

FCC Measurement/Technical Report on

WiBEAR11n-DF1 / ELLA-W161

FCC ID: PV7-WIBEAR11N-DF1

IC: 7738A-WB11NDF1

Test Report Reference: MDE_UBLOX_1624FCCa

Test Laboratory:

7layers GmbH
Borsigstrasse 11
40880 Ratingen
Germany



Note:

The following test results relate only to the devices specified in this document. This report shall not be reproduced in parts without the written approval of the test laboratory.

7layers GmbH

Borsigstraße 11
40880 Ratingen, Germany
T +49 (0) 2102 749 0
F +49 (0) 2102 749 350

Geschäftsführer/

Managing Directors:
Frank Spiller
Bernhard Retka
Alexandre Norré-Oudard

Registergericht/registered:

Düsseldorf HRB 75554
USt-Id.-Nr./VAT-No. DE203159652
Steuer-Nr./TAX-No. 147/5869/0385

*a Bureau Veritas
Group Company*

www.7layers.com

Table of Contents

1 Applied Standards and Test Summary	3
1.1 Applied Standards	3
1.2 FCC-IC Correlation Table	4
1.3 Measurement Summary / Signatures	4
2 Administrative Data	10
2.1 Testing Laboratory	10
2.2 Project Data	10
2.3 Applicant Data	10
2.4 Manufacturer Data	10
3 Test object Data	11
3.1 General EUT Description	11
3.2 EUT Main components	11
3.3 Ancillary Equipment	12
3.4 Auxiliary Equipment	12
3.5 EUT Setups	13
3.6 Operating Modes	13
3.7 Product labelling	13
4 Test Results	14
4.1 26 dB Bandwidth	14
4.2 6 dB Bandwidth	18
4.3 99 % Bandwidth	21
4.4 Maximum Conducted Output Power	24
4.5 Peak Power Spectral Density	29
4.6 Undesirable Emissions; General Field Strength Limits	33
4.7 Band Edge	41
5 Test Equipment	43
6 Antenna Factors, Cable Loss and Sample Calculations	46
6.1 LISN R&S ESH3-Z5 (150 kHz – 30 MHz)	46
6.2 Antenna R&S HFH2-Z2 (9 kHz – 30 MHz)	47
6.3 Antenna R&S HL562 (30 MHz – 1 GHz)	48
6.4 Antenna R&S HF907 (1 GHz – 18 GHz)	49
6.5 Antenna EMCO 3160-09 (18 GHz – 26.5 GHz)	50
6.6 Antenna EMCO 3160-10	51
7 Setup Drawings	52
8 Measurement Uncertainties	53
9 Photo Report	53

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 Notice "Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices - Part 15, Subpart E, 789033 D02 General U-NII Test Procedures v01r02, 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.

This test report should show compliance of the EUT according the standards mentioned above. Because the EUT has already tested against the "old rules" for 5 GHZ WLAN, not all applicable tests have been performed. For details please see 7layers tests reports: MDE_LESSW_1302_FCCb and MDE_LESSW_1401_FCCb.

Tests which were not affected by the "new rules" (Frequency Stability, Conducted Emissions on AC port) have not been performed again.

Also the "Unwanted Emissions" have only been performed in UNII band 3. The conducted tests were performed for all UNII-bands

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 1: 6.2.1 (1), 6.2.2 (1), 6.2.3 (1) (99%) RSS-247 Issue 1: 6.2.4 (1) (6 dB)
Maximum conducted output power	§ 15.407 (a) (1),(2),(3),(4)	RSS-247 Issue 1: : 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 1: : 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 1: : 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 1: 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, §15.403 (i)

26 dB Bandwidth

The measurement was performed according to ANSI C63.10

Final Result

OP-Mode	Setup	FCC	IC
Radio Technology, Operating Frequency, Subband			
WLAN a, high, U-NII-1	S01_AB01	N/A	N/A
WLAN a, high, U-NII-2A	S01_AB01	N/A	N/A
WLAN a, high, U-NII-2C	S01_AB01	N/A	N/A
WLAN a, high, U-NII-3	S01_AB01	N/A	N/A
WLAN a, low, U-NII-1	S01_AB01	N/A	N/A
WLAN a, low, U-NII-2A	S01_AB01	N/A	N/A
WLAN a, low, U-NII-2C	S01_AB01	N/A	N/A
WLAN a, low, U-NII-3	S01_AB01	N/A	N/A
WLAN a, mid, U-NII-1	S01_AB01	N/A	N/A
WLAN a, mid, U-NII-2A	S01_AB01	N/A	N/A
WLAN a, mid, U-NII-2C	S01_AB01	N/A	N/A
WLAN a, mid, U-NII-3	S01_AB01	N/A	N/A
WLAN n 20 MHz, high, U-NII-1	S01_AB01	N/A	N/A
WLAN n 20 MHz, high, U-NII-2A	S01_AB01	N/A	N/A
WLAN n 20 MHz, high, U-NII-2C	S01_AB01	N/A	N/A
WLAN n 20 MHz, high, U-NII-3	S01_AB01	N/A	N/A
WLAN n 20 MHz, low, U-NII-1	S01_AB01	N/A	N/A
WLAN n 20 MHz, low, U-NII-2A	S01_AB01	N/A	N/A
WLAN n 20 MHz, low, U-NII-2C	S01_AB01	N/A	N/A
WLAN n 20 MHz, low, U-NII-3	S01_AB01	N/A	N/A
WLAN n 20 MHz, mid, U-NII-1	S01_AB01	N/A	N/A
WLAN n 20 MHz, mid, U-NII-2A	S01_AB01	N/A	N/A
WLAN n 20 MHz, mid, U-NII-2C	S01_AB01	N/A	N/A
WLAN n 20 MHz, mid, U-NII-3	S01_AB01	N/A	N/A
WLAN n 40 MHz, high, U-NII-1	S01_AB01	N/A	N/A
WLAN n 40 MHz, high, U-NII-2A	S01_AB01	N/A	N/A
WLAN n 40 MHz, high, U-NII-2C	S01_AB01	N/A	N/A
WLAN n 40 MHz, high, U-NII-3	S01_AB01	N/A	N/A
WLAN n 40 MHz, low, U-NII-1	S01_AB01	N/A	N/A
WLAN n 40 MHz, low, U-NII-2A	S01_AB01	N/A	N/A
WLAN n 40 MHz, low, U-NII-2C	S01_AB01	N/A	N/A
WLAN n 40 MHz, low, U-NII-3	S01_AB01	N/A	N/A
WLAN n 40 MHz, mid, U-NII-2C	S01_AB01	N/A	N/A

**47 CFR CHAPTER I FCC PART 15 Subpart E
§15.407**

FCC §15.31, §15.403 (i)

6 dB Bandwidth

The measurement was performed according to ANSI C63.10

Final Result

OP-Mode	Setup	FCC	IC
Radio Technology, Operating Frequency, Subband			
WLAN a, high, U-NII-3	S01_AB01	Passed	Passed
WLAN a, low, U-NII-3	S01_AB01	Passed	Passed
WLAN a, mid, U-NII-3	S01_AB01	Passed	Passed
WLAN n 20 MHz, high, U-NII-3	S01_AB01	Passed	Passed
WLAN n 20 MHz, low, U-NII-3	S01_AB01	Passed	Passed
WLAN n 20 MHz, mid, U-NII-3	S01_AB01	Passed	Passed
WLAN n 40 MHz, high, U-NII-3	S01_AB01	Passed	Passed
WLAN n 40 MHz, low, U-NII-3	S01_AB01	Passed	Passed

**47 CFR CHAPTER I FCC PART 15 Subpart E
§15.407**

FCC §15.31, §15.403 (i)

99 % Bandwidth

The measurement was performed according to ANSI C63.10

Final Result

OP-Mode	Setup	FCC	IC
Radio Technology, Operating Frequency, Subband			
WLAN a, high, U-NII-1	S01_AB01	N/A	N/A
WLAN a, high, U-NII-2A	S01_AB01	N/A	N/A
WLAN a, high, U-NII-2C	S01_AB01	N/A	N/A
WLAN a, high, U-NII-3	S01_AB01	N/A	N/A
WLAN a, low, U-NII-1	S01_AB01	N/A	N/A
WLAN a, low, U-NII-2A	S01_AB01	N/A	N/A
WLAN a, low, U-NII-2C	S01_AB01	N/A	N/A
WLAN a, low, U-NII-3	S01_AB01	N/A	N/A
WLAN a, mid, U-NII-1	S01_AB01	N/A	N/A
WLAN a, mid, U-NII-2A	S01_AB01	N/A	N/A
WLAN a, mid, U-NII-2C	S01_AB01	N/A	N/A
WLAN a, mid, U-NII-3	S01_AB01	N/A	N/A
WLAN n 20 MHz, high, U-NII-1	S01_AB01	N/A	N/A
WLAN n 20 MHz, high, U-NII-2A	S01_AB01	N/A	N/A
WLAN n 20 MHz, high, U-NII-2C	S01_AB01	N/A	N/A
WLAN n 20 MHz, high, U-NII-3	S01_AB01	N/A	N/A
WLAN n 20 MHz, low, U-NII-1	S01_AB01	N/A	N/A
WLAN n 20 MHz, low, U-NII-2A	S01_AB01	N/A	N/A
WLAN n 20 MHz, low, U-NII-2C	S01_AB01	N/A	N/A
WLAN n 20 MHz, low, U-NII-3	S01_AB01	N/A	N/A
WLAN n 20 MHz, mid, U-NII-1	S01_AB01	N/A	N/A
WLAN n 20 MHz, mid, U-NII-2A	S01_AB01	N/A	N/A
WLAN n 20 MHz, mid, U-NII-2C	S01_AB01	N/A	N/A
WLAN n 20 MHz, mid, U-NII-3	S01_AB01	N/A	N/A
WLAN n 40 MHz, high, U-NII-1	S01_AB01	N/A	N/A
WLAN n 40 MHz, high, U-NII-2A	S01_AB01	N/A	N/A

WLAN n 40 MHz, high, U-NII-2C	S01_AB01	N/A	N/A
WLAN n 40 MHz, high, U-NII-3	S01_AB01	N/A	N/A
WLAN n 40 MHz, low, U-NII-1	S01_AB01	N/A	N/A
WLAN n 40 MHz, low, U-NII-2A	S01_AB01	N/A	N/A
WLAN n 40 MHz, low, U-NII-2C	S01_AB01	N/A	N/A
WLAN n 40 MHz, low, U-NII-3	S01_AB01	N/A	N/A
WLAN n 40 MHz, mid, U-NII-2C	S01_AB01	N/A	N/A

**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, high, U-NII-2A	S01_AB01	Passed	Passed
WLAN a, high, U-NII-2C	S01_AB01	Passed	Passed
WLAN a, high, U-NII-3	S01_AB01	Passed	Passed
WLAN a, low, U-NII-1	S01_AB01	Passed	Passed
WLAN a, low, U-NII-2A	S01_AB01	Passed	Passed
WLAN a, low, U-NII-2C	S01_AB01	Passed	Passed
WLAN a, low, U-NII-3	S01_AB01	Passed	Passed
WLAN a, mid, U-NII-1	S01_AB01	Passed	Passed
WLAN a, mid, U-NII-2A	S01_AB01	Passed	Passed
WLAN a, mid, U-NII-2C	S01_AB01	Passed	Passed
WLAN a, mid, U-NII-3	S01_AB01	Passed	Passed
WLAN n 20 MHz, high, U-NII-1	S01_AB01	Passed	Passed
WLAN n 20 MHz, high, U-NII-2A	S01_AB01	Passed	Passed
WLAN n 20 MHz, high, U-NII-2C	S01_AB01	Passed	Passed
WLAN n 20 MHz, high, U-NII-3	S01_AB01	Passed	Passed
WLAN n 20 MHz, low, U-NII-1	S01_AB01	Passed	Passed
WLAN n 20 MHz, low, U-NII-2A	S01_AB01	Passed	Passed
WLAN n 20 MHz, low, U-NII-2C	S01_AB01	Passed	Passed
WLAN n 20 MHz, low, U-NII-3	S01_AB01	Passed	Passed
WLAN n 20 MHz, mid, U-NII-1	S01_AB01	Passed	Passed
WLAN n 20 MHz, mid, U-NII-2A	S01_AB01	Passed	Passed
WLAN n 20 MHz, mid, U-NII-2C	S01_AB01	Passed	Passed
WLAN n 20 MHz, mid, U-NII-3	S01_AB01	Passed	Passed
WLAN n 40 MHz, high, U-NII-1	S01_AB01	Passed	Passed
WLAN n 40 MHz, high, U-NII-2A	S01_AB01	Passed	Passed
WLAN n 40 MHz, high, U-NII-2C	S01_AB01	Passed	Passed
WLAN n 40 MHz, high, U-NII-3	S01_AB01	Passed	Passed
WLAN n 40 MHz, low, U-NII-1	S01_AB01	Passed	Passed
WLAN n 40 MHz, low, U-NII-2A	S01_AB01	Passed	Passed
WLAN n 40 MHz, low, U-NII-2C	S01_AB01	Passed	Passed
WLAN n 40 MHz, low, U-NII-3	S01_AB01	Passed	Passed
WLAN n 40 MHz, mid, U-NII-2C	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 a, high, U-NII-1	S01_AB01	Passed	Passed
WLAN a, high, U-NII-2A	S01_AB01	Passed	Passed
WLAN a, high, U-NII-2C	S01_AB01	Passed	Passed
WLAN a, high, U-NII-3	S01_AB01	Passed	Passed
WLAN a, low, U-NII-1	S01_AB01	Passed	Passed
WLAN a, low, U-NII-2A	S01_AB01	Passed	Passed
WLAN a, low, U-NII-2C	S01_AB01	Passed	Passed
WLAN a, low, U-NII-3	S01_AB01	Passed	Passed
WLAN a, mid, U-NII-1	S01_AB01	Passed	Passed
WLAN a, mid, U-NII-2A	S01_AB01	Passed	Passed
WLAN a, mid, U-NII-2C	S01_AB01	Passed	Passed
WLAN a, mid, U-NII-3	S01_AB01	Passed	Passed
WLAN n 20 MHz, high, U-NII-1	S01_AB01	Passed	Passed
WLAN n 20 MHz, high, U-NII-2A	S01_AB01	Passed	Passed
WLAN n 20 MHz, high, U-NII-2C	S01_AB01	Passed	Passed
WLAN n 20 MHz, high, U-NII-3	S01_AB01	Passed	Passed
WLAN n 20 MHz, low, U-NII-1	S01_AB01	Passed	Passed
WLAN n 20 MHz, low, U-NII-2A	S01_AB01	Passed	Passed
WLAN n 20 MHz, low, U-NII-2C	S01_AB01	Passed	Passed
WLAN n 20 MHz, low, U-NII-3	S01_AB01	Passed	Passed
WLAN n 20 MHz, mid, U-NII-1	S01_AB01	Passed	Passed
WLAN n 20 MHz, mid, U-NII-2A	S01_AB01	Passed	Passed
WLAN n 20 MHz, mid, U-NII-2C	S01_AB01	Passed	Passed
WLAN n 20 MHz, mid, U-NII-3	S01_AB01	Passed	Passed
WLAN n 40 MHz, high, U-NII-1	S01_AB01	Passed	Passed
WLAN n 40 MHz, high, U-NII-2A	S01_AB01	Passed	Passed
WLAN n 40 MHz, high, U-NII-2C	S01_AB01	Passed	Passed
WLAN n 40 MHz, high, U-NII-3	S01_AB01	Passed	Passed
WLAN n 40 MHz, low, U-NII-1	S01_AB01	Passed	Passed
WLAN n 40 MHz, low, U-NII-2A	S01_AB01	Passed	Passed
WLAN n 40 MHz, low, U-NII-2C	S01_AB01	Passed	Passed
WLAN n 40 MHz, low, U-NII-3	S01_AB01	Passed	Passed
WLAN n 40 MHz, mid, U-NII-2C	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

Setup

FCC

IC

Radio Technology, Operating Frequency, Measurement range, Subband

WLAN a, high, 1GHz - 26GHz, U-NII-3	S01_AA01	Passed	Passed
WLAN a, low, 1GHz - 26GHz, U-NII-3	S01_AA01	Passed	Passed
WLAN a, low, 26GHz - 40GHz, U-NII-3	S01_AB01	Passed	Passed
WLAN a, mid, 1GHz - 26GHz, U-NII-3	S01_AA01	Passed	Passed
WLAN a, mid, 30MHz - 1GHz, U-NII-3	S01_AA01	Passed	Passed
WLAN a, mid, 9kHz - 30MHz, U-NII-3	S01_AA01	Passed	Passed
WLAN n 20 MHz, high, 1GHz - 26GHz, U-NII-3	S01_AA01	Passed	Passed
WLAN n 20 MHz, high, 26GHz - 40GHz, U-NII-3	S01_AB01	Passed	Passed
WLAN n 20 MHz, low, 1GHz - 26GHz, U-NII-3	S01_AA01	Passed	Passed
WLAN n 20 MHz, mid, 1GHz - 26GHz, U-NII-3	S01_AA01	Passed	Passed
WLAN n 40 MHz, high, 1GHz - 26GHz, U-NII-3	S01_AA01	Passed	Passed
WLAN n 40 MHz, high, 30MHz - 1GHz, U-NII-3	S01_AA01	Passed	Passed
WLAN n 40 MHz, high, 9kHz - 30MHz, U-NII-3	S01_AA01	Passed	Passed
WLAN n 40 MHz, low, 1GHz - 26GHz, U-NII-3	S01_AA01	Passed	Passed
WLAN n 40 MHz, low, 26GHz - 40GHz, U-NII-3	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

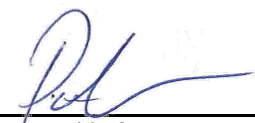
Radio Technology, Operating Frequency, Subband

	Setup	FCC	IC
WLAN a, high, U-NII-3	S01_AA01	Passed	Passed
WLAN a, low, U-NII-3	S01_AA01	Passed	Passed
WLAN n 20 MHz, high, U-NII-3	S01_AA01	Passed	Passed
WLAN n 20 MHz, low, U-NII-3	S01_AA01	Passed	Passed
WLAN n 40 MHz, high, U-NII-3	S01_AA01	Passed	Passed
WLAN n 40 MHz, low, U-NII-3	S01_AA01	Passed	Passed

N/A: Not applicable

N/P: Not performed

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



(responsible for testing and report) Patrick Lomax

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 FCC and accepted under the registration number 96716.

This facility has been fully described in a report submitted to the IC 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-12140-01-01
Responsible for accreditation scope: Dipl.-Ing. Bernhard Retka
Report Template Version: 2016-05-12

2.2 Project Data

Responsible for testing and report: Dipl.-Ing Marco Kullik
Employees who performed the tests: documented internally at 7Layers
Date of Report: 2016-05-23
Testing Period: 2016-05-13 to 2016-05-20

2.3 Applicant Data

Company Name: u-blox AG
Address: Zürcherstrasse 68
CH-8800 Thalwil
Germany
Contact Person: Giulio Comar

2.4 Manufacturer Data

Company Name: PRETTL Electronics AG
Address: Robert-Bosch-Str 10
01454 Radeberg
Germany
Contact Person: Mrs. Kerstin Sauer

3 Test object Data

3.1 General EUT Description

Kind of Device product description	IEEE 802.11a/b/g/n WLAN transceiver
Product name	ELLA-W161 (DF1)
Type	-
Declared EUT data by the supplier	
Voltage Type	DC
Voltage Level	1.8 V and 3.3 V
Tested Modulation Type	BPSK, QPSK, 16-QAM, 64-QAM
General product description	The EUT is industrial universal module, targeted for integration into different Original Equipment Manufacturer products. The module is designed for both - simultaneous and independent operation of the following: IEEE 802.11a/b/g/n payload data rates for Wireless Local Area Network (WLAN), Bluetooth 3.0+High Speed (HS) and Bluetooth 2.1+EDR. It provides a complete end-to-end solution for low power applications. It includes an integrated MAC/Baseband processor and RF front-end components, and can connect to a host processor via SDIO interface.
Specific product description	The EUT is a dual band WLAN (802.11 a/b/g/n, 2.5 and 5 GHz) and Bluetooth module with one joint antenna connector for WLAN and Bluetooth. In IEEE 802.11n mode it supports 20 MHz and 40 MHz bandwidth channels (both with MCS7), providing 72.2 Mbit/s, and 150 Mbit/s transfer data rates respectively. The object of this test report is the WLAN transceiver, consequently switched on the IEEE 802.11 a/n modes, working in the 5 GHz bands. In IEEE 802.11n mode, it was tested with 20 MHz and 40 MHz channel bandwidth.
Ports of the device	Enclosure Antenna connector DC port Data port
Antenna 1	Integral / Gain: 4.6 dBi (5GHz Band)
Tested Modulations	DBPSK; OFDM:BPSK; OFDM:64-QAM
Tested Datarates	<ul style="list-style-type: none"> WLAN a-Mode; Channel Bandwidth: 20 MHz ; Data rate: 6 Mbit/s WLAN n-Mode; Channel Bandwidth: 20 MHz ; Data rate: 72.2 Mbit/s WLAN n-Mode; Channel Bandwidth: 40 MHz ; Data rate: 150 Mbit/s
Special software used for testing	Marvell Labtool 8787 software is used to set the EUT into the different operating modes.
Duty Cycle	The duty cycle was for all operating modes was 100%.

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
Conducted Sample	DE1015036ab01	
Sample Parameter	Value	
HW Version	G8	
Integral Antenna	Gain: 4.6 dB	
Serial No.	None	
SW Version	MFG Firmware	
Comment	The antenna was disconnected for testing	

Sample Name	Sample Code	Description
Radiated Sample	DE1015036aa01	
Sample Parameter	Value	
HW Version	G8	
Integral Antenna	Gain: 4.6 dB	
Serial No.	None	
SW Version	MFG Firmware	
Comment		

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
-	-	-

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
HyCell HCPS1500	, -, -, -	Power Supply

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_AB01	Conducted Sample, HyCell HCPS1500,	Setup for conducted measurements
S01_AA01	Radiated Sample, HyCell HCPS1500,	Setup for radiated measurements

3.6 Operating Modes

This chapter describes the operating modes of the EUTs used for testing.

3.6.1 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
20 MHz Test Channels:													Ch.-No.
Channel:	36	44	48	52	56	64	100	116	140	149	157	165	
Frequency [MHz]	5180	5220	5240	5260	5280	5320	5500	5580	5700	5745	5785	5825	MHz
40 MHz Test Channels:													40 MHz
Channel:	38	-	46	54	-	62	102	110	138	151	-	159	Ch.-No.
Frequency [MHz]	5190	-	5230	5270	-	5310	5510	5550	5690	5755	-	5795	MHz

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 26 dB Bandwidth

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 occupied bandwidth measurements.

The reference level is the level of the highest amplitude signal observed from the transmitter at either the fundamental frequency or first-order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical. The results recorded were measured with the modulation which produce the worst-case (widest) emission bandwidth.

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

Analyzer settings:

- Resolution Bandwidth (RBW): initially approx. 1 % of nominal emission bandwidth
- Video Bandwidth (VBW): > RBW z
- Span: 30 / 60 / 120 / 320 MHz (for 20 / 40 / 80 / 160 MHz nominal bandwidth)
- Trace: Maxhold
- Sweeps: 2000
- Sweeptime: 20 ms
- Detector: Sample

4.1.2 Test Requirements / Limits

FCC Part 15, Subpart E, §15.403 (i)

There exist no applicable limits for the U-NII subbands 1, 2A and 2C. The test was performed to determine the limits for the "Maximum Conducted Output Power" test case. Therefore no result was applied.

4.1.3 Test Protocol

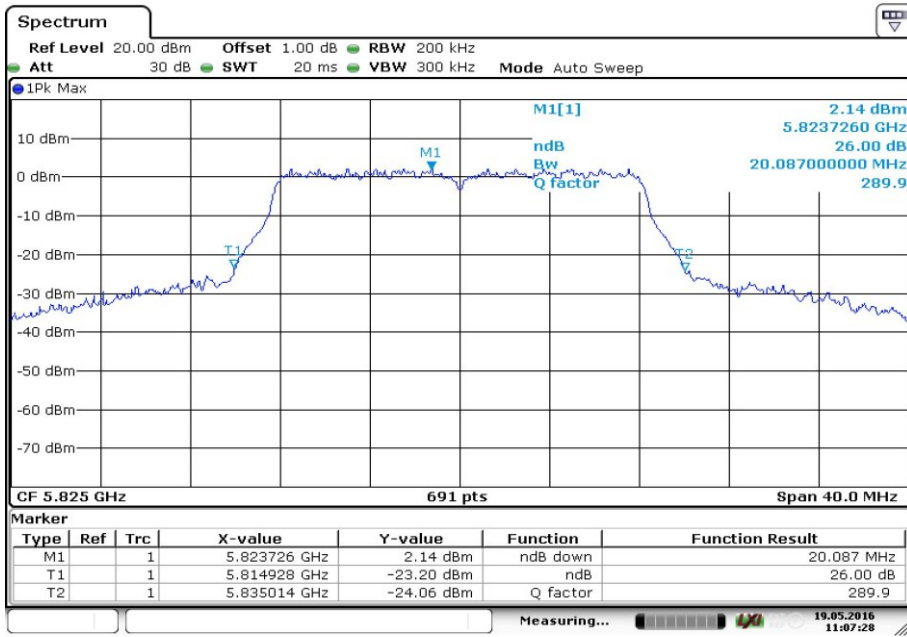
Ambient temperature: 23 °C
 Air Pressure: 1005 hPa
 Humidity: 36 %

Radio Technology	Operating Frequency	Subband	26 dB Bandwidth [MHz]
WLAN a	low	U-NII-1	20.0
WLAN a	mid	U-NII-1	20.0
WLAN a	high	U-NII-1	20.0
WLAN a	low	U-NII-2A	20.1
WLAN a	mid	U-NII-2A	20.0
WLAN a	high	U-NII-2A	20.0
WLAN a	low	U-NII-2C	20.0
WLAN a	mid	U-NII-2C	20.1
WLAN a	high	U-NII-2C	20.1
WLAN a	low	U-NII-3	20.0
WLAN a	mid	U-NII-3	20.1
WLAN a	high	U-NII-3	20.1
WLAN n 20 MHz	low	U-NII-1	20.3
WLAN n 20 MHz	mid	U-NII-1	20.3
WLAN n 20 MHz	high	U-NII-1	20.3
WLAN n 20 MHz	low	U-NII-2A	20.4
WLAN n 20 MHz	mid	U-NII-2A	20.5
WLAN n 20 MHz	high	U-NII-2A	20.5
WLAN n 20 MHz	low	U-NII-2C	20.4
WLAN n 20 MHz	mid	U-NII-2C	20.6
WLAN n 20 MHz	high	U-NII-2C	20.8
WLAN n 20 MHz	low	U-NII-3	20.6
WLAN n 20 MHz	mid	U-NII-3	20.6
WLAN n 20 MHz	high	U-NII-3	20.6
WLAN n 40 MHz	low	U-NII-1	40.9
WLAN n 40 MHz	high	U-NII-1	41.0
WLAN n 40 MHz	low	U-NII-2A	41.0
WLAN n 40 MHz	high	U-NII-2A	41.1
WLAN n 40 MHz	low	U-NII-2C	41.1
WLAN n 40 MHz	mid	U-NII-2C	41.1
WLAN n 40 MHz	high	U-NII-2C	41.3
WLAN n 40 MHz	low	U-NII-3	41.2
WLAN n 40 MHz	high	U-NII-3	41.1

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

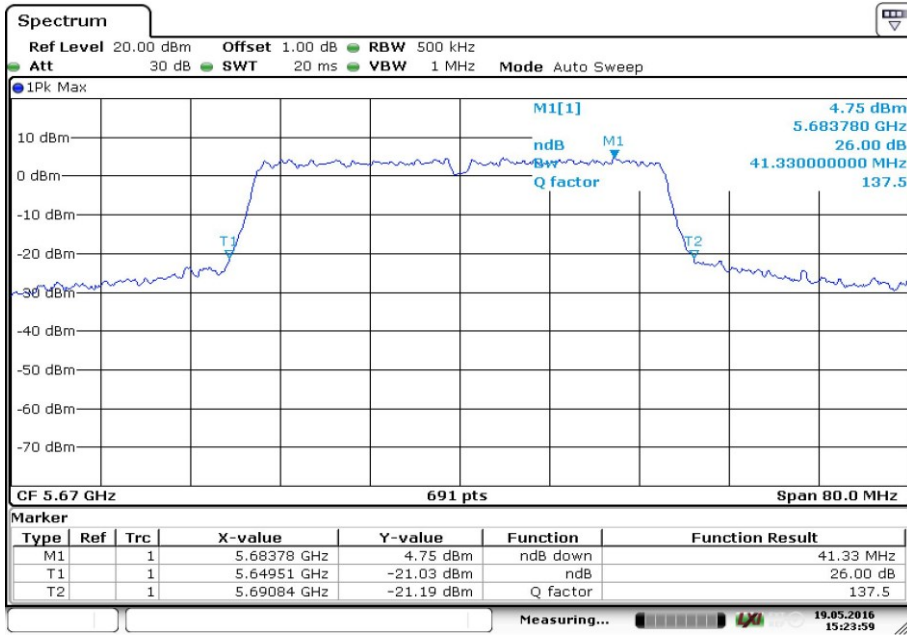
4.1.4 Measurement Plot (showing the highest value, "worst case")

Radio Technology = WLAN a, Operating Frequency = high, Subband = U-NII-3



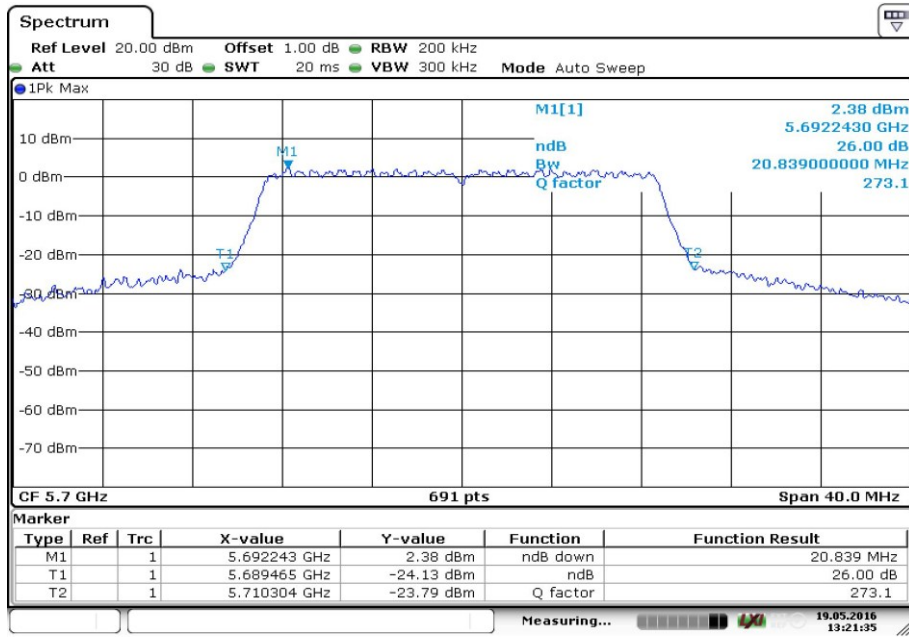
Date: 19.MAY.2016 11:07:28

Radio Technology = WLAN n 40 MHz, Operating Frequency = high, Subband = U-NII-2C



Date: 19.MAY.2016 15:23:59

Radio Technology = WLAN n 20 MHz, Operating Frequency = high, Subband = U-NII-2C



Date: 19.MAY.2016 13:21:36

4.1.5 Test Equipment used

R&S TS8997

4.2 6 dB Bandwidth

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 setup in a shielded room to perform the occupied bandwidth measurements.

The reference level is the level of the highest amplitude signal observed from the transmitter at either the fundamental frequency or first-order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical. The results recorded were measured with the modulation which produce the worst-case (smallest) emission bandwidth.

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

Analyzer settings:

- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Span: 30 / 50 MHz (for 20 / 40 MHz nominal bandwidth)
- Trace: Maxhold
- Sweeps: 2000
- Sweeptime: 20 ms
- Detector: Peak

4.2.2 Test Requirements / Limits

FCC Part 15, Subpart E, §15.407 (e)

Within the 5.725-5.850 GHz band, the minimum 6 dB bandwidth of U-NII devices shall be at least 500 kHz.

4.2.3 Test Protocol

Ambient temperature: 23°C
Air Pressure: 1005hPa
Humidity: 36 %

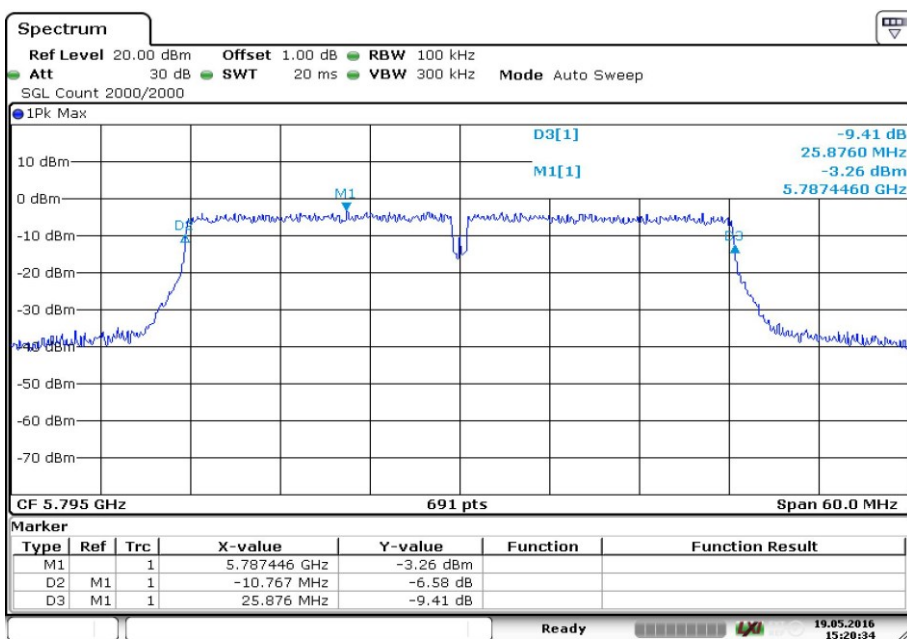
Radio Technology	Operating Frequency	6 dB Bandwidth [MHz]	Limit [MHz]	Margin [MHz]	Min. 6 dB Frequency [MHz]	Max. 6 dB Frequency [MHz]
WLAN a	low	16.5	0.5	16.0	-10.7	5.7
WLAN a	mid	16.5	0.5	16.0	-3.2	13.3
WLAN a	high	16.5	0.5	16.0	-3.3	13.2
WLAN n 20 MHz	low	17.9	0.5	17.4	-9.9	8.1
WLAN n 20 MHz	mid	17.9	0.5	17.4	-9.9	8.1

WLAN n 20 MHz	high	17.9	0.5	17.4	-9.9	8.1
WLAN n 40 MHz	low	36.6	0.5	36.1	-10.8	25.9
WLAN n 40 MHz	high	36.6	0.5	36.1	-10.8	25.9

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

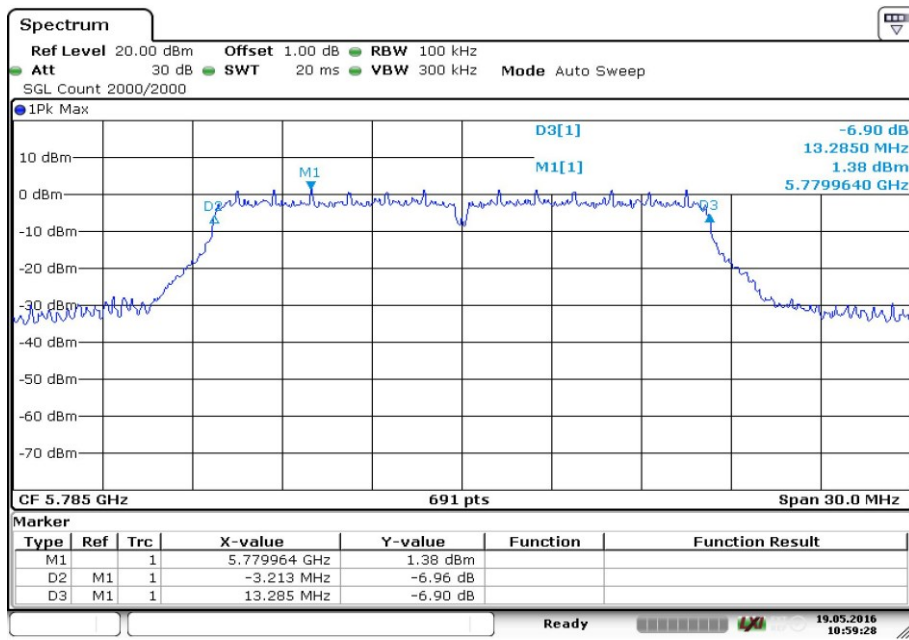
4.2.4 Measurement Plot (showing the highest value, "worst case")

Radio Technology = WLAN n 40 MHz, Operating Frequency = high, Subband = U-NII-3



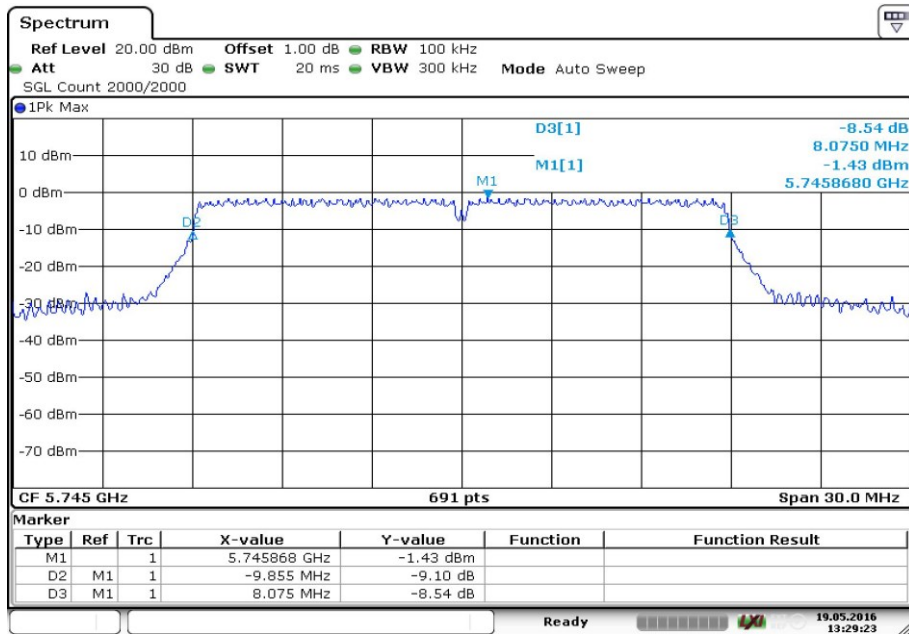
Date: 19.MAY.2016 15:20:35

Radio Technology = WLAN a, Operating Frequency = mid, Subband = U-NII-3



Date: 19.MAY.2016 10:59:29

Radio Technology = WLAN n 20 MHz, Operating Frequency = low, Subband = U-NII-3



Date: 19.MAY.2016 13:29:23

4.2.5 Test Equipment used

R&S TS8997

4.3 99 % Bandwidth

Standard: FCC Part 15, Subpart E

The test was performed according to:
ANSI C63.10

4.3.1 Test Description

The Equipment Under Test (EUT) was set up to perform the occupied bandwidth measurements.

The reference level is the level of the highest amplitude signal observed from the transmitter at either the fundamental frequency or first-order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical. The results recorded were measured with the modulation which produce the worst-case (widest) emission bandwidth.

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

Analyzer settings:

- Resolution Bandwidth (RBW): approx. ≥ 1 % of the span, but not below
- Video Bandwidth (VBW): ≥ 3 times the RBW
- Span: 30 / 60 / 120 / 320 MHz (for 20 / 40 / 80 / 160 MHz nominal bandwidth)
- Trace: Maxhold
- Sweeps: 2000
- Sweep time: 20 ms
- Detector: Sample

The 99 % measurement function of the spectrum analyser function was used to determine the 99 % bandwidth.

4.3.2 Test Requirements / Limits

No applicable limit:

4.3.3 Test Protocol

Ambient temperature: 23°C
Air Pressure: 1005hPa
Humidity: 0.36

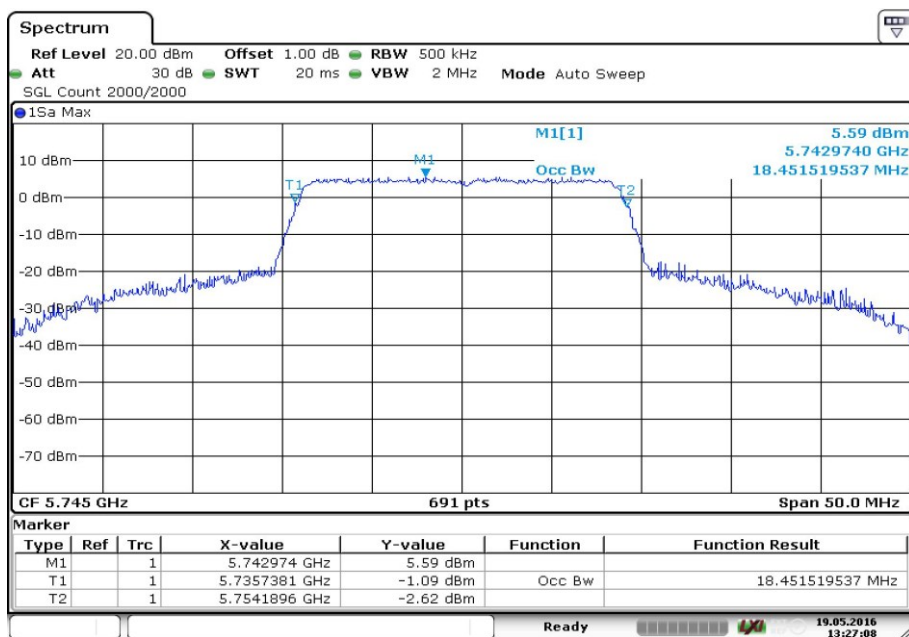
Radio Technology	Operating Frequency	Subband	99% Bandwidth [MHz]
WLAN a	low	U-NII-1	17.2
WLAN a	mid	U-NII-1	17.1
WLAN a	high	U-NII-1	17.2
WLAN a	low	U-NII-2A	17.2
WLAN a	mid	U-NII-2A	17.3
WLAN a	high	U-NII-2A	17.3
WLAN a	low	U-NII-2C	17.2
WLAN a	mid	U-NII-2C	17.3
WLAN a	high	U-NII-2C	17.4

WLAN a	low	U-NII-3	17.3
WLAN a	mid	U-NII-3	17.3
WLAN a	high	U-NII-3	17.3
WLAN n 20 MHz	low	U-NII-1	18.1
WLAN n 20 MHz	mid	U-NII-1	17.9
WLAN n 20 MHz	high	U-NII-1	18.0
WLAN n 20 MHz	low	U-NII-2A	18.2
WLAN n 20 MHz	mid	U-NII-2A	18.3
WLAN n 20 MHz	high	U-NII-2A	18.2
WLAN n 20 MHz	low	U-NII-2C	18.3
WLAN n 20 MHz	mid	U-NII-2C	18.3
WLAN n 20 MHz	high	U-NII-2C	18.4
WLAN n 20 MHz	low	U-NII-3	18.5
WLAN n 20 MHz	mid	U-NII-3	18.3
WLAN n 20 MHz	high	U-NII-3	18.4
WLAN n 40 MHz	low	U-NII-1	36.8
WLAN n 40 MHz	high	U-NII-1	36.8
WLAN n 40 MHz	low	U-NII-2A	36.8
WLAN n 40 MHz	high	U-NII-2A	36.9
WLAN n 40 MHz	low	U-NII-2C	36.9
WLAN n 40 MHz	mid	U-NII-2C	36.8
WLAN n 40 MHz	high	U-NII-2C	36.9
WLAN n 40 MHz	low	U-NII-3	36.9
WLAN n 40 MHz	high	U-NII-3	36.8

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

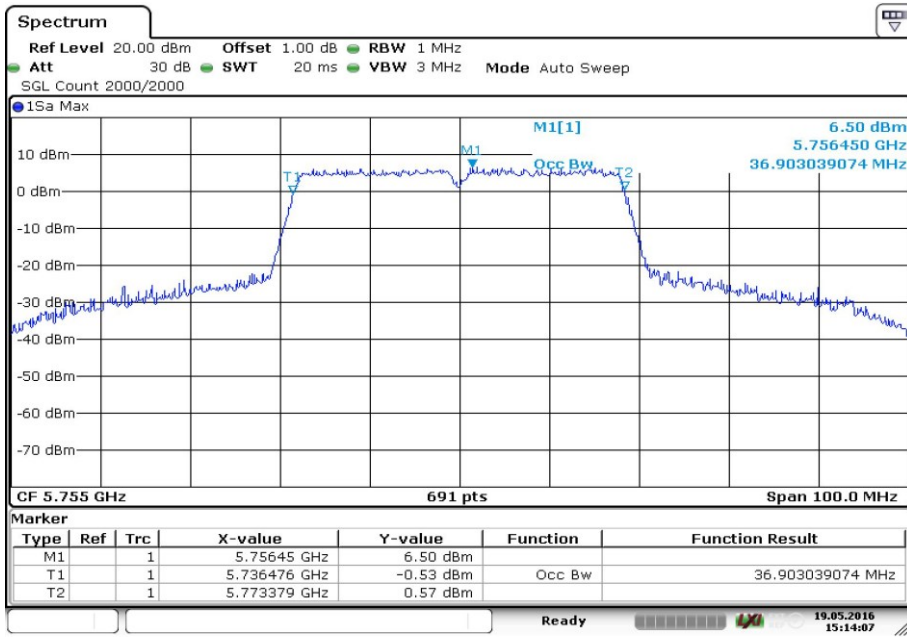
4.3.4 Measurement Plot (showing the highest value, “worst case”)

Radio Technology = WLAN n 20 MHz, Operating Frequency = low, Subband = U-NII-3



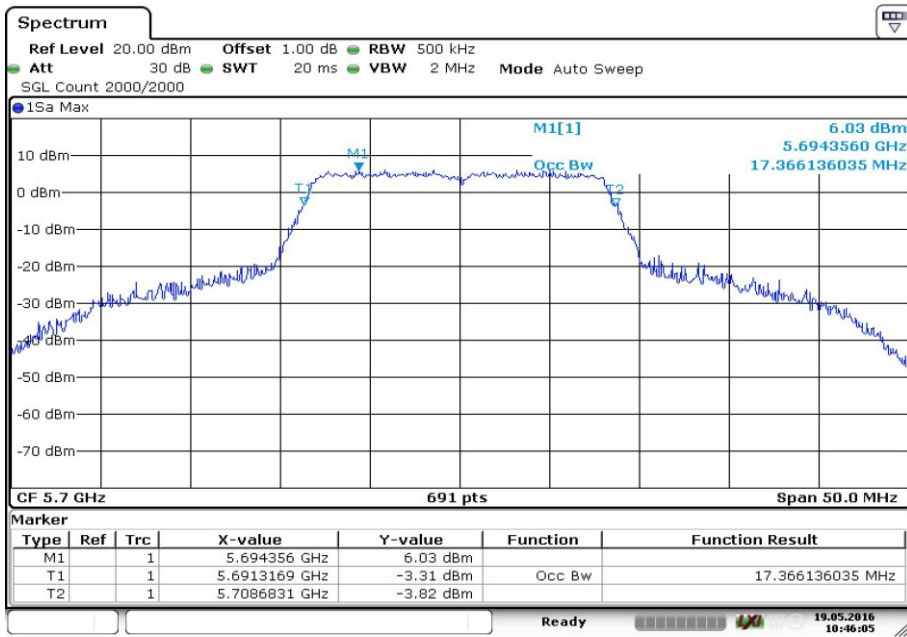
Date: 19.MAY.2016 13:27:08

Radio Technology = WLAN n 40 MHz, Operating Frequency = low, Subband = U-NII-3



Date: 19.MAY.2016 15:14:07

Radio Technology = WLAN a, Operating Frequency = high, Subband = U-NII-2C



Date: 19.MAY.2016 10:46:05

4.3.5 Test Equipment used

R&S TS8997

4.4 Maximum Conducted Output Power

Standard: FCC Part 15, Subpart E

The test was performed according to:
ANSI C63.10

4.4.1 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: 100
- Sweeptime: 5 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**.

4.4.2 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 $11 \text{ dBm} + 10 \log (26 \text{ dB bandwidth/MHz})$ 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 $17 \text{ dBm} + 10 \log (26 \text{ dB bandwidth/MHz})$ 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 $10 + 10 \log_{10} B \text{ [dBm]}$, 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 $11 + 10 \log_{10} B \text{ [dBm]}$, whichever power is less.

e.i.r.p.: 1.0 W (30 dBm) or $17 + 10 \log_{10} B \text{ [dBm]}$, 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 $11 + 10 \log_{10} B \text{ [dBm]}$, whichever power is less.

e.i.r.p.: 1.0 W (30 dBm) or $17 + 10 \log_{10} B \text{ [dBm]}$, whichever power is less.

RSS-247, 6.2.4 (1), Band 5725-5825 MHz:

Limits:

Maximum conducted Power: 1W (30 dBm) or $17 + 10 \log_{10} B \text{ [dBm]}$, whichever power is less.

e.i.r.p.: 4.0 W (36 dBm) or $23 + 10 \log_{10} B \text{ [dBm]}$, whichever power is less.

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

4.4.3 Test Protocol

Ambient temperature: 23 °C

Air Pressure: 1010 hPa

Humidity: 40 %

WLAN a-Mode; 20 MHz; 6 Mbit/s

U-NII-Sub-band	Ch. No.	Freq. [MHz]	Cond. Power [dBm]	EIRP [dBm]	FCC		IC			
					Cond. Limit [dBm]	Margin [dB]	Cond. Limit [dBm]	Margin [dB]	EIRP Limit [dBm]	Margin [dB]
1	36	5180.0	14.4	19.0	30.0	15.6	N/A		22.4	3.4
	44	5220.0	14.7	19.3	30.0	15.3	N/A		22.3	3.1
	48	5240.0	14.5	19.1	30.0	15.5	N/A		22.4	3.3
2A	52	5260.0	14.7	19.3	24.0	9.3	23.4	8.7	29.4	10.1
	56	5280.0	14.7	19.3	24.0	9.3	23.4	8.7	29.4	10.1
	64	5320.0	15.0	19.6	24.0	9.0	23.4	8.4	29.4	9.8
2C	100	5500.0	13.6	18.2	24.0	10.4	23.4	9.7	29.4	11.1
	116	5580.0	13.8	18.4	24.0	10.2	23.4	9.6	29.4	11.0
	140	5700.0	13.4	18.0	24.0	10.6	23.4	10.0	29.4	11.4
3	149	5745.0	13.2	17.8	30.0	16.8	30.0	16.8	36.0	18.2
	157	5785.0	13.3	17.9	30.0	16.7	30.0	16.7	36.0	18.1
	165	5825.0	12.8	17.4	30.0	17.2	30.0	17.2	36.0	18.6

WLAN n-Mode; 20 MHz; 72.2 Mbit/s MCS7

U-NII-Sub-band	Ch. No.	Freq. [MHz]	Cond. Power [dBm]	EIRP [dBm]	FCC		IC			
					Cond. Limit [dBm]	Margin [dB]	Cond. Limit [dBm]	Margin [dB]	EIRP Limit [dBm]	Margin [dB]
1	36	5180.0	14.6	19.2	30.0	15.4	N/A		22.6	3.4
	44	5220.0	14.9	19.5	30.0	15.1	N/A		22.5	3.0
	48	5240.0	14.8	19.4	30.0	15.2	N/A		22.6	3.2
2A	52	5260.0	14.8	19.4	24.0	9.2	23.6	8.8	29.6	10.2
	56	5280.0	15.0	19.6	24.0	9.0	23.6	8.6	29.6	10.0
	64	5320.0	14.9	19.5	24.0	9.1	23.6	8.7	29.6	10.1
2C	100	5500.0	13.6	18.2	24.0	10.4	23.6	10.1	29.6	11.5
	116	5580.0	13.7	18.3	24.0	10.3	23.6	9.9	29.6	11.3
	140	5700.0	13.4	18.0	24.0	10.6	23.6	10.3	29.6	11.7
3	149	5745.0	13.1	17.7	30.0	16.9	30.0	16.9	36.0	18.3
	157	5785.0	13.1	17.7	30.0	16.9	30.0	16.9	36.0	18.3
	165	5825.0	12.8	17.4	30.0	17.2	30.0	17.2	36.0	18.6

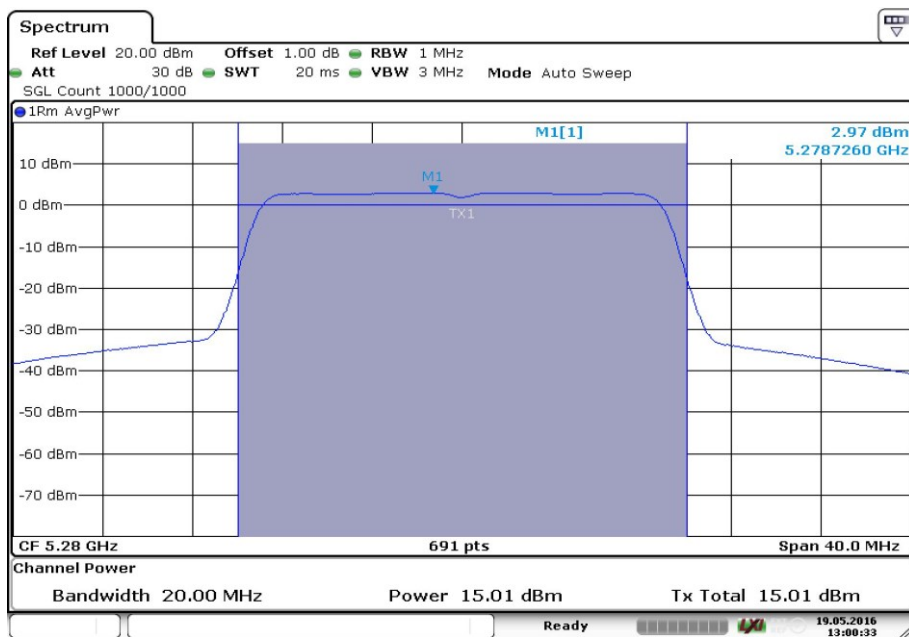
WLAN n-Mode; 40 MHz; 150 Mbit/s MCS7

U-NII-Sub band	Ch. No.	Freq. [MHz]	Cond. Power [dBm]	EIRP [dBm]	FCC		IC			
					Cond. Limit [dBm]	Margin [dB]	Cond. Limit [dBm]	Margin [dB]	EIRP Limit [dBm]	Margin [dB]
1	38	5190.0	14.2	18.8	30.0	15.8	N/A		23.0	4.2
1	46	5230.0	14.4	19.0	30.0	15.6	N/A		23.0	4.0
2A	54	5270.0	14.7	19.3	24.0	9.3	24.0	9.3	30.0	10.7
	62	5310.0	14.9	19.5	24.0	9.1	24.0	9.1	30.0	10.5
2C	102	5510.0	13.5	18.1	24.0	10.5	24.0	10.5	30.0	11.9
	110	5550.0	13.2	17.8	24.0	10.9	24.0	10.9	30.0	12.3
	134	5670.0	13.0	17.6	24.0	11.0	24.0	11.0	30.0	12.4
3	151	5755.0	12.2	16.8	30.0	17.9	30.0	17.9	36.0	19.3
	159	5795.0	12.1	16.7	30.0	17.9	30.0	17.9	36.0	19.3

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

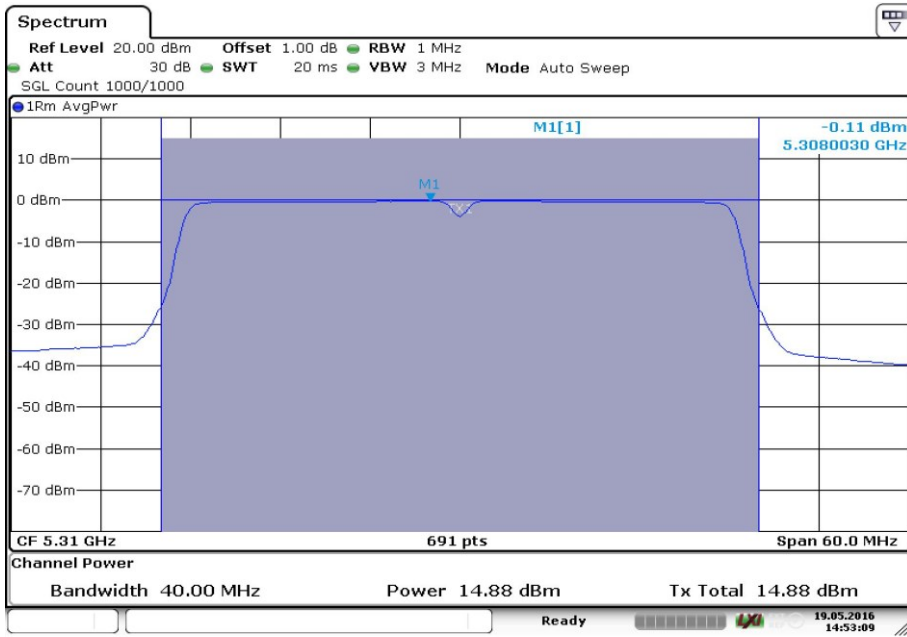
4.4.4 Measurement Plot (showing the highest value, "worst case")

Radio Technology = WLAN n 20 MHz, Operating Frequency = mid, Subband = U-NII-2A



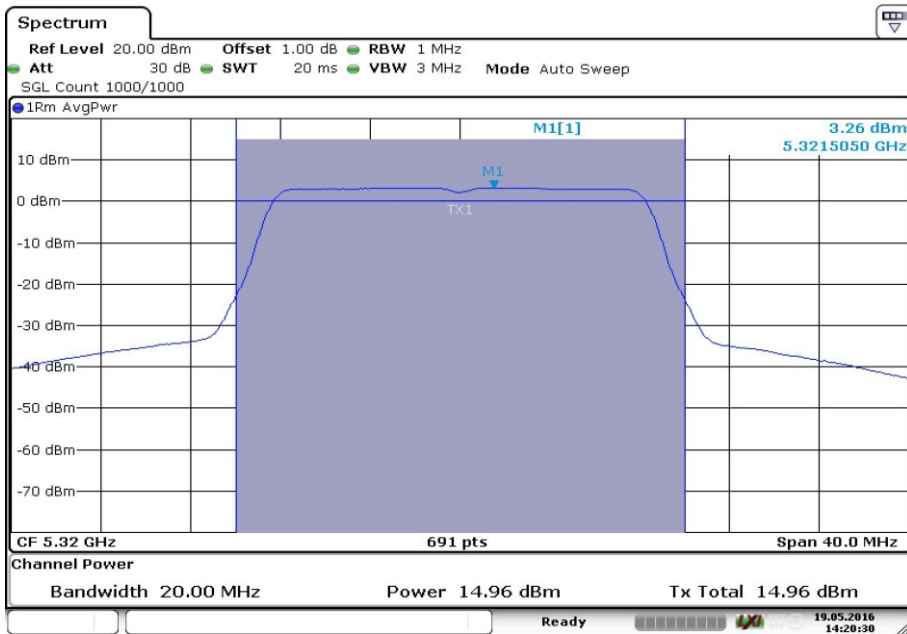
Date: 19.MAY.2016 13:00:33

Radio Technology = WLAN n 40 MHz, Operating Frequency = high, Subband = U-NII-2A



Date: 19.MAY.2016 14:53:10

Radio Technology = WLAN a, Operating Frequency = high, Subband = U-NII-2A



Date: 19.MAY.2016 14:20:30

4.4.5 Test Equipment used

R&S TS8997

4.5 Peak Power Spectral Density

Standard: FCC Part 15, Subpart E

The test was performed according to:
ANSI C63.10

4.5.1 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
- Sweptime: 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**.

4.5.2 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.

4.5.3 Test Protocol

Ambient temperature: 32 °C
Air Pressure: 1010 hPa
Humidity: 40 %

WLAN a-Mode; 20 MHz; 6 Mbit/s

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	2.4	17.0	14.6	10.0	3.0	7.0
	44	5220.0	3.0	17.0	14.0	10.0	2.4	7.6
	48	5240.0	2.8	17.0	14.2	10.0	2.6	7.4
2A	52	5260.0	3.0	11.0	8.0	11.0	8.0	unit:
	56	5280.0	3.0	11.0	8.0	11.0	8.0	dBm/
	64	5320.0	3.3	11.0	7.7	11.0	7.7	MHz
2C	100	5500.0	2.0	11.0	9.0	11.0	9.0	
	116	5580.0	2.1	11.0	8.9	11.0	8.9	
	140	5700.0	1.7	11.0	9.3	11.0	9.3	
3.0	149	5745.0	1.5	30.0	28.6	30.0	28.6	
	157	5785.0	1.6	30.0	28.4	30.0	28.4	
	165	5825.0	1.1	30.0	28.9	30.0	28.9	

WLAN n-Mode; 20 MHz; 72.2 Mbit/s MCS7

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	2.6	17.0	14.4	10.0	2.8	7.2
	44	5220.0	2.9	17.0	14.1	10.0	2.5	7.5
	48	5240.0	2.8	17.0	14.2	10.0	2.6	7.4
2A	52	5260.0	2.8	11.0	8.2	11.0	8.2	unit:
	56	5280.0	3.0	11.0	8.0	11.0	8.0	dBm/
	64	5320.0	2.9	11.0	8.1	11.0	8.1	MHz
2C	100	5500.0	1.5	11.0	9.5	11.0	9.5	
	116	5580.0	1.7	11.0	9.3	11.0	9.3	
	140	5700.0	1.4	11.0	9.6	11.0	9.6	
3	149	5745.0	1.1	30.0	28.9	30.0	28.9	
	157	5785.0	1.1	30.0	28.9	30.0	28.9	
	165	5825.0	0.7	30.0	29.3	30.0	29.3	

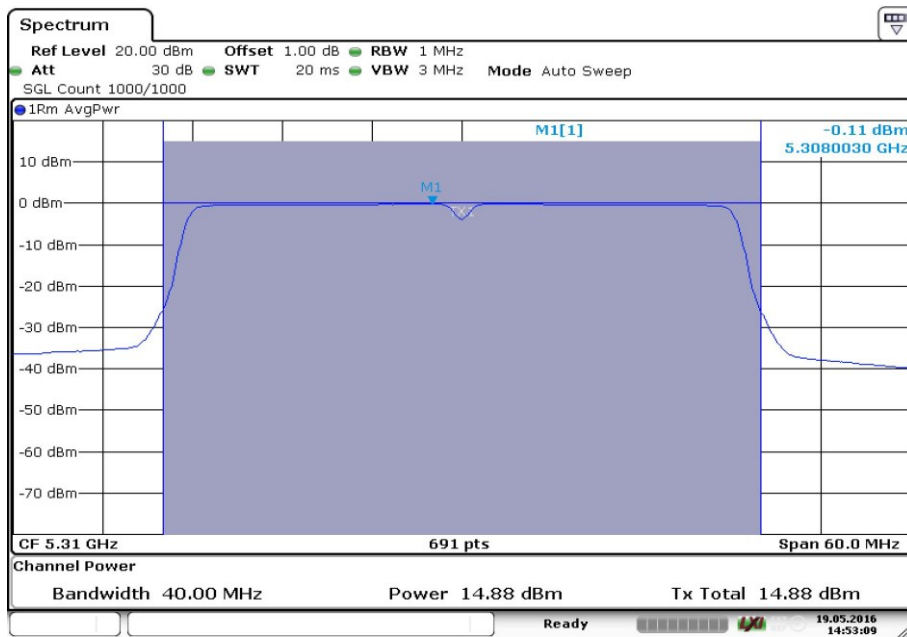
WLAN n-Mode; 40 MHz; 150 Mbit/s MCS7

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
1.0	38	5190.0	-0.7	17.0	17.7	10.0	6.1	3.9
	46	5230.0	-0.6	17.0	17.6	10.0	6.0	4.0
2A	54	5270.0	-0.3	11.0	11.3	11.0	11.3	unit:
	62	5310.0	-0.1	11.0	11.1	11.0	11.1	dBm/
2C	102	5510.0	-1.5	11.0	12.5	11.0	12.5	MHz
	110	5550.0	-1.9	11.0	12.9	11.0	12.9	
	134	5670.0	-2.0	11.0	13.0	11.0	13.0	
3	151	5755.0	-2.8	30.0	32.8	30.0	32.8	
	159	5795.0	-2.8	30.0	32.8	30.0	32.8	

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

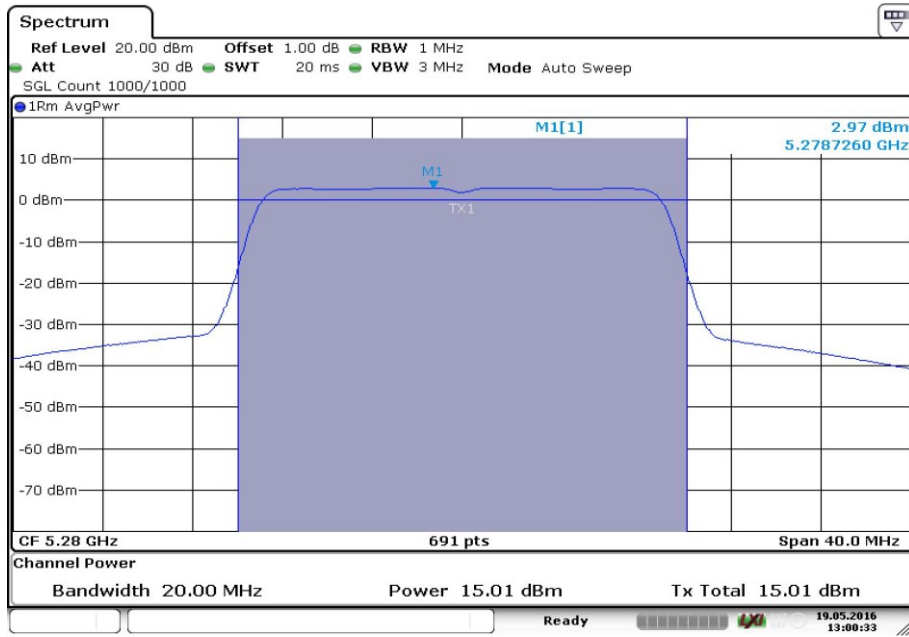
4.5.4 Measurement Plot (showing the highest value, "worst case")

Radio Technology = WLAN n 40 MHz, Operating Frequency = high, Subband = U-NII-2A



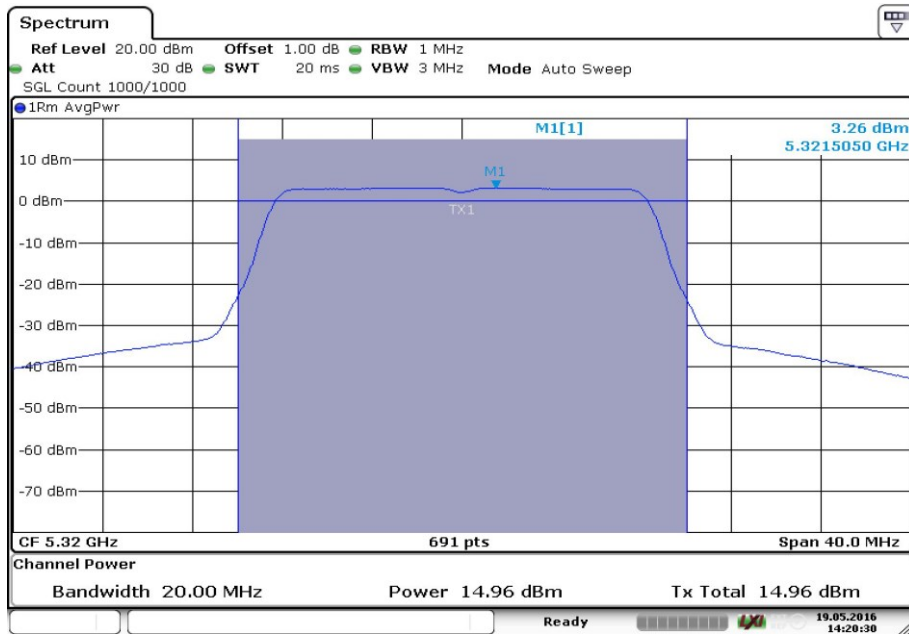
Date: 19.MAY.2016 14:53:10

Radio Technology = WLAN n 20 MHz, Operating Frequency = mid, Subband = U-NII-2A



Date: 19.MAY.2016 13:00:33

Radio Technology = WLAN a, Operating Frequency = high, Subband = U-NII-2A



Date: 19.MAY.2016 14:20:30

4.5.5 Test Equipment used

R&S TS8997

4.6 Undesirable Emissions; General Field Strength Limits

Standard: FCC Part 15, Subpart E

The test was performed according to:
ANSI C63.10

4.6.1 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 $\pm 45^{\circ}$ 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: $\pm 45^{\circ}$ 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 in step 2 is omitted. Instead of this, a maximum search with a step size $\pm 45^\circ$ for the elevation axis is performed.

The turn table azimuth will slowly vary by $\pm 22.5^\circ$.

The elevation angle will slowly vary by $\pm 45^\circ$

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

4.6.2 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 outside of the band 5715–5860 MHz and additionally

Limit: -17 dBm/MHz EIRP within the frequency ranges 5715–5725 and 5850–5860 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 outside of the band 5715–5835 MHz and additionally

Limit: -17 dBm/MHz EIRP within the frequency ranges 5715–5725 and 5825–5835 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.

4.6.3 Test Protocol

Ambient temperature: 24–29 °C

Air Pressure: 1000–1009 hPa

Humidity: 33–49 %

WLAN a-Mode; 20 MHz; 6 Mbit/s

Applied duty cycle correction (AV) [dB]: 0.0 dB

Ch. No.	Ch. Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBµV/m]	Detector	RBW [kHz]	Limit [dBµV/m]	Margin [dB]	Limit Type
149	5745.0	2883.8*	53.2	PEAK	1000.0	74.0	20.8	RB
149	5745.0	6834.9*	57.4	PEAK	1000.0	68.0	10.6	UE
149	5745.0	25133.2*	57.3	QP	1000.0	68.0	10.7	UE
157	5785.0	39.4	29.2	QP	120.0	40.0	10.8	RB
157	5785.0	44.0	32.4	QP	120.0	40.0	7.6	RB
157	5785.0	78.2	20.7	QP	120.0	40.0	19.3	RB

157	5785.0	147.8	30.6	QP	120.0	43.5	12.9	RB
157	5785.0	200.4	35.5	QP	120.0	43.5	8.0	RB
157	5785.0	259.1	38.5	QP	120.0	46.0	7.5	RB
157.0	5785.0	360.0	33.1	QP	120.0	46.0	12.9	RB

WLAN n-Mode; 20 MHz; 72.2 Mbit/s MCS7 Applied duty cycle correction (AV) [dB]: 0.0 dB

Ch. No.	Ch. Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBµV/m]	Detector	RBW [kHz]	Limit [dBµV/m]	Margin [dB]	Limit Type
149	5745.0	2587.0*	53.9	PEAK	1000.0	68.0	14.1	UE
149	5745.0	6591.7*	58.6	PEAK	1000.0	68.0	9.4	UE
149	5745.0	25357.1*	58.4	PEAK	1000.0	68.0	9.6	UE
157	5785.0	2890.8*	53.7	PEAK	1000.0	74.0	20.3	RB
157	5785.0	6591.7*	58.6	PEAK	1000.0	68.0	9.4	UE
157	5785.0	25294.5*	58.0	PEAK	1000.0	68.0	10.0	UE
165	5825.0	2543.3*	54.2	PEAK	1000.0	68.0	13.8	UE
165	5825.0	6999.2*	57.4	PEAK	1000.0	68.0	10.6	UE
165	5825.0	22177.2*	57.8	PEAK	1000.0	74.0	16.2	RB

Applied duty cycle correction (AV) [dB]: Applied duty cycle correction (AV) [dB]: 0.0 dB

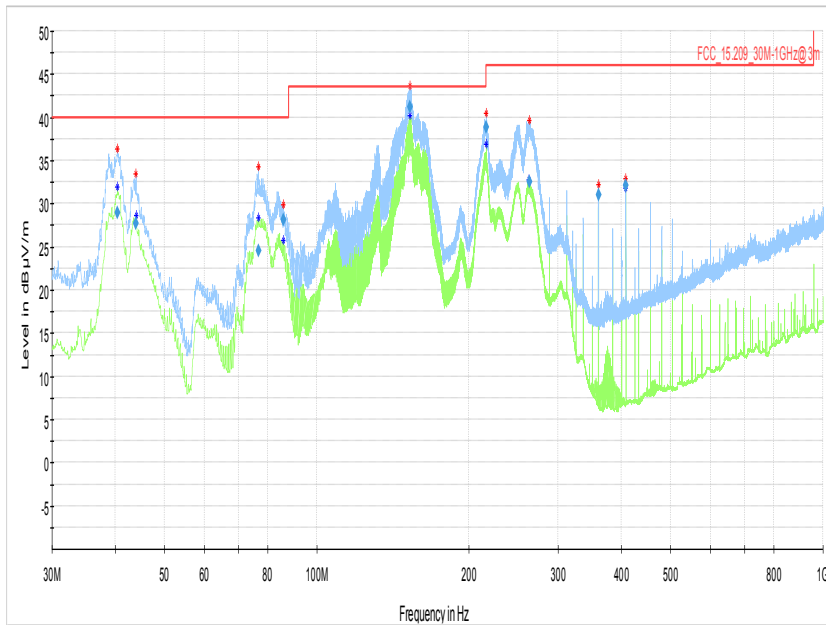
Ch. No.	Ch. Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBµV/m]	Detector	RBW [kHz]	Limit [dBµV/m]	Margin [dB]	Limit Type
151	5755.0	2892.4*	53.6	PEAK	1000.0	74.0	20.4	RB
151	5755.0	5717.2	66.7	PEAK	1000.0	78.0	11.3	BE
151	5755.0	25299.1*	57.6	PEAK	1000.0	68.0	10.4	UE
159	5795.0	40.4	28.9	QP	120.0	40.0	11.1	RB
159	5795.0	44.0	27.8	QP	120.0	40.0	12.2	RB
159	5795.0	76.7	24.5	QP	120.0	40.0	15.5	RB
159	5795.0	85.9	28.1	QP	120.0	40.0	11.9	RB
159	5795.0	152.9	41.2	QP	120.0	43.5	2.3	RB
159	5795.0	216.0	38.8	QP	120.0	43.5	4.7	RB
159	5795.0	263.0	32.5	QP	120.0	46.0	13.5	RB
159	5795.0	360.0	31.0	QP	120.0	46.0	15.0	RB
159	5795.0	408.0	32.1	QP	120.0	46.0	14.0	RB
159	5795.0	2681.3	53.5	PEAK	1000.0	68.0	14.5	UE
159	5795.0	6997.4*	57.5	PEAK	1000.0	68.0	10.5	UE
159	5795.0	25467.1*	57.9	PEAK	1000.0	68.0	10.1	UE

Remark 1: All values marked with a * are the typical noise values of the test system

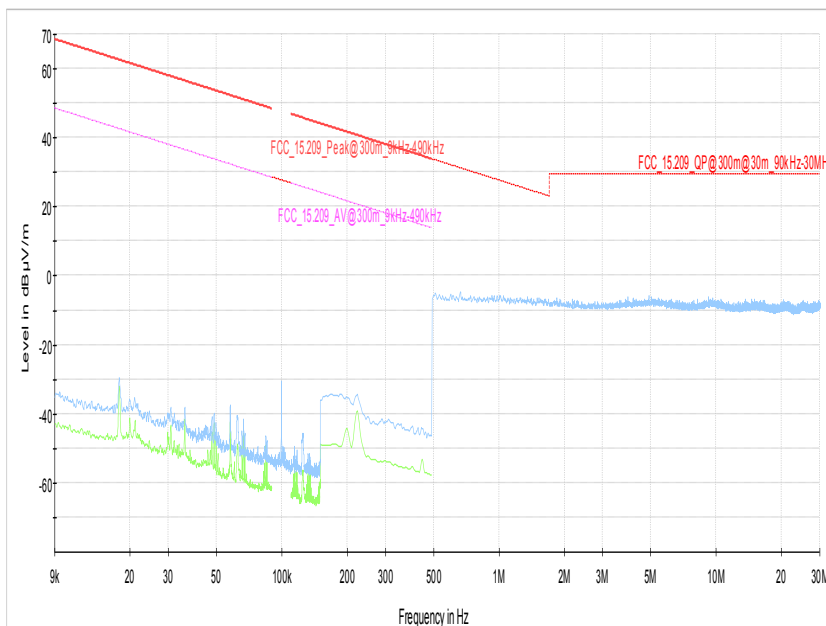
Remark 2: Please see next sub-clause for the measurement plot.

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

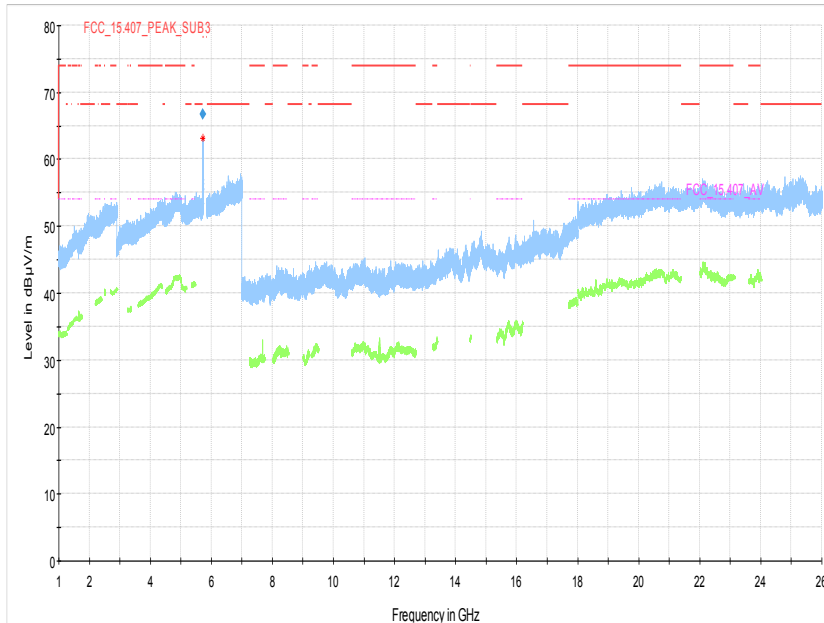
Radio Technology = WLAN n 40 MHz, Operating Frequency = high, Measurement range = 30MHz - 1GHz, Subband = U-NII-3



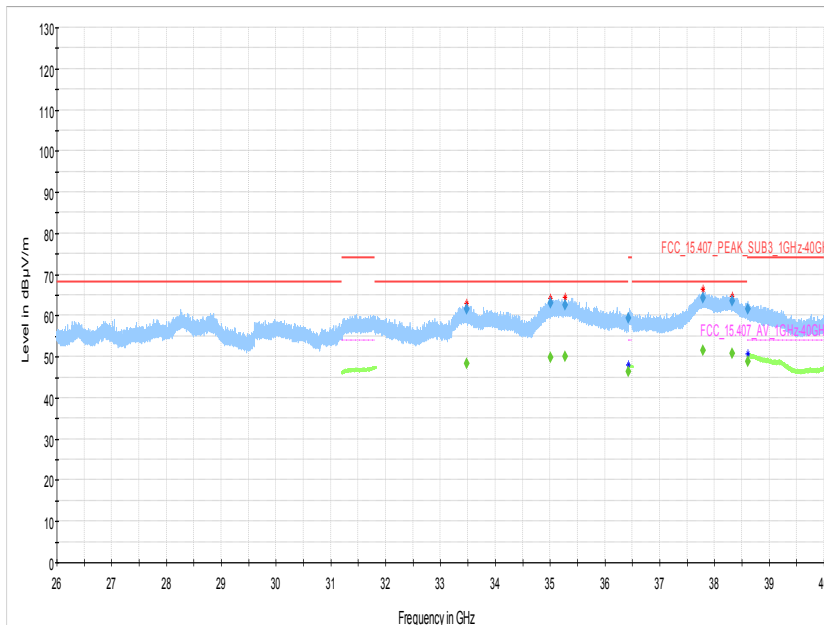
Radio Technology = WLAN n 40 MHz, Operating Frequency = high, Measurement range = 9kHz - 30MHz, Subband = U-NII-3



Radio Technology = WLAN n 40 MHz, Operating Frequency = low, Measurement range = 1GHz - 26GHz, Subband = U-NII-3



Radio Technology = WLAN a, Operating Frequency = low, Measurement range = 26GHz - 40GHz, Subband = U-NII-3



The diagram shows the noise level of the system

4.6.5 Test Equipment used

Radiated Emissions

4.7 Band Edge

Standard: FCC Part 15, Subpart E

The test was performed according to:
ANSI C63.10

4.7.1 Test Description

Please see test description for the test case "Spurious Radiated Emissions"

4.7.2 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)

4.7.3 Test Protocol

Ambient temperature: 24–29 °C
 Air Pressure: 1000–1009 hPa
 Humidity: 33–49 %

WLAN a-Mode; 20 MHz; 6 Mbit/s Applied duty cycle correction (AV) [dB]: 0.0 dB

U-NII-Subband	Ch. No.	Ch. Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBµV/m]	Detec-tor	RBW [kHz]	Limit [dBµV/m]	Margin [dB]	Limit Type
3	149	5745.0	5725.0	68.5	PEAK	1000	78.0	9.5	BE-UE
	165	5825.0	5850.0	55.0	PEAK	1000	78.0	23.0	BE-UE

WLAN n-Mode; 20 MHz; 72.2 Mbit/s MCS7 Applied duty cycle correction (AV) [dB]: 0.0 dB

U-NII-Subband	Ch. No.	Ch. Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBµV/m]	Detec-tor	RBW [kHz]	Limit [dBµV/m]	Margin [dB]	Limit Type
3	149	5745.0	5725.0	70.9	PEAK	1000	78.0	7.1	BE-UE
	165	5825.0	5850.0	55.0	PEAK	1000	78.0	23.0	BE-UE

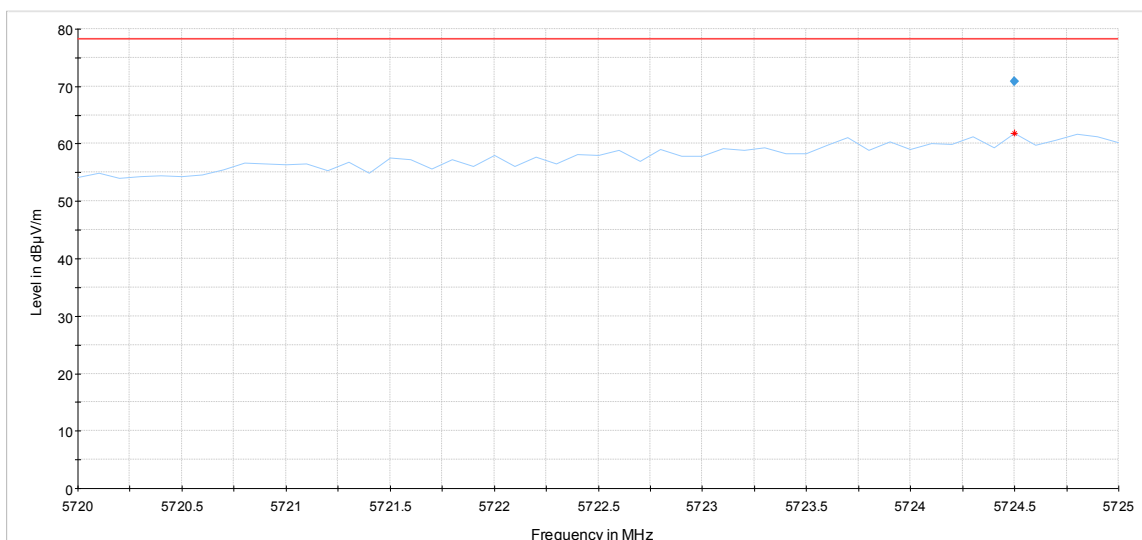
WLAN n-Mode; 40 MHz; 150 Mbit/s MCS7 Applied duty cycle correction (AV) [dB]: 0.0 dB

U-NII-Subband	Ch. No.	Ch. Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBµV/m]	Detec-tor	RBW [kHz]	Limit [dBµV/m]	Margin [dB]	Limit Type
3	151	5755.0	5725.0	68.5	PEAK	1000	78.0	9.5	BE-UE
	159	5795.0	5850.0	52.5	PEAK	1000	78.0	25.5	BE-UE

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

4.7.4 Measurement Plot (showing the highest value, “worst case”)

Radio Technology = WLAN n 20 MHz, Operating Frequency = low, Measurement range = 1GHz - 26GHz, Subband = U-NII-3



4.7.5 Test Equipment used

Radio Lab

5 Test Equipment

1 Radiated Emissions

Lab to perform radiated emission tests

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
	3160-09	Standard Gain / Pyramidal Horn Antenna 26.5 GHz	EMCO Electronic GmbH	00083069		
	WHKX 7.0/18G-8SS	High Pass Filter	Wainwright	09		
	5HC3500/1800-0-1.2-KK	High Pass Filter	Trilithic	200035008		
	Fully Anechoic Room	8.80m x 4.60m x 4.05m (l x w x h)	Albatross Projects	P26971-647-001-PRB		
	AM 4.0	Antenna mast	Maturo GmbH	AM4.0/180/11920513		
	ESR 7	EMI Receiver / Spectrum Analyzer	Rohde & Schwarz	101424	2014-11	2016-11
	TT 1.5 WI	Turn Table	Maturo GmbH	-		
	Anechoic Chamber	10.58 x 6.38 x 6.00 m ³	Frankonia	none	2014-01	2017-01
	ESIB 26	Spectrum Analyzer	Rohde & Schwarz	830482/004	2015-12	2017-12
	Tilt device Maturo (Rohacell)	Antrieb TD1.5-10kg	Maturo GmbH	TD1.5-10kg/024/3790709		
	5HC2700/1275-0-1.5-KK	High Pass Filter	Trilithic	9942012		
	AS 620 P	Antenna mast	HD GmbH	620/37		
	NRV-Z1	Sensor Head A	Rohde & Schwarz	827753/005	2015-05	2016-05
	4HC1600/1275-0-1.5-KK	High Pass Filter	Trilithic	9942011		
	ASP 1.2/1.8-10kg	Antenna Mast	Maturo GmbH	-		
	JS4-18002600-32-5P	Broadband Amplifier 18 GHz - 26 GHz	Miteq	849785		
	JS4-00101800-35-5P	Broadband Amplifier 30 MHz - 18 GHz	Miteq	896037		
	HL 562	Ultralog new biconicals	Rohde & Schwarz GmbH & Co. KG	830547/003	2015-06	2018-06
	Opus10 THI (8152.00)	ThermoHygro Datalogger 12 (Environ)	Lufft Mess- und Regeltechnik GmbH	12482	2015-03	2017-03

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
	JS4-00102600-42-5A	Broadband Amplifier 30 MHz - 26 GHz	Miteq	619368		
	HFH2-Z2	Loop Antenna	Rohde & Schwarz GmbH & Co. KG	829324/006	2014-11	2017-11
	FSW 43	Spectrum Analyzer	Rohde & Schwarz	103779	2014-11	2016-11
	Opus10 TPR (8253.00)	ThermoAirpressure Datalogger 13 (Environ)	Lufft Mess- und Regeltechnik GmbH	13936	2015-02	2017-02
	Chroma 6404	AC Power Source	Chroma ATE INC.	64040001304		
	3160-10	Standard Gain / Pyramidal Horn Antenna 40 GHz	EMCO Elektronik GmbH	00086675		
	HL 562 Ultralog	Log.-per. Antenna	Rohde & Schwarz GmbH & Co. KG	100609	2016-04	2019-04
	PAS 2.5 - 10 kg	Antenna Mast	Maturo GmbH	-		
	HF 907	Double-ridged horn	Rohde & Schwarz GmbH & Co. KG	102444	2015-05	2018-05

2 Radio Lab

Conducted Radio Test Lab

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
	A8455-4	4 Way Power Divider (SMA)		-		
	SMB100A	Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz GmbH & Co. KG	107695	2014-06	2017-06
	VT 4002	Climatic Chamber	Vötsch	58566002150010	2016-03	2018-03
	SMP03	Signal Generator 2 GHz - 27 GHz 1035.5005.03	Rohde & Schwarz GmbH & Co. KG	833680/003	2013-10	2016-10
	FSV30	Signal Analyzer 10 Hz - 30 GHz	Rohde & Schwarz	103005	2016-02	2018-02
	SMBV100A	Vector Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz GmbH & Co. KG	259291	2013-08	2016-08
	Voltcraft M-3860M	Digital Multimeter 01 (Multimeter)	Voltcraft	IJ096055		
	Chroma 6404	AC Power Source	Chroma ATE INC.	64040001304		

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
	Datum, Model: MFS	Rubidium Frequency Standard	Datum-Beverly	5489/001	2015-06	2016-06
	WA1515	Broadband Power Divider SMA	Weinschel Associates	A855		
	FSIQ26	Spectrum Analyzer 7layers, Ratingen OIL_RE	Rohde & Schwarz GmbH & Co. KG	840061/005	2015-04	2017-04

3 R&S TS8997
EN300328/301893 Test Lab

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
	OSP120	Switching Unit with integrated power meter	Rohde & Schwarz GmbH & Co. KG	101158	2015-08	2016-08
	A8455-4	4 Way Power Divider (SMA)		-		
	Opus10 THI (8152.00)	ThermoHygro Datalogger 03 (Environ)	Lufft Mess- und Regeltechnik GmbH	7482	2015-02	2017-02
	SMB100A	Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz GmbH & Co. KG	107695	2014-06	2017-06
	VT 4002	Climatic Chamber	Vötsch	58566002150010	2016-03	2018-03
	FSV30	Signal Analyzer 10 Hz - 30 GHz	Rohde & Schwarz	103005	2016-02	2018-02
	SMBV100A	Vector Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz GmbH & Co. KG	259291	2013-08	2016-08
	Voltcraft M-3860M	Digital Multimeter 01 (Multimeter)	Voltcraft	IJ096055		
	1515 / 93459	Broadband Power Divider SMA (Aux)	Weinschel Associates	LN673		
	Datum, Model: MFS	Rubidium Frequency Standard	Datum-Beverly	5489/001	2015-06	2016-06

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 MHz	Corr. dB	LISN insertion loss ESH3- Z5 dB	cable loss (incl. 10 dB atten- uator) 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

$$U_{\text{LISN}} \text{ (dB } \mu\text{V)} = U \text{ (dB } \mu\text{V)} + \text{Corr. (dB)}$$

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.

6.3 Antenna R&S HL562 (30 MHz – 1 GHz)

($d_{Limit} = 3\text{ m}$)

Frequency MHz	AF R&S HL562 dB (1/m)	Corr. dB
30	18,6	0,6
50	6,0	0,9
100	9,7	1,2
150	7,9	1,6
200	7,6	1,9
250	9,5	2,1
300	11,0	2,3
350	12,4	2,6
400	13,6	2,9
450	14,7	3,1
500	15,6	3,2
550	16,3	3,5
600	17,2	3,5
650	18,1	3,6
700	18,5	3,6
750	19,1	4,1
800	19,6	4,1
850	20,1	4,4
900	20,8	4,7
950	21,1	4,8
1000	21,6	4,9

cable loss 1 (inside chamber) dB	cable loss 2 (outside chamber) dB	cable loss 3 (switch unit) dB	cable loss 4 (to receiver) dB	distance corr. (-20 dB/ decade) dB	d_{Limit} (meas. distance (limit)) m	d_{used} (meas. distance (used)) m
0,29	0,04	0,23	0,02	0,0	3	3
0,39	0,09	0,32	0,08	0,0	3	3
0,56	0,14	0,47	0,08	0,0	3	3
0,73	0,20	0,59	0,12	0,0	3	3
0,84	0,21	0,70	0,11	0,0	3	3
0,98	0,24	0,80	0,13	0,0	3	3
1,04	0,26	0,89	0,15	0,0	3	3
1,18	0,31	0,96	0,13	0,0	3	3
1,28	0,35	1,03	0,19	0,0	3	3
1,39	0,38	1,11	0,22	0,0	3	3
1,44	0,39	1,20	0,19	0,0	3	3
1,55	0,46	1,24	0,23	0,0	3	3
1,59	0,43	1,29	0,23	0,0	3	3
1,67	0,34	1,35	0,22	0,0	3	3
1,67	0,42	1,41	0,15	0,0	3	3
1,87	0,54	1,46	0,25	0,0	3	3
1,90	0,46	1,51	0,25	0,0	3	3
1,99	0,60	1,56	0,27	0,0	3	3
2,14	0,60	1,63	0,29	0,0	3	3
2,22	0,60	1,66	0,33	0,0	3	3
2,23	0,61	1,71	0,30	0,0	3	3

($d_{Limit} = 10\text{ m}$)

30	18,6	-9,9
50	6,0	-9,6
100	9,7	-9,2
150	7,9	-8,8
200	7,6	-8,6
250	9,5	-8,3
300	11,0	-8,1
350	12,4	-7,9
400	13,6	-7,6
450	14,7	-7,4
500	15,6	-7,2
550	16,3	-7,0
600	17,2	-6,9
650	18,1	-6,9
700	18,5	-6,8
750	19,1	-6,3
800	19,6	-6,3
850	20,1	-6,0
900	20,8	-5,8
950	21,1	-5,6
1000	21,6	-5,6

0,29	0,04	0,23	0,02	-10,5	10	3
0,39	0,09	0,32	0,08	-10,5	10	3
0,56	0,14	0,47	0,08	-10,5	10	3
0,73	0,20	0,59	0,12	-10,5	10	3
0,84	0,21	0,70	0,11	-10,5	10	3
0,98	0,24	0,80	0,13	-10,5	10	3
1,04	0,26	0,89	0,15	-10,5	10	3
1,18	0,31	0,96	0,13	-10,5	10	3
1,28	0,35	1,03	0,19	-10,5	10	3
1,39	0,38	1,11	0,22	-10,5	10	3
1,44	0,39	1,20	0,19	-10,5	10	3
1,55	0,46	1,24	0,23	-10,5	10	3
1,59	0,43	1,29	0,23	-10,5	10	3
1,67	0,34	1,35	0,22	-10,5	10	3
1,67	0,42	1,41	0,15	-10,5	10	3
1,87	0,54	1,46	0,25	-10,5	10	3
1,90	0,46	1,51	0,25	-10,5	10	3
1,99	0,60	1,56	0,27	-10,5	10	3
2,14	0,60	1,63	0,29	-10,5	10	3
2,22	0,60	1,66	0,33	-10,5	10	3
2,23	0,61	1,71	0,30	-10,5	10	3

Sample calculation

$E\text{ (dB } \mu\text{V/m)} = U\text{ (dB } \mu\text{V)} + \text{AF (dB 1/m)} + \text{Corr. (dB)}$
 U = Receiver reading
 AF = Antenna factor
 Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
 distance correction = $-20 * \text{LOG}(d_{Limit}/d_{used})$
 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.
MHz	dB (1/m)	dB
1000	24,4	-19,4
2000	28,5	-17,4
3000	31,0	-16,1
4000	33,1	-14,7
5000	34,4	-13,7
6000	34,7	-12,7
7000	35,6	-11,0

cable loss 1 (relay + cable inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit, attenuator & pre-amp)	cable loss 4 (to receiver)		
dB	dB	dB	dB		
0,99	0,31	-21,51	0,79		
1,44	0,44	-20,63	1,38		
1,87	0,53	-19,85	1,33		
2,41	0,67	-19,13	1,31		
2,78	0,86	-18,71	1,40		
2,74	0,90	-17,83	1,47		
2,82	0,86	-16,19	1,46		

Frequency	AF R&S HF907	Corr.
MHz	dB (1/m)	dB
3000	31,0	-23,4
4000	33,1	-23,3
5000	34,4	-21,7
6000	34,7	-21,2
7000	35,6	-19,8

cable loss 1 (relay inside chamber)	cable loss 2 (inside chamber)	cable loss 3 (outside chamber)	cable loss 4 (switch unit, attenuator & pre-amp)	cable loss 5 (to receiver)	used for FCC 15.247
dB	dB	dB	dB	dB	
0,47	1,87	0,53	-27,58	1,33	
0,56	2,41	0,67	-28,23	1,31	
0,61	2,78	0,86	-27,35	1,40	
0,58	2,74	0,90	-26,89	1,47	
0,66	2,82	0,86	-25,58	1,46	

Frequency	AF R&S HF907	Corr.
MHz	dB (1/m)	dB
7000	35,6	-57,3
8000	36,3	-56,3
9000	37,1	-55,3
10000	37,5	-56,2
11000	37,5	-55,3
12000	37,6	-53,7
13000	38,2	-53,5
14000	39,9	-56,3
15000	40,9	-54,1
16000	41,3	-54,1
17000	42,8	-54,4
18000	44,2	-54,7

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)
dB	dB	dB	dB	dB	dB
0,56	1,28	-62,72	2,66	0,94	1,46
0,69	0,71	-61,49	2,84	1,00	1,53
0,68	0,65	-60,80	3,06	1,09	1,60
0,70	0,54	-61,91	3,28	1,20	1,67
0,80	0,61	-61,40	3,43	1,27	1,70
0,84	0,42	-59,70	3,53	1,26	1,73
0,83	0,44	-59,81	3,75	1,32	1,83
0,91	0,53	-63,03	3,91	1,40	1,77
0,98	0,54	-61,05	4,02	1,44	1,83
1,23	0,49	-61,51	4,17	1,51	1,85
1,36	0,76	-62,36	4,34	1,53	2,00
1,70	0,53	-62,88	4,41	1,55	1,91

Sample calculation

$$E \text{ (dB } \mu\text{V/m)} = U \text{ (dB } \mu\text{V)} + \text{AF (dB 1/m)} + \text{Corr. (dB)}$$

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 MHz	AF EMCO 3160-09 dB (1/m)	Corr. dB	cable loss 1 (inside chamber) dB	cable loss 2 (pre- amp) dB	cable loss 3 (inside chamber) dB	cable loss 4 (switch unit) dB	cable loss 5 (to receiver) 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

$E \text{ (dB } \mu\text{V/m)} = U \text{ (dB } \mu\text{V)} + \text{AF (dB 1/m)} + \text{Corr. (dB)}$
 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

Frequency	AF EMCO 3160-10	Corr.
GHz	dB (1/m)	dB
26,5	43,4	-11,2
27,0	43,4	-11,2
28,0	43,4	-11,1
29,0	43,5	-11,0
30,0	43,5	-10,9
31,0	43,5	-10,8
32,0	43,5	-10,7
33,0	43,6	-10,7
34,0	43,6	-10,6
35,0	43,6	-10,5
36,0	43,6	-10,4
37,0	43,7	-10,3
38,0	43,7	-10,2
39,0	43,7	-10,2
40,0	43,8	-10,1

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))
dB	dB	dB	dB	dB	m	m
4,4				-15,6	3	0,5
4,4				-15,6	3	0,5
4,5				-15,6	3	0,5
4,6				-15,6	3	0,5
4,7				-15,6	3	0,5
4,7				-15,6	3	0,5
4,8				-15,6	3	0,5
4,9				-15,6	3	0,5
5,0				-15,6	3	0,5
5,1				-15,6	3	0,5
5,1				-15,6	3	0,5
5,2				-15,6	3	0,5
5,3				-15,6	3	0,5
5,4				-15,6	3	0,5
5,5				-15,6	3	0,5

Sample calculation

$$E \text{ (dB } \mu\text{V/m)} = U \text{ (dB } \mu\text{V)} + AF \text{ (dB 1/m)} + Corr. \text{ (dB)}$$

U = Receiver reading

AF = Antenna factor

Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)

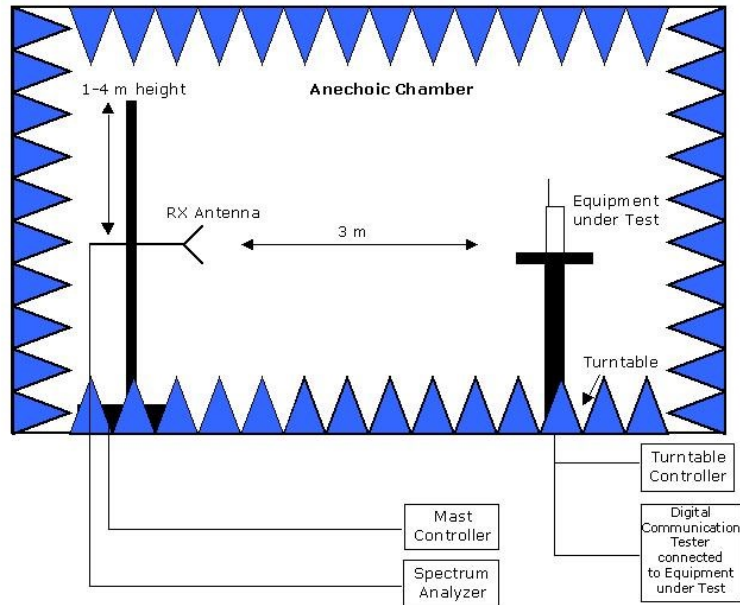
Linear interpolation will be used for frequencies in between the values in the table.

distance correction = $-20 * \text{LOG} (d_{\text{Limit}} / d_{\text{used}})$

Linear interpolation will be used for frequencies in between the values in the table.

Table shows an extract of values.

7 Setup Drawings



Remark: Depending on the frequency range suitable antenna types, attenuators or preamplifiers are used.

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.