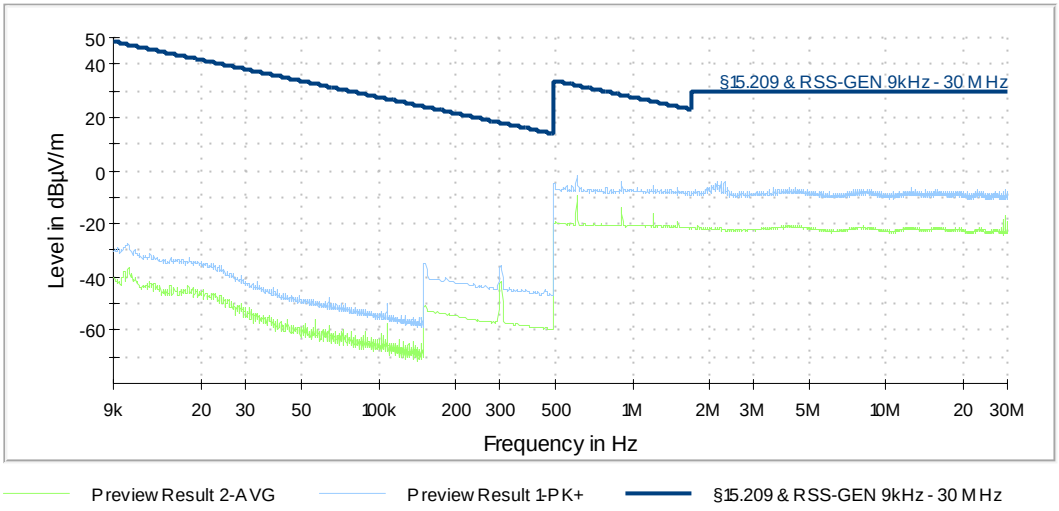
Position of EUT: For tests for f between 9 kHz and 30 MHz, the EUT was set-up on a table with a height of 80 cm. The distance between EUT and antenna was 3 m.

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

5.2.2.1.1.1 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).

5.2.2.1.1.2 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 - 12

5.2.2.2 Test results (30 MHz – 1 GHz)

Ambient temperature	21 °C
Relative humidity	71 %

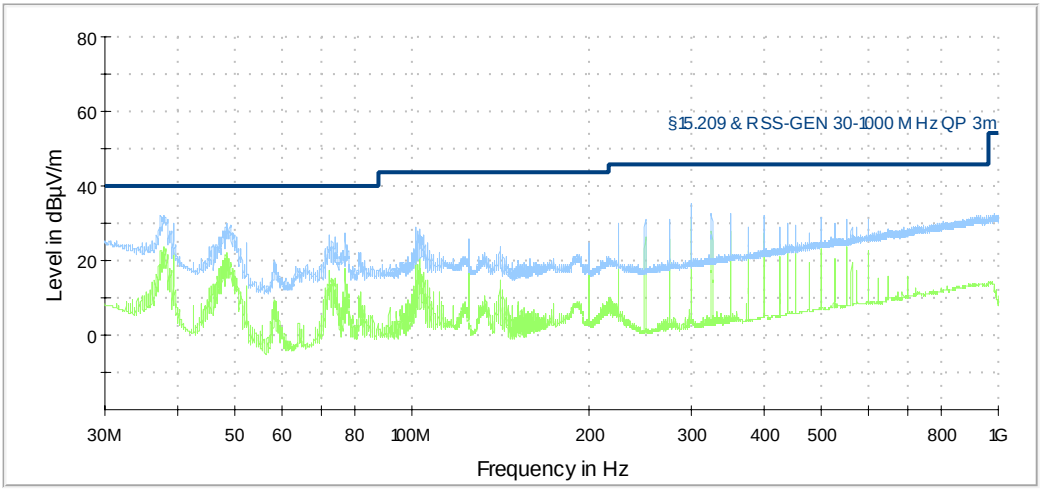
Date	17.06.2020
Tested by	B. ROHDE

Position of EUT: For tests for f between 30 MHz and the 1 GHz, the EUT was set-up on a table with a height of 80 cm. The distance between EUT and antenna was 3 m.

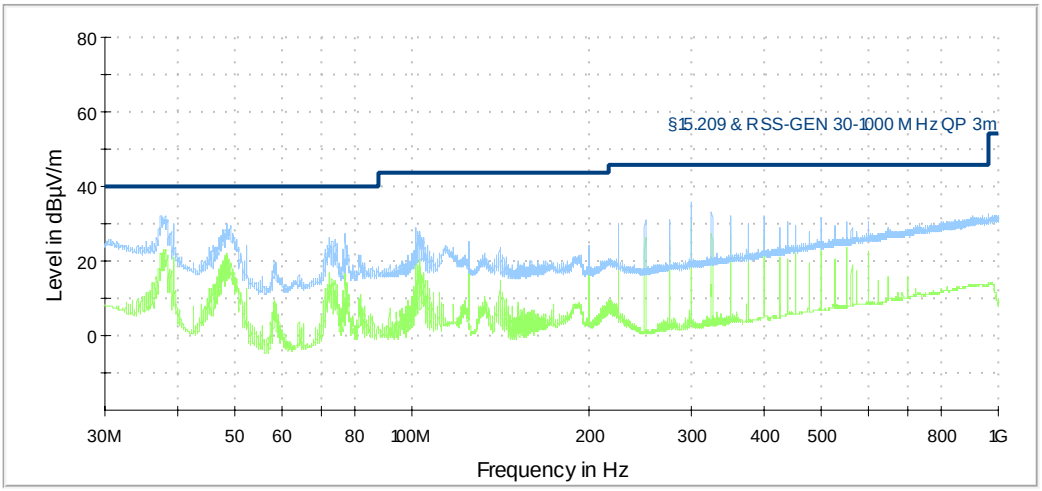
Cable guide: For detail information of test set-up and the cable guide refer to the pictures in the annex A in the test report.

Test record: Worst-cases were taken from test report FCC ID Z64-WL18SBMOD.

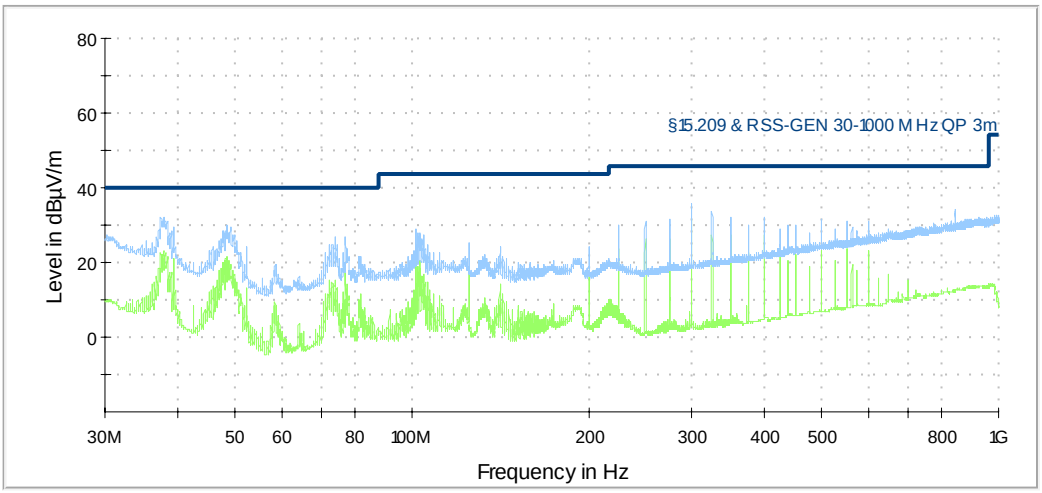
b-mode, 1 Mbps ch01: Spurious emissions from 30 MHz to 1 GHz (operation mode 1):



g-mode, 6 Mbps ch06: Spurious emissions from 30 MHz to 1 GHz (operation mode 2):



n20-mode, MCS0 ch11: Spurious emissions from 30 MHz to 1 GHz (operation mode 3):



Operation mode 1:

Frequency [MHz]	Result [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Readings [dBµV]	Correction [dB]	Height [cm]	Azimuth [deg]	Pol.	Result
37.540000	28.2	40	11.8	7.0	21.3	100	323	V	Passed
48.500000	25.6	40	14.4	11.1	14.5	104	50	V	Passed
300.000000	34.5	46.02	11.5	15.2	19.3	102	220	H	Passed
325.020000	31.3	46.02	14.7	11.2	20.1	100	108	H	Passed
350.010000	30.7	46.02	15.3	9.8	20.9	100	108	H	Passed
400.010000	30.4	46.02	15.6	8.3	22.1	106	136	H	Passed
Measurement uncertainty				±5.5 dB					

Operation mode 2:

Frequency [MHz]	Result [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Readings [dBµV]	Correction [dB]	Height [cm]	Azimuth [deg]	Pol.	Result
37.390000	28.1	40	11.9	6.8	21.4	108	323	V	Passed
48.470000	26.6	40	13.4	12.1	14.5	104	-17	V	Passed
101.900000	25.7	43.52	17.8	8.7	17.0	304	248	H	Passed
300.000000	34.5	46.02	11.5	15.2	19.3	102	220	H	Passed
325.020000	32.3	46.02	13.7	12.3	20.1	102	110	H	Passed
400.000000	30.8	46.02	15.2	8.6	22.1	102	137	H	Passed
Measurement uncertainty				±5.5 dB					

Operation mode 3:

Frequency [MHz]	Result [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Readings [dBµV]	Correction [dB]	Height [cm]	Azimuth [deg]	Pol.	Result
37.370000	28.4	40	11.6	7.0	21.4	100	343	V	Passed
48.460000	26.3	40	13.7	11.8	14.5	100	-22	V	Passed
77.210000	22.6	40	17.4	7.0	15.6	106	220	V	Passed
300.000000	34.7	46.02	11.3	15.3	19.3	100	211	H	Passed
325.000000	30.4	46.02	15.6	10.3	20.1	105	106	H	Passed
841.610000	19.7	46.02	26.3	-9.7	29.4	261	115	V	Passed
Measurement uncertainty				±5.5 dB					

Test equipment (please refer to chapter 6 for details)
1 - 12

5.2.2.3 Test results (above 1 GHz)

Ambient temperature	21 °C
Relative humidity	71 %

Date	17.06.2020
Tested by	B. ROHDE

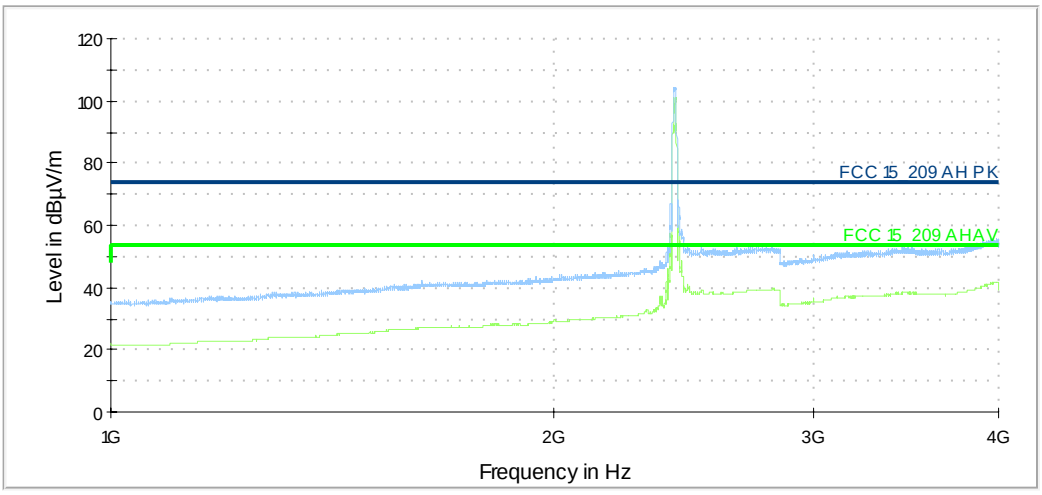
Position of EUT: For tests for f between 1 GHz and the 10th harmonic, the EUT was set-up on a table with a height of 150 cm. The distance between EUT and antenna was 3 m.

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.

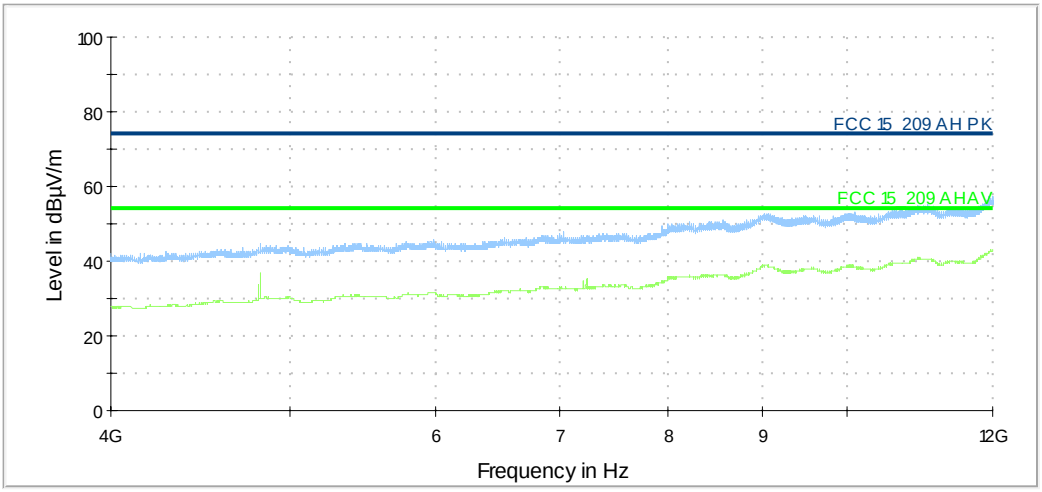
Test record: Only the worst-case plot for each frequency range is submitted below.
Worst-cases were taken from test report FCC ID Z64-WL18SBMOD.

Plots of the worst-case transmitter spurious emissions

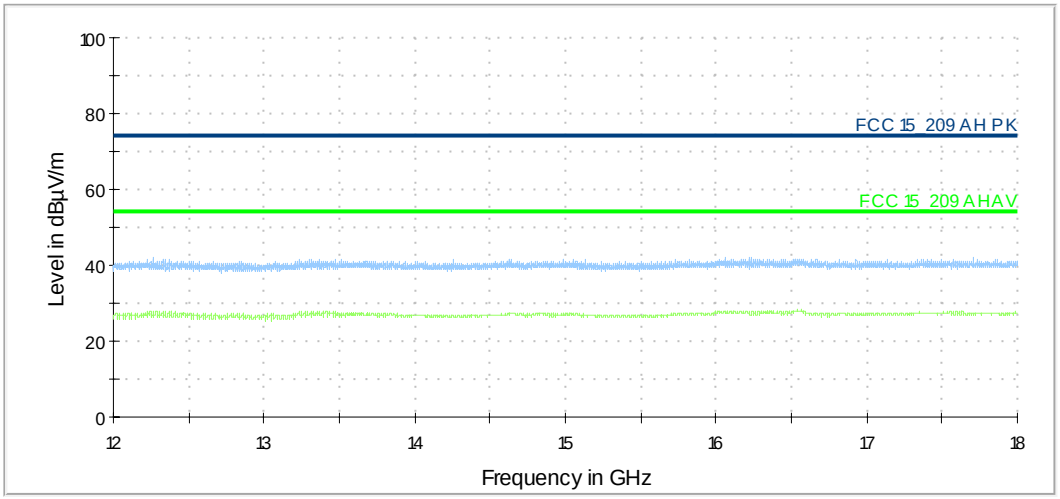
b-mode, 1 Mbps ch01: Spurious emissions from 1 GHz to 4 GHz (operation mode 1):



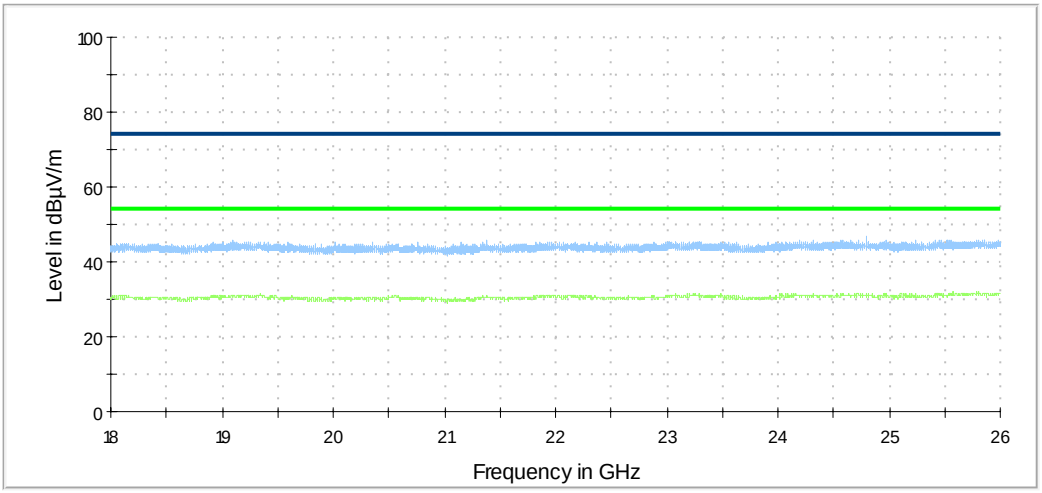
b-mode, 1 Mbps ch01: Spurious emissions from 4 GHz to 12 GHz (operation mode 1):



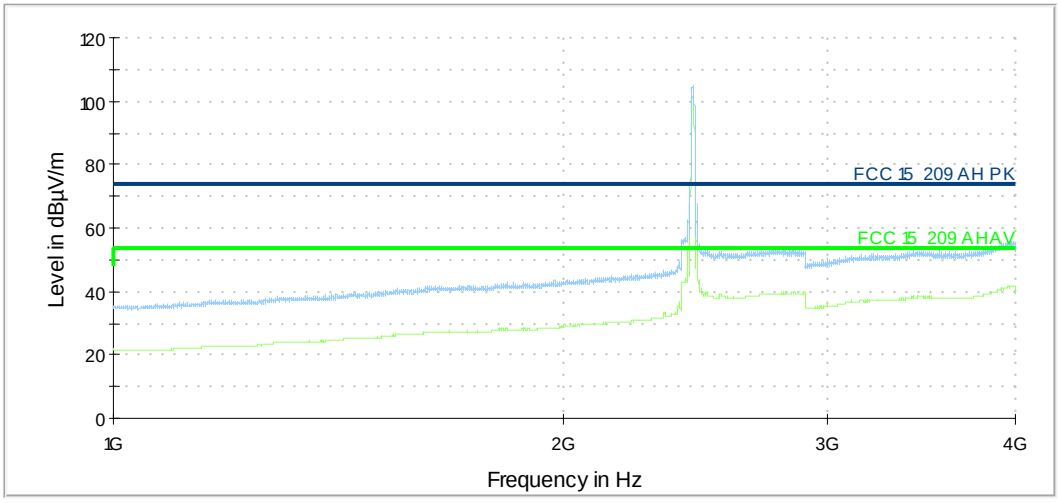
b-mode, 1 Mbps ch01: Spurious emissions from 12 GHz to 18 GHz (operation mode 1):



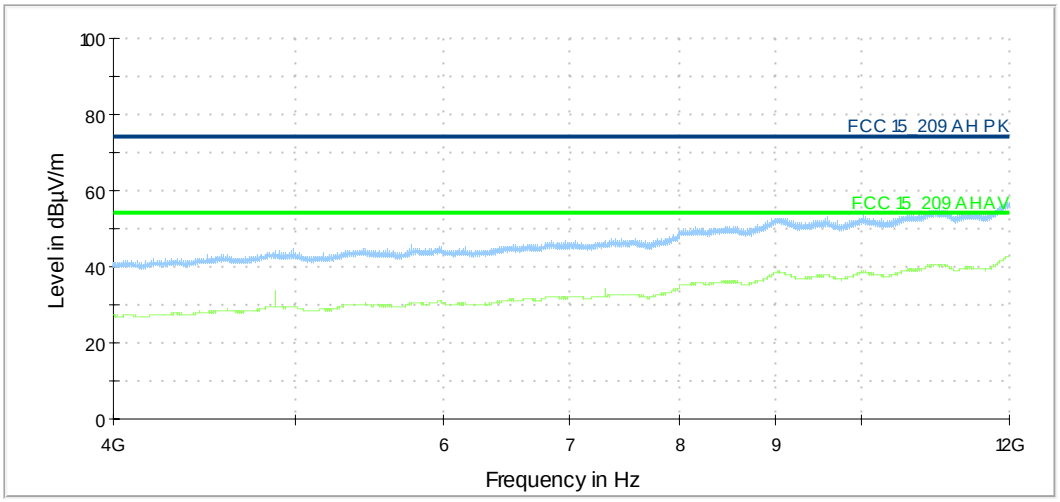
b-mode, 1 Mbps ch01: Spurious emissions from 18 GHz to 26 GHz (operation mode 1):



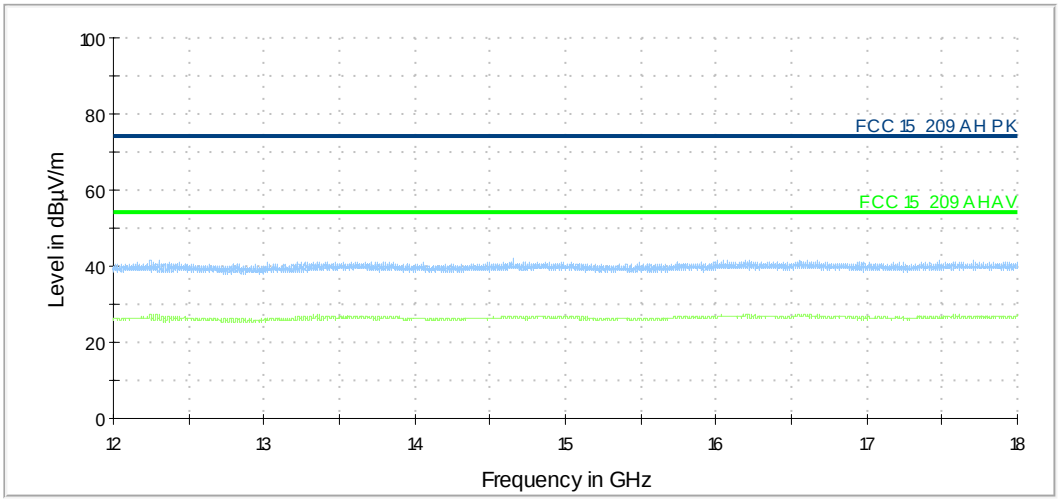
b-mode, 1 Mbps ch06: Spurious emissions from 1 GHz to 4 GHz (operation mode 2):



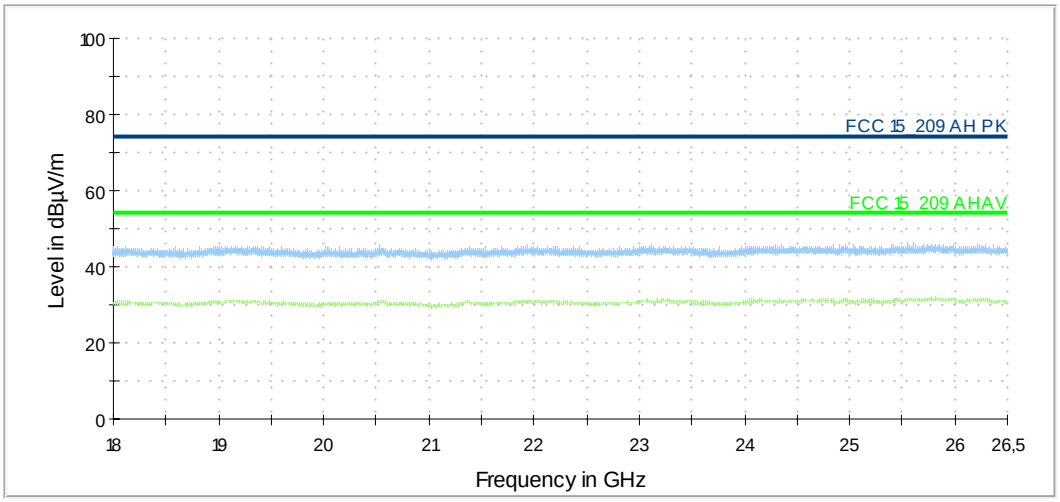
b-mode, 1 Mbps ch06: Spurious emissions from 4 GHz to 12 GHz (operation mode 2):



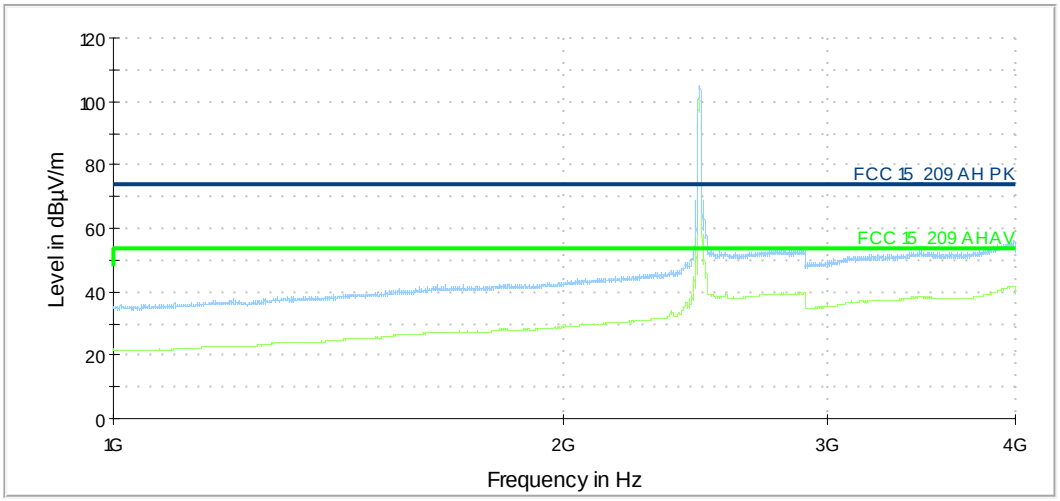
b-mode, 1 Mbps ch06: Spurious emissions from 12 GHz to 18 GHz (operation mode 2):



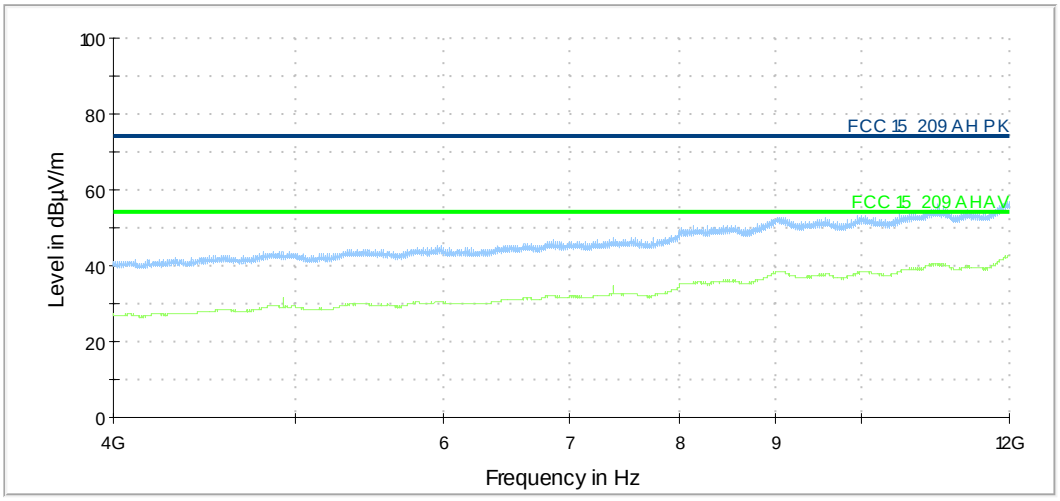
b-mode, 1 Mbps ch06: Spurious emissions from 18 GHz to 26 GHz (operation mode 2):



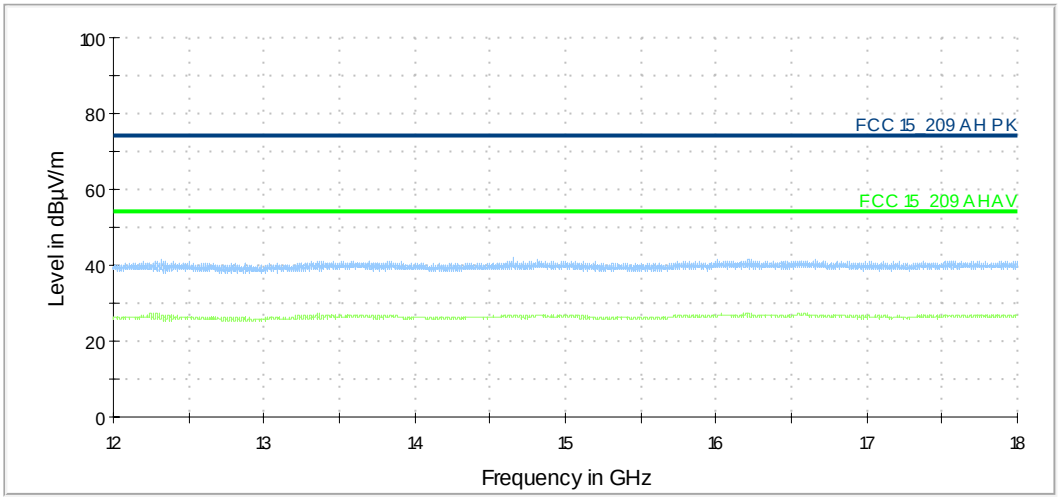
b-mode, 1 Mbps ch11: Spurious emissions from 1 GHz to 4 GHz (operation mode 3):



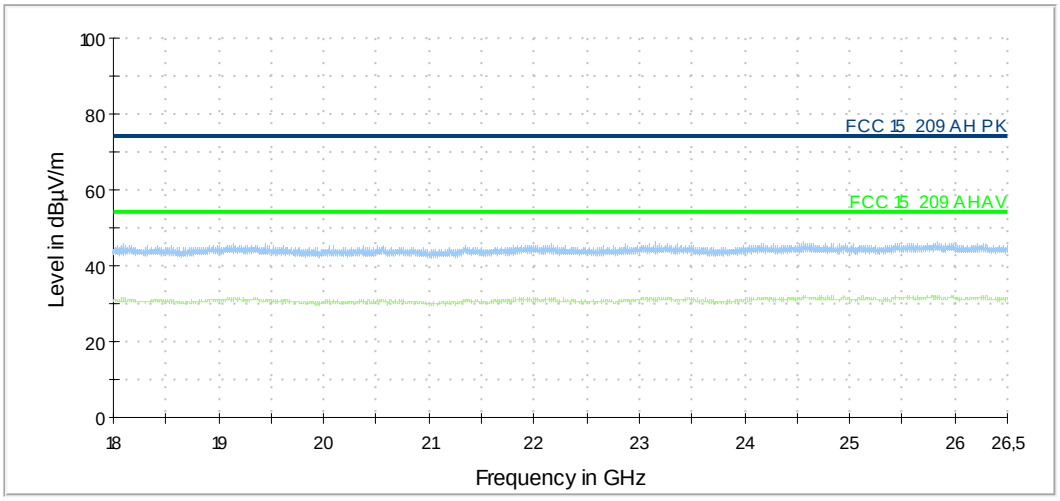
b-mode, 1 Mbps ch11: Spurious emissions from 4 GHz to 12 GHz (operation mode 3):



b-mode, 1 Mbps ch11: Spurious emissions from 12 GHz to 18 GHz (operation mode 3):



b-mode, 1 Mbps ch11: Spurious emissions from 18 GHz to 26 GHz (operation mode 3):



(Operation mode 1)

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
2386.350000	54.8	---	74	19.2	20.5	34.8	161	282	V	Passed
2386.350000	---	46.9	54	7.1	12.1	34.3	161	282	V	Passed
2412.900000	106.4	---	-	-	71.9	35.0	150	281	V	Fund.
2412.900000	---	102.5	-	-	67.5	34.5	150	281	V	Fund.
2485.800000	48.2	---	74	25.8	13.5	35.1	197	237	V	Passed
2485.800000	---	35.9	54	18.1	0.8	34.6	197	237	V	Passed
2491.850000	47.5	---	74	26.5	12.8	35.1	110	284	V	Passed
2491.850000	---	35.5	54	18.5	0.4	34.6	110	284	V	Passed
2513.300000	---	37.8	54	16.2	2.6	34.7	150	252	V	Passed
2513.300000	48.9	---	74	25.1	14.2	35.2	150	252	V	Passed
2736.100000	---	35.6	54	18.4	-1.2	36.4	191	348	V	Passed
2736.100000	47.3	---	74	26.7	10.9	36.9	191	348	V	Passed
3950.350000	---	42.8	54	11.2	2.1	40.2	353	86	H	Passed
3950.350000	55.0	---	74	19.0	14.8	40.7	353	86	H	Passed
Measurement uncertainty					±5.5 dB					

(Operation mode 2)

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
2388.350000	47.7	---	74	26.3	13.4	34.8	374	292	V	Passed
2388.350000	---	35.7	54	18.3	0.9	34.3	374	292	V	Passed
2436.150000	---	103.2	-	-	68.2	34.6	152	249	V	Fund.
2436.150000	106.8	---	-	-	72.3	35.1	152	249	V	Fund.
2490.000000	---	40.8	54	13.2	5.7	34.6	116	310	V	Passed
2490.000000	52.8	---	74	21.2	18.2	35.1	116	310	V	Passed
3979.550000	55.7	---	74	18.3	15.4	40.8	277	81	V	Passed
3979.550000	---	43.0	54	11.0	2.3	40.3	277	81	V	Passed
Measurement uncertainty					±5.5 dB					

(Operation mode 3)

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
2461.100000	106.9	---	-	-	72.4	35.1	169	276	V	Fund.
2461.100000	---	103.2	-	-	68.2	34.6	169	276	V	Fund.
2487.150000	55.6	---	74	18.4	21	35.1	240	250	V	Passed
2487.150000	---	45.3	54	8.7	10.2	34.6	240	250	V	Passed
3993.650000	---	43.2	54	10.8	2.3	40.3	221	76	H	Passed
3993.650000	55.3	---	74	18.7	15	40.8	221	76	H	Passed
Measurement uncertainty					±5.5 dB					

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

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

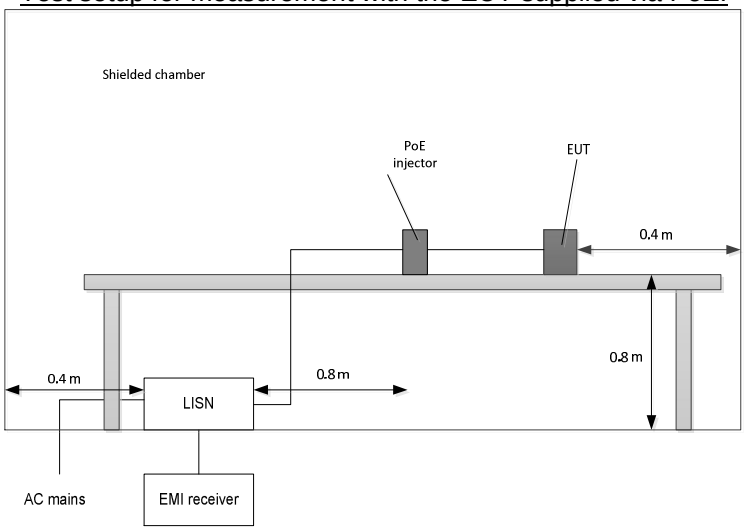
5.3.1 Method of measurement

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

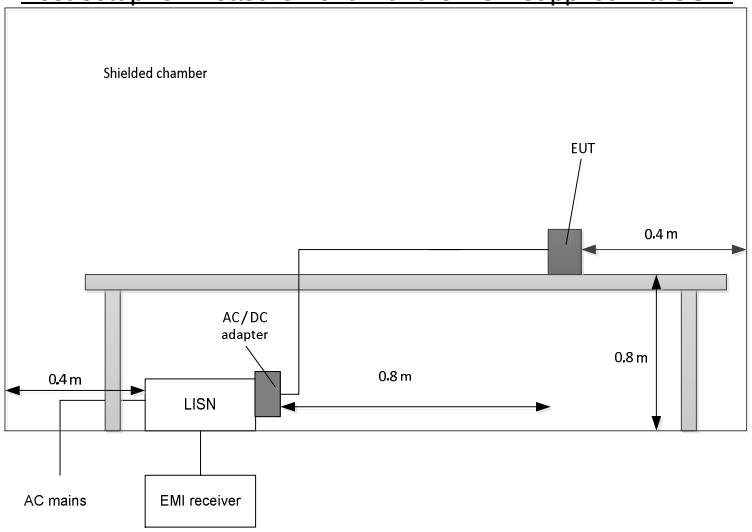
The frequency range 150 kHz to 30 MHz will be measured with an EMI Receiver set to MAX Hold mode with peak and average detector and a resolution bandwidth of 9 kHz. A scan will be carried out on the phase (or plus pole in case of DC powered devices) of the AC mains network. If levels detected 10 dB below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

Frequency range	Resolution bandwidth
150 kHz to 30 MHz	9 kHz

Test setup for measurement with the EUT supplied via PoE:



Test setup for measurement with the EUT supplied via USB:



5.3.2 Test results

5.3.2.1 Test results with EUT supplied via PoE

Ambient temperature	21 °C
Relative humidity	71 %

Date	09.07.2020
Tested by	Y. KHALEK

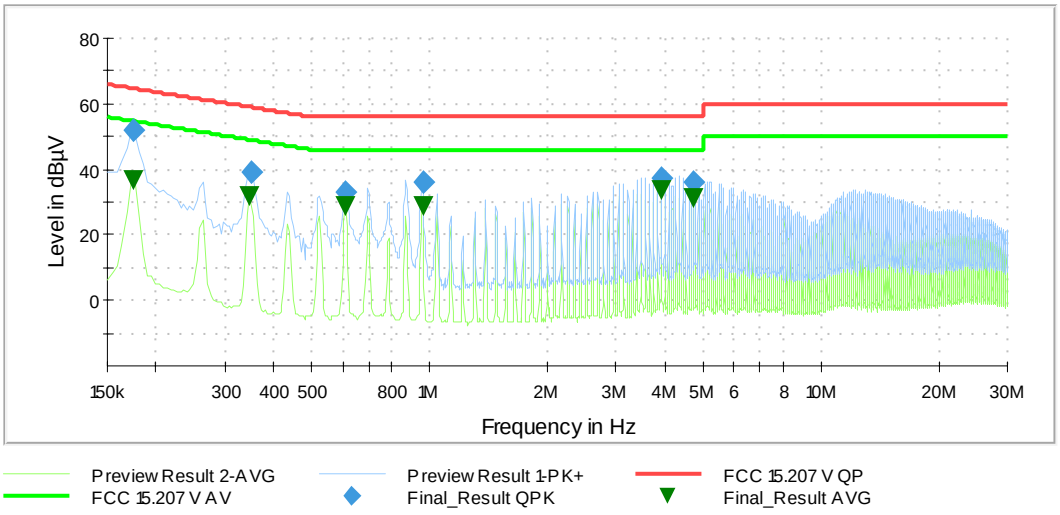
Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m.

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	Corr. [dB]
0.174300	51.65	---	64.75	13.10	5000.0	9.000	N	GND	9.8
0.174300	---	36.72	54.75	18.03	5000.0	9.000	L1	GND	9.8
0.348000	---	31.57	49.01	17.44	5000.0	9.000	L1	FLO	9.9
0.348900	39.33	---	58.99	19.66	5000.0	9.000	L1	FLO	9.9
0.609900	---	28.70	46.00	17.30	5000.0	9.000	N	FLO	9.9
0.610800	32.90	---	56.00	23.10	5000.0	9.000	N	GND	9.9
0.958200	---	29.05	46.00	16.95	5000.0	9.000	N	FLO	9.9
0.958200	35.99	---	56.00	20.01	5000.0	9.000	N	FLO	9.9
3.919200	37.32	---	56.00	18.68	5000.0	9.000	N	GND	10.3
3.920100	---	33.47	46.00	12.53	5000.0	9.000	N	FLO	10.3
4.703100	35.99	---	56.00	20.01	5000.0	9.000	N	GND	10.3
4.704000	---	31.35	46.00	14.65	5000.0	9.000	N	FLO	10.3
Measurement uncertainty			±2.8 dB						

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

5.3.2.2 Test results with EUT supplied via USB

Ambient temperature	21 °C
Relative humidity	71 %

Date	09.07.2020
Tested by	Y. KHALEK

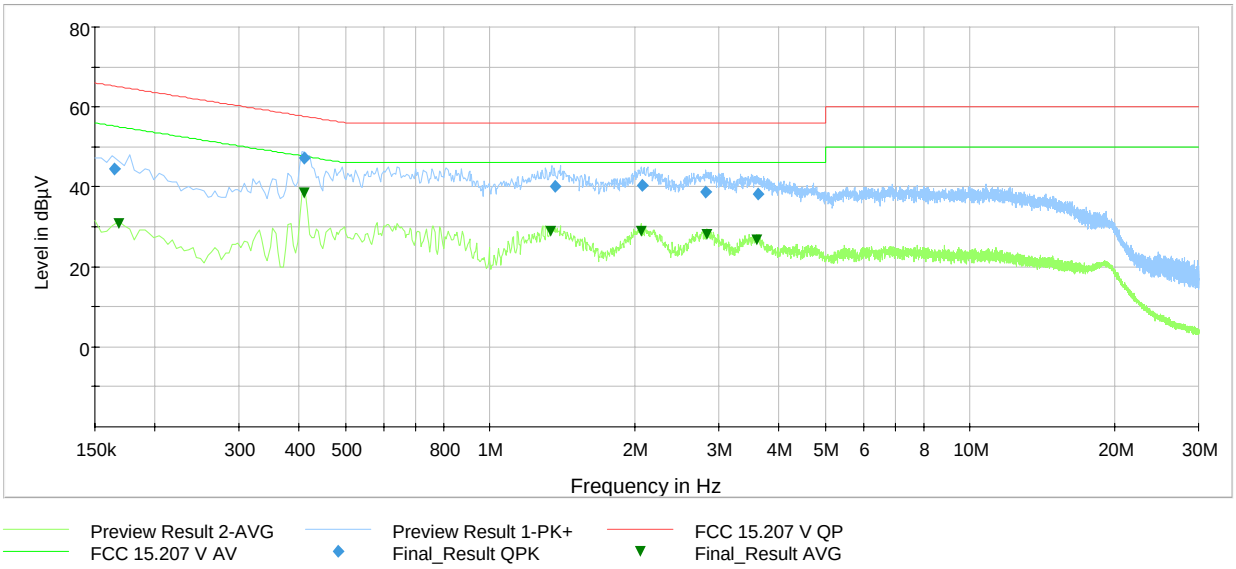
Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m.

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	Corr. [dB]
0.164400	44.37	---	65.24	20.87	5000.0	9.000	N	GND	9.8
0.168000	---	30.92	55.06	24.14	5000.0	9.000	L1	FLO	9.8
0.409200	47.25	---	57.66	10.42	5000.0	9.000	L1	FLO	9.9
0.409200	---	38.60	47.66	9.07	5000.0	9.000	L1	FLO	9.9
1.340700	---	29.00	46.00	17.00	5000.0	9.000	L1	FLO	9.9
1.364100	40.11	---	56.00	15.89	5000.0	9.000	L1	FLO	9.9
2.061600	---	28.97	46.00	17.03	5000.0	9.000	L1	GND	10.1
2.074200	40.32	---	56.00	15.68	5000.0	9.000	L1	FLO	10.1
2.812200	38.64	---	56.00	17.36	5000.0	9.000	L1	GND	10.2
2.832900	---	28.18	46.00	17.82	5000.0	9.000	L1	FLO	10.2
3.606000	---	26.78	46.00	19.22	5000.0	9.000	L1	FLO	10.3
3.621300	38.09	---	56.00	17.91	5000.0	9.000	L1	GND	10.3
Measurement uncertainty			±2.8 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 M276	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	

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal Due
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
F200106E1	21.12.2020	Initial Test Report
-	-	-
-	-	-

9 List of Annexes

Annex A Test Setup Photos 7 pages