

Test Report

Report Number:

F211305E3

Equipment under Test (EUT):

TRACKSENSE LYOPRO Access Point

Applicant:

Ellab A/S

Manufacturer:

Ellab A/S



Deutsche
Akkreditierungsstelle
D-PL-17186-01-01
D-PL-17186-01-02
D-PL-17186-01-03

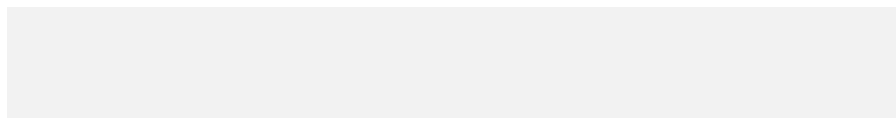
References

- [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
- [5] **RSS-Gen, Issue 5 (2021-02)** General Requirements for Compliance of Radio Apparatus

Test Result

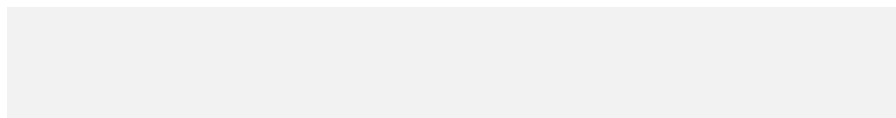
The requirements of the tests performed as shown in the overview (clause 4) were fulfilled by the equipment under test. The complete test results are presented in the following.
“Passed” indicates that the equipment under test conforms with the relevant limits of the testing standard without taking any measurement uncertainty into account as stated in clause 1.3 of ANSI C63.10 (2013). However, the measurement uncertainty is calculated and shown in this test report.

Tested and
written by:



Signature

Reviewed and
approved by:



Signature

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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.

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1 Identification

1.1 Applicant

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Country:	Denmark
Name for contact purposes:	Mr. James JACOBSSON
Phone:	+45 4452 0500
eMail Address:	info@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 0500
eMail Address:	info@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: *	IEEE 802.15.4 Access Point
PMN / Model name: *	TRACKSENSE LYOPRO Access Point
Model number: *	31206000
Order number: *	31206000
FCC ID: *	XUS-LYOAP1
IC: * ISED Certification number: *	8758A-LYOAP1

	EUT number		
	1	2	3
Serial number: *	635890	-	-
PCB identifier: *	900100114	-	-
Hardware version: * HVIN:*	66305200	-	-
Software version: * FVIN:*	N/A	-	-

* Declared by the applicant

EUT 1 was used for all tests.

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 EUT data			
Power supply EUT: *	AC/DC power adaptor		
Supply voltage EUT: *	$U_{nom} = 5.00 \text{ V}_{DC}$	$U_{min} = 4.75 \text{ V}_{DC}$	$U_{max} = 5.25 \text{ V}_{DC}$
Power supply EUT: *	USB interface		
Supply voltage EUT: *	$U_{nom} = 5.00 \text{ V}_{DC}$	$U_{min} = 4.75 \text{ V}_{DC}$	$U_{max} = 5.25 \text{ V}_{DC}$
Temperature range: *	+5 °C to +50 °C		
Supply voltage 802.15.4 ICs: *	$U_{nom} = 3.3 \text{ V}_{DC}$	$U_{min} = 3.2 \text{ V}_{DC}$	$U_{max} = 3.4 \text{ V}_{DC}$
Lowest / highest internal clock frequency: *	20 Hz / 2.475 GHz		

* Declared by the applicant

IEEE 802.15.4 radio part	
Fulfils radio specification: *	IEEE 802.15.4
Radio chip: *	AT86RF233* ²
Operating frequency range: *	2405 – 2475 MHz
Number of channels: *	15
Type of modulation: *	O-QPSK (250 kbit/s)
Antenna type: *	Mono pole antenna
Antenna name: *	2144150011 WiFi/BT Antenna by Molex
Antenna gain: *	5.3 dBi
Antenna connector: *	SMA reverse

* Declared by the applicant

*² The radio chip is used for both transmitters.

Ports / Connectors				
Identification	Connector		Length during test	Shielding (Yes / No)
	EUT	Ancillary		
Power connection	DC socket	AC plug / adapter	1 m	No
USB	USB-B	Laptop computer	2 m*	Yes
Ethernet	RJ45	Laptop computer	2 m* ²	Yes
-	-	-	-	-

* Length of the USB cable used for the antenna port conducted radio tests.

*² Length of the Ethernet cable used for the radiated radio tests.

IEEE 802.15.4 channels				
Channel 11	RX	2405 MHz	TX	2405 MHz
Channel 18	RX	2440 MHz	TX	2440 MHz
Channel 25	RX	2475 MHz	TX	2475 MHz

1.5.1 Ancillary Equipment / Equipment used for testing

Equipment used for testing	
Laptop computer* ¹	ThinkPad X1 Carbon
Reader Station for wireless data loggers* ¹	TrackSense LyoPro Reader Station by ellab A/S
Wireless data logger* ¹	TrackSense LyoPro (S/N: 557855 & 557771) by ellab A/S

*¹ Provided by the applicant

Ancillary equipment	
AC/DC adaptor* ¹	GE12I05-P1L by Mean Well
-	-

1.6 Dates

Date of receipt of test sample:	27.08.2021
Start of test:	02.09.2021
End of test:	09.09.2021

2 Operational States

2.1 Description of function of the EUT

The EUT is an 802.15.4 access point for communication to data loggers and the reader station, as well as allowing live data transmission to a PC.

The EUT contains two separate transceivers with the same radio chip, which each are connected to a separate antenna of the same model.

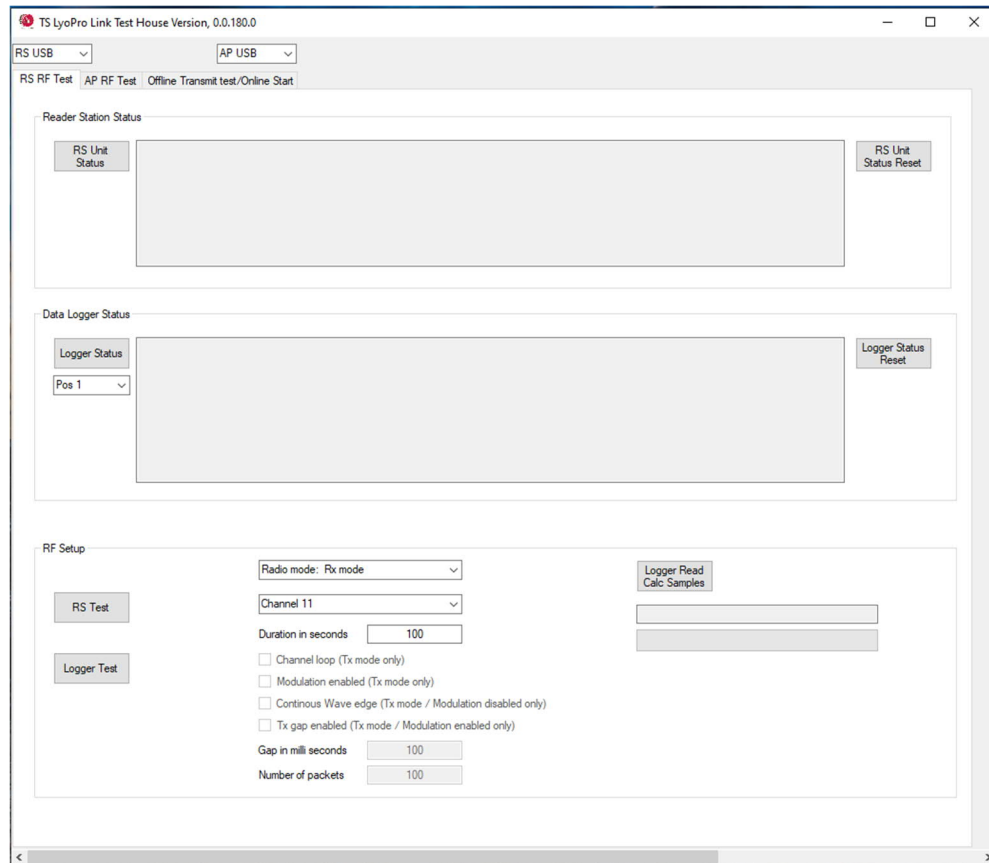
The conducted tests at the antenna port were performed at the SMA reverse antenna interfaces of the EUT.

The radiated tests were performed using the dedicated antennas.

2.2 The following states were defined as the operating conditions

A connection to the EUT was established via the USB or the Ethernet interface.

The test modes were started using test software named "TS LyoPro Link Test House Version, 0.0.180.0" running on a laptop computer. Both the laptop computer and the test software were provided by the applicant.



In the test software as detailed above, the test modes were set using the register card “AP RF Test”.



2.2.1 Operation modes Transceiver 1

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	+4dBm*
2	IEEE 802.15.4	2440	18	O-QPSK	250 kbit/s	+4dBm*
3	IEEE 802.15.4	2475	25	O-QPSK	250 kbit/s	+4dBm*

2.2.2 Operation modes Transceiver 2

Operation mode #	Radio technology	Frequency [MHz]	Channel / Band	Modulation / Mode	Data rate	Power setting
4	IEEE 802.15.4	2405	11	O-QPSK	250 kbit/s	+4dBm*
5	IEEE 802.15.4	2440	18	O-QPSK	250 kbit/s	+4dBm*
6	IEEE 802.15.4	2475	25	O-QPSK	250 kbit/s	+4dBm*

2.2.3 Operation simultaneous transmission

Operation mode 2 and 6 simultaneous (see tables above)

Operation mode #	Radio technology	Frequency [MHz]	Channel / Band	Modulation / Mode	Data rate	Power setting
7	IEEE 802.15.4	Transmitter 1: 2475 Transmitter 2: 2470	Transmitter 1: 25 Transmitter 2: 24	O-QPSK	250 kbit/s	+4dBm*
8	IEEE 802.15.4	Transmitter 1: 2475 Transmitter 2: 2405	Transmitter 1: 25 Transmitter 2: 11	O-QPSK	250 kbit/s	+4dBm*

2.2.4 Operation mode normal

A connection between the EUT and an ancillary device was established using the software TS LyoPro Link Test House Version, 0.0.180.0 (delivered by the applicant). The ancillary device was a wireless data logger type "TrackSense® LyoPro by ellab".

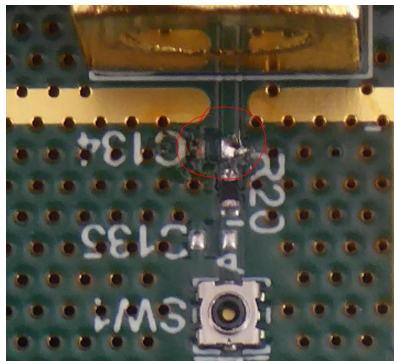
In the test software, the RSSI from the ancillary device, as well as the seconds since the last time the ancillary device was detected by the EUT, were displayed in the test software on the laptop computer.

The EUT was powered with 5 V DC via an AC/DC power adaptor as described in 1.5.1.

3 Additional Information

The EUT was not labeled as required by FCC / IC.

For the tests, the capacitor C134 was removed by the laboratory, as requested by the applicant. The photograph with the removed capacitor can be seen below. This was done to have the same antenna matching at both antenna ports.



4 Overview

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	RSS-247 [4] RSS-Gen [5]	Status	EUT
Maximum peak conducted output power	2400.0 - 2483.5	15.247 (b) (3), (4)	5.4 (d) [4]	Passed	-
Maximum conducted output power	2400.0 - 2483.5	15.247 (b) (3), (4)	5.4 (d) [4]	Not tested*1	1
DTS Bandwidth / 99% Bandwidth	2400.0 - 2483.5	15.247 (a) (2)	5.2 (a) [4]	Passed	1
Peak Power Spectral Density	2400.0 - 2483.5	15.247 (e)	5.2 (b) [4]	Passed	1
Average Power Spectral Density	2400.0 - 2483.5	15.247 (e)	5.2 (b) [4]	Not tested*1	-
Band edge compliance	2400.0 - 2483.5	15.247 (d) 15.205 (a) 15.209 (a)	5.5 [4]	Passed	1
Maximum unwanted emissions	0.009 – 26,500	15.247 (d) 15.205 (a) 15.209 (a)	8.9 [5]	Passed	1
Antenna Requirement	-	15.203 15.247 (b)	5.4 (f) (ii) [4]	Passed*2	-
Conducted emissions on supply line	0.15 - 30	§15.207 (a)	8.8 [4]	Passed	1

*1 Not necessary, testing of peak value is sufficient.

*2 Fix Antenna, gain below 6 dBi, no power reduction necessary.

5 Results

5.1 Test setup

5.1.1 Test Setup (radiated)

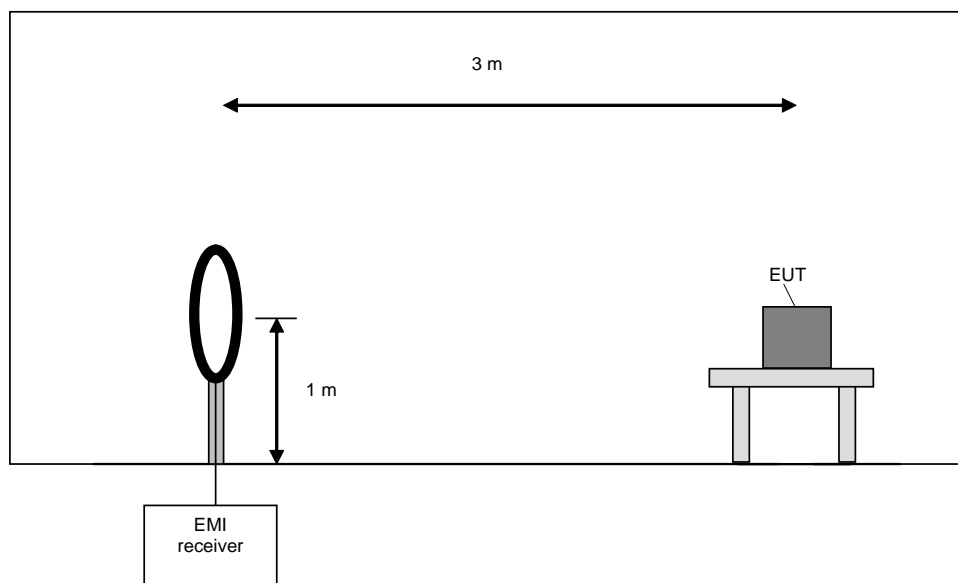
5.1.1.1 Preliminary measurement 9 kHz to 30 MHz

In the first stage a preliminary measurement is performed in an anechoic chamber with a measuring distance of 3 meters. Table-top and portable devices are set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices are placed directly on the turntable / ground plane. The setup of the equipment under test is in accordance to [1].

The frequency range 9 kHz to 30 MHz is monitored with an EMI receiver while the system and its cables are manipulated to find out the configuration with the maximum emission levels if applicable. The EMI receiver is set to MAX hold mode. The EUT and the measuring antenna are rotated around their vertical axis to find the maximum emission levels.

The resolution bandwidth of the EMI receiver is set to the following values:

Frequency range	Resolution bandwidth
9 kHz to 150 kHz	200 Hz
150 kHz to 30 MHz	9 kHz



Procedure preliminary measurement:

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

The following procedure is used:

- 1) Monitor the frequency range with the measuring antenna facing the EUT and an EUT / turntable azimuth of 0 °.
- 2) Manipulate the system cables to produce the maximum levels of emissions.
- 3) Rotate the EUT by 360 ° to maximize the detected signals.
- 4) Measure the frequencies of the highest detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency values.
- 5) If the EUT is portable or ceiling mounted, repeat steps 1 to 4 with other orientations (x,y,z) of the EUT.
- 6) Rotate the measuring antenna and repeat steps 1 to 5.

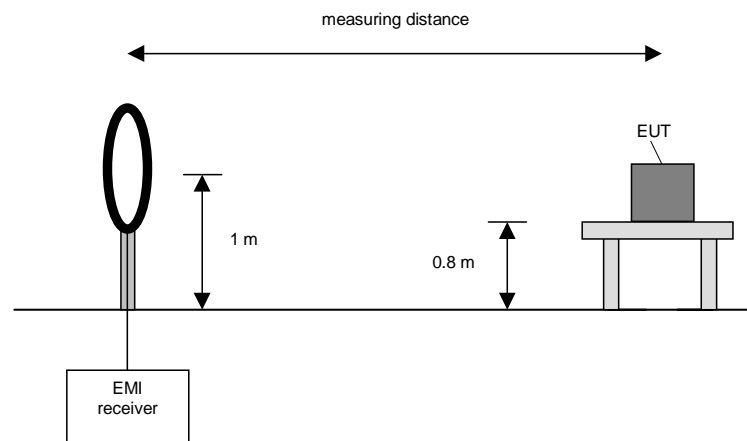
5.1.1.2 Final measurement 9 kHz to 30 MHz

In the second stage a final measurement is performed on an open area test site with no conducting ground plane in a measuring distances of 3 m, 10 m or 30 m. In the case where larger measuring distances are required the results are extrapolated based on the values measured on the closer distances according to section 15.31 (f) (2) [2]. The final measurement is performed with an 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 is used according section 15.209 (d) [2].

At the frequencies, which were detected during the preliminary measurements, the final measurement is performed while rotating the EUT and the measuring antenna in the range of 0 ° to 360 ° around their vertical axis until the maximum level value is found.

The resolution bandwidth of the EMI receiver is set to the following values:

Frequency range	Resolution bandwidth
9 kHz to 150 kHz	200 Hz
150 kHz to 30 MHz	9 kHz



Procedure final measurement:

The following procedure is used:

- 1) Monitor the selected frequencies from the preliminary measurement with the measuring antenna facing the EUT and an EUT azimuth of 0 °.
- 2) Rotate the EUT by 360 ° to maximize the detected signals.
- 3) Rotate the measuring antenna and repeat steps 1 to 2 until the maximum value is found and note it.
- 4) If the EUT is portable or ceiling mounted, repeat steps 1 to 3 with other orientations (x,y,z) of the EUT.

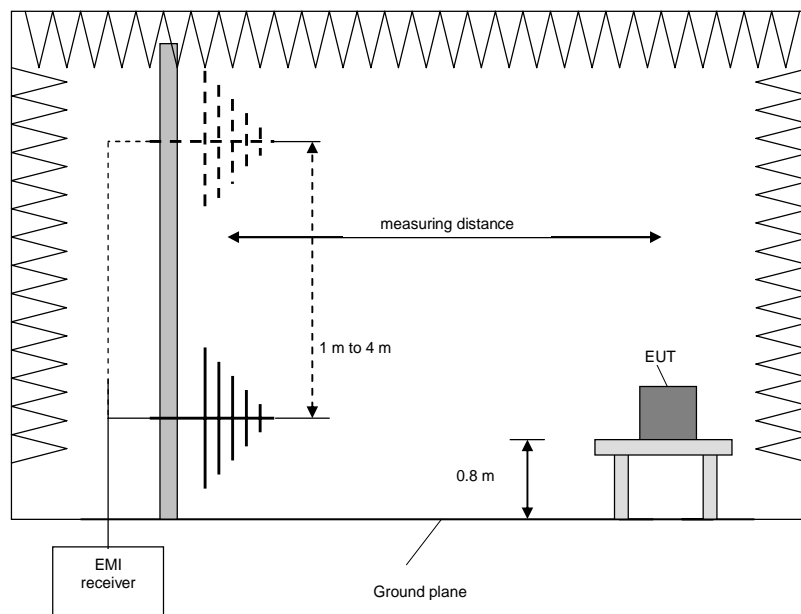
5.1.1.3 Preliminary and final measurement 30 MHz to 1 GHz

The preliminary and final measurements are performed in a semi-anechoic chamber with a metal ground plane in a 3 m distance.

During the tests the EUT is rotated in the range of 0 ° to 360 °, the measuring antenna is 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 is set to the following values:

Test	Frequency range	Step-size	Resolution bandwidth	Detector
Preliminary measurement	30 MHz to 1 GHz	30 kHz	120 kHz	Peak Average
Frequency peak search	± 120 kHz	10 kHz	120 kHz	Peak
Final measurement	30 MHz to 1 GHz	-	120 kHz	QuasiPeak



Procedure preliminary measurement:

The following procedure is used:

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

Procedure final measurement:

The following procedure is used:

- 1) Select the highest frequency peaks (lowest margin to the limit) for the final measurement.
- 2) The software determines the exact peak frequencies by doing a partial scan with reduced step size 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-case measuring antenna height is found via varying the height by +/- 0.5 m from the value obtained in the preliminary measurement while monitoring the emission level.
- 5) The worst-case turntable position is found via varying the turntable azimuth by +/- 30° from the value obtained in the preliminary measurement while monitoring the emission level.
- 6) The final measurement is performed at the worst-case measuring antenna height and the worst-case turntable azimuth.
- 7) Steps 2 to 6 are repeated for each frequency peak selected in step 1.

5.1.1.4 Preliminary and final measurement > 1 GHz

This measurement will be performed in a fully anechoic chamber. Tabletop and portable devices will set up on a non-conducting turn device on the height of 1.5m.

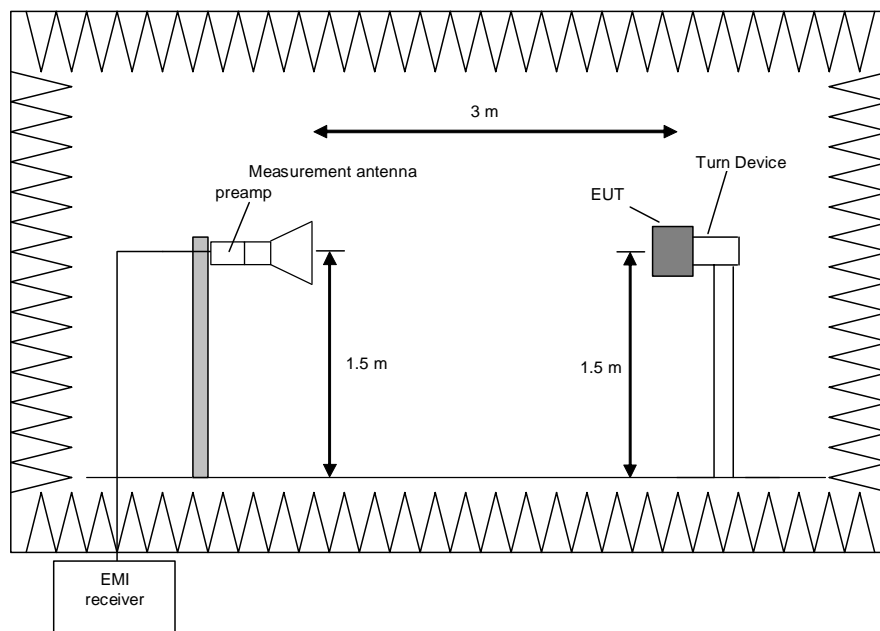
The set-up of the Equipment under test will be in accordance to [1].

Preliminary measurement (1 GHz to 40 GHz)

The frequency range will be divided into different sub ranges depending on 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:

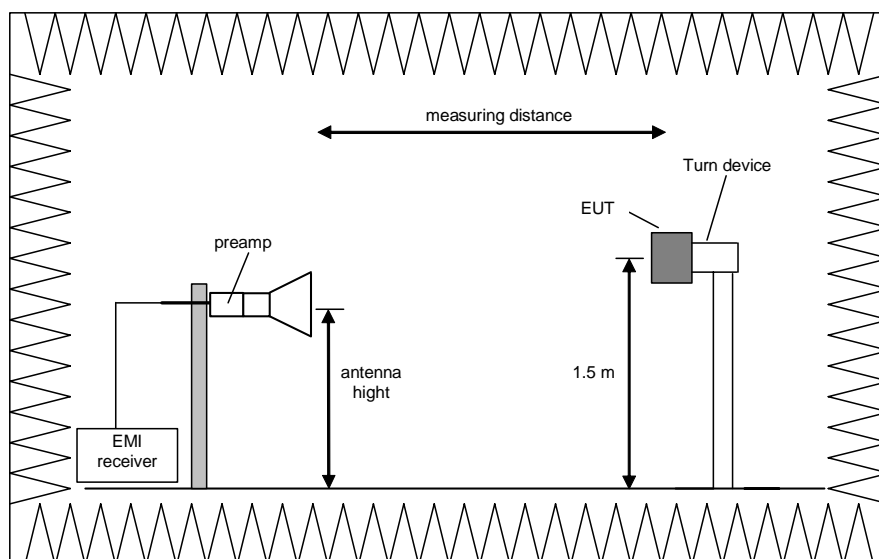
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Rotate the EUT by 360° to maximize the detected signals.
3. Repeat 1) to 2) with the vertical polarisation of the measuring antenna.
4. Make a hardcopy of the spectrum.
5. Repeat 1) to 4) with the EUT raised by an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

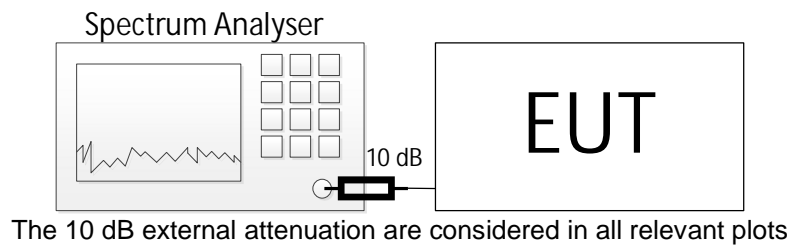
The measurements were performed in the frequency ranges 1 GHz to 4 GHz, 4 GHz to 12 GHz, 12 GHz to 18 GHz, 18 GHz to 25 /26.5 GHz and 26.5 GHz to 40 GHz.

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.

5.1.2 Test setup (conducted)

Test setup (conducted)		
Used	Antenna connector	Comment
<input type="checkbox"/>	Temporary antenna connector	As provided by the applicant
<input checked="" type="checkbox"/>	Normal antenna connector	



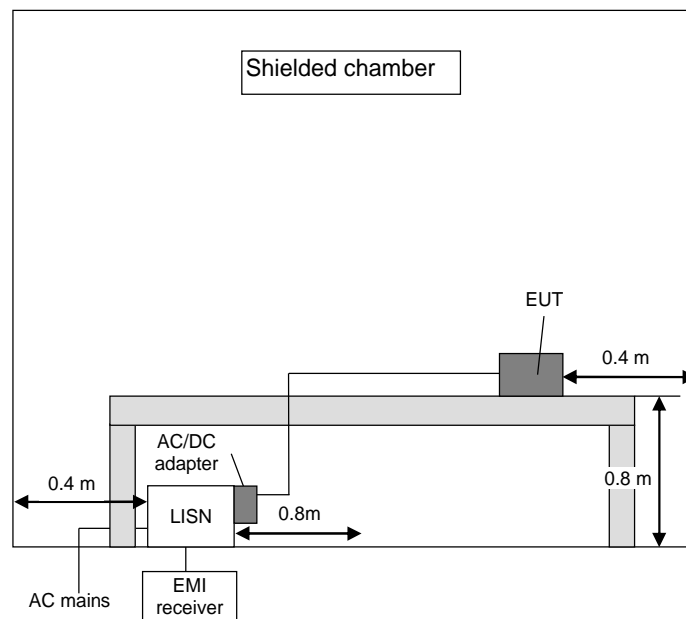
5.1.3 Test setup (AC powerline)

The test is carried out in a shielded chamber. Table-top and portable devices are 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 are placed directly on the ground plane. In case of DC powered equipment, which is not exclusively powered by a battery, it is connected to the LISN via a suitable AC/DC adaptor. The setup of the equipment under test is in accordance to [1].

The frequency range 150 kHz to 30 MHz is measured with an EMI receiver set to MAX hold mode with Peak and Average detectors and a resolution bandwidth of 9 kHz. A scan is carried out on the phase and neutral line of the AC mains network. If emissions less than 10 dB below the appropriate limit are detected, these emissions are measured with an Average and Quasi-Peak detector on all lines.

Frequency range	Resolution bandwidth
150 kHz to 30 MHz	9 kHz

5.1.3.1 Test setup (AC powerline) with AC/DC adapter



5.2 Duty cycle

5.2.1 Test setup (Duty cycle)

Test setup (Duty cycle)			
Used	Setup	See sub-clause	Comment
<input type="checkbox"/>	Test setup (radiated)	5.1.1	
<input checked="" type="checkbox"/>	Test setup (antenna port conducted)	5.1.2	

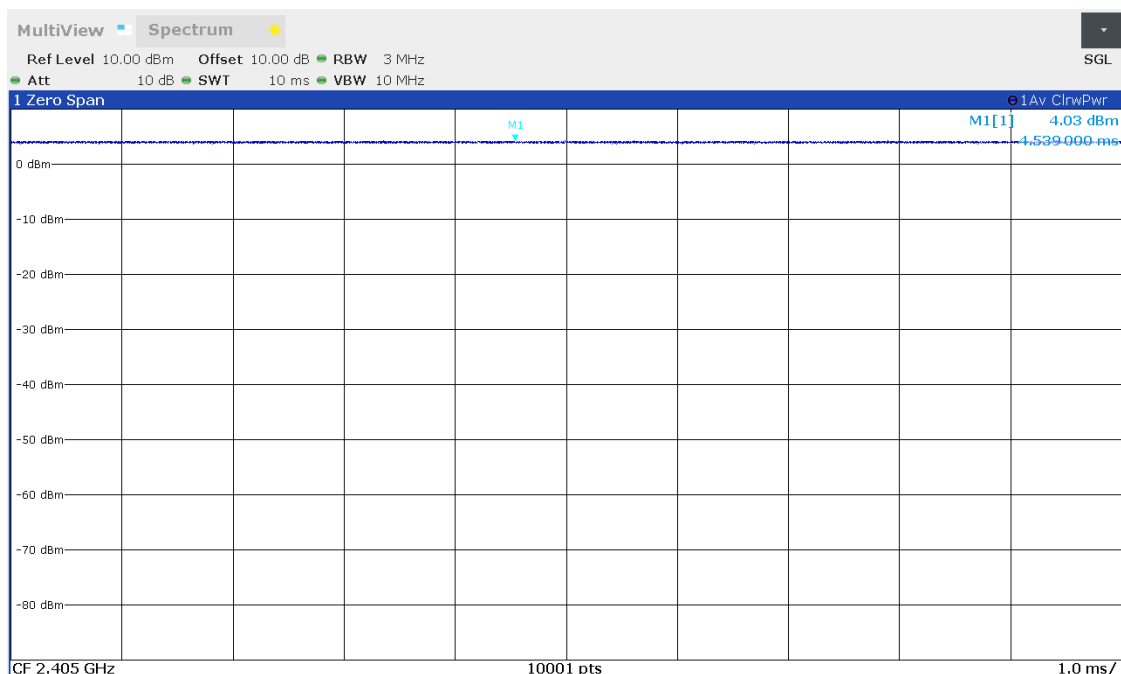
5.2.2 Test method (Duty cycle)

Test method (Duty cycle)				
Used	Sub-Clause [3]	Name of method	Applicability	Comment
<input type="checkbox"/>	11.6. a)	Diode detector	No limitation	
<input checked="" type="checkbox"/>	11.6. b)	Zero span	No limitation	

5.2.3 Test results (Duty cycle)

Ambient temperature:	22 °C
Relative humidity:	50 %

Date:	13.09.2021
Tested by:	P. NEUFELD



No DCCF is applied, duty cycle $\geq 98\%$.

Test equipment (please refer to chapter 6 for details)
1, 2

5.3 Transmit Antenna Performance considerations

Test result (Transmit antenna requirements)			
Integral antenna	Antenna gain \leq 6dBi	Result	Comment
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Passed	No output power reduction necessary

5.4 DTS bandwidth

5.4.1 Test setup (DTS bandwidth)

Test setup (Duty cycle)			
Used	Setup	See sub-clause	Comment
<input type="checkbox"/>	Test setup (radiated)	5.1.1	
<input checked="" type="checkbox"/>	Test setup (antenna port conducted)	5.1.2	

5.4.2 Test method (DTS bandwidth)

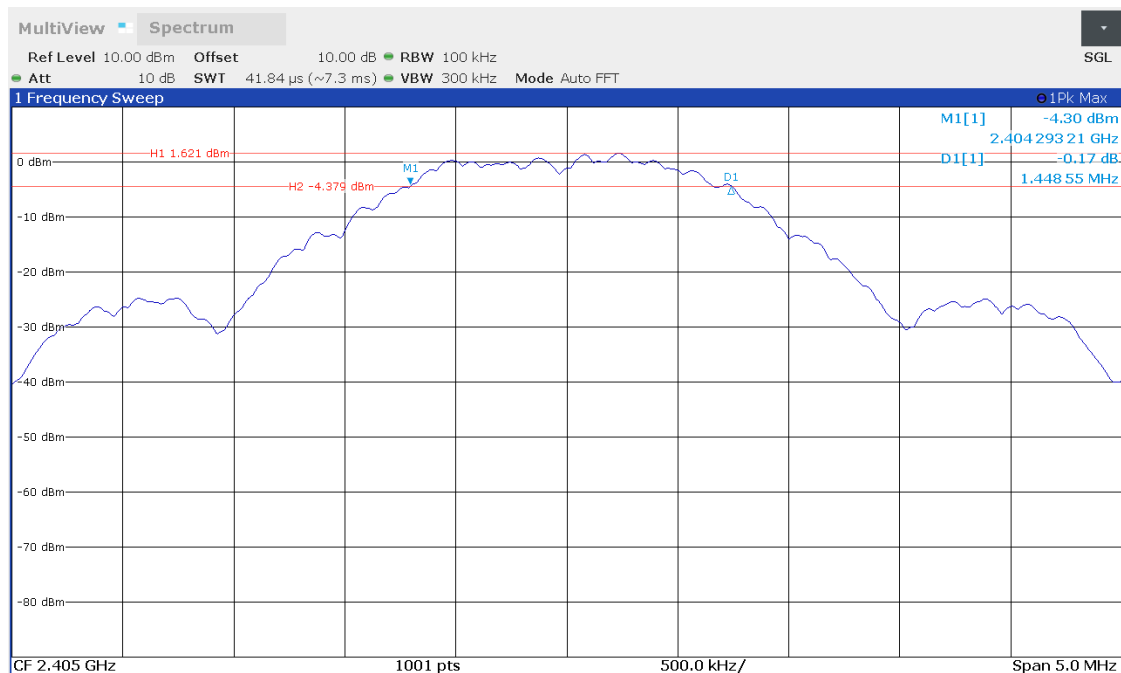
Test method				
Used	Sub-Clause [3]	Name of method	Applicability	Comment
<input checked="" type="checkbox"/>	11.8.1	Option 1	No limitations	
<input type="checkbox"/>	11.8.2	Option 2	No limitations	6 dB down function

5.4.3 Test results (DTS bandwidth)

Ambient temperature:	22 °C
Relative humidity:	50 %

Date	13.09.2021
Tested by	P. NEUFELD

Worst case mode (operation mode 4):



Operation mode #	DTS bandwidth [MHz]	Minimum DTS bandwidth Limit [MHz]	Result
1	1.488511	0.5	Passed
2	1.508492	0.5	Passed
3	1.513487	0.5	Passed
4	1.448551	0.5	Passed
5	1.473526	0.5	Passed
6	1.518482	0.5	Passed
Measurement uncertainty:		9.0×10 ⁻⁸	

Test equipment (please refer to chapter 6 for details)
1, 2

5.5 Occupied bandwidth – power bandwidth (99%)

5.5.1 Test Setup (Occupied bandwidth – power bandwidth (99%))

Test setup (Occupied bandwidth – power bandwidth (99%))			
Used	Setup	See sub-clause	Comment
<input type="checkbox"/>	Test setup (radiated)	5.1.1	
<input checked="" type="checkbox"/>	Test setup (antenna port conducted)	5.1.2	

5.5.2 Test method (Occupied bandwidth – power bandwidth (99%))

Test method				
Used	Sub-Clause [3]	Name of method	Applicability	Comment
<input type="checkbox"/>	6.9.2	relative measurement procedure		n-dB down
<input checked="" type="checkbox"/>	6.9.3	power bandwidth (99%)	*1	99% power function

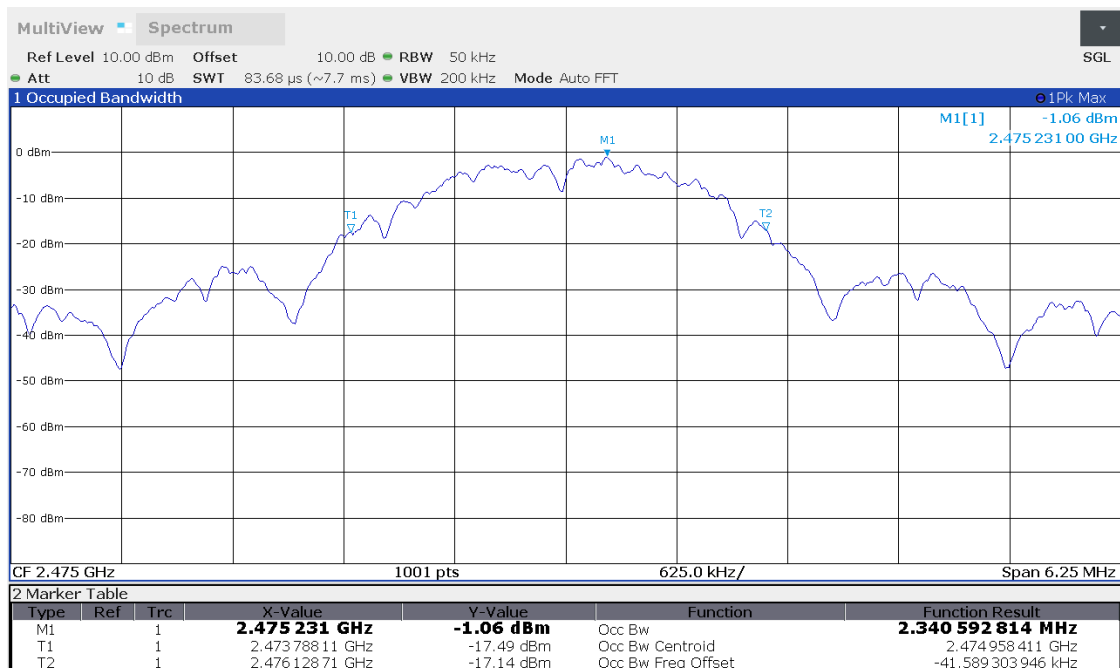
*1 See RSS-GEN Issue 5 (2018-05) sub-clause 6.7 for details.

5.5.3 Test results (Occupied bandwidth – power bandwidth (99%))

Ambient temperature:	22 °C
Relative humidity:	50 %

Date	13.09.2021
Tested by	P. NEUFELD

Worst-case plot (operation mode 3):



Operation mode #	99% bandwidth [MHz]
1	2.276859
2	2.312456
3	2.340593
4	2.265649
5	2.297368
6	2.314466
Measurement uncertainty: 9.0×10^{-8}	

Test equipment (please refer to chapter 6 for details)
1, 2

5.6 DTS fundamental emission output power

5.6.1 Test setup (DTS fundamental emission output power)

Test setup (DTS fundamental emission output power)			
Used	Setup	See sub-clause	Comment
<input type="checkbox"/>	Test setup (radiated)	5.1.1	
<input checked="" type="checkbox"/>	Test setup (antenna port conducted)	5.1.2	

5.6.2 Test method (DTS fundamental emission output power)

Test method				
Used	Sub-Clause [3]	Name of method	Applicability	Comment
<input checked="" type="checkbox"/>	11.9.1.1	RBW \geq DTS bandwidth		
<input type="checkbox"/>	11.9.1.2	Integrated band power method	Not for DTS	
<input type="checkbox"/>	11.9.1.3	PKPM1 Peak power meter method* ¹		

*¹ Check if the VBW of the Peak power meter is $>$ OBW of the fundamental emission.

Test method (Maximum conducted (average) output power)				
Used	Sub-Clause [3]	Name of method	Applicability	Comment
<input type="checkbox"/>	11.9.2.2.2	Method AVGSA-1	$D \geq 98\%$	
<input type="checkbox"/>	11.9.2.2.3	Method AVGSA-1A (alternative)	$D \geq 98\%$	
<input type="checkbox"/>	11.9.2.2.4	Method AVGSA-2	Constant D ($\pm 2\%$)	
<input type="checkbox"/>	11.9.2.2.5	Method AVGSA-2A (alternative)	Constant D ($\pm 2\%$)	
<input type="checkbox"/>	11.9.2.2.6	Method AVGSA-3A		
<input type="checkbox"/>	11.9.2.2.7	Method AVGSA-3A (alternative)		
<input type="checkbox"/>	11.9.2.3.1	Method AVGPM	Constant D ($\pm 2\%$)	
<input type="checkbox"/>	11.9.2.3.2	Method AVGPM-G		

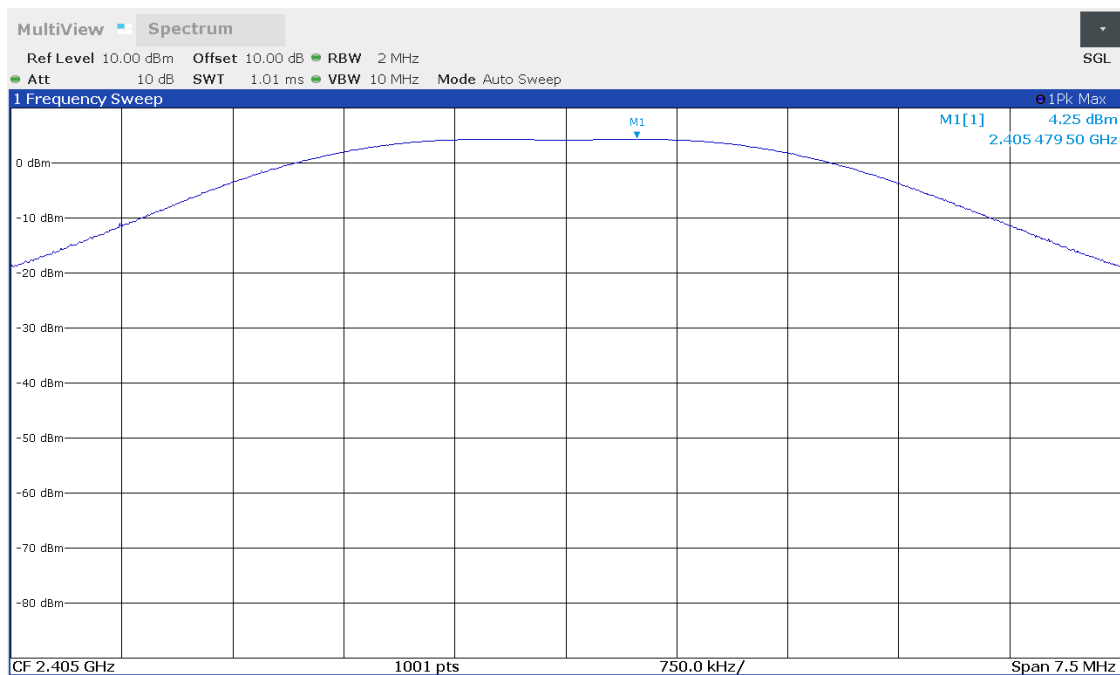
5.6.3 Test results (DTS fundamental emission output power)

Maximum peak conducted output power:

Ambient temperature:	22 °C
Relative humidity:	50 %

Date	13.09.2021
Tested by	P. NEUFELD

Worst case plot (operation mode 4):



Operation mode	Reading [dBm]	Corr. Fact.* [dB]	Result [dBm]	Limit [dBm]
1	4.1	1.0	5.1	30
2	4.1	1.0	5.1	30
3	4.1	1.0	5.1	30
4	4.3	1.0	5.3	30
5	4.2	1.0	5.2	30
6	4.2	1.0	5.2	30
Measurement uncertainty: +/- 2.3 dB				

* Cable attenuation

Test equipment (please refer to chapter 6 for details)
1, 2

5.7 DTS maximum PSD level in the fundamental emission

5.7.1 Test setup (DTS maximum PSD level in the fundamental emission)

Test setup (DTS fundamental emission output power)			
Used	Setup	See sub-clause	Comment
<input type="checkbox"/>	Test setup (radiated)	5.1.1	
<input checked="" type="checkbox"/>	Test setup (antenna port conducted)	5.1.2	

5.7.2 Test method (DTS maximum PSD level in the fundamental emission)

Test method (Maximum <i>peak</i> power spectral density level in the fundamental emission)				
Used	Sub-Clause [3]	Name of method	Applicability	Comment
<input checked="" type="checkbox"/>	11.10.2	Method PKPSD (peak PSD)	No limitations	

Test method (Maximum <i>peak</i> power spectral density level in the fundamental emission)				
Used	Sub-Clause [3]	Name of method	Applicability	Comment
<input type="checkbox"/>	11.10.3	Method AVGPSD-1	$D \geq 98\%$	
<input type="checkbox"/>	11.10.4	Method AVGPSD-1A (alternative)	$D \geq 98\%$	
<input type="checkbox"/>	11.10.5	Method AVGPSD-2	Constant D ($\pm 2\%$)	
<input type="checkbox"/>	11.10.6	Method AVGPSD-2A (alternative)	Constant D ($\pm 2\%$)	
<input type="checkbox"/>	11.10.7	Method AVGPSD-3	No limitations	
<input type="checkbox"/>	11.10.8	Method AVGPSD-3A (alternative)	No limitations	

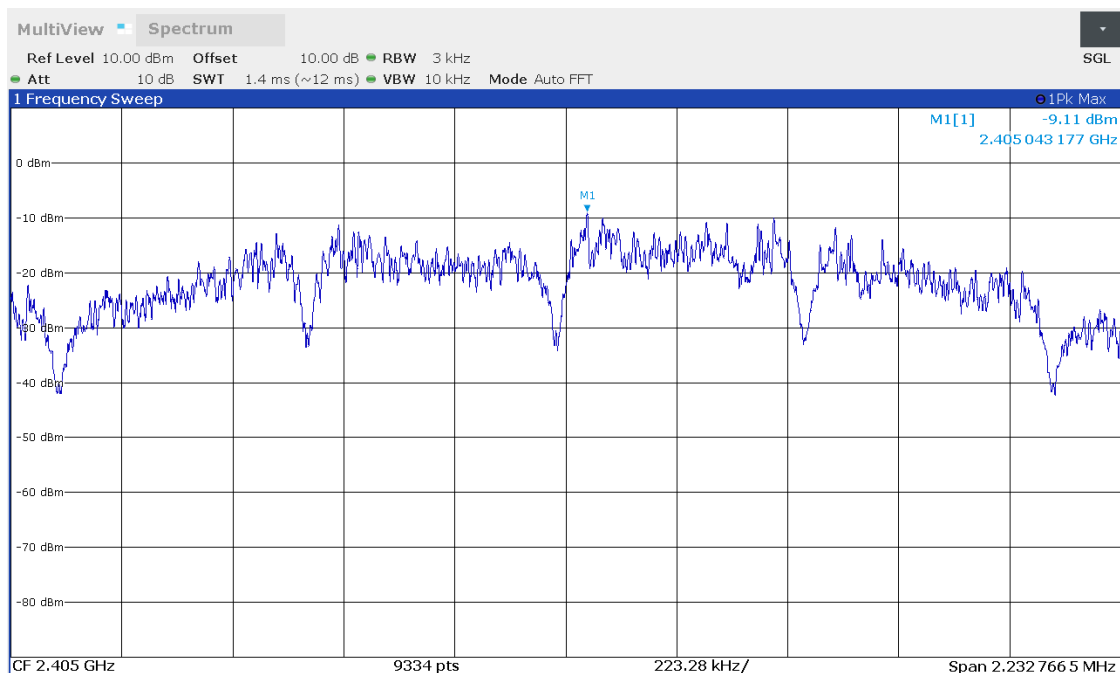
5.7.3 Test results (DTS maximum PSD level in the fundamental emission)

Maximum peak PSD:

Ambient temperature:	22 °C
Relative humidity:	50 %

Date	13.09.2021
Tested by	P. NEUFELD

Worst case plot (operation mode 1):



Operation mode	Reading [dBm/3 kHz]	Corr. Fact.* [dB]	Result [dBm/3 kHz]	Limit [dBm/3 kHz]
1	-9.1	1.0	-8.1	8.0
2	-9.4	1.0	-8.4	8.0
3	-9.6	1.0	-8.6	8.0
4	-9.3	1.0	-8.3	8.0
5	-9.4	1.0	-8.4	8.0
6	-9.4	1.0	-8.4	8.0
Measurement uncertainty: +/- 2.3 dB				

* Cable attenuation

Test equipment (please refer to chapter 6 for details)
1, 2

5.8 Band edge

5.8.1 Test setup (Band edge – unrestricted bands)

Test setup (Band edge – unrestricted bands)			
Used	Setup	See sub-clause	Comment
<input type="checkbox"/>	Test setup (radiated)	5.1.1	
<input checked="" type="checkbox"/>	Test setup (antenna port conducted)	5.1.2	

5.8.2 Test method (Band edge – unrestricted bands)

Test method (Band edge – unrestricted bands)				
Used	Sub-Clause [3]	Name of method	Applicability	Comment
<input checked="" type="checkbox"/>	11.11.	20 dBc (Peak)	Peak power	*1
<input type="checkbox"/>	11.11.	30 dBc (Average)	RMS power	*2

*1 As declared in “47 CFR 15.247(d)” In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits

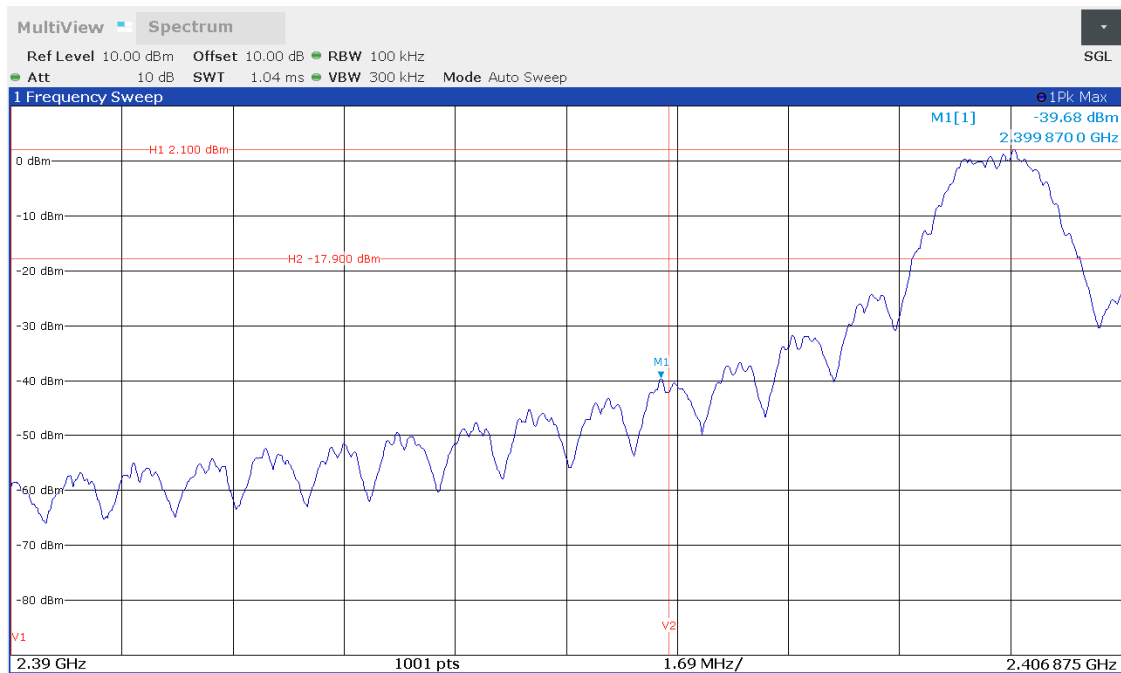
*2 If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

5.8.3 Test results (Band edge – unrestricted bands)

Ambient temperature:	20 °C
Relative humidity:	50 %

Date	13.09.2021
Tested by	P. NEUFELD

Worst case plot (operation mode 1):



Operation mode	Frequency [MHz]	Reference [dB μ V/m]	Limit [dB μ V/m]	Unrestricted band emission [dB μ V/m]	Margin [dB]	Result
1	2399.87	1.8	-18.2	-40.1	21.9	Passed
4	2399.87	2.1	-17.9	-39.7	21.8	Passed
Measurement uncertainty: +/- 2.3 dB						

Test equipment (please refer to chapter 6 for details)
1, 2

5.8.4 Test setup (Band edge – restricted bands)

Test setup (Band edge – restricted bands)			
Used	Setup	See sub-clause	Comment
<input checked="" type="checkbox"/>	Test setup (radiated)	5.1.1	
<input type="checkbox"/>	Test setup (antenna port conducted)	5.1.2	

5.8.5 Test method (Band edge – restricted bands)

Test method (Band edge – restricted bands)				
Used	Sub-Clause [3]	Name of method	Applicability	Comment
<input checked="" type="checkbox"/>	11.13.1	Standard method	No limitations	
<input type="checkbox"/>	11.13.2	Marker-delta method		See 6.10.6 [3]
<input type="checkbox"/>	11.13.3.2	Peak detection	Not for DTS testing	2 MHz from band
<input type="checkbox"/>	11.13.3.3	Trace averaging with cont. EUT	D ≥ 98%	2 MHz from band
<input type="checkbox"/>	11.13.3.4	Trace averaging with cont. EUT & D	Constant D (±2%)	2 MHz from band
<input type="checkbox"/>	11.13.3.5	Reduced VBW		2 MHz from band

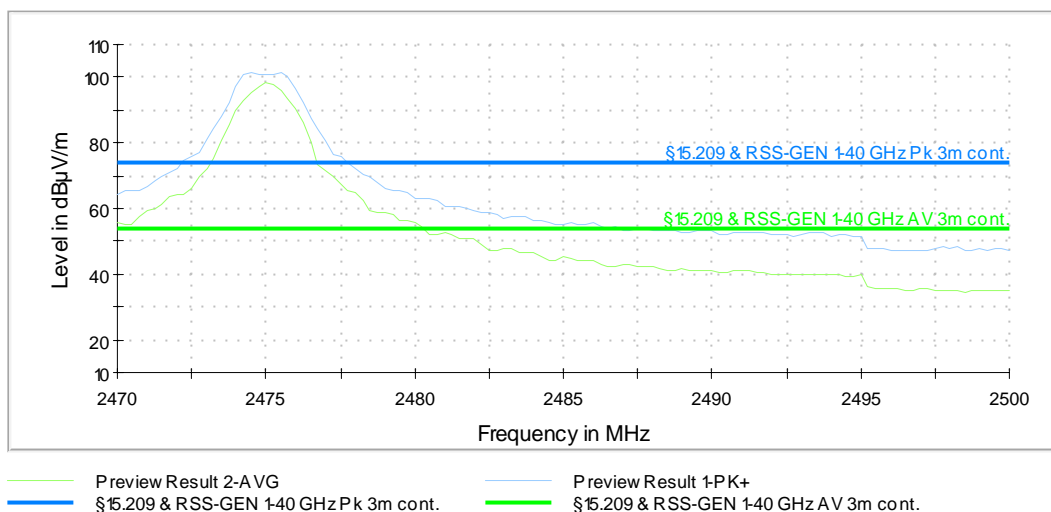
*1

5.8.6 Test results (Band edge – restricted bands)

Ambient temperature:	23 °C; 22 % 23 °C
Relative humidity:	49 %; 49 % 50 %

Date	02.09.2021; 06.09.2021 07.09.2021
Tested by	P. NEUFELD

Worst case plot (operation mode 6):



Lower band edge (operation mode 1):

Frequency [MHz]	Result (Pk) [dB μ V/m]	Result (Av) [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Result
2390.000	---	37.04	54.0	17.0	Passed
2390.000	49.60	---	74.0	24.4	Passed
Measurement uncertainty: +/- 5.1 dB					

Upper band edge (operation mode 3):

Frequency [MHz]	Result (Pk) [dB μ V/m]	Result (Av) [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Result
2484.000	54.90	---	74.0	19.1	Passed
2484.000	---	45.06	54.0	8.9	Passed
2484.250	55.09	---	74.0	18.9	Passed
2484.250	---	44.17	54.0	9.8	Passed
Measurement uncertainty: +/- 5.1 dB					

Lower band edge (operation mode 4):

Frequency [MHz]	Result (Pk) [dB μ V/m]	Result (Av) [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Result
2390.000	49.79	---	74.0	24.0	Passed
2390.000	---	38.66	54.0	15.3	Passed
Measurement uncertainty: +/- 5.1 dB					

Upper band edge (operation mode 6):

Frequency [MHz]	Result (Pk) [dB μ V/m]	Result (Av) [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Result
2484.000	---	46.55	54.0	7.5	Passed
2484.000	55.95	---	74.0	18.0	Passed
2485.000	53.95	---	74.0	20.1	Passed
2485.000	---	43.68	54.0	10.3	Passed
Measurement uncertainty: +/- 5.1 dB					

Test equipment (please refer to chapter 6 for details)

3 – 9, 11

5.9 Maximum unwanted emissions

5.9.1 Test setup (Maximum unwanted emissions)

Test setup (Maximum unwanted emissions)			
Used	Setup	See sub-clause	Comment
<input checked="" type="checkbox"/>	Test setup (radiated)	5.1.1	
<input type="checkbox"/>	Test setup (antenna port conducted)	5.1.2	

5.9.2 Test method (Maximum unwanted emissions)

- Test method (radiated) see sub-clause 5.1.1 as described herein

5.9.3 Test results (Maximum unwanted emissions)

5.9.3.1 Test results (9 kHz – 30 MHz)

Ambient temperature:	22 °C
Relative humidity:	50 %

Date	03.09.2021
Tested by	P. NEUFELD

Position of EUT: For tests for f between 9 kHz to 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.

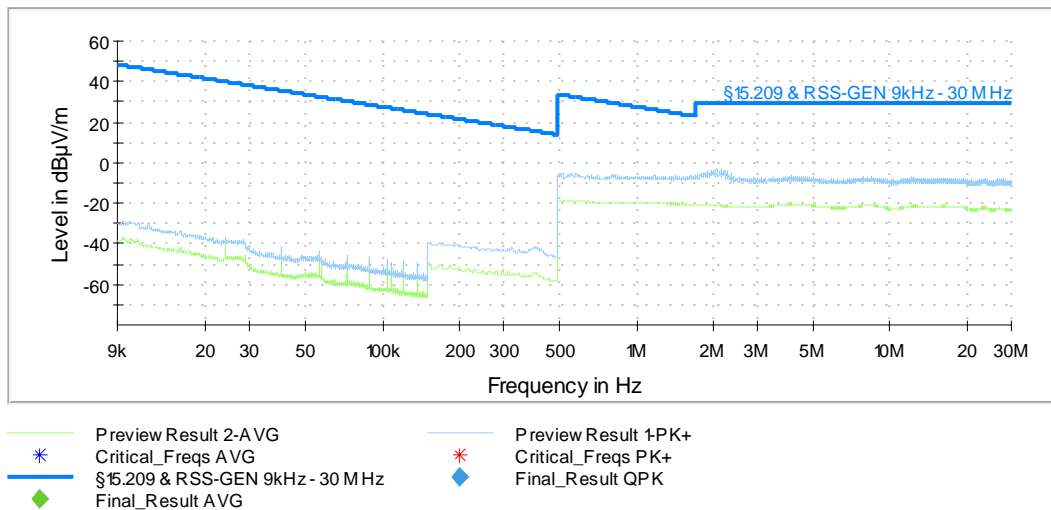
Test record: The measurement value was already corrected by 40 dB/decade as described in §15.31 (f) (2) regarding to the measurement distance as requested in §15.209

Remark: Result [dB μ V/m] = Reading [dB μ V] + Correction [dB μ V/m]
 Correction [dB μ V/m] = AF [dB/m] + Cable attenuation [dB] + distance correction factor [dB]
 Margin [dB] = Limit [dB μ V/m] - Result [dB μ V/m]
 Table-top device, tested in representative setup.

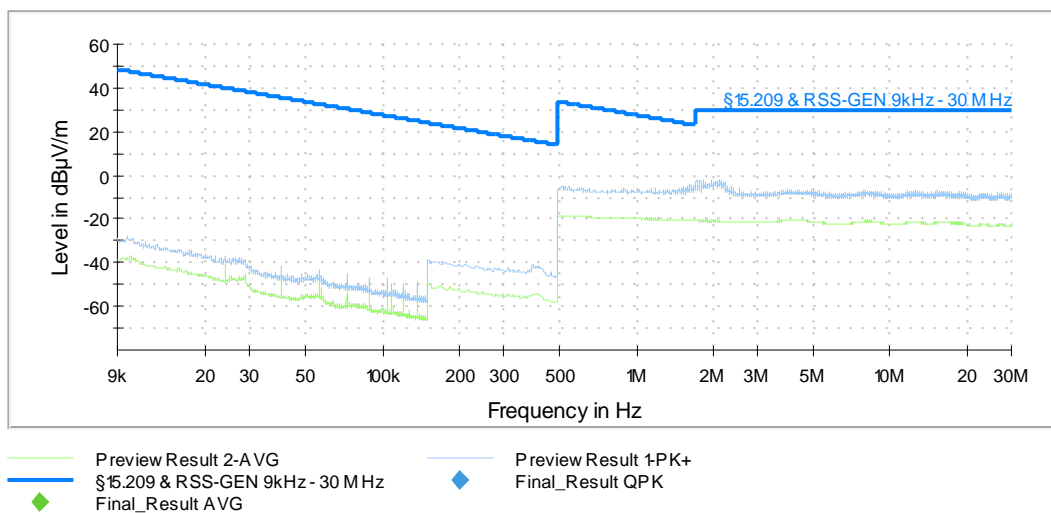
Since no differences occurred by changing the channel and or the active transceiver, only a representative plot is submitted below.

5.9.3.1.1 Plots

5.9.3.1.1.1 (All operation modes):



5.9.3.1.1.2 (Simultaneous transmissions, transmitter 1 – ch11, transmitter 2 – ch25):



5.9.3.1.2 Result tables

5.9.3.1.2.1 (All operation modes):

No final measurement was done because no emissions closer than 20 dB to the limit

Test equipment (please refer to chapter 6 for details)

3, 4, 6 – 9, 18

5.9.3.2 Test results (30 MHz – 1 GHz)

Ambient temperature:	22 °C
Relative humidity:	50 %

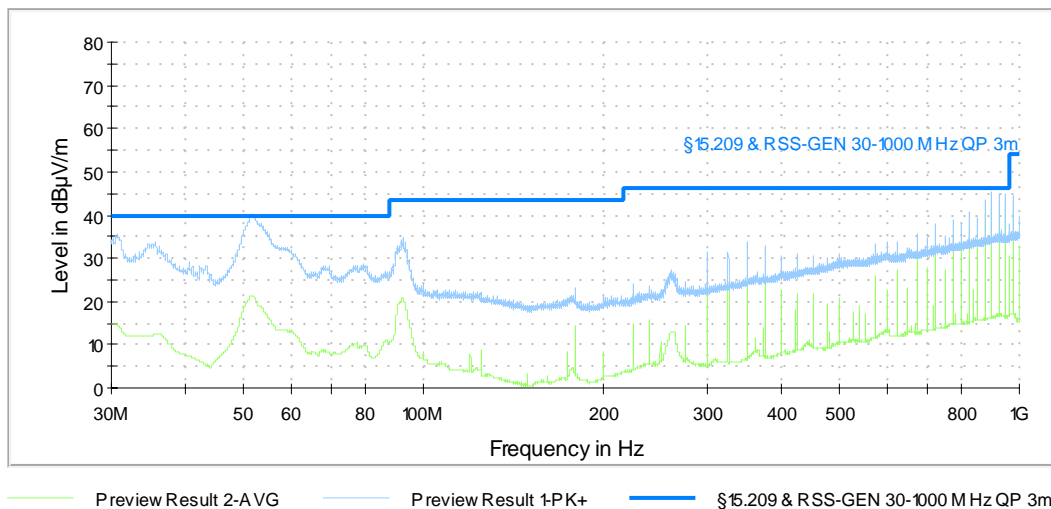
Date	03.09.2021
Tested by	P. NEUFELD

- Position of EUT:** For tests for f between 30 MHz to 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:** Plots for each frequency range are submitted below.
- Remark:** Result [dB μ V/m] = Reading [dB μ V] + Correction [dB μ V/m]
 Correction [dB μ V/m] = AF [dB/m] + Cable attenuation [dB] + optional preamp gain [dB]
 Margin [dB] = Limit [dB μ V/m] - Result [dB μ V/m]
 Table-top device, tested in representative setup.

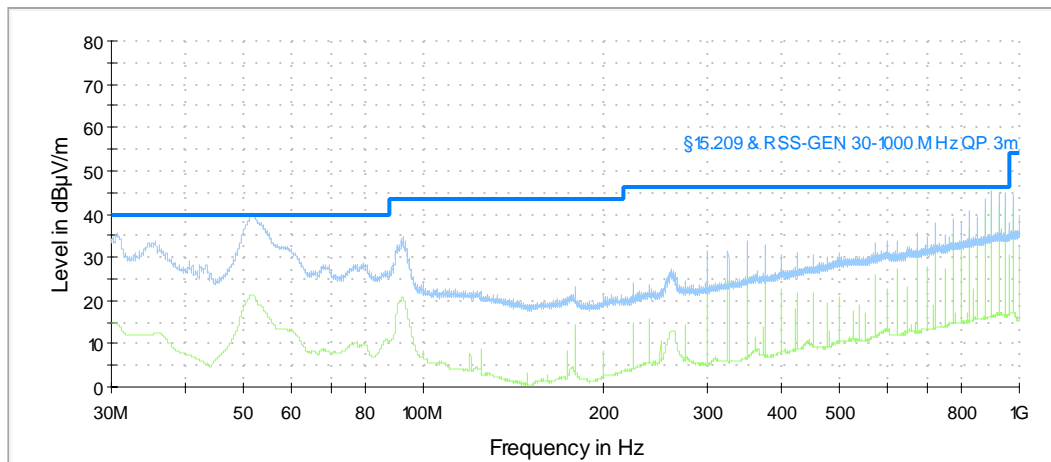
Since no differences occurred by changing the channel and or the active transceiver, only a representative plot is submitted below.

5.9.3.2.1 Plots

- 5.9.3.2.1.1 (All operation modes):
 Spurious emissions from 30 MHz to 1 GHz:



5.9.3.2.1.2 (Simultaneous transmissions, transmitter 1 – ch18, transmitter 2 – ch25):
Spurious emissions from 30 MHz to 1 GHz:



Preview Result 2-AVG Preview Result 1PK+ §15.209 & RSS-GEN 30-1000 MHz QP 3m

5.9.3.2.2 Result tables

5.9.3.2.2.1 (All operation modes):

Frequency [MHz]	Result QP [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Readings [dBµV]	Correction [dB/m]	Height [cm]	Azimuth [deg]	Pol.	Result
51.600	36.13	40.0	3.9	23.0	13.1	100.0	340	V	Passed
825.030	38.14	46.0	7.9	8.9	29.2	140.0	230	V	Passed
875.030	43.58	46.0	2.4	14.0	29.6	162.0	185	V	Passed
900.030	42.70	46.0	3.3	12.7	30.0	155.0	182	V	Passed
925.030	42.76	46.0	3.3	12.6	30.2	100.0	301	H	Passed
950.030	40.26	46.0	5.8	10.0	30.2	100.0	307	H	Passed
Measurement uncertainty				±5.5 dB					

5.9.3.2.2.2 (Simultaneous transmissions, transmitter 1 – ch18, transmitter 2 – ch25):

Frequency [MHz]	Result QP [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]	Readings [dB μ V]	Correction [dB/m]	Height [cm]	Azimuth [deg]	Pol.	Result
52.200	34.68	40.0	5.3	21.8	12.8	100.0	-20	V	Passed
825.030	38.57	46.0	7.5	9.4	29.2	146.0	230	V	Passed
875.030	44.05	46.0	2.0	14.5	29.6	162.0	178	V	Passed
900.030	42.70	46.0	3.3	12.7	30.0	153.0	175	V	Passed
925.030	44.25	46.0	1.8	14.1	30.2	148.0	176	V	Passed
950.040	41.35	46.0	4.7	11.1	30.2	138.0	172	V	Passed
Measurement uncertainty				±5.5 dB					

Test equipment (please refer to chapter 6 for details)

3 – 9, 16, 17

5.9.3.3 Test results (above 1 GHz)

Ambient temperature:	23 °C; 22 °C 22 °C; 23 °C 23 °C; 23 °C
Relative humidity:	49 %, 50 % 49 %; 50 % 51 %; 57 %

Date	02.09.2021; 03.09.2021; 06.09.2021; 07.09.2021; 08.09.2021; 09.09.2021;
Tested by	P. NEUFELD

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.

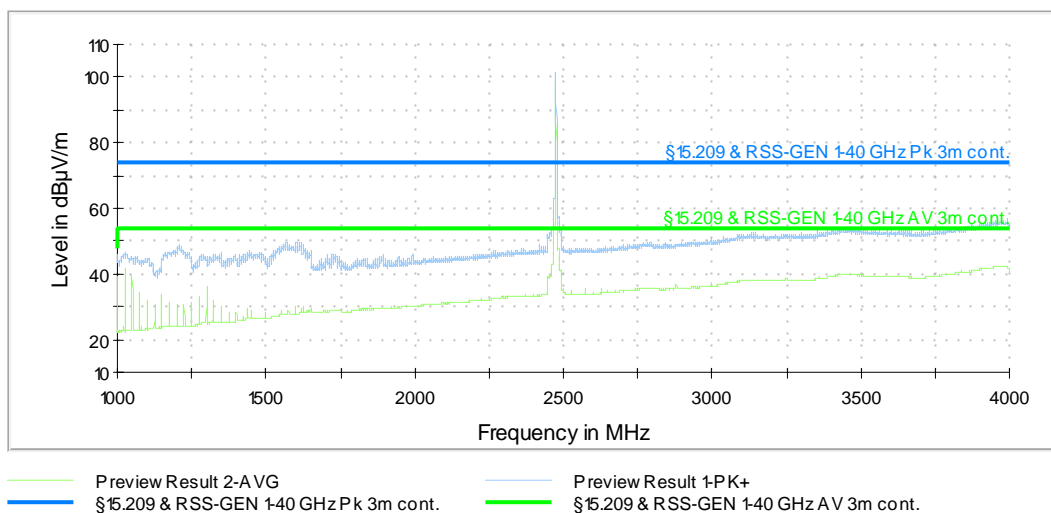
Test record: Plots for each frequency range are submitted below.

Remark: Max Peak [dBμV/m] = Reading [dBμV] + Correction [dBμV/m]
Average [dBμV/m] = Reading [dBμV] + Correction [dBμV/m]
Correction [dBμV/m] = AF [dB/m] + Cable attenuation [dB] + optional preamp gain [dB]+DCCF [dB] (if applicable)
Margin [dB] = Limit [dBμV/m] – Max Peak // Average [dBμV/m]

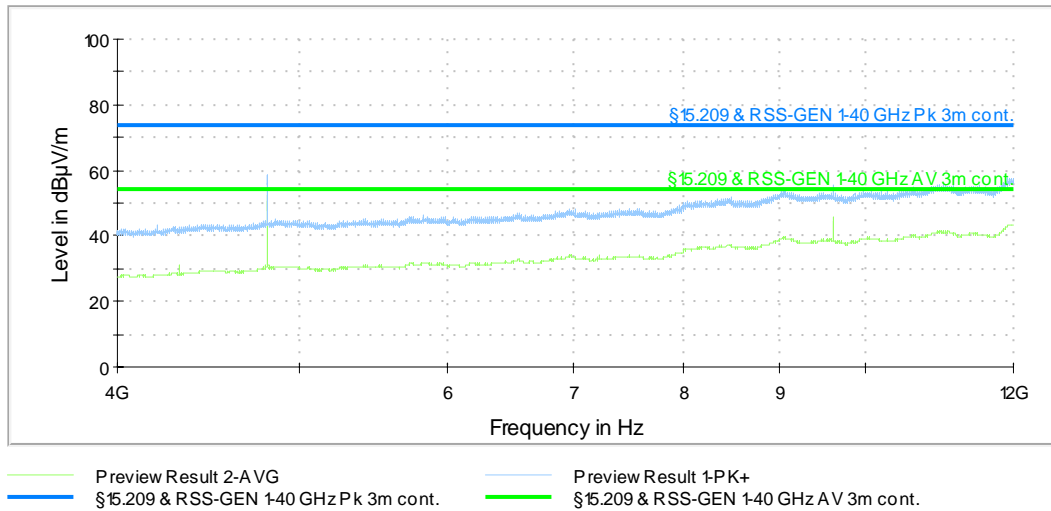
5.9.3.3.1 Plots

5.9.3.3.1.1 Plots of the worst-case operation modes

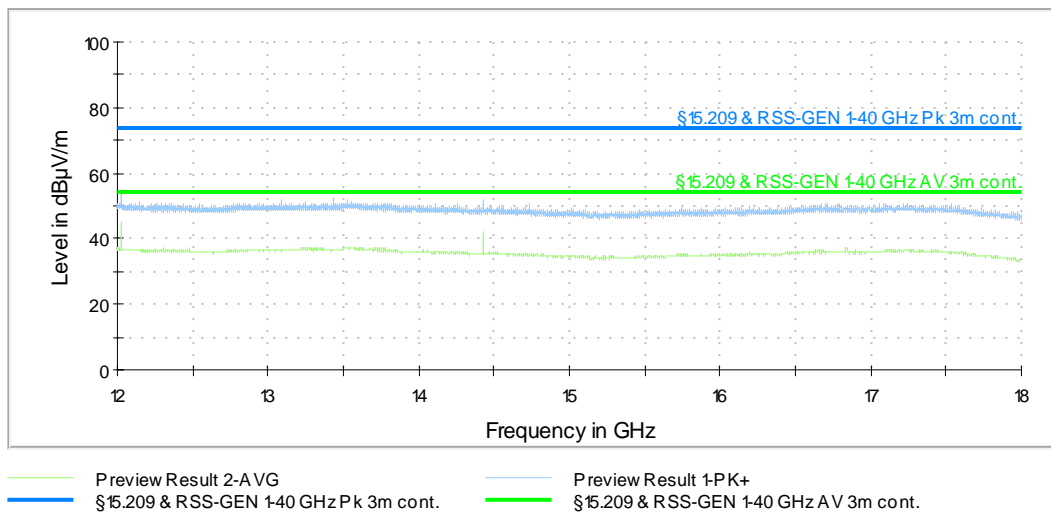
Spurious emissions from 1 GHz to 4 GHz (Operation mode 6):



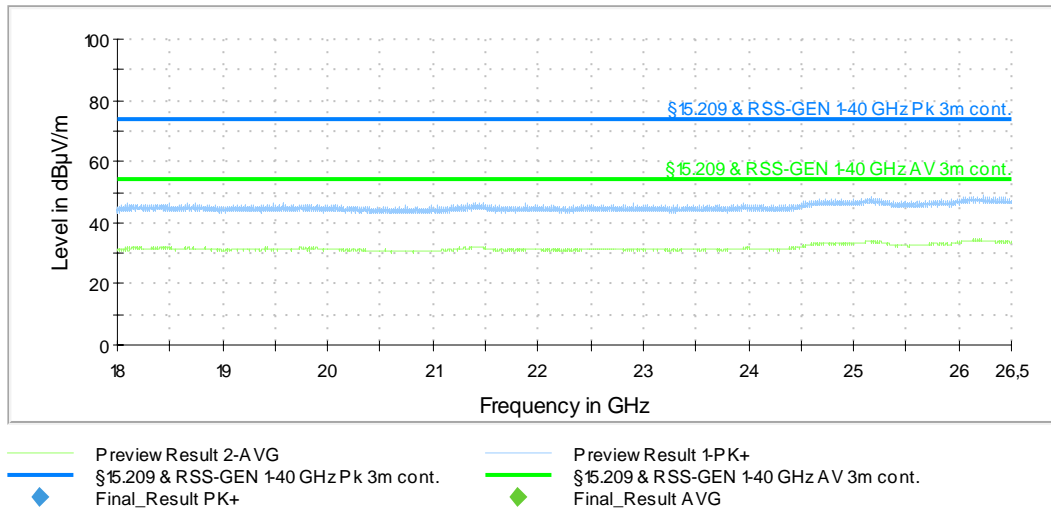
Spurious emissions from 4 GHz to 12 GHz (operation mode 1):



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



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



5.9.3.3.2 Result tables

5.9.3.3.2.1 (operation mode 1):

Frequency [MHz]	MaxPeak [dBµV/m]	Average [dBµV/m]	Limit [dBµV/m]	Margin (dB)	Reading [dBµV]	Corr. [dB/m]	Pol	Azimuth [deg]	Elevation [deg]	Comment
1000.000	40.87	---	74.0	33.1	15.2	25.6	H	228	120	Passed
1000.000	---	32.83	54.0	21.2	7.2	25.6	H	228	120	Passed
1025.000	45.24	---	74.0	28.8	19.5	25.8	H	160	0	Passed
1025.000	---	40.84	54.0	13.2	15.1	25.8	H	160	0	Passed
1050.000	41.72	---	74.0	32.3	15.7	26.0	V	50	0	Passed
1050.000	---	34.74	54.0	19.3	8.7	26.0	V	50	0	Passed
2390.000	---	37.04	54.0	17.0	1.8	35.2	H	324	0	Passed
2390.000	49.60	---	74.0	24.4	14.4	35.2	H	324	0	Passed
2405.500	---	97.99	54.0	-44.0	62.7	35.3	H	205	60	Fund.
2405.500	101.48	---	74.0	-27.5	66.2	35.3	H	205	60	Fund.
4319.900	40.69	---	74.0	33.3	33.2	7.5	H	242	120	Passed
4319.900	---	28.75	54.0	25.2	21.3	7.5	H	242	120	Passed
4810.950	58.57	---	74.0	15.4	48.8	9.7	H	282	120	Passed
4810.950	---	52.04	54.0	2.0	42.3	9.7	H	282	120	Passed
9622.250	53.45	---	74.0	20.6	34.7	18.8	H	334	30	Passed
9622.250	---	42.23	54.0	11.8	23.5	18.8	H	334	30	Passed
12027.350	54.34	---	74.0	19.7	43.7	10.6	V	146	150	Passed
12027.350	---	44.77	54.0	9.2	34.1	10.6	V	146	150	Passed
14432.950	49.97	---	74.0	24.0	39.4	10.6	H	218	90	Passed
14432.950	---	38.87	54.0	15.1	28.3	10.6	H	218	90	Passed
Measurement uncertainty					+/- 5.9 dB					

5.9.3.3.2.2 (operation mode 2):

Frequency [MHz]	MaxPeak [dBμV/m]	Average [dBμV/m]	Limit [dBμV/m]	Margin (dB)	Reading [dBμV]	Corr. [dB/m]	Pol	Azimuth [deg]	Elevation [deg]	Comment
1000.000	---	35.01	54.0	19.0	9.4	25.6	H	222	120	Passed
1000.000	41.94	---	74.0	32.1	16.3	25.6	H	222	120	Passed
1025.000	---	38.87	54.0	15.1	13.1	25.8	H	229	150	Passed
1025.000	43.60	---	74.0	30.4	17.8	25.8	H	229	150	Passed
1075.000	42.58	---	74.0	31.4	16.4	26.2	V	328	30	Passed
1075.000	---	36.53	54.0	17.5	10.3	26.2	V	328	30	Passed
2440.000	101.23	---	74.0	-27.2	65.8	35.4	H	209	30	Fund.
2440.000	---	99.83	54.0	-45.8	64.4	35.4	H	209	30	Fund.
4878.950	55.87	---	74.0	18.1	46.0	9.9	H	284	90	Passed
4878.950	---	47.24	54.0	6.8	37.3	9.9	H	284	90	Passed
7321.450	---	37.49	54.0	16.5	23.0	14.5	H	31	90	Passed
7321.450	49.08	---	74.0	24.9	34.6	14.5	H	31	90	Passed
9762.100	57.92	---	74.0	16.1	39.5	18.5	H	319	30	Passed
9762.100	---	49.44	54.0	4.6	31.0	18.5	H	319	30	Passed
12197.500	---	43.96	54.0	10.0	33.5	10.5	V	210	0	Passed
12197.500	54.60	---	74.0	19.4	44.1	10.5	V	210	0	Passed
12202.350	---	44.35	54.0	9.6	33.9	10.5	V	211	0	Passed
12202.350	53.62	---	74.0	20.4	43.1	10.5	V	211	0	Passed
14636.400	---	36.27	54.0	17.7	25.7	10.5	H	139	90	Passed
14636.400	48.57	---	74.0	25.4	38.0	10.5	H	139	90	Passed
14642.750	---	39.71	54.0	14.3	29.2	10.5	H	148	90	Passed
14642.750	50.73	---	74.0	23.3	40.2	10.5	H	148	90	Passed
Measurement uncertainty					+/- 5.9 dB					

5.9.3.3.2.3 (operation mode 3):

Frequency [MHz]	MaxPeak [dBμV/m]	Average [dBμV/m]	Limit [dBμV/m]	Margin (dB)	Reading [dBμV]	Corr. [dB/m]	Pol	Azimuth [deg]	Elevation [deg]	Comment
1000.000	41.75	---	74.0	32.2	16.1	25.6	H	213	120	Passed
1000.000	---	34.88	54.0	19.1	9.2	25.6	H	213	120	Passed
1025.000	---	40.47	54.0	13.5	14.7	25.8	H	214	150	Passed
1025.000	44.55	---	74.0	29.4	18.8	25.8	H	214	150	Passed
1050.000	---	34.66	54.0	19.3	8.7	26.0	H	165	0	Passed
1050.000	41.56	---	74.0	32.4	15.6	26.0	H	165	0	Passed
2475.000	100.38	---	74.0	-26.4	65.0	35.4	H	67	150	Fund.
2475.000	---	99.03	54.0	-45.0	63.7	35.4	H	67	150	Fund.
2484.000	54.90	---	74.0	19.1	19.5	35.4	H	304	0	Passed
2484.000	---	45.06	54.0	8.9	9.7	35.4	H	304	0	Passed
2484.250	55.09	---	74.0	18.9	19.7	35.4	H	307	0	Passed
2484.250	---	44.17	54.0	9.8	8.8	35.4	H	307	0	Passed
4949.000	52.91	---	74.0	21.1	42.9	10.0	H	278	120	Passed
4949.000	---	43.95	54.0	10.1	33.9	10.0	H	278	120	Passed
7426.600	49.89	---	74.0	24.1	34.9	15.0	H	37	90	Passed
7426.600	---	39.85	54.0	14.2	24.8	15.0	H	37	90	Passed
9897.950	---	48.40	54.0	5.6	28.9	19.5	H	306	120	Passed
9897.950	57.86	---	74.0	16.1	38.4	19.5	H	306	120	Passed
9901.850	---	49.63	54.0	4.4	30.1	19.5	H	306	120	Passed
9901.850	57.62	---	74.0	16.4	38.1	19.5	H	306	120	Passed
12372.600	---	45.80	54.0	8.2	35.3	10.5	V	243	30	Passed
12372.600	55.76	---	74.0	18.2	45.2	10.5	V	243	30	Passed
12377.350	---	44.77	54.0	9.2	34.2	10.5	V	244	30	Passed
12377.350	54.23	---	74.0	19.8	43.7	10.5	V	244	30	Passed
17328.450	---	37.52	54.0	16.5	27.8	9.7	H	286	60	Passed
17328.450	49.37	---	74.0	24.6	39.6	9.7	H	286	60	Passed
Measurement uncertainty					+/- 5.9 dB					

5.9.3.3.2.4 (operation mode 4):

Frequency [MHz]	MaxPeak [dB μ V/m]	Average [dB μ V/m]	Limit [dB μ V/m]	Margin (dB)	Reading [dB μ V]	Corr. [dB/m]	Pol	Azimuth [deg]	Elevation [deg]	Comment
1000.000	43.42	---	74.0	30.6	17.8	25.6	H	207	120	Passed
1000.000	---	37.61	54.0	16.4	12.0	25.6	H	207	120	Passed
1025.000	44.98	---	74.0	29.0	19.2	25.8	H	206	150	Passed
1025.000	---	41.14	54.0	12.9	15.4	25.8	H	206	150	Passed
1075.000	42.80	---	74.0	31.2	16.6	26.2	V	325	30	Passed
1075.000	---	36.35	54.0	17.7	10.1	26.2	V	325	30	Passed
2405.000	101.99	---	74.0	-28.0	66.7	35.3	H	153	60	Fund.
2405.000	---	100.58	54.0	-46.6	65.3	35.3	H	153	60	Fund.
4810.950	---	50.03	54.0	4.0	40.3	9.7	H	278	60	Passed
4810.950	57.07	---	74.0	16.9	47.3	9.7	H	278	60	Passed
9621.550	---	43.25	54.0	10.7	24.5	18.8	H	319	60	Passed
9621.550	53.69	---	74.0	20.3	34.9	18.8	H	319	60	Passed
12022.600	53.43	---	74.0	20.6	42.8	10.7	H	323	150	Passed
12022.600	---	42.46	54.0	11.5	31.8	10.7	H	323	150	Passed
12027.350	53.53	---	74.0	20.5	42.9	10.6	H	323	150	Passed
12027.350	---	43.37	54.0	10.6	32.7	10.6	H	323	150	Passed
14427.000	52.04	---	74.0	22.0	41.5	10.6	H	257	90	Passed
14427.000	---	40.64	54.0	13.4	30.1	10.6	H	257	90	Passed
14432.950	51.75	---	74.0	22.3	41.2	10.6	H	259	90	Passed
14432.950	---	40.99	54.0	13.0	30.4	10.6	H	259	90	Passed
Measurement uncertainty					+/- 5.9 dB					

5.9.3.3.2.5 (operation mode 5):

Frequency [MHz]	MaxPeak [dB μ V/m]	Average [dB μ V/m]	Limit [dB μ V/m]	Margin (dB)	Reading [dB μ V]	Corr. [dB/m]	Pol	Azimuth [deg]	Elevation [deg]	Comment
1000.000	43.69	---	74.0	30.3	18.0	25.6	H	210	120	Passed
1000.000	---	38.16	54.0	15.8	12.5	25.6	H	210	120	Passed
1025.000	45.23	---	74.0	28.8	19.5	25.8	H	210	150	Passed
1025.000	---	41.32	54.0	12.7	15.5	25.8	H	210	150	Passed
1075.000	42.42	---	74.0	31.6	16.2	26.2	V	325	30	Passed
1075.000	---	36.68	54.0	17.3	10.5	26.2	V	325	30	Passed
2440.000	101.41	---	74.0	-27.4	66.0	35.4	H	154	60	Fund.
2440.000	---	99.99	54.0	-46.0	64.6	35.4	H	154	60	Fund.
4878.950	---	48.17	54.0	5.8	38.3	9.9	H	279	60	Passed
4878.950	56.76	---	74.0	17.2	46.8	9.9	H	279	60	Passed
7318.750	---	37.68	54.0	16.3	23.2	14.5	H	324	90	Passed
7318.750	48.67	---	74.0	25.3	34.2	14.5	H	324	90	Passed
9758.050	---	49.45	54.0	4.6	31.0	18.5	H	332	120	Passed
9758.050	58.89	---	74.0	15.1	40.4	18.5	H	332	120	Passed
9761.950	---	51.11	54.0	2.9	32.7	18.5	H	331	120	Passed
9761.950	59.06	---	74.0	14.9	40.6	18.5	H	331	120	Passed
12197.700	---	42.81	54.0	11.2	32.3	10.5	H	323	60	Passed
12197.700	53.01	---	74.0	21.0	42.5	10.5	H	323	60	Passed
12202.350	---	42.19	54.0	11.8	31.7	10.5	H	325	60	Passed
12202.350	52.72	---	74.0	21.3	42.2	10.5	H	325	60	Passed
14637.100	---	38.10	54.0	15.9	27.6	10.5	H	221	120	Passed
14637.100	50.17	---	74.0	23.8	39.6	10.5	H	221	120	Passed
14643.650	---	34.86	54.0	19.1	24.3	10.5	H	227	120	Passed
14643.650	47.84	---	74.0	26.2	37.3	10.5	H	227	120	Passed
Measurement uncertainty					+/- 5.9 dB					

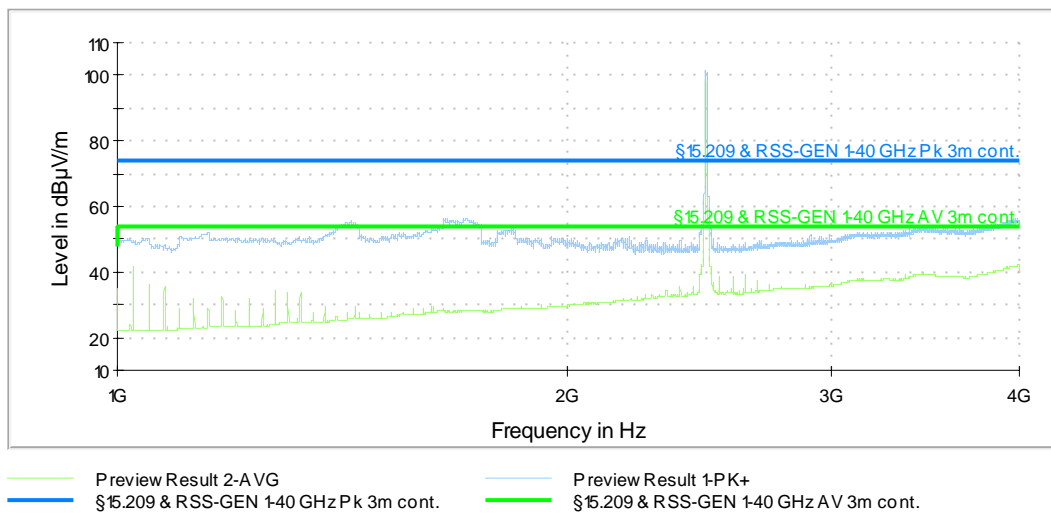
5.9.3.3.2.6 (operation mode 6):

Frequency [MHz]	MaxPeak [dBμV/m]	Average [dBμV/m]	Limit [dBμV/m]	Margin (dB)	Reading [dBμV]	Corr. [dB/m]	Pol	Azimuth [deg]	Elevation [deg]	Comment
1000.000	---	35.67	54.0	18.3	10.0	25.6	H	158	0	Passed
1000.000	42.18	---	74.0	31.8	16.5	25.6	H	158	0	Passed
1025.000	---	40.42	54.0	13.6	14.6	25.8	H	226	150	Passed
1025.000	44.97	---	74.0	29.0	19.2	25.8	H	226	150	Passed
1050.000	40.32	---	74.0	33.7	14.3	26.0	H	174	0	Passed
1050.000	---	31.55	54.0	22.5	5.5	26.0	H	174	0	Passed
2484.000	---	46.55	54.0	7.5	11.2	35.4	H	295	90	Passed
2484.000	55.95	---	74.0	18.0	20.6	35.4	H	295	90	Passed
2485.000	53.95	---	74.0	20.1	18.6	35.4	H	288	90	Passed
2485.000	---	43.68	54.0	10.3	8.3	35.4	H	288	90	Passed
4949.000	51.24	---	74.0	22.8	41.2	10.0	H	284	90	Passed
4949.000	---	41.68	54.0	12.3	31.6	10.0	H	284	90	Passed
7426.350	52.69	---	74.0	21.3	37.7	15.0	H	314	60	Passed
7426.350	---	43.36	54.0	10.6	28.4	15.0	H	314	60	Passed
9897.950	---	50.37	54.0	3.6	30.9	19.5	H	327	120	Passed
9897.950	59.62	---	74.0	14.4	40.1	19.5	H	327	120	Passed
9901.900	---	51.90	54.0	2.1	32.4	19.5	H	326	120	Passed
9901.900	59.53	---	74.0	14.5	40.0	19.5	H	326	120	Passed
12372.500	53.97	---	74.0	20.0	43.4	10.5	H	284	90	Passed
12372.500	---	43.58	54.0	10.4	33.0	10.5	H	284	90	Passed
12377.450	54.33	---	74.0	19.7	43.8	10.5	H	284	90	Passed
12377.450	---	44.29	54.0	9.7	33.8	10.5	H	284	90	Passed
14846.400	47.07	---	74.0	26.9	36.6	10.5	H	282	90	Passed
14846.400	---	34.87	54.0	19.1	24.4	10.5	H	282	90	Passed
14852.650	48.99	---	74.0	25.0	38.5	10.5	H	257	90	Passed
14852.650	---	38.00	54.0	16.0	27.5	10.5	H	257	90	Passed
Measurement uncertainty					+/- 5.9 dB					

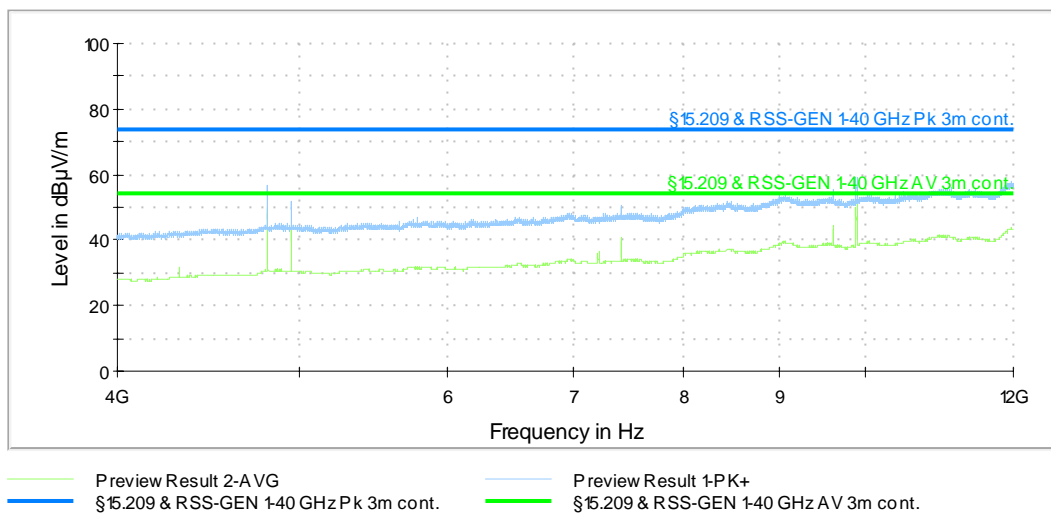
5.9.3.3.3 Plots (Simultaneous transmissions)

5.9.3.3.3.1 Plots of the worst-case operation modes

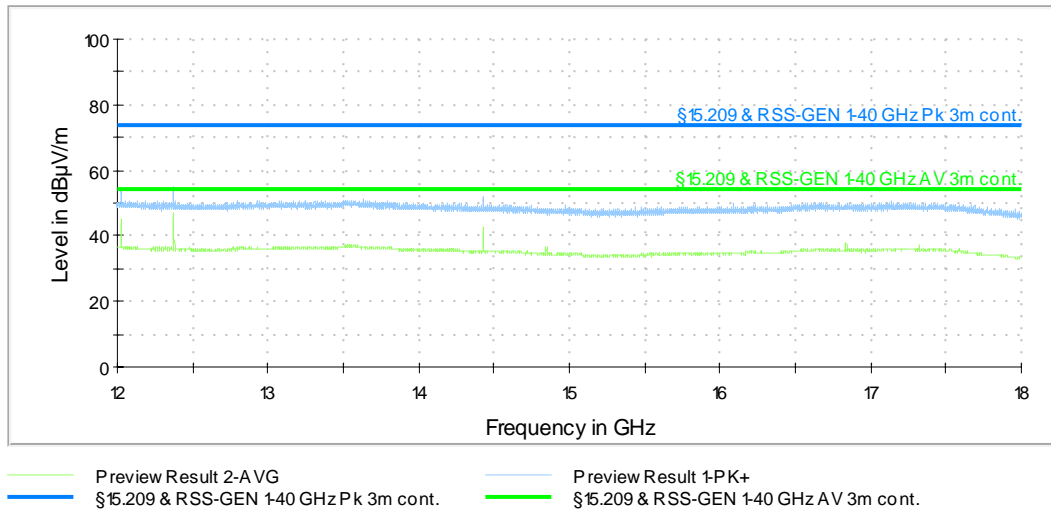
Spurious emissions from 1 GHz to 4 GHz (operation mode 7):



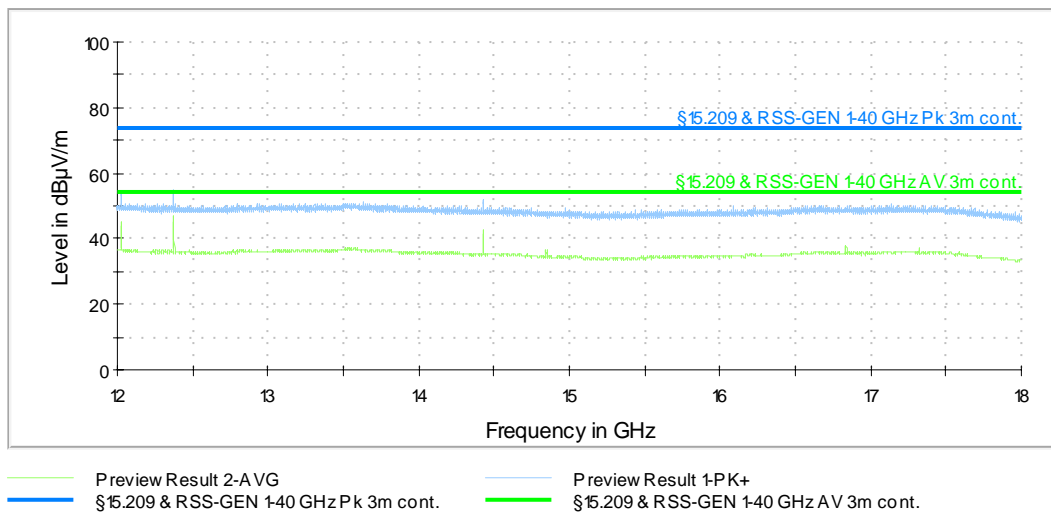
Spurious emissions from 4 GHz to 12 GHz (operation mode 8):



Spurious emissions from 12 GHz to 18 GHz (operation mode 8):



Spurious emissions from 18 GHz to 26.5 GHz (operation mode 8):



5.9.3.3.4 Result tables (Simultaneous transmissions)

5.9.3.3.4.1 1 GHz to 4 GHz (operation mode 7):

Frequency [MHz]	MaxPeak [dB μ V/m]	Average [dB μ V/m]	Limit [dB μ V/m]	Margin (dB)	Reading [dB μ V]	Corr. [dB/m]	Pol	Azimuth [deg]	Elevation [deg]	Comment
1000.000	---	30.51	54.0	23.5	4.9	25.6	H	213	0	Passed
1000.000	40.51	---	74.0	33.5	14.9	25.6	H	213	0	Passed
1025.000	---	41.48	54.0	12.5	15.7	25.8	H	214	150	Passed
1025.000	45.38	---	74.0	28.6	19.6	25.8	H	214	150	Passed
1050.000	---	31.91	54.0	22.1	5.9	26.0	H	194	150	Passed
1050.000	40.28	---	74.0	33.7	14.3	26.0	H	194	150	Passed
2470.000	100.90	---	74.0	-26.9	65.5	35.4	H	59	30	Passed
2470.000	---	99.41	54.0	-45.4	64.0	35.4	H	59	30	Passed
2475.000	---	99.06	54.0	-45.1	63.7	35.4	H	64	150	Passed
2475.000	100.38	---	74.0	-26.4	65.0	35.4	H	64	150	Passed
2484.000	56.23	---	74.0	17.8	20.9	35.4	H	288	90	Passed
2484.000	---	45.72	54.0	8.3	4.9	35.4	H	288	90	Passed
2485.000	---	43.85	54.0	10.2	14.9	35.4	H	290	90	Passed
2485.000	54.71	---	74.0	19.3	15.7	35.4	H	290	90	Passed
2625.000	---	39.02	54.0	15.0	19.6	35.9	H	247	120	Passed
2625.000	50.37	---	74.0	23.6	5.9	35.9	H	247	120	Passed
Measurement uncertainty					+/- 5.9 dB					

5.9.3.3.4.2 4 GHz to 26.5 GHz (operation mode 8):

Frequency [MHz]	MaxPeak [dB μ V/m]	Average [dB μ V/m]	Limit [dB μ V/m]	Margin (dB)	Reading [dB μ V]	Corr. [dB/m]	Pol	Azimuth [deg]	Elevation [deg]	Comment
4810.800	57.16	---	74.0	16.8	47.4	9.7	H	272	60	Passed
4810.800	---	50.32	54.0	3.7	40.6	9.7	H	272	60	Passed
4811.050	57.40	---	74.0	16.6	47.7	9.7	H	271	60	Passed
4811.050	---	50.16	54.0	3.8	40.4	9.7	H	271	60	Passed
4949.000	---	43.58	54.0	10.4	33.5	10.0	H	279	120	Passed
4949.000	52.88	---	74.0	21.1	42.8	10.0	H	279	120	Passed
9621.500	---	42.76	54.0	11.2	24.0	18.8	H	41	150	Passed
9621.500	53.39	---	74.0	20.6	34.6	18.8	H	41	150	Passed
9897.950	58.92	---	74.0	15.1	39.4	19.5	H	305	120	Passed
9897.950	---	49.59	54.0	4.4	30.1	19.5	H	305	120	Passed
9901.950	59.01	---	74.0	15.0	39.5	19.5	H	305	120	Passed
9901.950	---	51.11	54.0	2.9	31.6	19.5	H	305	120	Passed
12023.300	---	35.88	54.0	18.1	25.2	10.7	235	60	10.7	Passed
12023.300	48.98	---	74.0	25.0	38.3	10.7	235	60	10.7	Passed
12027.850	---	35.83	54.0	18.2	25.2	10.6	201	60	10.6	Passed
12027.850	48.47	---	74.0	25.5	37.8	10.6	201	60	10.6	Passed
12372.400	---	43.39	54.0	10.6	32.9	10.5	244	30	10.5	Passed
12372.400	54.41	---	74.0	19.6	43.9	10.5	244	30	10.5	Passed
12377.350	---	44.55	54.0	9.5	34.0	10.5	244	30	10.5	Passed
12377.350	54.01	---	74.0	20.0	43.5	10.5	244	30	10.5	Passed
14426.600	---	40.22	54.0	13.8	29.6	10.6	151	30	10.6	Passed
14426.600	52.61	---	74.0	21.4	42.0	10.6	151	30	10.6	Passed
14433.050	---	41.52	54.0	12.5	30.9	10.6	152	30	10.6	Passed
14433.050	52.71	---	74.0	21.3	42.1	10.6	152	30	10.6	Passed
Measurement uncertainty					+/- 5.9 dB					

Test equipment (please refer to chapter 6 for details)
3 – 15, 19

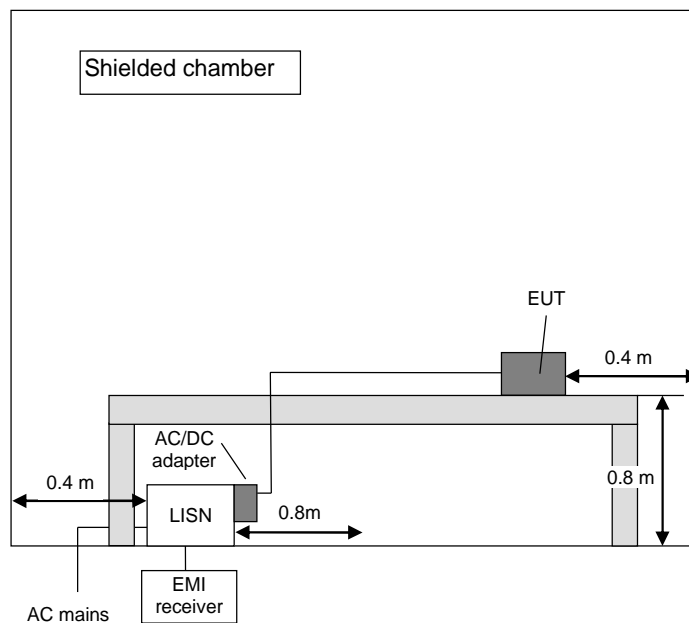
5.10 Conducted emissions on power supply lines

5.10.1 Test method

The test is carried out in a shielded chamber. Table-top devices are 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 are placed directly on the ground plane. In case of DC powered equipment, which is not exclusively powered by a battery, it is connected to the LISN via a suitable AC/DC adaptor. The setup of the equipment under test is in accordance to [1].

The frequency range 150 kHz to 30 MHz is measured with an EMI receiver set to MAX hold mode with Peak and Average detectors and a resolution bandwidth of 9 kHz. A scan is carried out on the phase and neutral line of the AC mains network. If emissions less than 10 dB below the appropriate limit are detected, these emissions are measured with an Average and Quasi-Peak detector on all lines.

Frequency range	Resolution bandwidth
150 kHz to 30 MHz	9 kHz

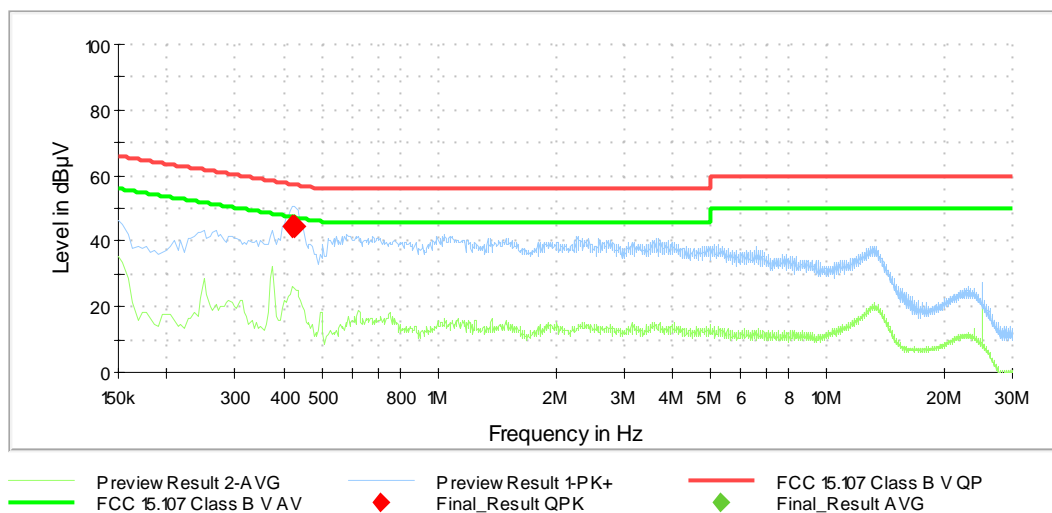


5.10.2 Test results

Ambient temperature:	22 °C
Relative humidity:	57 %

Date:	25.09.2021
Tested by:	P. NEUFELD

The curves in the diagrams below 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 ◆ and the average measured points by ▼.



Frequency in MHz	QuasiPeak in dB(µV)	Average in dB(µV)	Limit in dB(µV)	Margin in dB	Meas. Time in ms	Bandwidth in kHz	Line	PE	Corr. in dB
0.421800	44.65	---	57.41	12.76	5000.0	9.000	N	FLO	9.9
0.428100	44.36	---	57.29	12.93	5000.0	9.000	L1	FLO	9.9

Measurement uncertainty ± 2.8 dB

Test result: Passed

Test equipment (please refer to chapter 6 for details)
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6 Test Equipment used for Tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal Due
1	Signal & Spectrum Analyzer	FSW43	Rohde & Schwarz	100586 & 100926	481720	30.03.2021	03.2023
2	Attenuator	WA54-10-12	Weinschel	-	481618	Calibration not necessary	
3	RF Switch Matrix	OSP220	Rohde & Schwarz		482976	Calibration not necessary	
4	Turntable	TT3.0-3t	Maturo	825/2612/.01	483224	Calibration not necessary	
5	Antenna support	BAM 4.5-P-10kg	Maturo	222/2612.01	483225	Calibration not necessary	
6	Controller	NCD	Maturo	474/2612.01	483226	Calibration not necessary	
7	Semi Anechoic Chamber M276	SAC5-2	Albatross Projects	C62128-A540-A138-10-0006	483227	Calibration not necessary	
8	Measuring software EMC32 M276	EMC32	Rohde & Schwarz	100970	482972	Calibration not necessary	
9	EMI Test receiver	ESW44	Rohde & Schwarz	101828	482979	14.11.2019	11.2021
10	Low Noise Amplifier 100 MHz - 18 GHz	LNA-30-00101800-25-10P	Narda-Miteq	2110917	482967	18.02.2020	02.2022
11	Log.-Per. antenna	HL050	Rohde & Schwarz	100908	482977	13.08.2019	08.2022
12	Low Noise Amplifier 12 GHz - 18 GHz	LNA-30-12001800-13-10P	Narda-Miteq	2089798	482968	Calibration not necessary	
13	Standard Gain Horn 20 dB, 12 GHz-18 GHz	18240-20	Flann	267220	483025	Calibration not necessary	
14	Low Noise Amplifier 18 GHz - 26.5 GHz	LNA-30-18002650-20-10P	Narda-Miteq	2110911	482969	17.02.2020	02.2022
15	Standard Gain Horn 20 dB, 18 GHz -26 GHz	20240-20	Flann	266399	483026	Calibration not necessary	
16	Attenuator 6 dB	WA2-6	Weinschel		482793	Calibration not necessary	
17	Ultralog Antenna	HL562E	Rohde & Schwarz	101079	482978	18.03.2021	03.2024
18	loop antenna	HFH2-Z2	Rohde & Schwarz	100417	481912	25.02.2021	02.2022
19	High-pass filter	WHKX4.0/18G-8SS	Wainwright Instruments	1	480587	Calibration not necessary	

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/RSM	CISPR 16-1-4 + Cor1:2010 + A1:2012 +A2:2017	03.03.2021	02.03.2023
Semi anechoic chamber M276	483227	1 -18 GHz	SVSWR	CISPR 16-1-4 + Cor1:2010 + A1:2012 +A2:2017	25.02.2021	24.02.2023
Shielded chamber M155	482784	9 kHz – 30 MHz	GND-Plane	ANSI C63.4-2014	25.09.2020	24.09.2022

8 Report History

Report Number	Date	Comment
F211305E3	16.10.2021	Initial Test Report
-	-	-
-	-	-

9 List of Annexes

Annex A	Test Setup Photos	14 pages
Annex B	External Photos	6 pages
Annex C	Internal Photos	6 pages