FCC Measurement/Technical Report on

WLAN and Bluetooth module JODY-W164-03A

FCC ID: XPYJODYW164
IC: 8595A-JODYW164

Test Report Reference: MDE_UBLOX_1814_FCCb_rev2

Test Laboratory:
7layers GmbH
Borsigstrasse 11
40880 Ratingen
Germany

Deutsche Akkreditierungsstelle D-PL-12140-01-00

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1 APPLIED STANDARDS AND TEST SUMMARY

1.1 APPLIED STANDARDS

Type of Authorization
Certification for an Intentional Radiator (Digital Device / Spread Spectrum).

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2 (10-1-15 Edition) and 15 (10-1-15 Edition). The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

Part 15, Subpart C – Intentional Radiators

§ 15.201 Equipment authorization requirement

§ 15.207 Conducted limits

§ 15.209 Radiated emission limits; general requirements

Part 15, Subpart E – Unlicensed National Information Infrastructure Devices

§ 15.403 Definitions

§ 15.407 General technical requirements

Note:
The tests were selected and performed with reference to the FCC Public Notices
"Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices - Part 15, Subpart E, 789033 D02 General U-NII Test Procedures v02r01, 2017-12-14".
"Compliance measurement procedures for unlicensed-national information infrastructure devices operating in the 5250-5350 MHz and 5470-5725 MHz bands incorporating dynamic frequency selection, 905462 D02 UNII DFS Compliance Procedures New Rules v02, 2016-04-08".

ANSI C63.10-2013 is applied.

FCC ET Docket No. 13-49, FIRST REPORT AND ORDER, April 1, 2014 ("new rules") is applied.

Summary Test Results:

The EUT complied with all performed tests as listed in chapter 1.3 Measurement Summary / Signatures.

1.2 FCC-IC CORRELATION TABLE

Correlation of measurement requirements for UNII / LE-LAN (e.g. WLAN 5 GHz) equipment from FCC and IC

UNII equipment

Measurement	FCC reference	IC reference
Conducted emissions on AC Mains	§ 15.207	RSS-Gen Issue 4: 8.8
Occupied bandwidth	§ 15.403 (i) (26 dB) / § 15.407 (e) (6 dB)	RSS-247 Issue 2: 6.2.1.1, 6.2.2.1, 6.2.3.1 (99%) RSS-247 Issue 2: 6.2.4.1 (6 dB)
Maximum conducted output power	§ 15.407 (a) (1),(2),(3),(4)	RSS-247 Issue 2: 6.2.1.1, 6.2.2.1, 6.2.3.1, 6.2.4.1
Maximum power spectral density	§ 15.407 (a) (1),(2),(3),(5)	RSS-247 Issue 2: 6.2.1.1, 6.2.2.1, 6.2.3.1, 6.2.4.1
Transmitter undesirable emissions; General Field Strength Limits, Restricted Bands	§ 15.407 (b) § 15.209 (a)	RSS-Gen Issue 4: 6.13/8.9/8.10; RSS-247 Issue 2: 3.3/6.2 6.2.1.2, 6.2.2.2, 6.2.3.2, 6.2.4.2
Frequency stability	§ 15.407 (g)	RSS-Gen Issue 4: 6.11/8.11
Transmit Power Control (TPC) and Dynamic Frequency Selection (DFS)	§ 15.407 (h)	RSS-247 Issue 2: 6.2.2.1, 6.2.3.1, 6.3
Antenna requirement	§ 15.203 / 15.204	RSS-Gen Issue 4: 8.3
Receiver spurious emissions	–	-

1.3 MEASUREMENT SUMMARY / SIGNATURES

47 CFR CHAPTER I FCC PART 15 Subpart E §15.407	**FCC §15.31, §15.407 (a)(1)**
Maximum Conducted Output Power The measurement was performed according to ANSI C63.10	**Final Result**

OP-Mode Radio Technology, Operating Frequency, Subband	**Setup**	**FCC**	**IC**
WLAN a, high, U-NII-1	S01_AB01	Passed	Passed
WLAN a, low, U-NII-1	S01_AB01	Passed	Passed
WLAN a, mid, U-NII-1	S01_AB01	Passed	Passed
WLAN n 20 MHz, high, U-NII-1	S01_AB01	Passed	Passed
WLAN n 20 MHz, low, U-NII-1	S01_AB01	Passed	Passed
WLAN n 20 MHz, mid, U-NII-1	S01_AB01	Passed	Passed
WLAN ac 20 MHz, high, U-NII-1	S01_AB01	Passed	Passed
WLAN ac 20 MHz, low, U-NII-1	S01_AB01	Passed	Passed
WLAN ac 20 MHz, mid, U-NII-1	S01_AB01	Passed	Passed
WLAN n 40 MHz, low, U-NII-1	S01_AB01	Passed	Passed
WLAN n 40 MHz, high, U-NII-1	S01_AB01	Passed	Passed
WLAN ac 40 MHz, low, U-NII-1	S01_AB01	Passed	Passed
WLAN ac 40 MHz, high, U-NII-1	S01_AB01	Passed	Passed
WLAN ac 80 MHz, mid, U-NII-1	S01_AB01	Passed	Passed
WLAN ac 80 MHz, mid, U-NII-1	S01_AB01	Passed	Passed

47 CFR CHAPTER I FCC PART 15 Subpart E §15.407	**FCC §15.31, §15.407 (a) (1),(5)**
Peak Power Spectral Density The measurement was performed according to ANSI C63.10	**Final Result**

OP-Mode Radio Technology, Operating Frequency, Subband	**Setup**	**FCC**	**IC**
WLAN n 20 MHz, high, U-NII-1	S01_AB01	Passed	Passed
WLAN n 20 MHz, low, U-NII-1	S01_AB01	Passed	Passed
WLAN n 20 MHz, mid, U-NII-1	S01_AB01	Passed	Passed

47 CFR CHAPTER I FCC PART 15 Subpart E §15.407	**FCC §15.407 (b), (1),(2),(3),(4); FCC §15.205, §15.209, §15.407 (b) (5),(6)**
Undesirable Emissions; General Field Strength Limits The measurement was performed according to ANSI C63.10	**Final Result**

OP-Mode Radio Technology, Operating Frequency, Measurement range, Subband, Measurement Method	**Setup**	**FCC**	**IC**
WLAN a, low, 9kHz - 30MHz, U-NII-1, Radiated	S01_AA01	Passed	Passed
WLAN a, low, 30MHz - 1GHz, U-NII-1, Radiated	S01_AA01	Passed	Passed
WLAN a, low, 1GHz - 26GHz, U-NII-1, Radiated	S01_AA01	Passed	Passed
WLAN n 20MHz, high, 1GHz – 40 GHz, U-NII-1, Conducted	S01_AB01	Passed	Passed
WLAN n 20MHz, mid, 1GHz – 40 GHz, U-NII-3, Conducted	S01_AB01	Passed	Passed

47 CFR CHAPTER I FCC PART 15 Subpart E §15.407	FCC §15.407 (b), (1),(2),(3),(4)

Band Edge

The measurement was performed according to ANSI C63.10

Final Result

OP-Mode Radio Technology, Operating Frequency, Subband	Setup	FCC	IC
WLAN n 20 MHz, low, U-NII-1	S01_AA01	Passed	Passed
WLAN n 20 MHz, high, U-NII-2A	S01_AA01	Passed	Passed
WLAN n 20 MHz, low, U-NII-2C	S01_AA01	Passed	Passed
WLAN n 20 MHz, high, U-NII-2C	S01_AA01	Passed	Passed
WLAN n 20 MHz, low, U-NII-3	S01_AA01	Passed	Passed
WLAN n 20 MHz, high, U-NII-3	S01_AA01	Passed	Passed
WLAN ac 80 MHz, mid, U-NII-3	S01_AA01	Passed	Passed

N/A: Not applicable
N/P: Not performed

The module has already been certified with an antenna gain of 2 dBi. This report is to show compliance with a dedicated antenna of 5.2 dBi gain with new antenna trace (see ancillary equipment anc1).
Only tests which are related to the antenna gain and did not have enough margin were performed as well as radiated measurements using the new antennas in the worst case modulation of the original module certification. If the power of the worst case modulation had to be lowered the power of the other modulations was lowered in the same way.
Reference to the complete module report with 2 dBi antenna: MDE_UBLOX_1701_FCCb

Revision History

Report version control			
Version	**Release date**	**Change Description**	**Version validity**
initial	2018-07-27	--	invalid
rev1	2018-11-15	Corrected type of external antenna and EUT Type, corrected power table ac 80 MHz ch. 122	valid
rev2	2018-12-08	Added additional modes to conducted output power test case, added conducted spurious emissions	valid

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(responsible for accreditation scope)
Dipl.-Ing. Marco Kullik

(responsible for testing and report)
Dipl.-Ing. Daniel Gall

2 ADMINISTRATIVE DATA

2.1 TESTING LABORATORY

Company Name:	7layers GmbH
Address:	Borsigstr. 11 40880 Ratingen Germany

This facility has been fully described in a report submitted to the ISED and accepted under the registration number: Site# 3699A-1.

The test facility is also accredited by the following accreditation organisation:

Laboratory accreditation no:	DAkkS D-PL-12140-01-00
FCC Designation Number:	DE0015
FCC Test Firm Registration:	929146
Responsible for accreditation scope:	Dipl.-Ing. Marco Kullik
Report Template Version:	2018-01-10

2.2 PROJECT DATA

Responsible for testing and report:	Dipl.-Ing. Daniel Gall
Employees who performed the tests:	documented internally at 7Layers
Date of Report:	2018-12-08
Testing Period:	2018-05-29 to 2018-12-08

2.3 APPLICANT DATA

Company Name:	u-blox AG
Address:	Zürcherstrasse 68 8800 Thalwil Switzerland
Contact Person:	Mr. Filip Kruzela

2.4 MANUFACTURER DATA

Company Name:	Please see applicant data
Address:	
Contact Person:	

3 TEST OBJECT DATA

3.1 GENERAL EUT DESCRIPTION

Kind of Device product description	The EUT is a module supporting WLAN in the 2.4 GHz and 5 GHz bands
Product name	JODY-W164-03A
Type	JODY-W164-03A
Declared EUT data by the supplier	
Voltage Type	DC
Voltage Level	3.3 V
Tested Modulation Type	WLAN: Mode a: OFDM Modulation, 6Mbps Mode n: OFDM Modulation, MCS 0 (20 / 40 MHz) Mode ac: OFDM Modulation, MCS 0 (20 / 40 / 80 MHz)
Specific product description	The JODY-W1 is a compact automotive grade module that provides Wi-Fi communication. The JODY-W164-03A module can be operated in the following modes: Wi-Fi 2x2 MIMO 802.11n/ac in the 5 GHz band Wi-Fi 1x1 802.11ac in 2.4 / 5 GHz real simultaneous dual band It is equipped with two antenna pins connected to two RP-SMA antenna connectors. Maximum supported band width in 2.4 GHz WLAN mode: 20 MHz, 5 GHz WLAN mode: 80 MHz
Ports of the device	DC Power Supply Antenna ports Signal ports
Antennas	Two external antennas mounted onto the HGW1033-3, 4dBi antenna gain in the 2.4 GHz band and 5.2 dBi in the 5 GHz bands.
Special software used for testing	The test modes were set using scripts that were run on the HGW1033-3 device the module was build into.
DFS capability	Slave without radar detection

The main components of the EUT are listed and described in chapter 3.2 EUT Main components.

3.2 EUT MAIN COMPONENTS

Sample Name	Sample Code	Description
EUT A	DE1015095aa01	
Sample Parameter	**Value**	
Serial No.	-	
HW Version	01	
SW Version	P8_2 (firmware version: 9.40.80)	
Antenna	Two external antennas mounted onto the HGW1033-3, 4dBi antenna gain in the 2.4 GHz band and 5.2 dBi in the 5 GHz bands.	

Sample Name	Sample Code	Description
EUT B	DE1015095ab01	
Sample Parameter	**Value**	
Serial No.	-	
HW Version	01	
SW Version	P8_2 (firmware version: 9.40.80)	
Antenna	Two external antennas mounted onto the HGW1033-3, 4dBi antenna gain in the 2.4 GHz band and 5.2 dBi in the 5 GHz bands.	

NOTE:The short description is used to simplify the identification of the EUT in this test report.

3.3 ANCILLARY EQUIPMENT

For the purposes of this test report, ancillary equipment is defined as equipment which is used in conjunction with the EUT to provide operational and control features to the EUT. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Ancillary Equipment can influence the test results.

Device	Details (Manufacturer, Type Model, OUT Code)	Description
ANC1	ABRACON, APAMBJ-170	Dedicated Antenna
ANC1	SIGMATEK, HGW1033-3	The module (EUT) is integrated into this device and controlled by it's hardware. For testing below 1 GHz the display of the device was disconnected.

3.4 AUXILIARY EQUIPMENT

For the purposes of this test report, auxiliary equipment is defined as equipment which is used temporarily to enable operational and control features especially used for the tests of the EUT which is not used during normal operation or equipment that is used during the tests in combination with the EUT but is not subject of this test report. It is necessary to configure the system in a typical fashion, as a customer would normally use it.
But nevertheless Auxiliary Equipment can influence the test results.

Device	Details (Manufacturer, HW, SW, S/N)	Description
-	-	-

3.5 EUT SETUPS

This chapter describes the combination of EUTs and equipment used for testing. The rationale for selecting the EUTs, ancillary and auxiliary equipment and interconnecting cables, is to test a representative configuration meeting the requirements of the referenced standards.

Setup	Combination of EUTs	Description and Rationale
S01_AA01	EUT A, ANC1, ANC2	Representative setup for radiated testing
S01_AB01	EUT B, ANC2	Representative setup for conducted testing

3.6 TEST CHANNELS AND POWER SETTING

Test Channels:

U-NII-Subband 1 5150 - 5250 MHz			U-NII-Subband 2A 5250 - 5350 MHz			U-NII-Subband 2C 5470 - 5725 MHz			U-NII-Subband 3 5725 - 5850 MHz			Nom. BW
low	mid	high	low	mid	high	low	mid	high	low	mid	high	20 MHz
36	40	48	52	60	64	100/104[2)]	116	140/144[1)]	149	157	165	Ch.-No.
5180	5200	5240	5260	5300	5320	5500/5520	5580	5700/5720	5745	5785	5825	MHz
low	mid	high	low	mid	high	low	mid	high	low	mid	high	40 MHz
38	-	46	54	-	62	102[2)]	110	134/142[1)]	151	-	159	Ch.-No.
5190	-	5230	5270	-	5310	5510	5550	5690/5710	5755	-	5795	MHz
low	mid	high	low	mid	high	low	mid	high	low	mid	high	80 MHz
-	42	-	-	58	-	106	122	138	-	155	-	Ch.-No.
-	5210	-	-	5290	-	5530	5610	5690	-	5775	-	MHz

1)The lower channel is applicable for a/n mode, the higher channel for ac mode ("straddle" channels acc. KDB 789033)
2)Since the power of the second lowest channel is higher than the power of the lowest channel, the second lowest was also tested for some test cases.

Power Levels:

Power Setting in EUT Script used for testing (power levels of final product):

20 MHz Channel

Channel No.	36	40	44	48	52	56	60	64	100	104	108	112	116	120	124	128	132	136	140	144	149	153	157	161	165
Channel freq. [MHz]	5180	5200	5220	5240	5260	5280	5300	5320	5500	5520	5540	5560	5580	5600	5620	5640	5660	5680	5700	5720	5745	5765	5785	5805	5825
WLAN mode a	12	14	14	14	14	14	14	12	11	14	14	14	14	14	14	14	14	14	11	14	17	17	17	17	17
WLAN mode n	12	12	12	12	14	14	14	12	11	14	14	14	14	14	14	14	14	14	11	14	17	17	17	17	17
WLAN mode ac	12	12	12	12	14	14	14	12	11	14	14	14	14	14	14	14	14	14	11	14	17	17	17	17	17

40 MHz Channel

Channel No.	38	46	54	62	102	110	118	126	134	142	151	159
Channel freq. [MHz]	5190	5230	5270	5310	5510	5550	5590	5630	5670	5710	5755	5795
WLAN mode n	10	13	13	12	10	14	14	14	11	14	17	17
WLAN mode ac	10	13	13	12	10	14	14	14	11	14	17	17

80 MHz Channel

Channel No.	42	58	106	122	138	155
Channel freq. [MHz]	5210	5290	5530	5610	5690	5775
WLAN mode ac	10	10	9	9	12	15

3.7 PRODUCT LABELLING

3.7.1 FCC ID LABEL

Please refer to the documentation of the applicant.

3.7.2 LOCATION OF THE LABEL ON THE EUT

Please refer to the documentation of the applicant.

4 TEST RESULTS

4.1 MAXIMUM CONDUCTED OUTPUT POWER

Standard **FCC Part 15 Subpart E**

The test was performed according to:
ANSI C63.10

4.1.1 TEST DESCRIPTION

The Equipment Under Test (EUT) was set up to perform the output power measurements. The results recorded were measured with the modulation which produces the worst-case (highest) output power. The reference level of the spectrum analyzer was set higher than the output power of the EUT.

The EUT was connected to the spectrum analyzer via a short coax cable with a known loss.

Analyzer settings:
- Resolution Bandwidth (RBW): 1 MHz
- Video Bandwidth (VBW): 3 MHz
- Trace: Average, RMS power averaging mode
- Sweeps: 1000
- Sweeptime: 20 ms
- Detector: RMS
- Trigger: gated mode

The channel power function of the spectrum analyser was used (Used channel bandwidth = nominal bandwidth)

Note:
The analyser settings are according FCC Public Note "Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices - Part 15, Subpart E, 789033 D02", method **SA-1**.

4.1.2 TEST REQUIREMENTS / LIMITS

A) FCC
For systems using digital modulation techniques in the 5.15 – 5.25 GHz bands:
§15.407 (a) (1)
Limit: 50 mW (17 dBm) or 4 dBm + 10 log (26 dB bandwidth/MHz) whatever is the lesser.
FCC ET Docket No. 13-49, FIRST REPORT AND ORDER, April 1, 2014 ("new rules"):
§15.407 (a) (1) (i): Outdoor access point:
Limit: 1 W (30 dBm) provided the maximum antenna gain does not exceed 6 dBi.
The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

§15.407 (a) (1) (ii): Indoor access point:
Limit: 1 W (30 dBm) provided the maximum antenna gain does not exceed 6 dBi.
§15.407 (a) (1) (iv): Mobile and portable client devices:
Limit: 250 mW (24 dBm) provided the maximum antenna gain does not exceed 6 dBi.

For systems using digital modulation techniques in the 5.25 – 5.35 GHz and 5.47 – 5.725 GHz bands:
§15.407 (a) (2)
Limit: 250 mW (24 dBm) or 11 dBm + 10 log (26 dB bandwidth/MHz) whatever is the lesser.

For systems using digital modulation techniques in the 5.725 – 5.850 GHz bands:
§15.407 (a) (3)
Limit: 1 W (30 dBm) or 17 dBm + 10 log (26 dB bandwidth/MHz) whatever is the lesser.
FCC ET Docket No. 13-49, FIRST REPORT AND ORDER, April 1, 2014 ("new rules"):
§15.407 (a) (3):
Limit: 1 W (30 dBm).

§15.407 (a) (4):
The maximum conducted output power must be measured over any interval of continuous transmission using instrumentation calibrated in terms of an rms-equivalent voltage.

B) IC
Different frequency bands and limits apply, as compared to the FCC requirements.

RSS-247, 6.2.1 (1), Band 5150-5250 MHz, indoor operation only:
Limit (e.i.r.p.): 200 mW (23 dBm) or 10 + 10 log10 B [dBm], whichever power is less.
B is the 99% emission bandwidth in MHz.

RSS-247, 6.2.2 (1), Band 5250-5350 MHz:
Limits:
Maximum conducted Power: 250 mW (24 dBm) or 11 + 10 log10 B [dBm], whichever power is less.
e.i.r.p.: 1.0 W (30 dBm) or 17 + 10 log10 B [dBm], whichever power is less.

Note: For EUTs operating at a higher e.i.r.p. than 200 mW (23 dBm), compliance with the e.i.r.p. elevation mask is required.

RSS-247, 6.2.3 (1), Bands 5470-5600 MHz and 5650-5725 MHz:
Limits:
Maximum conducted Power: 250 mW (24 dBm) or 11 + 10 log10 B [dBm], whichever power is less.
e.i.r.p.: 1.0 W (30 dBm) or 17 + 10 log10 B [dBm], whichever power is less.

RSS-247, 6.2.4 (1), Band 5725-5825 MHz:
Limits:
Maximum conducted Power: 1W (30 dBm) or 17 + 10 log10 B [dBm], whichever power is less.
e.i.r.p.: 4.0 W (36 dBm) or 23 + 10 log10 B [dBm], whichever power is less.

All frequency bands: B is the 99% emission bandwidth in MHz.

4.1.3 TEST PROTOCOL

Measured Single Core Output
Core 0

Ambient temperature: 25 °C
Air Pressure: 1002 hPa
Humidity: 35 %

WLAN a-Mode; 20 MHz; 6Mbps

U-NII-Subband	Ch. No.	Freq. [MHz]	Cond. Power [dBm]	EIRP [dBm]	Cond. Limit [dBm]	Margin [dB]	Cond. Limit [dBm]	Margin [dB]	EIRP Limit [dBm]	Margin [dB]	
1	36	5180	10.5	15.7	24.0	13.5	N/A	-	22.4	6.7	1)
	40	5200	12.4	17.6	24.0	11.6	N/A	-	22.4	4.8	1)
	48	5240	12.5	17.7	24.0	11.5	N/A	-	22.5	4.8	1)

WLAN n-Mode; 20 MHz; MCS0

U-NII-Subband	Ch. No.	Freq. [MHz]	Cond. Power [dBm]	EIRP [dBm]	Cond. Limit [dBm]	Margin [dB]	Cond. Limit [dBm]	Margin [dB]	EIRP Limit [dBm]	Margin [dB]	
1	36	5180	10.2	15.4	24.0	13.8	N/A	-	22.7	7.3	1)
	40	5200	10.3	15.5	24.0	13.7	N/A	-	22.7	7.2	1)
	48	5240	10.4	15.6	24.0	13.6	N/A	-	22.7	7.1	1)

WLAN ac-Mode; 20 MHz; MCS0

U-NII-Subband	Ch. No.	Freq. [MHz]	Cond. Power [dBm]	EIRP [dBm]	Cond. Limit [dBm]	Margin [dB]	Cond. Limit [dBm]	Margin [dB]	EIRP Limit [dBm]	Margin [dB]	
1	36	5180	10.4	15.6	24.0	13.6	N/A	-	22.7	7.1	1)
	40	5200	10.7	15.9	24.0	13.3	N/A	-	23.0	7.1	1)
	48	5240	10.7	15.9	24.0	13.3	N/A	-	22.7	6.8	1)

WLAN n-Mode; 40 MHz; MCS0

U-NII-Subband	Ch. No.	Freq. [MHz]	Cond. Power [dBm]	EIRP [dBm]	Cond. Limit [dBm]	Margin [dB]	Cond. Limit [dBm]	Margin [dB]	EIRP Limit [dBm]	Margin [dB]	
1	38	5190	8.3	13.5	24.0	15.7	N/A	-	23.0	9.5	1)
	46	5230	10.9	16.1	24.0	13.1	N/A	-	23.0	6.9	1)

WLAN ac-Mode; 40 MHz; MCS0

U-NII-Subband	Ch. No.	Freq. [MHz]	Cond. Power [dBm]	EIRP [dBm]	Cond. Limit [dBm]	Margin [dB]	Cond. Limit [dBm]	Margin [dB]	EIRP Limit [dBm]	Margin [dB]	
1	38	5190	8.1	13.3	24.0	15.9	N/A	-	23.0	9.7	1)
	46	5230	11.0	16.2	24.0	13.0	N/A	-	23.0	6.8	1)

WLAN ac-Mode; 80 MHz; MCS0

U-NII-Subband	Ch. No.	Freq. [MHz]	Cond. Power [dBm]	EIRP [dBm]	Cond. Limit [dBm]	Margin [dB]	Cond. Limit [dBm]	Margin [dB]	EIRP Limit [dBm]	Margin [dB]	
1	42	5210	8.1	13.3	24.0	15.9	N/A	-	23.0	9.7	1)

Measured Single Core Output
Core 1

WLAN a-Mode; 20 MHz; 6Mbps

U-NII-Subband	Ch. No.	Freq. [MHz]	Cond. Power [dBm]	EIRP [dBm]	Cond. Limit [dBm]	Margin [dB]	Cond. Limit [dBm]	Margin [dB]	EIRP Limit [dBm]	Margin [dB]	
1	36	5180	12.2	17.4	24.0	11.8	N/A		22.5	5.1	1)
	40	5200	14.3	19.5	24.0	9.7	N/A		22.5	3.0	1)
	48	5240	14.2	19.4	24.0	9.8	N/A		22.5	3.1	1)

WLAN n-Mode; 20 MHz; MCS0

U-NII-Subband	Ch. No.	Freq. [MHz]	Cond. Power [dBm]	EIRP [dBm]	Cond. Limit [dBm]	Margin [dB]	Cond. Limit [dBm]	Margin [dB]	EIRP Limit [dBm]	Margin [dB]	
1	36	5180	12.0	17.2	24.0	12.0	N/A		22.7	5.5	1)
	40	5200	12.2	17.4	24.0	11.8	N/A		22.7	5.3	1)
	48	5240	12.0	17.2	24.0	12.0	N/A		22.7	5.5	1)

WLAN ac-Mode; 20 MHz; MCS0

U-NII-Subband	Ch. No.	Freq. [MHz]	Cond. Power [dBm]	EIRP [dBm]	Cond. Limit [dBm]	Margin [dB]	Cond. Limit [dBm]	Margin [dB]	EIRP Limit [dBm]	Margin [dB]	
1	36	5180	12.3	17.5	24.0	11.7	N/A		22.7	5.2	1)
	40	5200	12.3	17.5	24.0	11.7	N/A		22.9	5.4	1)
	48	5240	12.5	17.7	24.0	11.5	N/A		22.7	5.0	1)

WLAN n-Mode; 40 MHz; MCS0

U-NII-Subband	Ch. No.	Freq. [MHz]	Cond. Power [dBm]	EIRP [dBm]	Cond. Limit [dBm]	Margin [dB]	Cond. Limit [dBm]	Margin [dB]	EIRP Limit [dBm]	Margin [dB]	
1	38	5190	9.4	14.6	24.0	14.6	N/A		23.0	8.4	1)
	46	5230	12.3	17.5	24.0	11.7	N/A		23.0	5.5	1)

WLAN ac-Mode; 40 MHz; MCS0

U-NII-Subband	Ch. No.	Freq. [MHz]	Cond. Power [dBm]	EIRP [dBm]	Cond. Limit [dBm]	Margin [dB]	Cond. Limit [dBm]	Margin [dB]	EIRP Limit [dBm]	Margin [dB]	
1	38	5190	9.5	14.7	24.0	14.5	N/A		23.0	8.3	1)
	46	5230	12.4	17.6	24.0	11.6	N/A		23.0	5.4	1)

WLAN ac-Mode; 80 MHz; MCS0

U-NII-Subband	Ch. No.	Freq. [MHz]	Cond. Power [dBm]	EIRP [dBm]	Cond. Limit [dBm]	Margin [dB]	Cond. Limit [dBm]	Margin [dB]	EIRP Limit [dBm]	Margin [dB]	
1	42	5210	9.2	14.4	24.0	14.8	N/A		23.0	8.6	1)

Calculated MIMO Output
Core 0 + Core 1

WLAN n-Mode; 20 MHz; MCS0

U-NII-Subband	Ch. No.	Freq. [MHz]	Cond. Power [dBm]	EIRP [dBm]	Cond. Limit [dBm]	Margin [dB]	Power Core 0 [dBm]	Power Core 1 [dBm]	
1	36	5180	14.2	19.4	24.0	9.8	10.2	12.0	1)
	40	5200	14.4	19.6	24.0	9.6	**10.3**	**12.2**	1)
	48	5240	14.3	19.5	24.0	9.7	10.4	12.0	1)

table continued			IC				
U-NII-Subband	Ch. No.	Freq. [MHz]	Cond. Limit [dBm]	Margin [dB]	EIRP Limit [dBm]	Margin [dB]	
1	36	5180	N/A		22.7	3.3	
	44	5220	N/A		22.7	3.1	
	48	5240	N/A		22.7	3.2	

WLAN ac-Mode; 20 MHz; MCS0

U-NII-Subband	Ch. No.	Freq. [MHz]	Cond. Power [dBm]	EIRP [dBm]	Cond. Limit [dBm]	Margin [dB]	Power Core 0 [dBm]	Power Core 1 [dBm]	
1	36	5180	14.5	19.7	30.0	15.5	10.4	12.3	1)
	40	5200	14.6	19.8	24.0	9.4	10.7	12.3	1)
	48	5240	14.7	19.9	24.0	9.3	10.7	12.5	1)

table continued			IC				
U-NII-Subband	Ch. No.	Freq. [MHz]	Cond. Limit [dBm]	Margin [dB]	EIRP Limit [dBm]	Margin [dB]	
1	36	5180	N/A		22.7	3.0	
	44	5220	N/A		22.7	2.9	
	48	5240	N/A		22.7	2.8	

WLAN n-Mode; 40 MHz; MCS0

U-NII-Subband	Ch. No.	Freq. [MHz]	Cond. Power [dBm]	EIRP [dBm]	Cond. Limit [dBm]	Margin [dB]	Power Core 0 [dBm]	Power Core 1 [dBm]	
1	38	5190	11.9	17.1	24.0	12.1	8.3	9.4	1)
	46	5230	14.7	19.9	24.0	9.3	10.9	12.3	1)

table continued			IC				
U-NII-Subband	Ch. No.	Freq. [MHz]	Cond. Limit [dBm]	Margin [dB]	EIRP Limit [dBm]	Margin [dB]	
1	38	5190	N/A		23.0	5.9	
	46	5230	N/A		23.0	3.1	

WLAN ac-Mode; 40 MHz; MCS0

U-NII-Subband	Ch. No.	Freq. [MHz]	Cond. Power [dBm]	EIRP [dBm]	Cond. Limit [dBm]	Margin [dB]	Power Core 0 [dBm]	Power Core 1 [dBm]	
1	38	5190	11.9	17.1	24.0	12.1	8.1	9.5	1)
	46	5230	14.8	20.0	24.0	9.2	11.0	12.4	1)

table continued			IC				
U-NII-Subband	Ch. No.	Freq. [MHz]	Cond. Limit [dBm]	Margin [dB]	EIRP Limit [dBm]	Margin [dB]	
1	38	5190	N/A		23.0	5.9	
	46	5230	N/A		23.0	3.0	

WLAN ac-Mode; 80 MHz; MCS0

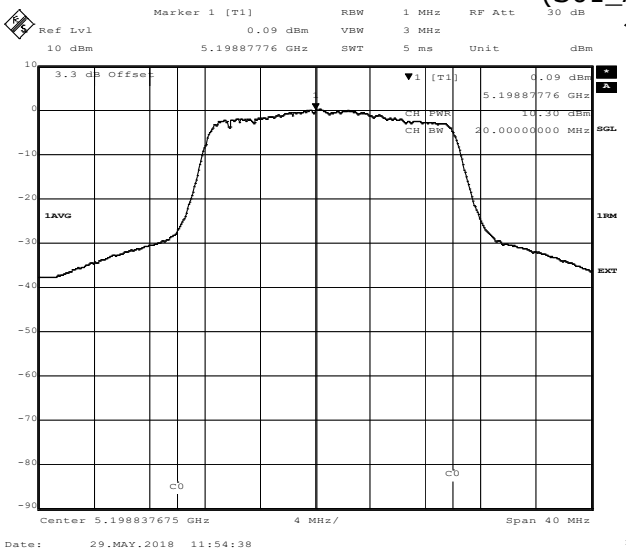
U-NII-Subband	Ch. No.	Freq. [MHz]	Cond. Power [dBm]	EIRP [dBm]	Cond. Limit [dBm]	Margin [dB]	Power Core 0 [dBm]	Power Core 1 [dBm]	
1	42	5210	11.7	16.9	24.0	12.3	8.1	9.2	1)

table continued			IC				
U-NII-Subband	Ch. No.	Freq. [MHz]	Cond. Limit [dBm]	Margin [dB]	EIRP Limit [dBm]	Margin [dB]	
1	38	5190	N/A		23.0	6.1	

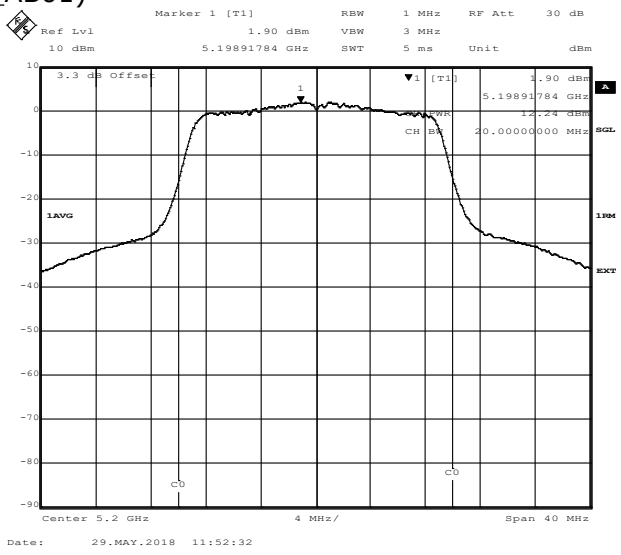
Remark: Except for n-mode 20 MHz, all tests were performed with a power meter. Thus the next chapter shows only the worst case plots of the n-mode 20 MHz.

4.1.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

Radio Technology = WLAN n 20 MHz MIMO, Operating Frequency = mid, Subband U-NII-1 (S01_AB01)



Core 0, mid channel



Core 1, mid channel

4.1.5 TEST EQUIPMENT USED

- Regulatory WLAN RF Test Solution

4.2 PEAK POWER SPECTRAL DENSITY

Standard **FCC Part 15 Subpart E**

The test was performed according to:
ANSI C63.10

4.2.1 TEST DESCRIPTION

The Equipment Under Test (EUT) was set up in a shielded room to perform the Maximum Power Spectral Density measurements.
The results recorded were measured with the modulation which produces the worst-case (highest) output power.

The EUT was connected to the spectrum analyzer via a short coax cable with a known loss.

Analyzer settings:
- Resolution Bandwidth (RBW): 1 MHz
- Video Bandwidth (VBW): 3 MHz
- Trace: Average, RMS power averaging mode
- Sweeps: 100
- Sweeptime: 5 ms
- Detector: RMS
- Trigger: gated mode

Note:
The analyser settings are according FCC Public Note "Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices - Part 15, Subpart E, 789033 D02", method **SA-1**.

4.2.2 TEST REQUIREMENTS / LIMITS

A) FCC
FCC Part 15, Subpart E, §15.407 (a) (1)
For systems using digital modulation techniques in the 5.15 – 5.25 GHz bands:
(i) and (ii), outdoor and indoor access points: Limit: 17 dBm/MHz.
(iv), mobile and portable client devices: Limit: 11 dBm/MHz.

FCC Part 15, Subpart E, §15.407 (a) (2)
For systems using digital modulation techniques in the 5.25 – 5.35 GHz and 5.47 – 5.725 GHz bands:
Limit: 11 dBm/MHz.

FCC Part 15, Subpart E, §15.407 (a) (3)
For systems using digital modulation techniques in the 5.725 – 5.850 GHz bands:
Limit: 30 dBm/500 kHz.

Note: The limit will be also fulfilled when measuring at any bandwidth greater than 500 kHz. This applies to signals where the maximum conducted output power was measured at a bandwidth exceeding 500 kHz and which fulfil that limit of 30 dBm.

B) IC
Different frequency bands and limits apply, as compared to the FCC requirements.

RSS-247, 6.2.1 (1), Band 5150-5250 MHz, indoor operation only:
Limit (e.i.r.p.): 10 dBm/MHz.

RSS-247, 6.2.2 (1), Band 5250-5350 MHz:
Limit: 11 dBm/MHz.

RSS-247, 6.2.3 (1), Bands 5470-5600 MHz and 5650-5725 MHz:
Limit: 11 dBm/MHz.

RSS-247, 6.2.4 (1), Band 5725-5850 MHz:
Limit: 30 dBm/500 kHz.

4.2.3 TEST PROTOCOL

Measured Single Core Output Core 0

Ambient temperature: 25 °C
Air Pressure: 1002 hPa
Humidity: 35 %

WLAN n-Mode; 20 MHz; MCS0

U-NII-Subband	Ch. No.	Freq. [MHz]	MPSD [dBm/MHz]	FCC Limit [dBm/MHz]	Margin [dB]	IC Limit [dBm/MHz]	Margin [dB]	IC EIRP MPSD
1	36	5180	-0.1	11.0	11.1	10.0	4.9	5.1
	40	5200	0.1	11.0	10.9	10.0	4.7	5.3
	48	5240	0.1	11.0	10.9	10.0	4.7	5.3

Measured Single Core Output Core 1

WLAN n-Mode; 20 MHz; MCS0

U-NII-Subband	Ch. No.	Freq. [MHz]	MPSD [dBm/MHz]	FCC Limit [dBm/MHz]	Margin [dB]	IC Limit [dBm/MHz]	Margin [dB]	IC EIRP MPSD
1	36	5180	1.7	11.0	9.3	10.0	3.1	6.9
	40	5200	1.9	11.0	9.1	10.0	2.9	7.1
	48	5240	1.7	11.0	9.3	10.0	3.1	6.9

Calculated MIMO Output Core 0 + Core 1

Ambient temperature: 25 °C
Air Pressure: 1002 hPa
Humidity: 35 %
WLAN n-Mode; 20 MHz; MCS0

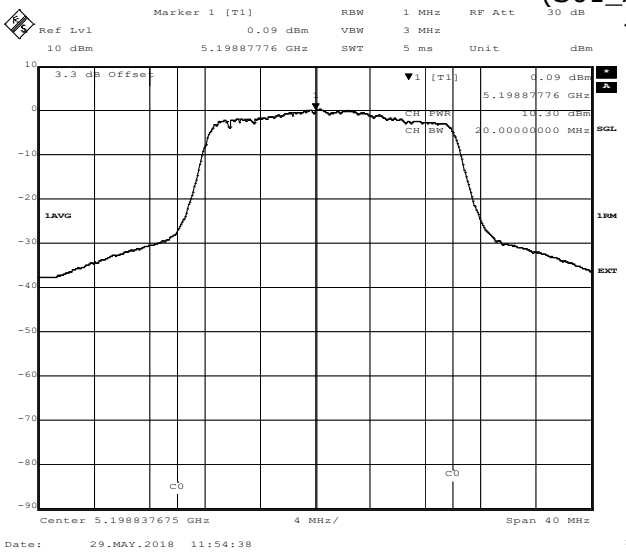
U-NII-Subband	Ch. No.	Freq. [MHz]	MPSD [dBm/MHz]	FCC Limit [dBm/MHz]	Margin [dB]	Power Core 0 [dBm/MHz]	Power Core 1 [dBm/MHz]
1	36	5180	3.9	11.0	7.1	-0.1	1.7
	40	5200	4.1	11.0	6.9	**0.1**	**1.9**
	48	5240	4.0	11.0	7.0	0.1	1.7

table continued					
U-NII-Subband	Ch. No.	Freq. [MHz]	IC EIRP MPSD	IC Limit [dBm/MHz]	Margin [dB]
1	36	5180	9.1	10.0	0.9
	44	5220	9.3	10.0	0.7
	48	5240	9.2	10.0	0.8

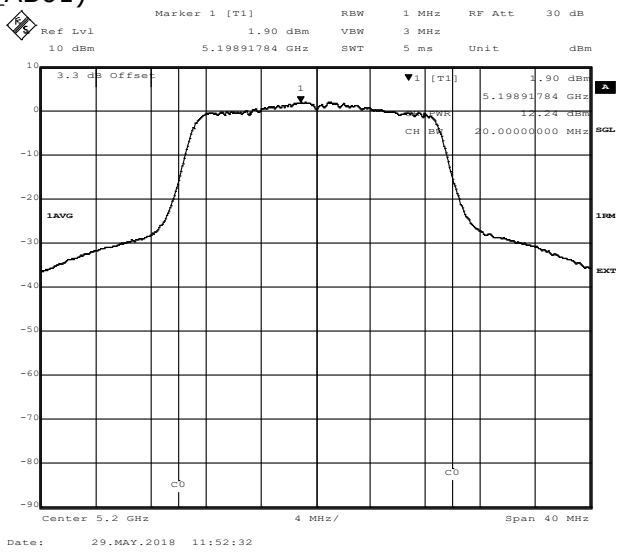
Remark: Please see next sub-clause for the measurement plot.

4.2.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

Radio Technology = WLAN n 20 MHz MIMO, Operating Frequency = mid, Subband U-NII-1 (S01_AB01)



Core 0, mid channel



Core 1, mid channel

4.2.5 TEST EQUIPMENT USED

- Regulatory WLAN RF Test Solution
- R&S TS8997

4.3 UNDESIRABLE EMISSIONS; GENERAL FIELD STRENGTH LIMITS

Standard **FCC Part 15 Subpart E**

4.3.1 RADIATED MEASUREMENTS

The test was performed according to:
ANSI C63.10

4.3.1.1 Test Description

The test set-up was made in accordance to the general provisions of ANSI C63.10 in a typical installation configuration. The Equipment Under Test (EUT) was set up on a non-conductive table 1.0 x 2.0 m² in the semi-anechoic chamber. The influence of the EUT support table that is used between 30–1000 MHz was evaluated.
The measurement procedure is implemented into the EMI test software EMC32 from R&S. Exploratory tests are performed at 3 orthogonal axes to determine the worst-case orientation of a body-worn or handheld EUT. The final test on all kind of EUTs is also performed at 3 axes. A pre-check is performed while the EUT is powered from a DC power source.

1. Measurement up to 30 MHz
The Loop antenna HFH2-Z2 is used.

Step 1: pre measurement
- Anechoic chamber
- Antenna distance: 3 m
- Detector: Peak-Maxhold
- Frequency range: 0.009 - 0.15 MHz and 0.15 – 30 MHz
- Frequency steps: 0.05 kHz and 2.25 kHz
- IF–Bandwidth: 0.2 kHz and 9 kHz
- Measuring time / Frequency step: 100 ms (FFT-based)

Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

Step 2: final measurement
For the relevant emissions determined in step 1, an additional measurement with the following settings will be performed. Intention of this step is to find the maximum emission level.
- Open area test side
- Antenna distance: according to the Standard
- Detector: Quasi-Peak
- Frequency range: 0.009 – 30 MHz
- Frequency steps: measurement at frequencies detected in step 1
- IF–Bandwidth: 0.2 - 10 kHz
- Measuring time / Frequency step: 1 s

2. Measurement above 30 MHz and up to 1 GHz

Step 1: Preliminary scan
This is a preliminary test to identify the highest amplitudes relative to the limit.
Settings for step 1:
- Antenna distance: 3 m
- Detector: Peak-Maxhold / Quasipeak (FFT-based)
- Frequency range: 30 – 1000 MHz

- Frequency steps: 30 kHz
- IF–Bandwidth: 120 kHz
- Measuring time / Frequency step: 100 ms
- Turntable angle range: –180° to 90°
- Turntable step size: 90°
- Height variation range: 1 – 3 m
- Height variation step size: 2 m
- Polarisation: Horizontal + Vertical

Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

Step 2: Adjustment measurement
In this step the accuracy of the turntable azimuth and antenna height will be improved. This is necessary to find out the maximum value of every frequency.
For each frequency, which was determined the turntable azimuth and antenna height will be adjusted. The turntable azimuth will slowly vary by ± 45° around this value. During this action, the value of emission is continuously measured. The turntable azimuth at the highest emission will be recorded and adjusted. In this position, the antenna height will also slowly vary by ± 100 cm around the antenna height determined. During this action, the value of emission is also continuously measured. The antenna height of the highest emission will also be recorded and adjusted.
- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range: ± 45 ° around the determined value
- Height variation range: ± 100 cm around the determined value
- Antenna Polarisation: max. value determined in step 1

Step 3: Final measurement with QP detector
With the settings determined in step 3, the final measurement will be performed:
EMI receiver settings for step 4:
- Detector: Quasi-Peak (< 1 GHz)
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 1 s

After the measurement a plot will be generated which contains a diagram with the results of the preliminary scan and a chart with the frequencies and values of the results of the final measurement.

3. Measurement above 1 GHz
The following modifications apply to the measurement procedure for the frequency range above 1 GHz:
Step 1:
The Equipment Under Test (EUT) was set up on a non-conductive support (tilt device) at 1.5 m height in the fully-anechoic chamber.
All steps were performed with one height (1.5 m) of the receiving antenna only.
The EUT is turned during the preliminary measurement across the elevation axis, with a step size of 90 °.
The turn table step size (azimuth angle) for the preliminary measurement is 45 °.
Above 26 GHz the measurement distance is reduced to 1 m.
Step 2:

Due to the fact, that in this frequency range the test is performed in a fully anechoic room, the height scan of the receiving antenna instep 2 is omitted. Instead of this, a maximum search with a step size ± 45° for the elevation axis is performed.
The turn table azimuth will slowly vary by ± 22.5°.
The elevation angle will slowly vary by ± 45°
EMI receiver settings (for all steps):
- Detector: Peak, Average
- IF Bandwidth = 1 MHz

Step 3:
Spectrum analyser settings for step 3:
- Detector: Peak / Average
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 1 MHz
- Measuring time: 1 s

4.3.1.2 Test Requirements / Limits

A) FCC

FCC Part 15 Subpart E, §15.407 (b)(1)
For transmitters operating in the 5150–5250 MHz band:
Limit: –27 dBm/MHz EIRP outside of the band 5150–5350 MHz.

FCC Part 15 Subpart E, §15.407 (b)(2)
For transmitters operating in the 5250–5350 MHz band:
Limit: –27 dBm/MHz EIRP outside of the band 5150–5350 MHz.

FCC Part 15 Subpart E, §15.407 (b)(3)
For transmitters operating in the 5470–5725 MHz band:
Limit: –27 dBm/MHz EIRP outside of the band 5470–5725 MHz.

FCC Part 15 Subpart E, §15.407 (b)(4)
For transmitters operating in the 5725–5850 MHz band:
Limit: –27 dBm/MHz EIRP at >= 75 MHz away from the band edge,
75 MHz to 25 MHz away from the band edge increasing linearly to 10 dBm/MHz
25 MHz to 5 MHz away from the band edge increasing linearly to 15.6 dBm/MHz
5 MHz to the band edge increasing linearly to 27 dBm/MHz

B) IC
Different frequency bands and limits apply, as compared to the FCC requirements.

RSS-247, 6.2.1.2, Emissions outside the band 5150-5250 MHz, indoor operation only:
Limit: –27 dBm/MHz EIRP outside of the band 5150–5250 MHz.

RSS-247, 6.2.2.2, Emissions outside the band 5250-5350 MHz:
Limit: –27 dBm/MHz EIRP outside of the band 5250–5350 MHz.

RSS-247, 6.2.3.2, Emissions outside the bands 5470-5600 MHz and 5650-5725 MHz:
Limit: –27 dBm/MHz EIRP outside of the band 5470–5725 MHz.
Note: No operation is permitted for the frequency range 5600–5650 MHz.

RSS-247, 6.2.4.2, Emissions outside the band 5725-5825 MHz:
Limit: –27 dBm/MHz EIRP at >= 75 MHz away from the band edge,
75 MHz to 25 MHz away from the band edge increasing linearly to 10 dBm/MHz

25 MHz to 5 MHz away from the band edge increasing linearly to 15.6 dBm/MHz
5 MHz to the band edge increasing linearly to 27 dBm/MHz

C) FCC & IC

FCC Part 15 Subpart E, §15.405
The provisions of §§ 15.203 and 15.205 are included.

§15.407 (b)(6)
Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in § 15.209.

§15.407 (b)(7)
The provisions of §15.205 apply to intentional radiators operating under this section

FCC Part 15, Subpart C, §15.209, Radiated Emission Limits

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limits (dBµV/m)
0.009 – 0.49	2400/F(kHz)@300m	3	(48.5 – 13.8)@300m
0.49 – 1.705	24000/F(kHz)@30m	3	(33.8 – 23.0)@30m
1.705 – 30	30@30m	3	29.5@30m

The measured values are corrected with an inverse linear distance extrapolation factor (40 dB/decade) according FCC 15.31 (2).

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limits (dBµV/m)
30 – 88	100@3m	3	40.0@3m
88 – 216	150@3m	3	43.5@3m
216 – 960	200@3m	3	46.0@3m
960 - 26000	500@3m	3	54.0@3m
26000 - 40000	500@3m	1	54.0@3m

The measured values above 26 GHz are corrected with an inverse linear distance extrapolation factor (20 dB/decade).

§15.35(b) ..., there is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit....

Used conversion factor:
- Limit (dBµV/m) = 20 log (Limit (µV/m)/1µV/m)
- Limit (dBµV/m) = EIRP [dBm] – 20 log (d [m]) + 104.8

Limit types (in result tables on next page):
RB – Emissions falls into a "Restricted Band" according FCC §§15.205 and 15.209 *)
UE – "Undesirable Emission Limit" according FCC §15.407
BE-RB – Band Edge Limit basing on "Restricted Band Limits"
BE-UE – Band Edge Limit basing on "Undesirable Emission Limit"
*) Below 1 GHz the limits of §15.209 are applied for all frequencies.

4.3.1.3 Test Protocol

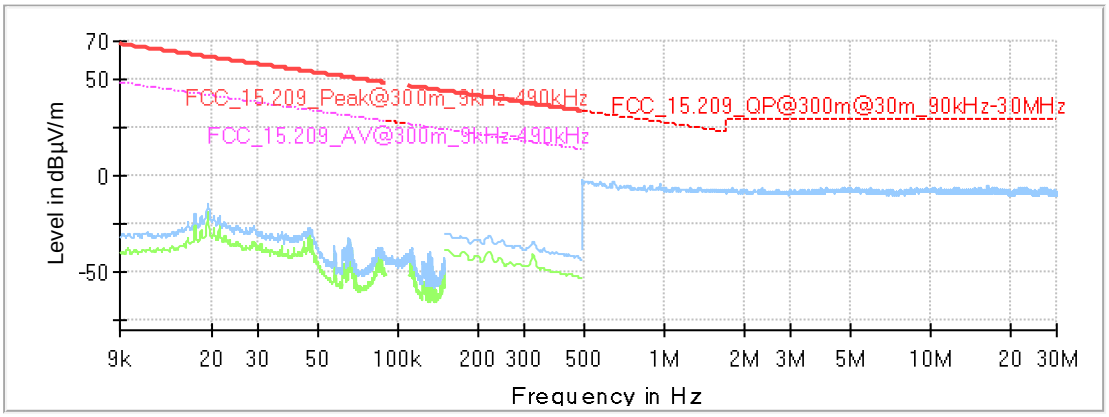
Ambient temperature: **24-28 °C**
Air Pressure: **1007-1012 hPa**
Humidity: **42-55 %**

WLAN a-Mode; 20 MHz; 6 Mbit/s							
Applied duty cycle correction (AV): 0 dB							
Ch. No.	**Ch. Center Freq. [MHz]**	**Spurious Freq. [MHz]**	**Spurious Level [dBµV/m]**	**Detec-tor**	**RBW [kHz]**	**Limit [dBµV/m]**	**Margin [dB]**
36	5180	50.9	29.6	QP	120	40.0	10.4
36	5180	80.9	37.0	QP	120	40.0	3.0
36	5180	84.0	33.6	QP	120	40.0	6.4

Remark: Please see next sub-clause for the measurement plot.

4.3.1.4 Measurement Plot (showing the highest value, "worst case")

Radio Technology = WLAN a 20 MHz, Range 9 kHz – 30 MHz, Core 1, Channel 36 (S01_AA01)



Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
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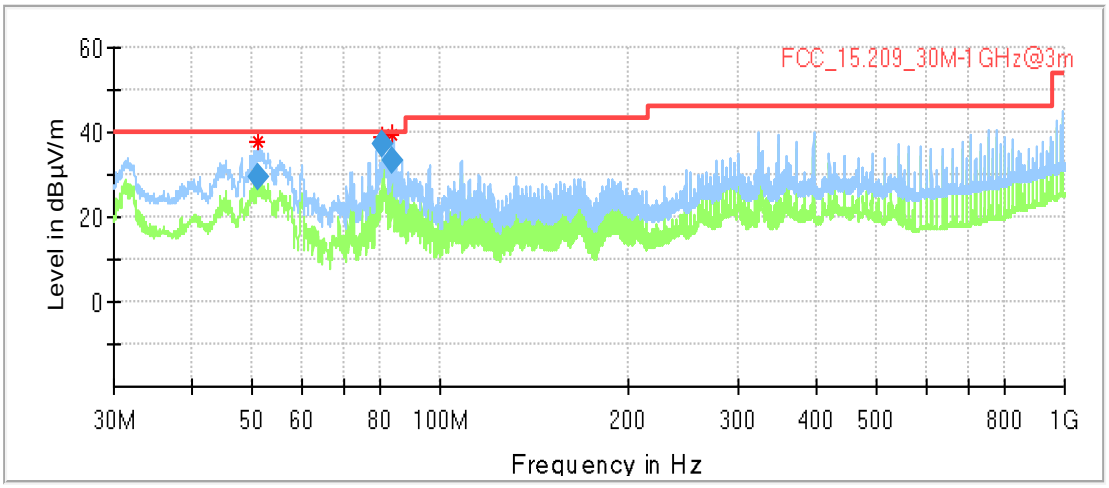
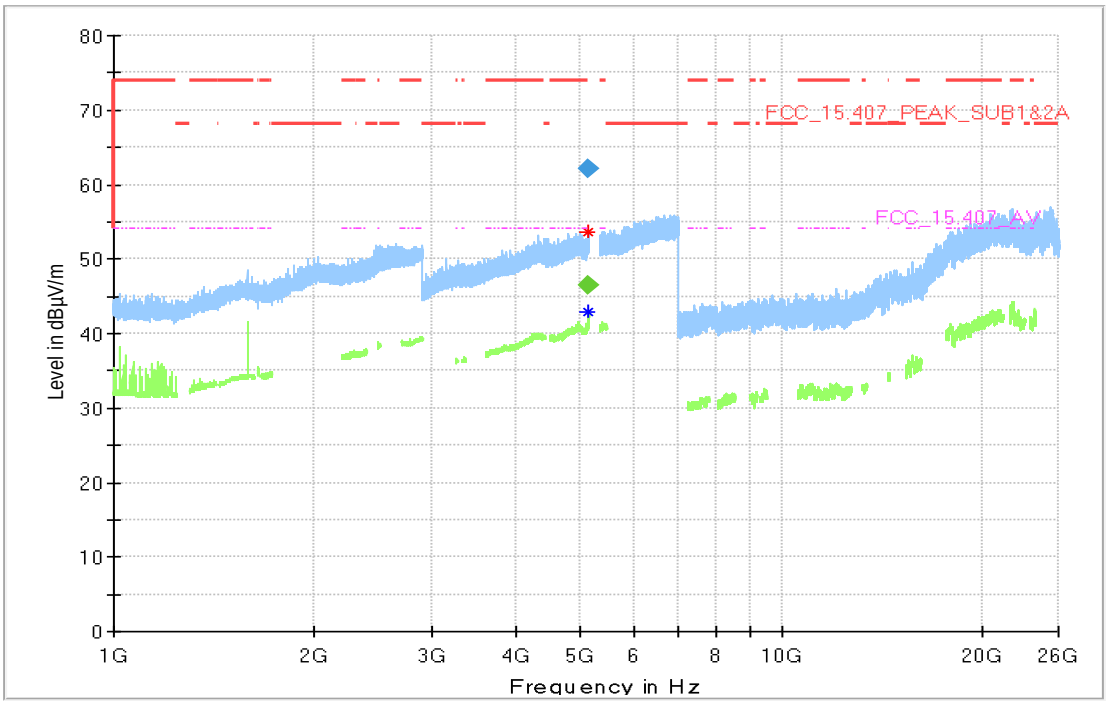
Radio Technology = WLAN a 20 MHz, Range 30 MHz – 1 GHz, Core 1, Channel 36 (S01_AA01)



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment	Corr. (dB)
50.940000	29.58	40.00	10.42	1000.0	120.000	105.0	V	-109.0	6.1		---
80.910000	36.95	40.00	3.05	1000.0	120.000	123.0	V	46.0	10.2		---
84.000000	33.55	40.00	6.45	1000.0	120.000	107.0	V	-78.0	10.4		---

Radio Technology = WLAN a 20 MHz, Range 1 GHz – 26 GHz, Core 1, Channel 36 (S01_AA01)



Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)
5149.838	53.5	---	74.00	20.45	---	---	150.0	H	6.0	86.0
5150.000	---	42.9	54.00	11.06	---	---	150.0	H	6.0	78.0

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)
5149.838	62.0	---	74.00	11.97	1000.0	1000.000	150.0	H	6.0	86.0
5150.000	---	46.4	54.00	7.60	1000.0	1000.000	150.0	H	6.0	78.0

4.3.2 CONDUCTED MEASUREMENTS AT ANTENNA PORT

The test was performed according to:
ANSI C63.10

4.3.2.1 Test Description

The Equipment Under Test (EUT) was set up to perform the conducted spurious emissions measurements. The antenna port of the EUT was connected to spectrum analyzer via a short coax cable with a known cable loss C_L. The measured voltage U_{meas} at the 50 Ohm input of the analyser was used to calculate the EUT output power at the antenna port:

$P = U_{meas} + C_L - 107$

where
P is the output power in dBm
U_{meas} is the measured voltage at the 50 Ohm input of the analyzer in dBµV
C_L is the cable loss of the used cable.

The maximum transmit isotropically antenna gain G_i (in dBi) was added to the measured output power P to determine the equivalent isotropically radiated power EIRP.

$EIRP = P + Gi$

where
P is the output power in dBm
G_i is maximum transmit antenna gain in dBi.

The resultant EIRP level was converted to an equivalent electric filed strength using the following relationship:

$E = EIRP - 20 \log d + 104.8$

where
E is the electric field strength in dBµV/m
EIRP is the equivalent isotropically radiated power in dBm
d is the specified measurement distance in m.

The appropriate maximum ground reflection factor was added to the EIRP:
6 dB for frequencies ≤ 30 MHz;
4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive; and
0 dB for frequencies > 1000 MHz).

Frequency range [MHz]	measurement distance d [m]	-20 log d [dB]	ground reflection factor [dB]
0,009 – 0,49	300	-49,54	6
0,49 – 30	30	-29,54	6
30 – 1000	3	-9,54	4,7
>1000	3	-9,54	0

For the MIMO values of Core 0 + Core 1, the measured dBm values were converted to mW, than added together, reconverted to dBm and afterwards converted to dBµV/m as described above.

1. Measurement up to 30 MHz
Step 1: pre measurement
This is a preliminary test to identify the highest amplitudes relative to the limit.
- Detector: Peak-Maxhold/ Quasipeak (FFT-based)
- Frequency range: 0.009 - 0.15 MHz and 0.15 – 30 MHz
- Frequency steps: 0.05 kHz and 2.25 kHz
- IF–Bandwidth: 0.2 kHz and 9 kHz
- Measuring time / Frequency step: 100 ms (FFT-based)

Intention of this step is, to determine the EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.
Step 2: final measurement
EMI receiver settings:
- Detector: Peak / Average / Quasi-Peak (depending on frequency)
- Frequency range: 0.009 – 30 MHz
- Frequency steps: measurement at frequencies detected in step 1
- IF–Bandwidth: 0.2 - 10 kHz (depending on frequency)
- Measuring time / Frequency step: 1 s

2. Measurement above 30 MHz and up to 1 GHz
Step 1: pre measurement
This is a preliminary test to identify the highest amplitudes relative to the limit.
Settings:
- Detector: Peak-Maxhold / Quasipeak (FFT-based)
- Frequency range: 30 – 1000 MHz
- Frequency steps: 30 kHz
- IF–Bandwidth: 120 kHz
- Measuring time / Frequency step: 100 ms

Step 2: final measurement
EMI receiver settings:
- Detector: Quasi-Peak (< 1 GHz)
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 1 s

3. Measurement above 1 GHz
Step 1: pre measurement
Ssettings:
- Detector: Peak, Average
- IF Bandwidth = 1 MHz

Step 2: final measurement
Spectrum analyzer settings:
- Detector: Peak / Average
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 1 MHz
- Measuring time: 1 s

4.3.2.2 Test Requirements / Limits

Please see test description for radiated measurement

4.3.2.3 Test Protocol

Ambient temperature: 24 °C
Air Pressure: 997 hPa
Humidity: 42 %

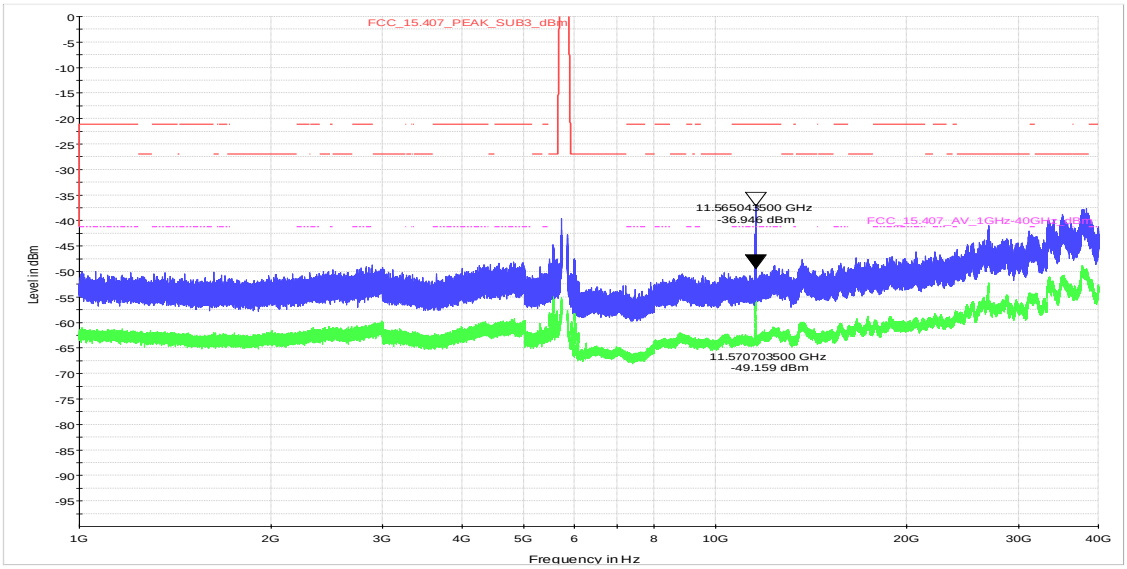
WLAN n-Mode; 20 MHz; MCS 0
Applied duty cycle correction (AV): 0 dB

Ch. No.	Ch. Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level Core 0 [dBµV/m]	Spurious Level Core 1 [dBµV/m]	Spurious Level Core 0 + 1 [dBµV/m]	Detec-tor	RBW [kHz]	Limit [dBµV/m]	Margin [dB]	Limit Type
48	5240	10479.0	49.1	47.7	51.5	PEAK	1000	68.2	16.7	UE
48	5240	15720.7	54.6	50.8	56.1	PEAK	1000	74.0	17.9	RB
48	5240	15718.5	40.9	38.7	42.9	AV	1000	54.0	11.1	RB
157	5785	11565.0	61.5	51.1	61.9	PEAK	1000	74.0	12.1	RB
157	5785	11570.7	49.2	39.5	49.6	AV	1000	54.0	4.4	RB

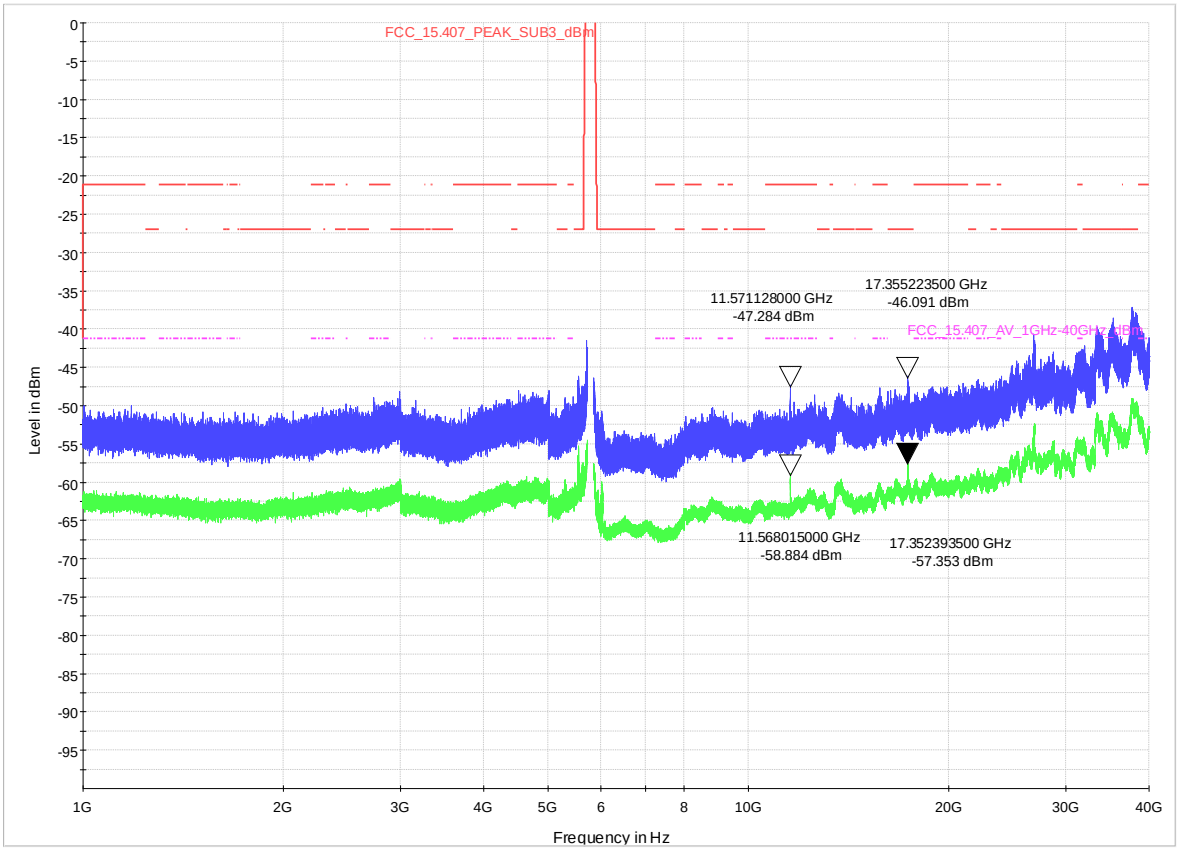
Remark: Please see next sub-clause for the measurement plot.

4.3.2.4 Measurement Plot (showing the highest value, "worst case")

Radio Technology = WLAN a 20 MHz, Range 1 GHz – 40 MHz, Channel 157 (S01_AB01)



Core 0, 2 dBi antenna gain included in result, additional 3.2 dB added for spurious level given in result table



Core 1, 2 dBi antenna gain included in result, additional 3.2 dB added for spurious level given in result table

4.3.3 TEST EQUIPMENT USED

- Radiated Emissions

4.4 BAND EDGE

Standard **FCC Part 15 Subpart E**

4.4.1 RADIATED MEASUREMENTS

The test was performed according to:
ANSI C63.10

4.4.1.1 Test Description

Please see test description for the test case "UNDESIRABLE EMISSIONS"

4.4.1.2 Test Requirements / Limits

For band edges connected to a restricted band, the limits are specified in Section 15.209(a)

FCC Part 15, Subpart C, §15.209, Radiated Emission Limits

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limits (dBµV/m)
0.009 – 0.49	2400/F(kHz)@300m	3	(48.5 – 13.8)@300m
0.49 – 1.705	24000/F(kHz)@30m	3	(33.8 – 23.0)@30m
1.705 – 30	30@30m	3	29.5@30m

The measured values are corrected with an inverse linear distance extrapolation factor (40 dB/decade) according FCC 15.31 (2).

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limits (dBµV/m)
30 – 88	100@3m	3	40.0@3m
88 – 216	150@3m	3	43.5@3m
216 – 960	200@3m	3	46.0@3m
960 - 26000	500@3m	3	54.0@3m
26000 - 40000	500@3m	1	54.0@3m

The measured values above 26 GHz are corrected with an inverse linear distance extrapolation factor (20 dB/decade).

§15.35(b) ..., there is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit....

Used conversion factor: Limit (dBµV/m) = 20 log (Limit (µV/m)/1µV/m)

4.4.1.3 Test Protocol

Ambient temperature:	24-28 °C
Air Pressure:	1007-1012 hPa
Humidity:	42-55 %

WLAN n-Mode; 20 MHz; MCS0

U-NII-Subband	Ch. No.	Ch. Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level Core 0 [dBµV/m]	Spurious Level Core 1 [dBµV/m]	Spurious Level Core 0 + 1 [dBµV/m]	Detec-tor	RBW [kHz]	Limit [dBµV/m]	Margin [dB]	
1	36	5180	5150.0	63.1	63.0	66.1	PEAK	1000	74.0	7.9	
	36	5180	5150.0	45.4	46.2	48.8	AV	1000	54.0	5.2	
	40	5200	5150.0	58.7	58.5	61.6	PEAK	1000	74.0	12.4	
	40	5200	5150.0	45.6	44.7	48.2	AV	1000	54.0	5.8	
2A	60	5300	5350.0	56.4	56.9	59.7	PEAK	1000	74.0	14.3	
	60	5300	5350.0	44.2	47.1	48.9	AV	1000	54.0	5.1	
	64	5320	5350.0	63.4	62.6	66.0	PEAK	1000	74.0	8.0	
	64	5320	5350.0	46.1	46.2	49.2	AV	1000	54.0	4.8	
2C	100	5500	5460.0	59.0	60.0	62.5	PEAK	1000	74.0	11.5	
	100	5500	5460.0	45.2	47.9	49.8	AV	1000	54.0	4.2	
	100	5500	5470.0	65.3	58.3	66.1	PEAK	1000	68.2	2.1	
	104	5520	5460.0	56.9	59.8	61.6	PEAK	1000	74.0	12.4	
	104	5520	5460.0	44.8	46.6	48.8	AV	1000	54.0	5.2	
	104	5520	5470.0	60.1	60.5	63.3	PEAK	1000	68.2	4.9	
	136	5680	5725.0	60.5	56.5	62.0	PEAK	1000	68.2	6.2	
	140	5700	5725.0	64.5	63.1	66.9	PEAK	1000	68.2	1.3	1)
3	149	5745	5725.0	53.3	54.0	56.7	PEAK	1000	68.2	11.5	
	165	5825	5850.0	54.7	54.0	57.4	PEAK	1000	68.2	10.8	

1) Integration method used.

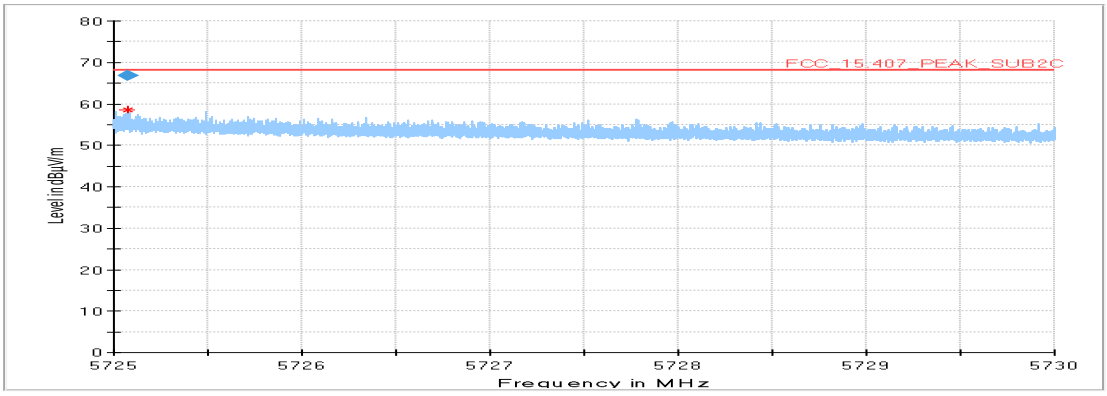
WLAN ac-Mode; 80 MHz; MCS0

U-NII-Subband	Ch. No.	Ch. Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level Core 0 [dBµV/m]	Spurious Level Core 1 [dBµV/m]	Spurious Level Core 0 + 1 [dBµV/m]	Detec-tor	RBW [kHz]	Limit [dBµV/m]	Margin [dB]
3	149	5745	5725.0	56.1	54.6	58.4	PEAK	1000	68.2	9.8
	165	5825	5850.0	53.9	54.0	57.0	PEAK	1000	68.2	11.2

Remark: Please see next sub-clause for the measurement plot.

4.4.1.4 Measurement Plot (showing the highest value, "worst case")

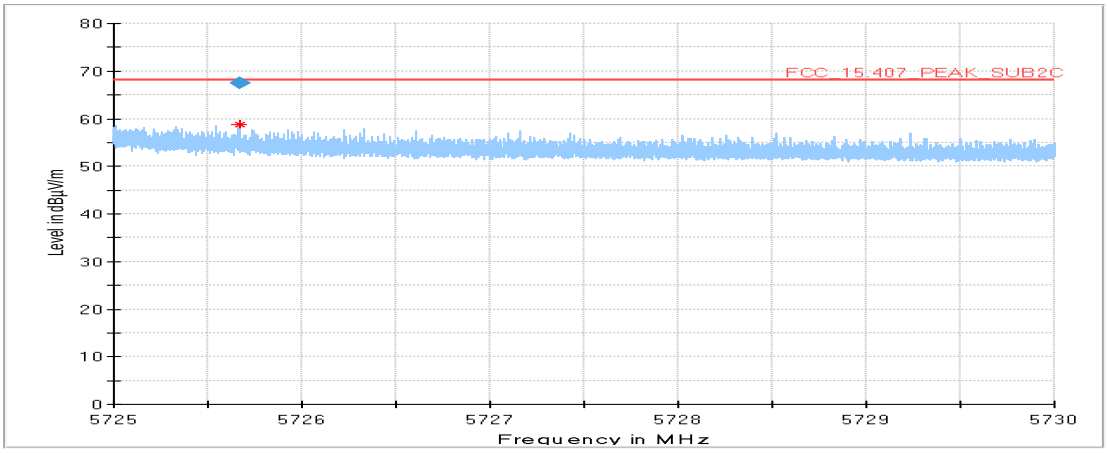
Radio Technology = WLAN n 20 MHz, Channel 140
(S01_AA01)
Core 0



Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)
5725.073	66.8	---	68.20	1.40	1000.0	1000.000	150.0	H	39.0	15.0

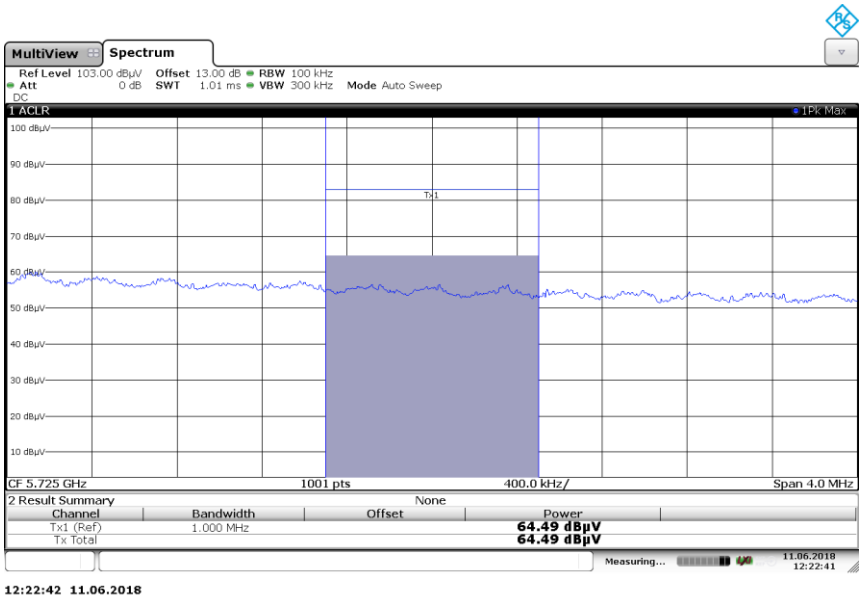
Core 1



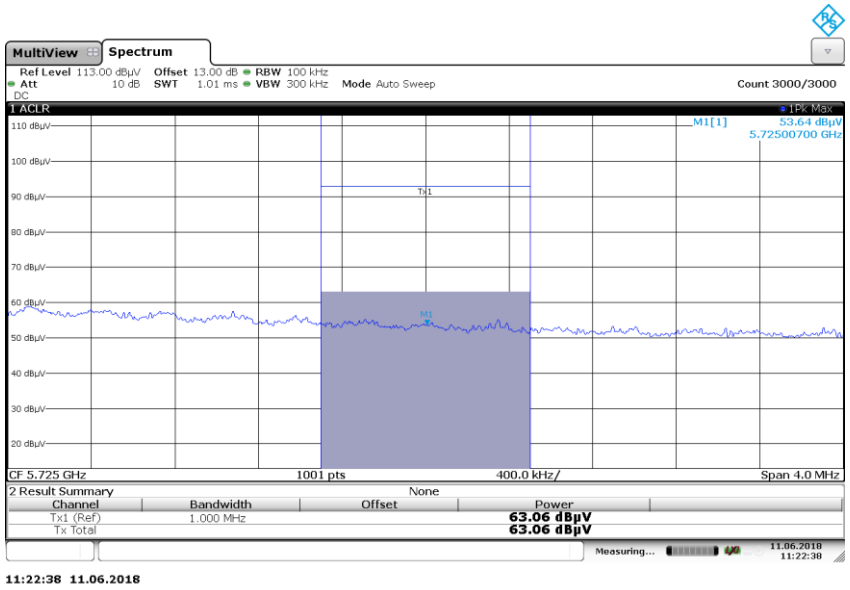
Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)
5725.668	67.6	---	68.20	0.64	1000.0	1000.000	150.0	H	-10.0	82.0

Final Measurement Integration Method
Core 0



Core 1



4.4.2 TEST EQUIPMENT USED

- Radiated Emissions

5 TEST EQUIPMENT

1 Radiated Emissions
Lab to perform radiated emission tests
Used for measurements on 2018-05-29 to 2018-11-06, FSW only also on 2018-12-08

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
1.1	MFS	Rubidium Frequency Normal MFS	Datum GmbH	002	2017-10	2018-10
1.2	Opus10 TPR (8253.00)	ThermoAirpressure Datalogger 13 (Environ)	Lufft Mess- und Regeltechnik GmbH	13936	2017-04	2019-04
1.3	ESW44	EMI Test Receiver	Rohde & Schwarz GmbH & Co. KG	101603	2018-05	2019-05
1.4	Anechoic Chamber	10.58 x 6.38 x 6.00 m³	Frankonia	none	2016-05 2018-06	2018-05 2021-06
1.5	FS-Z60	Harmonic Mixer 40 - 60 GHz	Rohde & Schwarz Messgerätebau GmbH	100178	2016-12	2019-12
1.6	FS-Z220	Harmonic Mixer 140 - 220 GHz	Rohde & Schwarz Messgerätebau GmbH	101005	2017-03	2020-03
1.7	SGH-05	Antenna (140 - 220 GHz)		075		
1.8	HL 562	Ultralog new biconicals	Rohde & Schwarz	830547/003	2015-06	2018-06
1.9	5HC2700/12750-1.5-KK	High Pass Filter	Trilithic	9942012		
1.10	ASP 1.2/1.8-10 kg	Antenna Mast	Maturo GmbH	-		
1.11	Fully Anechoic Room	8.80m x 4.60m x 4.05m (l x w x h)	Albatross Projects	P26971-647-001-PRB	2015-06	2018-06
1.12	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2018-04	2020-04
1.13	JS4-18002600-32-5P	Broadband Amplifier 18 GHz - 26 GHz	Miteq	849785		
1.14	FSW 43	Spectrum Analyzer	Rohde & Schwarz	103779	2016-12	2018-12
1.15	3160-09	Standard Gain / Pyramidal Horn Antenna 26.5 GHz	EMCO Elektronic GmbH	00083069		
1.16	SGH-19	Antenna (40 - 60 GHz)		093		
1.17	WHKX 7.0/18G-8SS	High Pass Filter	Wainwright	09		
1.18	4HC1600/12750-1.5-KK	High Pass Filter	Trilithic	9942011		
1.19	Chroma 6404	AC Power Source	Chroma ATE INC.	64040001304		
1.20	JS4-00102600-42-5A	Broadband Amplifier 30 MHz - 26 GHz	Miteq	619368		

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
1.21	TT 1.5 WI	Turn Table	Maturo GmbH	-		
1.22	HL 562 Ultralog	Log.-per. Antenna	Rohde & Schwarz	100609	2016-04	2019-04
1.23	FS-Z325	Harmonic Mixer 220 - 325 GHz	Rohde & Schwarz Messgerätebau GmbH	101006	2017-03	2020-03
1.24	3160-10	Standard Gain / Pyramidal Horn Antenna 40 GHz	EMCO Elektronic GmbH	00086675		
1.25	SGH-08	Antenna (90 - 140 GHz)		064		
1.26	SGH-12	Antenna (60 - 90 GHz)		326		
1.27	5HC3500/18000-1.2-KK	High Pass Filter	Trilithic	200035008		
1.28	FS-Z140	Harmonic Mixer 90 -140 GHz	Rohde & Schwarz Messgerätebau GmbH	101007	2017-02	2020-02
1.29	HFH2-Z2	Loop Antenna	Rohde & Schwarz	829324/006	2018-01	2021-01
1.30	Opus10 THI (8152.00)	ThermoHygro Datalogger 12 (Environ)	Lufft Mess- und Regeltechnik GmbH	12482	2017-03	2019-03
1.31	ESR 7	EMI Receiver / Spectrum Analyzer	Rohde & Schwarz	101424	2016-11	2018-11
1.32	JS4-00101800-35-5P	Broadband Amplifier 30 MHz - 18 GHz	Miteq	896037		
1.33	AS 620 P	Antenna mast	HD GmbH	620/37		
1.34	Tilt device Maturo (Rohacell)	Antrieb TD1.5-10kg	Maturo GmbH	TD1.5-10kg/024/3790709		
1.35	SGH-03	Antenna (220 - 325 GHz)		060		
1.36	FS-Z90	Harmonic Mixer 60 - 90 GHz	Rohde & Schwarz Messgerätebau GmbH	101686	2017-03	2020-03
1.37	ESIB 26	Spectrum Analyzer	Rohde & Schwarz	830482/004	2018-01	2020-01
1.38	PAS 2.5 - 10 kg	Antenna Mast	Maturo GmbH	-		
1.39	AFS42-00101800-25-S-42	Broadband Amplifier 25 MHz - 18 GHz	Miteq	2035324		
1.40	AM 4.0	Antenna mast	Maturo GmbH	AM4.0/180/11920513		
1.41	HF 907	Double-ridged horn	Rohde & Schwarz	102444	2015-05	2018-05
1.42	HF 906	Double-ridged horn	Rohde & Schwarz	357357/001	2018-03	2021-03

2 Regulatory WLAN RF Test Solution
Regulatory WLAN RF Tests

Used for measurements on 2018-05-29

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
2.1	MFS	Rubidium Frequency Normal MFS	Datum GmbH	002	2017-10	2018-10
2.2	TGA12101	Arbitrary Waveform Generator	Aim and Thurlby Thandar Instruments	284482		
2.3	NRV Z1 A	Power Sensor	Rohde & Schwarz	832279/013	2017-09	2018-09
2.4	Opus10 THI (8152.00)	T/H Logger 15	Lufft Mess- und Regeltechnik GmbH	13985	2017-04	2019-04
2.5	TOCT Switching Unit		7layers, Inc.	040107		
2.6	NRVD	Power Meter	Rohde & Schwarz	832025/059	2017-09	2018-09
2.7	FSU3	Spectrum Analyser	Rohde & Schwarz GmbH & Co. KG	200046	2017-06	2018-06
2.8	FSIQ26	Signal Analyser	Rohde & Schwarz	832695/007	2016-09	2018-09
2.9	FSU26	Spectrum Analyser	Rohde & Schwarz GmbH & Co. KG	100136	2018-01	2019-01
2.10	SMIQ 03B	Signal Generator	Rohde & Schwarz GmbH & Co. KG	832870/017	2016-06	2019-06
2.11	NGSM 32/10	Power Supply	Rohde & Schwarz	2725	2017-06	2019-06

3 R&S TS8997
EN300328/301893 test lab

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
3.1	SMB100A	Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz	107695	2017-07	2020-07
3.2	MFS	Rubidium Frequency Standard	Datum-Beverly	5489/001	2017-07 2018-07	2018-07 2019-07
3.3	1515 / 93459	Broadband Power Divider SMA (Aux)	Weinschel Associates	LN673		
3.4	Opus10 THI (8152.00)	ThermoHygro Datalogger 03 (Environ)	Lufft Mess- und Regeltechnik GmbH	7482	2017-03	2019-03
3.5	OSP120	Switching Unit with integrated power meter	Rohde & Schwarz	101158	2016-11 2018-05	2018-11 2021-05
3.6	FSV 30	Signal Analyzer 10 Hz – 30 GHz	Rohde & Schwarz	103005	2018-04	2020-04
3.7	SMIQ 03B	Signal Generator	Rohde & Schwarz GmbH & Co. KG	832870/017	2016-06	2019-06

The calibration interval is the time interval between “Last Calibration” and “Calibration Due”

6 ANTENNA FACTORS, CABLE LOSS AND SAMPLE CALCULATIONS

This chapter contains the antenna factors with their corresponding path loss of the used measurement path for all antennas as well as the insertion loss of the LISN.

6.1 LISN R&S ESH3-Z5 (150 KHZ – 30 MHZ)

Frequency		Corr.	LISN insertion loss ESH3-Z5	cable loss (incl. 10 dB atten-uator)
MHz		dB	dB	dB
0.15		10.1	0.1	10.0
5		10.3	0.1	10.2
7		10.5	0.2	10.3
10		10.5	0.2	10.3
12		10.7	0.3	10.4
14		10.7	0.3	10.4
16		10.8	0.4	10.4
18		10.9	0.4	10.5
20		10.9	0.4	10.5
22		11.1	0.5	10.6
24		11.1	0.5	10.6
26		11.2	0.5	10.7
28		11.2	0.5	10.7
30		11.3	0.5	10.8

Sample calculation

U_{LISN} (dB µV) = U (dB µV) + Corr. (dB)
U = Receiver reading
LISN Insertion loss = Voltage Division Factor of LISN
Corr. = sum of single correction factors of used LISN, cables, switch units (if used)
Linear interpolation will be used for frequencies in between the values in the table.

6.2 ANTENNA R&S HFH2-Z2 (9 KHZ – 30 MHZ)

Frequency	AF HFH-Z2)	Corr.	cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-40 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	m	m
0.009	20.50	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.01	20.45	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.015	20.37	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.02	20.36	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.025	20.38	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.03	20.32	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.05	20.35	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.08	20.30	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.1	20.20	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.2	20.17	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.3	20.14	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.49	20.12	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.490001	20.12	-39.6	0.1	0.1	0.1	0.1	-40	30	3
0.5	20.11	-39.6	0.1	0.1	0.1	0.1	-40	30	3
0.8	20.10	-39.6	0.1	0.1	0.1	0.1	-40	30	3
1	20.09	-39.6	0.1	0.1	0.1	0.1	-40	30	3
2	20.08	-39.6	0.1	0.1	0.1	0.1	-40	30	3
3	20.06	-39.6	0.1	0.1	0.1	0.1	-40	30	3
4	20.05	-39.5	0.2	0.1	0.1	0.1	-40	30	3
5	20.05	-39.5	0.2	0.1	0.1	0.1	-40	30	3
6	20.02	-39.5	0.2	0.1	0.1	0.1	-40	30	3
8	19.95	-39.5	0.2	0.1	0.1	0.1	-40	30	3
10	19.83	-39.4	0.2	0.1	0.2	0.1	-40	30	3
12	19.71	-39.4	0.2	0.1	0.2	0.1	-40	30	3
14	19.54	-39.4	0.2	0.1	0.2	0.1	-40	30	3
16	19.53	-39.3	0.3	0.1	0.2	0.1	-40	30	3
18	19.50	-39.3	0.3	0.1	0.2	0.1	-40	30	3
20	19.57	-39.3	0.3	0.1	0.2	0.1	-40	30	3
22	19.61	-39.3	0.3	0.1	0.2	0.1	-40	30	3
24	19.61	-39.3	0.3	0.1	0.2	0.1	-40	30	3
26	19.54	-39.3	0.3	0.1	0.2	0.1	-40	30	3
28	19.46	-39.2	0.3	0.1	0.3	0.1	-40	30	3
30	19.73	-39.1	0.4	0.1	0.3	0.1	-40	30	3

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
distance correction = -40 * LOG (d_{Limit}/ d_{used})
Linear interpolation will be used for frequencies in between the values in the table.
Table shows an extract of values

6.3 ANTENNA R&S HL562 (30 MHZ – 1 GHZ)

(d_{Limit} = 3 m)

Frequency	AF R&S HL562	Corr.	cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-20 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	m	m
30	18.6	0.6	0.29	0.04	0.23	0.02	0.0	3	3
50	6.0	0.9	0.39	0.09	0.32	0.08	0.0	3	3
100	9.7	1.2	0.56	0.14	0.47	0.08	0.0	3	3
150	7.9	1.6	0.73	0.20	0.59	0.12	0.0	3	3
200	7.6	1.9	0.84	0.21	0.70	0.11	0.0	3	3
250	9.5	2.1	0.98	0.24	0.80	0.13	0.0	3	3
300	11.0	2.3	1.04	0.26	0.89	0.15	0.0	3	3
350	12.4	2.6	1.18	0.31	0.96	0.13	0.0	3	3
400	13.6	2.9	1.28	0.35	1.03	0.19	0.0	3	3
450	14.7	3.1	1.39	0.38	1.11	0.22	0.0	3	3
500	15.6	3.2	1.44	0.39	1.20	0.19	0.0	3	3
550	16.3	3.5	1.55	0.46	1.24	0.23	0.0	3	3
600	17.2	3.5	1.59	0.43	1.29	0.23	0.0	3	3
650	18.1	3.6	1.67	0.34	1.35	0.22	0.0	3	3
700	18.5	3.6	1.67	0.42	1.41	0.15	0.0	3	3
750	19.1	4.1	1.87	0.54	1.46	0.25	0.0	3	3
800	19.6	4.1	1.90	0.46	1.51	0.25	0.0	3	3
850	20.1	4.4	1.99	0.60	1.56	0.27	0.0	3	3
900	20.8	4.7	2.14	0.60	1.63	0.29	0.0	3	3
950	21.1	4.8	2.22	0.60	1.66	0.33	0.0	3	3
1000	21.6	4.9	2.23	0.61	1.71	0.30	0.0	3	3

(d_{Limit} = 10 m)

30	18.6	-9.9	0.29	0.04	0.23	0.02	-10.5	10	3
50	6.0	-9.6	0.39	0.09	0.32	0.08	-10.5	10	3
100	9.7	-9.2	0.56	0.14	0.47	0.08	-10.5	10	3
150	7.9	-8.8	0.73	0.20	0.59	0.12	-10.5	10	3
200	7.6	-8.6	0.84	0.21	0.70	0.11	-10.5	10	3
250	9.5	-8.3	0.98	0.24	0.80	0.13	-10.5	10	3
300	11.0	-8.1	1.04	0.26	0.89	0.15	-10.5	10	3
350	12.4	-7.9	1.18	0.31	0.96	0.13	-10.5	10	3
400	13.6	-7.6	1.28	0.35	1.03	0.19	-10.5	10	3
450	14.7	-7.4	1.39	0.38	1.11	0.22	-10.5	10	3
500	15.6	-7.2	1.44	0.39	1.20	0.19	-10.5	10	3
550	16.3	-7.0	1.55	0.46	1.24	0.23	-10.5	10	3
600	17.2	-6.9	1.59	0.43	1.29	0.23	-10.5	10	3
650	18.1	-6.9	1.67	0.34	1.35	0.22	-10.5	10	3
700	18.5	-6.8	1.67	0.42	1.41	0.15	-10.5	10	3
750	19.1	-6.3	1.87	0.54	1.46	0.25	-10.5	10	3
800	19.6	-6.3	1.90	0.46	1.51	0.25	-10.5	10	3
850	20.1	-6.0	1.99	0.60	1.56	0.27	-10.5	10	3
900	20.8	-5.8	2.14	0.60	1.63	0.29	-10.5	10	3
950	21.1	-5.6	2.22	0.60	1.66	0.33	-10.5	10	3
1000	21.6	-5.6	2.23	0.61	1.71	0.30	-10.5	10	3

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
distance correction = -20 * LOG (d_{Limit}/ d_{used})
Linear interpolation will be used for frequencies in between the values in the table.
Tables show an extract of values.

6.4 ANTENNA R&S HF907 (1 GHZ – 18 GHZ)

Frequency	AF R&S HF907	Corr.	cable loss 1 (relay + cable inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit, atten-uator & pre-amp)	cable loss 4 (to receiver)		
MHz	dB (1/m)	dB	dB	dB	dB	dB		
1000	24.4	-19.4	0.99	0.31	-21.51	0.79		
2000	28.5	-17.4	1.44	0.44	-20.63	1.38		
3000	31.0	-16.1	1.87	0.53	-19.85	1.33		
4000	33.1	-14.7	2.41	0.67	-19.13	1.31		
5000	34.4	-13.7	2.78	0.86	-18.71	1.40		
6000	34.7	-12.7	2.74	0.90	-17.83	1.47		
7000	35.6	-11.0	2.82	0.86	-16.19	1.46		

Frequency	AF R&S HF907	Corr.	cable loss 1 (relay inside chamber)	cable loss 2 (inside chamber)	cable loss 3 (outside chamber)	cable loss 4 (switch unit, atten-uator & pre-amp)	cable loss 5 (to receiver)	used for FCC 15.247
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	
3000	31.0	-23.4	0.47	1.87	0.53	-27.58	1.33	
4000	33.1	-23.3	0.56	2.41	0.67	-28.23	1.31	
5000	34.4	-21.7	0.61	2.78	0.86	-27.35	1.40	
6000	34.7	-21.2	0.58	2.74	0.90	-26.89	1.47	
7000	35.6	-19.8	0.66	2.82	0.86	-25.58	1.46	

Frequency	AF R&S HF907	Corr.	cable loss 1 (relay inside chamber)	cable loss 2 (High Pass)	cable loss 3 (pre-amp)	cable loss 4 (inside chamber)	cable loss 5 (outside chamber)	cable loss 6 (to receiver)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	dB
7000	35.6	-57.3	0.56	1.28	-62.72	2.66	0.94	1.46
8000	36.3	-56.3	0.69	0.71	-61.49	2.84	1.00	1.53
9000	37.1	-55.3	0.68	0.65	-60.80	3.06	1.09	1.60
10000	37.5	-56.2	0.70	0.54	-61.91	3.28	1.20	1.67
11000	37.5	-55.3	0.80	0.61	-61.40	3.43	1.27	1.70
12000	37.6	-53.7	0.84	0.42	-59.70	3.53	1.26	1.73
13000	38.2	-53.5	0.83	0.44	-59.81	3.75	1.32	1.83
14000	39.9	-56.3	0.91	0.53	-63.03	3.91	1.40	1.77
15000	40.9	-54.1	0.98	0.54	-61.05	4.02	1.44	1.83
16000	41.3	-54.1	1.23	0.49	-61.51	4.17	1.51	1.85
17000	42.8	-54.4	1.36	0.76	-62.36	4.34	1.53	2.00
18000	44.2	-54.7	1.70	0.53	-62.88	4.41	1.55	1.91

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
Linear interpolation will be used for frequencies in between the values in the table.
Tables show an extract of values.

6.5 ANTENNA EMCO 3160-09 (18 GHZ – 26.5 GHZ)

Frequency	AF EMCO 3160-09	Corr.	cable loss 1 (inside chamber)	cable loss 2 (pre-amp)	cable loss 3 (inside chamber)	cable loss 4 (switch unit)	cable loss 5 (to receiver)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB
18000	40.2	-23.5	0.72	-35.85	6.20	2.81	2.65
18500	40.2	-23.2	0.69	-35.71	6.46	2.76	2.59
19000	40.2	-22.0	0.76	-35.44	6.69	3.15	2.79
19500	40.3	-21.3	0.74	-35.07	7.04	3.11	2.91
20000	40.3	-20.3	0.72	-34.49	7.30	3.07	3.05
20500	40.3	-19.9	0.78	-34.46	7.48	3.12	3.15
21000	40.3	-19.1	0.87	-34.07	7.61	3.20	3.33
21500	40.3	-19.1	0.90	-33.96	7.47	3.28	3.19
22000	40.3	-18.7	0.89	-33.57	7.34	3.35	3.28
22500	40.4	-19.0	0.87	-33.66	7.06	3.75	2.94
23000	40.4	-19.5	0.88	-33.75	6.92	3.77	2.70
23500	40.4	-19.3	0.90	-33.35	6.99	3.52	2.66
24000	40.4	-19.8	0.88	-33.99	6.88	3.88	2.58
24500	40.4	-19.5	0.91	-33.89	7.01	3.93	2.51
25000	40.4	-19.3	0.88	-33.00	6.72	3.96	2.14
25500	40.5	-20.4	0.89	-34.07	6.90	3.66	2.22
26000	40.5	-21.3	0.86	-35.11	7.02	3.69	2.28
26500	40.5	-21.1	0.90	-35.20	7.15	3.91	2.36

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
Linear interpolation will be used for frequencies in between the values in the table.
Table shows an extract of values.

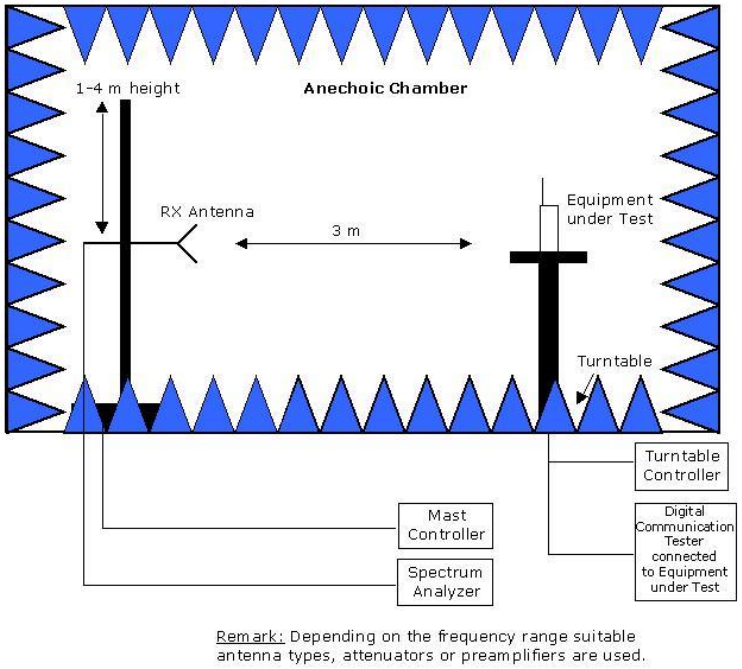
6.6 ANTENNA EMCO 3160-10 (26.5 GHZ – 40 GHZ)

Frequency	AF EMCO 3160-10	Corr.	cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-20 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
GHz	dB (1/m)	dB	dB	dB	dB	dB	dB	m	m
26.5	43.4	-11.2	4.4				-15.6	3	0.5
27.0	43.4	-11.2	4.4				-15.6	3	0.5
28.0	43.4	-11.1	4.5				-15.6	3	0.5
29.0	43.5	-11.0	4.6				-15.6	3	0.5
30.0	43.5	-10.9	4.7				-15.6	3	0.5
31.0	43.5	-10.8	4.7				-15.6	3	0.5
32.0	43.5	-10.7	4.8				-15.6	3	0.5
33.0	43.6	-10.7	4.9				-15.6	3	0.5
34.0	43.6	-10.6	5.0				-15.6	3	0.5
35.0	43.6	-10.5	5.1				-15.6	3	0.5
36.0	43.6	-10.4	5.1				-15.6	3	0.5
37.0	43.7	-10.3	5.2				-15.6	3	0.5
38.0	43.7	-10.2	5.3				-15.6	3	0.5
39.0	43.7	-10.2	5.4				-15.6	3	0.5
40.0	43.8	-10.1	5.5				-15.6	3	0.5

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
Linear interpolation will be used for frequencies in between the values in the table.
distance correction = -20 * LOG (d_{Limit}/ d_{used})
Linear interpolation will be used for frequencies in between the values in the table.
Table shows an extract of values.

7 SETUP DRAWINGS



Drawing 1: Setup in the Anechoic chamber. For measurements below 1 GHz the ground was replaced by a conducting groundplane.

8 MEASUREMENT UNCERTAINTIES

Test Case	Parameter	Uncertainty
AC Power Line	Power	± 3.4 dB
Field Strength of spurious radiation	Power	± 5.5 dB
6 dB / 26 dB / 99% Bandwidth	Power Frequency	± 2.9 dB ± 11.2 kHz
Conducted Output Power	Power	± 2.2 dB
Band Edge Compliance	Power Frequency	± 2.2 dB ± 11.2 kHz
Frequency Stability	Frequency	± 25 Hz
Power Spectral Density	Power	± 2.2 dB

9 PHOTO REPORT

Please see separate photo report.