

FCC Measurement/Technical Report on

WLAN and Bluetooth module

JODY-W167-03A

FCC ID: XPYJODYW167
IC: 8595A-JODYW167

Test Report Reference: MDE_UBLOX_1828_FCCd

Test Laboratory:

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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.

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1 APPLIED STANDARDS AND TEST SUMMARY

1.1 APPLIED STANDARDS

Type of Authorization

Certification for an Intentional Radiator.

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2 and 15 (10-1-17 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

§ 15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz

Note:

The tests were selected and performed with reference to the FCC Public Notice "Guidance for Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating under Section 15.247 of the FCC Rules, 558074 D01 15.247 Meas Guidance v05_r02, 2019-04-02". ANSI C63.10-2013 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 DTS (e.g. WLAN 2.4 GHz, BT LE) equipment from FCC and IC

DTS equipment

Measurement	FCC reference	IC reference
Conducted emissions on AC Mains	§ 15.207	RSS-Gen Issue 5: 8.8
Occupied bandwidth	§ 15.247 (a) (2)	RSS-247 Issue 2: 5.2 (a)
Peak conducted output power	§ 15.247 (b) (3), (4)	RSS-247 Issue 2: 5.4 (d)
Transmitter spurious RF conducted emissions	§ 15.247 (d)	RSS-Gen Issue 5: 6.13 / 8.9/8.10; RSS-247 Issue 2: 5.5
Transmitter spurious radiated emissions	§ 15.247 (d); § 15.209 (a)	RSS-Gen Issue 5: 6.13 / 8.9/8.10; RSS-247 Issue 2: 5.5
Band edge compliance	§ 15.247 (d)	RSS-247 Issue 2: 5.5
Power density	§ 15.247 (e)	RSS-247 Issue 2: 5.2 (b)
Antenna requirement	§ 15.203 / 15.204	RSS-Gen Issue 5: 8.3
Receiver spurious emissions	–	–

1.3 MEASUREMENT SUMMARY / SIGNATURES

47 CFR CHAPTER I FCC PART 15 Subpart C §15.247

§ 15.207

Conducted Emissions at AC Mains

The measurement was performed according to ANSI C63.10

Final Result

OP-Mode

Operating mode, Connection to AC mains
worst case, via ancillary/auxiliary equipment

Setup

S01_7_AA01

FCC

Passed

IC

Passed

47 CFR CHAPTER I FCC PART 15 Subpart C §15.247

§ 15.247 (a) (2)

Occupied Bandwidth (6 dB)

The measurement was performed according to ANSI C63.10

Final Result

OP-Mode

Radio Technology, Operating Frequency

Bluetooth BDR, high

S02_7_AC02

Passed

Passed

Bluetooth BDR, low

S02_7_AC02

Passed

Passed

Bluetooth BDR, mid

S02_7_AC02

Passed

Passed

Bluetooth EDR 2, high

S02_7_AC02

Passed

Passed

Bluetooth EDR 2, low

S02_7_AC02

Passed

Passed

Bluetooth EDR 2, mid

S02_7_AC02

Passed

Passed

Bluetooth EDR 3, high

S02_7_AC02

Passed

Passed

Bluetooth EDR 3, low

S02_7_AC02

Passed

Passed

Bluetooth EDR 3, mid

S02_7_AC02

Passed

Passed

Bluetooth LE, high

S02_7_AC02

Passed

Passed

Bluetooth LE, low

S02_7_AC02

Passed

Passed

Bluetooth LE, mid

S02_7_AC02

Passed

Passed

WLAN b, high

S02_7_AA01

Passed

Passed

WLAN b, low

S02_7_AA01

Passed

Passed

WLAN b, mid

S02_7_AA01

Passed

Passed

WLAN g, high

S02_7_AA01

Passed

Passed

WLAN g, low

S02_7_AA01

Passed

Passed

WLAN g, mid

S02_7_AA01

Passed

Passed

WLAN n 20 MHz, high

S02_7_AA01

Passed

Passed

WLAN n 20 MHz, low

S02_7_AA01

Passed

Passed

WLAN n 20 MHz, mid

S02_7_AA01

Passed

Passed

**47 CFR CHAPTER I FCC PART 15 Subpart C
§15.247**

**IC RSS-Gen & IC TRC-43; Ch.
6.7 & Ch. 8**

Occupied Bandwidth (99%)

The measurement was performed according to ANSI C63.10

Final Result

OP-Mode

Radio Technology, Operating Frequency

	Setup	FCC	IC
Bluetooth BDR, high	S02_7_AC02	N/A	Passed
Bluetooth BDR, low	S02_7_AC02	N/A	Passed
Bluetooth BDR, mid	S02_7_AC02	N/A	Passed
Bluetooth EDR 2, high	S02_7_AC02	N/A	Passed
Bluetooth EDR 2, low	S02_7_AC02	N/A	Passed
Bluetooth EDR 2, mid	S02_7_AC02	N/A	Passed
Bluetooth EDR 3, high	S02_7_AC02	N/A	Passed
Bluetooth EDR 3, low	S02_7_AC02	N/A	Passed
Bluetooth EDR 3, mid	S02_7_AC02	N/A	Passed
Bluetooth LE, high	S02_7_AC02	N/A	Passed
Bluetooth LE, low	S02_7_AC02	N/A	Passed
Bluetooth LE, mid	S02_7_AC02	N/A	Passed
WLAN b, high	S02_7_AA01	N/A	Passed
WLAN b, low	S02_7_AA01	N/A	Passed
WLAN b, mid	S02_7_AA01	N/A	Passed
WLAN g, high	S02_7_AA01	N/A	Passed
WLAN g, low	S02_7_AA01	N/A	Passed
WLAN g, mid	S02_7_AA01	N/A	Passed
WLAN n 20 MHz, high	S02_7_AA01	N/A	Passed
WLAN n 20 MHz, low	S02_7_AA01	N/A	Passed
WLAN n 20 MHz, mid	S02_7_AA01	N/A	Passed

**47 CFR CHAPTER I FCC PART 15 Subpart C
§15.247**

§ 15.247 (b) (3)

Peak Power Output

The measurement was performed according to ANSI C63.10

Final Result

OP-Mode

Radio Technology, Operating Frequency, Measurement method

	Setup	FCC	IC
Bluetooth BDR, high, conducted	S02_7_AC02	Passed	Passed
Bluetooth BDR, low, conducted	S02_7_AC02	Passed	Passed
Bluetooth BDR, mid, conducted	S02_7_AC02	Passed	Passed
Bluetooth EDR 2, high, conducted	S02_7_AC02	Passed	Passed
Bluetooth EDR 2, low, conducted	S02_7_AC02	Passed	Passed
Bluetooth EDR 2, mid, conducted	S02_7_AC02	Passed	Passed
Bluetooth EDR 3, high, conducted	S02_7_AC02	Passed	Passed
Bluetooth EDR 3, low, conducted	S02_7_AC02	Passed	Passed
Bluetooth EDR 3, mid, conducted	S02_7_AC02	Passed	Passed
Bluetooth LE, high, conducted	S02_7_AC02	Passed	Passed
Bluetooth LE, low, conducted	S02_7_AC02	Passed	Passed
Bluetooth LE, mid, conducted	S02_7_AC02	Passed	Passed
WLAN b, high, conducted	S02_7_AA01	Passed	Passed

47 CFR CHAPTER I FCC PART 15 Subpart C
§15.247

§ 15.247 (b) (3)

Peak Power Output

The measurement was performed according to ANSI C63.10

Final Result

OP-Mode

Radio Technology, Operating Frequency, Measurement method

WLAN b, low, conducted

Setup

FCC

IC

S02_7_AA01

Passed

Passed

WLAN b, mid, conducted

S02_7_AA01

Passed

Passed

WLAN g, high, conducted

S02_7_AA01

Passed

Passed

WLAN g, low, conducted

S02_7_AA01

Passed

Passed

WLAN g, mid, conducted

S02_7_AA01

Passed

Passed

WLAN n 20 MHz MIMO, high, conducted

S02_7_AA01

Passed

Passed

Remark: MIMO test mode not provided, values calculated from single core results

WLAN n 20 MHz MIMO, low, conducted

S02_7_AA01

Passed

Passed

Remark: MIMO test mode not provided, values calculated from single core results

WLAN n 20 MHz MIMO, mid, conducted

S02_7_AA01

Passed

Passed

Remark: MIMO test mode not provided, values calculated from single core results

WLAN n 20 MHz, high, conducted

S02_7_AA01

Passed

Passed

WLAN n 20 MHz, low, conducted

S02_7_AA01

Passed

Passed

WLAN n 20 MHz, mid, conducted

S02_7_AA01

Passed

Passed

47 CFR CHAPTER I FCC PART 15 Subpart C
§15.247

§ 15.247 (d)

Spurious RF Conducted Emissions and Conducted Emissions in
 Restricted Bands

The measurement was performed according to ANSI C63.10

Final Result

OP-Mode

Radio Technology, Operating Frequency

Bluetooth BDR, high

Setup

FCC

IC

S02_7_AA01

Passed

Passed

Bluetooth BDR, low

S02_7_AA01

Passed

Passed

Bluetooth BDR, mid

S02_7_AA01

Passed

Passed

Bluetooth EDR 2, high

S02_7_AA01

Passed

Passed

Bluetooth EDR 2, low

S02_7_AA01

Passed

Passed

Bluetooth EDR 2, mid

S02_7_AA01

Passed

Passed

Bluetooth EDR 3, high

S02_7_AA01

Passed

Passed

Bluetooth EDR 3, low

S02_7_AA01

Passed

Passed

Bluetooth EDR 3, mid

S02_7_AA01

Passed

Passed

Bluetooth LE, high

S02_7_AA01

Passed

Passed

Bluetooth LE, low

S02_7_AA01

Passed

Passed

Bluetooth LE, mid

S02_7_AA01

Passed

Passed

WLAN b, high

S02_7_AA01

Passed

Passed

WLAN b, low

S02_7_AA01

Passed

Passed

WLAN b, mid

S02_7_AA01

Passed

Passed

WLAN g, high

S02_7_AA01

Passed

Passed

WLAN g, low

S02_7_AA01

Passed

Passed

WLAN g, mid

S02_7_AA01

Passed

Passed

WLAN n 20 MHz, high

S02_7_AA01

Passed

Passed

47 CFR CHAPTER I FCC PART 15 Subpart C
§15.247

§ 15.247 (d)

Spurious RF Conducted Emissions and Conducted Emissions in
 Restricted Bands

The measurement was performed according to ANSI C63.10

Final Result

OP-Mode

Radio Technology, Operating Frequency

WLAN n 20 MHz, low

WLAN n 20 MHz, mid

WLAN n 20 MHz MIMO, high 1)

Remark: MIMO test mode not provided, values calculated from
 single core results

WLAN n 20 MHz MIMO, low 1)

Remark: MIMO test mode not provided, values calculated from
 single core results

WLAN n 20 MHz MIMO, mid 1)

Remark: MIMO test mode not provided, values calculated from
 single core results

Setup

FCC

IC

S02_7_AA01

Passed

Passed

S02_7_AA01

Passed

Passed

S02_7_AA01

Passed

Passed

S02_7_AA01

Passed

Passed

S02_7_AA01

Passed

Passed

47 CFR CHAPTER I FCC PART 15 Subpart C
§15.247

§ 15.247 (d)

Transmitter Spurious Radiated Emissions

The measurement was performed according to ANSI C63.10

Final Result

OP-Mode

Radio Technology, Operating Frequency, Measurement range

Bluetooth BDR, high, 1 GHz - 26 GHz

Bluetooth BDR, high, 30 MHz - 1 GHz

Bluetooth BDR, low, 1 GHz - 26 GHz

Bluetooth BDR, low, 30 MHz - 1 GHz

Bluetooth BDR, mid, 1 GHz - 26 GHz

Bluetooth BDR, mid, 30 MHz - 1 GHz

Bluetooth BDR, mid, 9 kHz - 30 MHz

Bluetooth EDR 2, high, 1 GHz - 26 GHz

Remark: 1-8GHz

Bluetooth EDR 2, low, 1 GHz - 26 GHz

Remark: 1-8GHz

Bluetooth EDR 2, mid, 1 GHz - 26 GHz

Remark: 1-8GHz

WLAN b, high, 1 GHz - 26 GHz

WLAN b, high, 30 MHz - 1 GHz

WLAN b, low, 1 GHz - 26 GHz

WLAN b, low, 30 MHz - 1 GHz

WLAN b, mid, 1 GHz - 26 GHz

WLAN b, mid, 30 MHz - 1 GHz

WLAN b, mid, 9 kHz - 30 MHz

WLAN g, high, 1 GHz - 26 GHz

Remark: 1-8GHz

WLAN g, low, 1 GHz - 26 GHz

Remark: 1-8GHz

WLAN g, mid, 1 GHz - 26 GHz

Remark: 1-8GHz

Setup

FCC

IC

S01_7_AA01

Passed

Passed

S01_7_AA01

Passed

Passed

S01_7_AA01

Passed

Passed

S01_7_AA01

Passed

Passed

S01_7_AA01

Passed

Passed

S01_7_AA01

Passed

Passed

S01_7_AA01

Passed

Passed

S01_7_AA01

Passed

Passed

S01_7_AA01

Passed

Passed

S01_7_AA01

Passed

Passed

S01_7_AA01

Passed

Passed

S01_7_AA01

Passed

Passed

S01_7_AA01

Passed

Passed

S01_7_AA01

Passed

Passed

S01_7_AA01

Passed

Passed

S01_7_AA01

Passed

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S01_7_AA01

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S01_7_AA01

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S01_7_AA01

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S01_7_AA01

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S01_7_AA01

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Passed

S01_7_AA01

Passed

Passed

S01_7_AA01

Passed

Passed

S01_7_AA01

Passed

Passed

S01_7_AA01

Passed

Passed

47 CFR CHAPTER I FCC PART 15 Subpart C
§15.247

§ 15.247 (d)

Band Edge Compliance Conducted

The measurement was performed according to ANSI C63.10

Final Result

OP-Mode

Radio Technology, Operating Frequency, Band Edge

Bluetooth BDR, high, high

Setup

FCC

IC

S02_7_AA01

Passed

Passed

Bluetooth BDR, low, low

S02_7_AA01

Passed

Passed

Bluetooth EDR 2, high, high

S02_7_AA01

Passed

Passed

Bluetooth EDR 2, low, low

S02_7_AA01

Passed

Passed

Bluetooth EDR 3, high, high

S02_7_AA01

Passed

Passed

Bluetooth EDR 3, low, low

S02_7_AA01

Passed

Passed

Bluetooth LE, high, high

S02_7_AC02

Passed

Passed

Bluetooth LE, low, low

S02_7_AC02

Passed

Passed

WLAN b, high, high

S02_7_AA01

Passed

Passed

WLAN b, low, low

S02_7_AA01

Passed

Passed

WLAN g, high, high

S02_7_AA01

Passed

Passed

WLAN g, low, low

S02_7_AA01

Passed

Passed

WLAN n 20 MHz, high, high

S02_7_AA01

Passed

Passed

WLAN n 20 MHz, low, low

S02_7_AA01

Passed

Passed

47 CFR CHAPTER I FCC PART 15 Subpart C
§15.247

§ 15.247 (d)

Band Edge Compliance Radiated

The measurement was performed according to ANSI C63.10

Final Result

OP-Mode

Radio Technology, Operating Frequency, Band Edge

Bluetooth BDR, high, high

Setup

FCC

IC

S01_7_AA01

Passed

Passed

Bluetooth EDR 2, high, high

S01_7_AA01

Passed

Passed

Bluetooth EDR 3, high, high

S01_7_AA01

Passed

Passed

Bluetooth LE, high, high

S02_7_AC02

Passed

Passed

Remark: tested conducted only

WLAN b, high, high

S01_7_AA01

Passed

Passed

WLAN g, high, high

S01_7_AA01

Passed

Passed

WLAN n 20 MHz MIMO, high, high

S02_7_AA01

Passed

Passed

Remark: MIMO test mode not provided, values calculated from single core results

WLAN n 20 MHz, high, high

S01_7_AA01

Passed

Passed

47 CFR CHAPTER I FCC PART 15 Subpart C

§ 15.247 (e)

§15.247

Power Density

The measurement was performed according to ANSI C63.10

Final Result

OP-Mode

Radio Technology, Operating Frequency

	Setup	FCC	IC
Bluetooth BDR, high	S02_7_AC02	Passed	Passed
Bluetooth BDR, low	S02_7_AC02	Passed	Passed
Bluetooth BDR, mid	S02_7_AC02	Passed	Passed
Bluetooth EDR 2, high	S02_7_AC02	Passed	Passed
Bluetooth EDR 2, low	S02_7_AC02	Passed	Passed
Bluetooth EDR 2, mid	S02_7_AC02	Passed	Passed
Bluetooth EDR 3, high	S02_7_AC02	Passed	Passed
Bluetooth EDR 3, low	S02_7_AC02	Passed	Passed
Bluetooth EDR 3, mid	S02_7_AC02	Passed	Passed
Bluetooth LE, high	S02_7_AC02	Passed	Passed
Bluetooth LE, low	S02_7_AC02	Passed	Passed
Bluetooth LE, mid	S02_7_AC02	Passed	Passed
WLAN b, high	S02_7_AA01	Passed	Passed
WLAN b, low	S02_7_AA01	Passed	Passed
WLAN b, mid	S02_7_AA01	Passed	Passed
WLAN g, high	S02_7_AA01	Passed	Passed
WLAN g, low	S02_7_AA01	Passed	Passed
WLAN g, mid	S02_7_AA01	Passed	Passed
WLAN n 20 MHz MIMO, high	S02_7_AA01	Passed	Passed
Remark: MIMO test mode not provided, values calculated from single core results			
WLAN n 20 MHz MIMO, low	S02_7_AA01	Passed	Passed
Remark: MIMO test mode not provided, values calculated from single core results			
WLAN n 20 MHz MIMO, mid	S02_7_AA01	Passed	Passed
Remark: MIMO test mode not provided, values calculated from single core results			
WLAN n 20 MHz, high	S02_7_AA01	Passed	Passed
WLAN n 20 MHz, low	S02_7_AA01	Passed	Passed
WLAN n 20 MHz, mid	S02_7_AA01	Passed	Passed

1) Only Conducted Emissions in Restricted Bands

N/A: Not applicable

N/P: Not performed

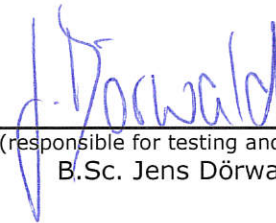
2 REVISION HISTORY

Report version control			
Version	Release date	Change Description	Version validity
initial	2019-04-18	--	valid
--	--	--	--

COMMENT: The filter in the Bluetooth antenna path was changed during the testing process. Due to this the conducted measurements for Bluetooth and Bluetooth Low Energy were repeated, while the radiated measurements (enclosure only, no antenna connected) were not repeated (spot check did not show degradation).



(responsible for accreditation scope)
Dipl.-Ing. Daniel Gall



(responsible for testing and report)
B.Sc. Jens Dörwald



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3 ADMINISTRATIVE DATA

3.1 TESTING LABORATORY

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

The test facility is accredited by the following accreditation organisation:

Laboratory accreditation no: DAkkS D-PL-12140-01-00
FCC Designation Number: DE0015
FCC Test Firm Registration: 929146
ISED CAB Identifier: DE0007; ISED#: 3699A

Responsible for accreditation scope: Dipl.-Ing. Daniel Gall
Report Template Version: 2019-02-12

3.2 PROJECT DATA

Responsible for testing and report: B.Sc. Jens Dörwald
Employees who performed the tests: documented internally at 7Layers
Date of Report: 2019-04-18
Testing Period: 2018-09-11 to 2019-03-22

3.3 APPLICANT DATA

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

3.4 MANUFACTURER DATA

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

4 TEST OBJECT DATA

4.1 GENERAL EUT DESCRIPTION

Kind of Device product description	The EUT is a module supporting WLAN in the 2.4 GHz and 5 GHz bands as well as Bluetooth (BT) 4.2 including Bluetooth Low Energy (BT LE)
Product name	WLAN and Bluetooth module
Type	JODY-W167-03A
Declared EUT data by the supplier	
Voltage Type	DC
Voltage Level	3.3 V
Tested Modulation Type	BT: GFSK Modulation, DHx packets (Bluetooth and Bluetooth Low Energy), 1 Mbps π/4 DQPSK Modulation, 2-DHx packets, 2 Mbps 8-DPSK Modulation, 3-DHx packets, 3 Mbps WLAN: Mode b: DSSS Modulation, 1Mbps Mode g/n: OFDM Modulation, 6Mbps / MCS 0 (20 MHz only)
Specific product description for the EUT	The JODY-W1 is a compact automotive grade module that provides Wi-Fi, Bluetooth, and Bluetooth low energy communication. The JODY-W1647-03A module can be operated in the following modes: Wi-Fi 2x2 MIMO 802.11n in the 2.4 GHz and 5 GHz bands. Wi-Fi 2x2 MIMO 802.11ac in the 5GHz band. Wi-Fi 802.11n/ac real simultaneous dual band on two antennas. Dual-mode Bluetoothv4.2, can be operated fully simultaneous with both the Wi-Fi modes. It is equipped with three antenna pins connected two three SMA connectors on the evaluation board. Maximum supported band width in 2.4 GHz Wi-Fi mode: 20 MHz, 5GHz Wi-Fi mode: 80 MHz
The EUT provides the following ports:	DC Power Supply Antenna ports Signal ports
Special software used for testing	The test modes were set using scripts that were run on a board computer with linux operating system provided by the applicant.

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

4.2 EUT MAIN COMPONENTS

Sample Name	Sample Code	Description
EUT AA01	DE1015104aa01	
Sample Parameter	Value	
Serial No.	946D4CA6ED141C40500	
HW Version	00	
SW Version	P8.1	
Comment		
Integral Antenna	None, two external 50 Ohm connectors on evaluation board. Antenna gain used for evaluation of test results: 2dBi	

Sample Name	Sample Code	Description
EUT AC02	DE1015104ac02	
Sample Parameter	Value	
Serial No.	946D4CA6ED288040700	
HW Version	00	
SW Version	P8.1	
Comment	Modified BT and BT LE filter	
Integral Antenna	None, two external 50 Ohm connectors on evaluation board. Antenna gain used for evaluation of test results: 2dBi	

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

4.3 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
Evaluation Board	-, UBLOX JODY-W1 EVB Certification board,	Board providing ports to the EUT
Sample Name	Description	
Evaluation Board	Evaluation Board	

4.4 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, Type Model, HW, SW, S/N)	Description
Board Computer	Toradex, Ixora, -, - , -	Computer used for setting the test modes
Power Supply	PeakTech, -, -, 081062045	AC/DC power supply (115 V 60 Hz) PeakTech 6005D

4.5 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
S02_7_AA01	Evaluation Board, EUT AA01, Board Computer,	Representative setup conducted testing
S01_7_AA01	Evaluation Board, EUT AA01,	Representative setup radiated testing
S02_7_AC02	Evaluation Board, EUT AC02, Board Computer,	Representative setup conducted testing
S03_7_AA01	Evaluation Board, EUT AA01, Power Supply	Representative setup AC conducted emissions

4.6 OPERATING MODES

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

4.6.1 TEST CHANNELS

WLAN

20 MHz Test Channels:

Channel:

Frequency [MHz]

2.4 GHz ISM 2400 - 2483.5 MHz				
Low ¹⁾		mid	High ¹⁾	
1	2	6	10	11
2412	2417	2437	2457	2462

BT Test Channels:

Channel:

Frequency [MHz]

2.4 GHz ISM 2400 - 2483.5 MHz		
low	mid	high
0	39	78
2402	2441	2480

BT LE Test Channels:

Channel:

Frequency [MHz]

2.4 GHz ISM 2400 - 2483.5 MHz		
low	mid	high
0	19	39
2402	2440	2480

1) Since in WLAN mode g and n the lowest and highest channels have lower output power than the other channels, additional testing was performed for the second lowest and highest channels in those modes.

Output power per channel and mode to be set in EUT WLAN script acc. to customer declaration:

Channel No.	1	2	3	4	5	6	7	8	9	10	11
Channel freq. [MHz]	2412	2417	2422	2427	2432	2437	2442	2447	2452	2457	2462
WLAN mode b	18	18	18	18	18	18	18	18	18	18	18
WLAN mode g	13	15	15	15	15	15	15	15	15	15	13
WLAN mode n	13	15	15	15	15	15	15	15	15	15	13

4.7 PRODUCT LABELLING

4.7.1 FCC ID LABEL

Please refer to the documentation of the applicant.

4.7.2 LOCATION OF THE LABEL ON THE EUT

Please refer to the documentation of the applicant.

5 TEST RESULTS

5.1 CONDUCTED EMISSIONS AT AC MAINS

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.1.1 TEST DESCRIPTION

The test set-up was made in accordance to the general provisions of ANSI C 63.10. The Equipment Under Test (EUT) was setup in a shielded room to perform the conducted emissions measurements in a typical installation configuration. The EUT was powered from 50 μ H || 50 Ohm Line Impedance Stabilization Network (LISN). The LISN's unused connections were terminated with 50 Ohm loads.

The measurement procedure consists of two steps. It is implemented into the EMI test software EMC-32 from R&S.

Step 1: Preliminary scan

Intention of this step is, to determine the conducted EMI-profile of the EUT.

EMI receiver settings:

- Detector: Peak – Maxhold & Average
- Frequency range: 150 kHz – 30 MHz
- Frequency steps: 2.5 kHz
- IF-Bandwidth: 9 kHz
- Measuring time / Frequency step: 100 ms (FFT-based)
- Measurement on phase + neutral lines of the power cords

On basis of this preliminary scan the highest amplitudes and the corresponding frequencies relative to the limit are identified. Emissions above the limit and emissions which are in the 10 dB range below the limit are considered.

Step 2: Final measurement

Intention of this step is, to determine the highest emissions with the settings defined in the test specification for the frequencies identified in step 1.

EMI receiver settings:

- Detector: Quasi-Peak
- IF Bandwidth: 9 kHz
- Measuring time: 1 s / frequency

At each frequency determined in step 1, four measurements are performed in the following combinations:

- 1) Neutral lead - reference ground (PE grounded)
- 2) Phase lead - reference ground (PE grounded)
- 3) Neutral lead - reference ground (PE floating)
- 4) Phase lead - reference ground (PE floating)

The highest value is reported.

5.1.2 TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart C, §15.207

Frequency (MHz)	QP Limits (dBμV)	AV Limits (dBμV)
0.15 – 0.5	66 - 56	56 - 46
0.5 – 5	56	46
5 – 30	60	50

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

5.1.3 TEST PROTOCOL

Temperature: 24 °C
Air Pressure: 1010 hPa
Humidity: 32 %

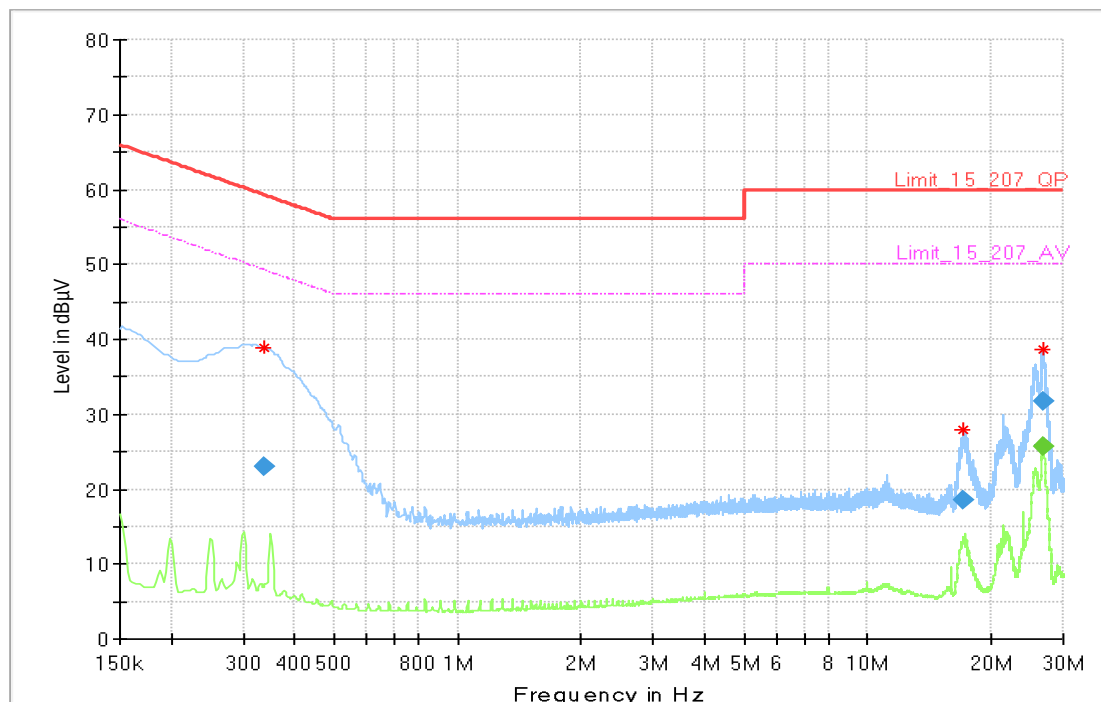
Power line	PE	Frequency [MHz]	Measured value QP [dBμV]	Measured value AV [dBμV]	Limit [dBμV]	Margin [dB]
-	-	-	-	-	-	>10

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

5.1.4 MEASUREMENT PLOT

Common Information

Test Description:	Conducted Emissions
Test Standard:	FCC §15.107, ANSI C63.4, FCC §15.207, ANSI C63.10, EN 55016-2-1, EN 55022, EN 55032
EUT / Setup Code:	DE1015104aa01
Operating Conditions:	120 V 60 Hz, BT loopback on 2441 MHz
Operator Name:	Gal
Comment:	
Legend:	Trace: blue = PK, green = CISPR AV; Star: red or blue = critical frequency; Rhombus: blue = final QP, green = final CISPR AV
Tested Port / used LISN:	AC mains => ESH3-Z5, DC => 2 x ESH3-Z6 (CAR-LISN)
Termination of other ports:	N/A, AC of AUX => 2nd LISN ESH3-Z5 +50 Ohm, shielded LAN => ISN-ST08 +50 Ohm



Final Result

Frequency (MHz)	QuasiPeak (dBμV)	CAverage (dBμV)	Limit (dBμV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)	Corr. (dB)
0.339000	23.02	---	59.23	36.21	1000.0	9.000	L1	FLO	10.1	---
17.088000	18.45	---	60.00	41.55	1000.0	9.000	L1	FLO	10.9	---
26.742750	---	25.73	50.00	24.27	1000.0	9.000	L1	GND	11.2	---
26.749500	31.80	---	60.00	28.20	1000.0	9.000	L1	GND	11.2	---

5.1.5 TEST EQUIPMENT USED

- Conducted Emissions FCC

5.2 OCCUPIED BANDWIDTH (6 DB)

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.2.1 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 (smallest) emission bandwidth.

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

Analyzer settings:

See worst case analyser plots.

5.2.2 TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart C, §15.247 (a) (2)

Systems using digital modulation techniques may operate in the 902-928 MHz and 2400-2483.5 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

5.2.3 TEST PROTOCOL

Ambient temperature: 25 °C
Air Pressure: 1010 hPa
Humidity: 40 %

BT GFSK (1-DH1)

Band	Channel No.	Frequency [MHz]	6 dB Bandwidth [MHz]	Limit [MHz]	Margin to Limit [MHz]
2.4 GHz ISM	0	2402	0.504	0.5	0.004
	39	2441	0.502	0.5	0.002
	78	2480	0.502	0.5	0.002

BT π/4 DQPSK (2-DH1)

Band	Channel No.	Frequency [MHz]	6 dB Bandwidth [MHz]	Limit [MHz]	Margin to Limit [MHz]
2.4 GHz ISM	0	2402	1.109	0.5	0.609
	39	2441	1.030	0.5	0.530
	78	2480	1.089	0.5	0.589

BT 8-DPSK (3-DH1)

Band	Channel No.	Frequency [MHz]	6 dB Bandwidth [MHz]	Limit [MHz]	Margin to Limit [MHz]
2.4 GHz ISM	0	2402	1.109	0.5	0.609
	39	2441	1.189	0.5	0.689
	78	2480	1.069	0.5	0.569

BT LE GFSK

Band	Channel No.	Frequency [MHz]	6 dB Bandwidth [MHz]	Limit [MHz]	Margin to Limit [MHz]
2.4 GHz ISM	0	2402	0.693	0.5	0.193
	19	2440	0.713	0.5	0.213
	39	2480	0.713	0.5	0.213

WLAN b-Mode; 20 MHz; 1 Mbit/s

Band	Channel No.	Frequency [MHz]	6 dB Bandwidth Core 1 [MHz]	6 dB Bandwidth Core 2 [MHz]	Limit [MHz]	Margin to Limit [MHz]
2.4 GHz ISM	1	2412	7.3	7.3	0.5	6.8
	6	2437	7.8	7.3	0.5	6.8
	11	2462	7.3	7.8	0.5	6.8

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

Band	Channel No.	Frequency [MHz]	6 dB Bandwidth Core 1 [MHz]	6 dB Bandwidth Core 2 [MHz]	Limit [MHz]	Margin to Limit [MHz]
2.4 GHz ISM	1	2412	16.5	16.5	0.5	16.0
	6	2437	16.5	16.5	0.5	16.0
	11	2462	16.5	16.5	0.5	16.0

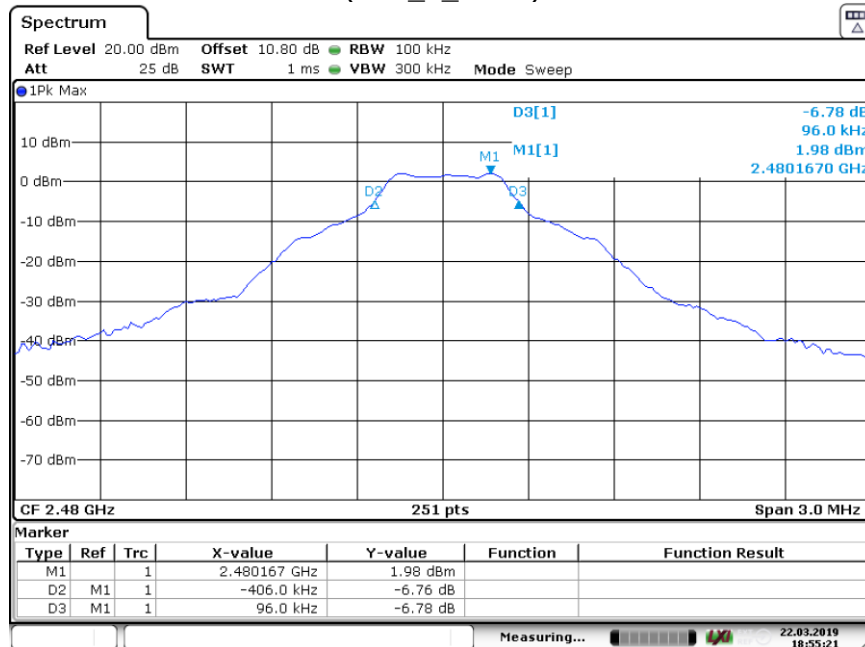
WLAN n-Mode; 20 MHz; MCS0

Band	Channel No.	Frequency [MHz]	6 dB Bandwidth Core 1 [MHz]	6 dB Bandwidth Core 2 [MHz]	Limit [MHz]	Margin to Limit [MHz]
2.4 GHz ISM	1	2412	17.7	17.7	0.5	17.2
	6	2437	17.7	17.5	0.5	17.0
	11	2462	17.7	17.7	0.5	17.2

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

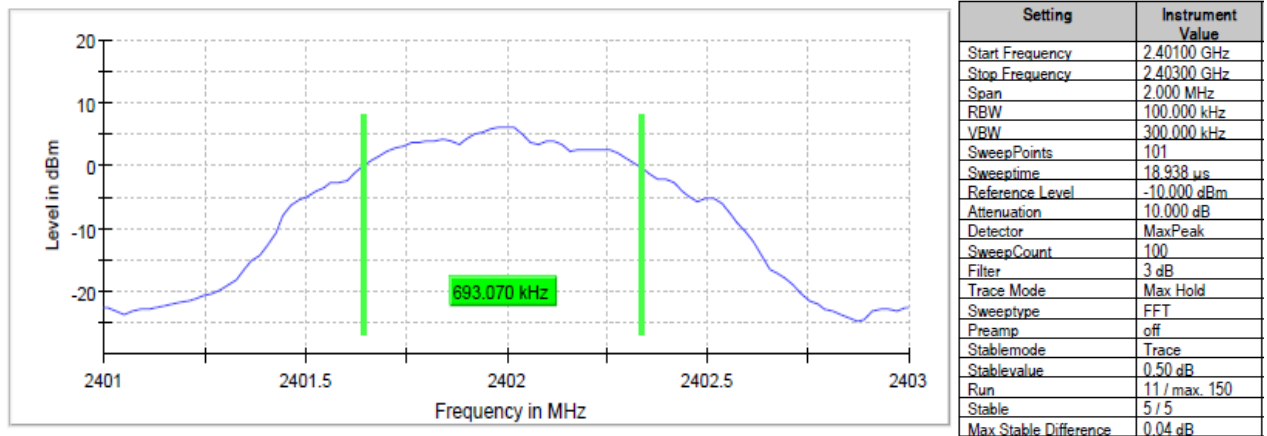
5.2.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

Radio Technology = BT GFSK (1-DH1), Operating Frequency = high
(S02_7_AC02)

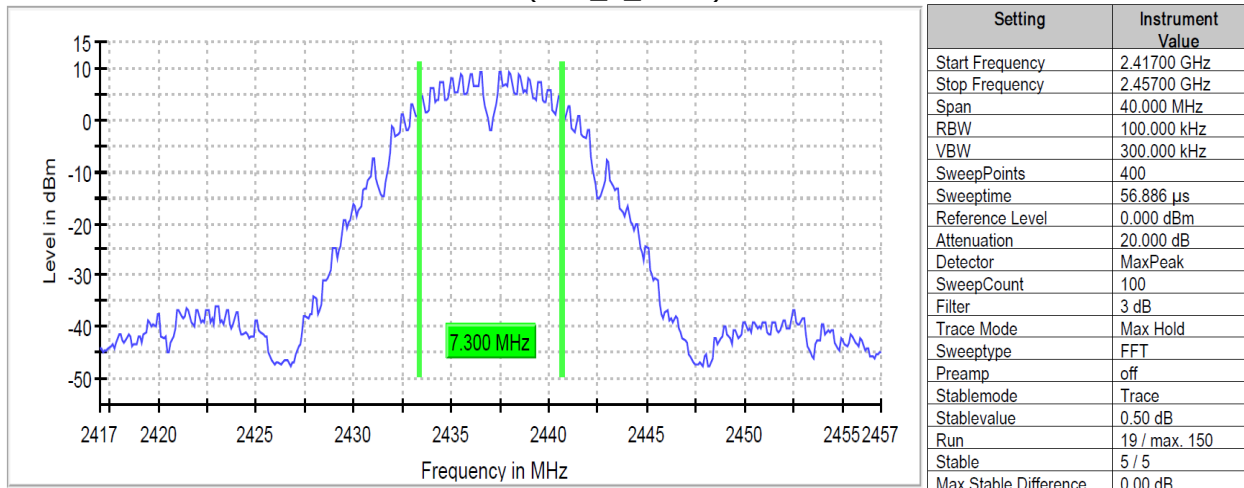


Date: 22 MAR 2019 18:55:22

Radio Technology = Bluetooth LE, Operating Frequency = low
(S02_7_AC02)



Radio Technology = WLAN b, Operating Frequency = mid, Core 2
(S02_7_AA01)



5.2.5 TEST EQUIPMENT USED

- R&S TS8997

5.3 OCCUPIED BANDWIDTH (99%)

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.3.1 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 EUT was connected to spectrum analyzer via a short coax cable with a known loss.
Analyzer settings:

See measurement plots.

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

5.3.2 TEST REQUIREMENTS / LIMITS

No applicable limit:

5.3.3 TEST PROTOCOL

Ambient temperature: 25 °C
Air Pressure: 1010 hPa
Humidity: 40 %

BT GFSK (1-DH1)

Band	Channel No.	Frequency [MHz]	99 % Bandwidth [MHz]
2.4 GHz ISM	0	2402	0.885
	39	2441	0.885
	78	2480	0.880

BT π/4 DQPSK (2-DH1)

Band	Channel No.	Frequency [MHz]	99 % Bandwidth [MHz]
2.4 GHz ISM	0	2402	1.210
	39	2441	1.205
	78	2480	1.205

BT 8-DPSK (3-DH1)

Band	Channel No.	Frequency [MHz]	99 % Bandwidth [MHz]
2.4 GHz ISM	0	2402	1.220
	39	2441	1.210
	78	2480	1.210

BT LE

Band	Channel No.	Frequency [MHz]	99 % Bandwidth [MHz]
2.4 GHz ISM	0	2402	1.040
	19	2440	1.045
	39	2480	1.040

WLAN b-Mode; 20 MHz; 1 Mbit/s

Band	Channel No.	Frequency [MHz]	99 % Bandwidth Core 1 [MHz]	99 % Bandwidth Core 2 [MHz]
2.4 GHz ISM	1	2412	10.6	10.6
	6	2437	10.7	10.7
	11	2462	10.5	10.5

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

Band	Channel No.	Frequency [MHz]	99 % Bandwidth Core 1 [MHz]	99 % Bandwidth Core 2 [MHz]
2.4 GHz ISM	1	2412	17.5	17.4
	6	2437	17.5	17.4
	11	2462	17.4	17.4

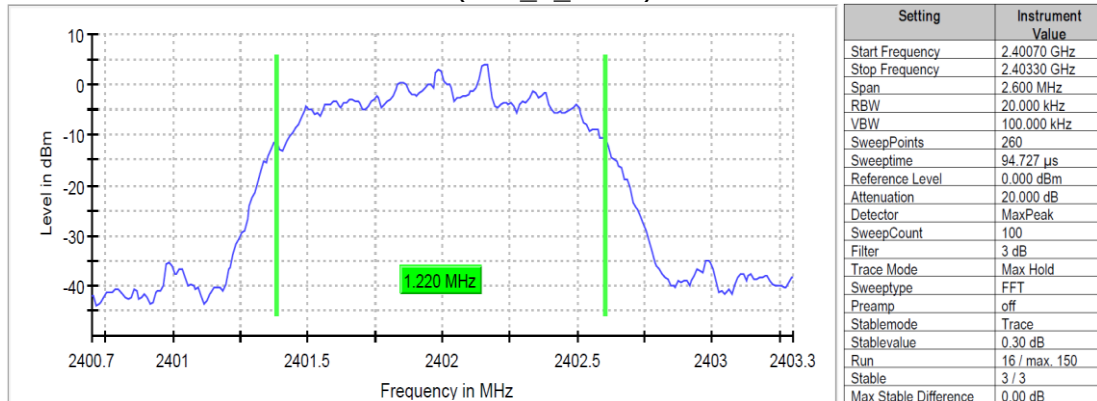
WLAN n-Mode; 20 MHz; MCS0

Band	Channel No.	Frequency [MHz]	99 % Bandwidth Core 1 [MHz]	99 % Bandwidth Core 2 [MHz]
2.4 GHz ISM	1	2412	18.6	18.4
	6	2437	18.4	18.5
	11	2462	18.4	18.5

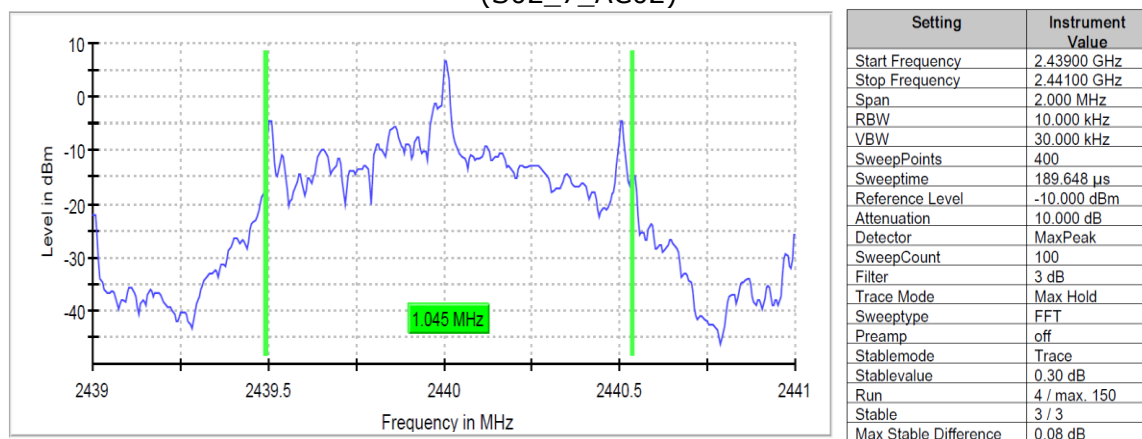
Remark: Please see next sub-clause for the measurement plot.

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

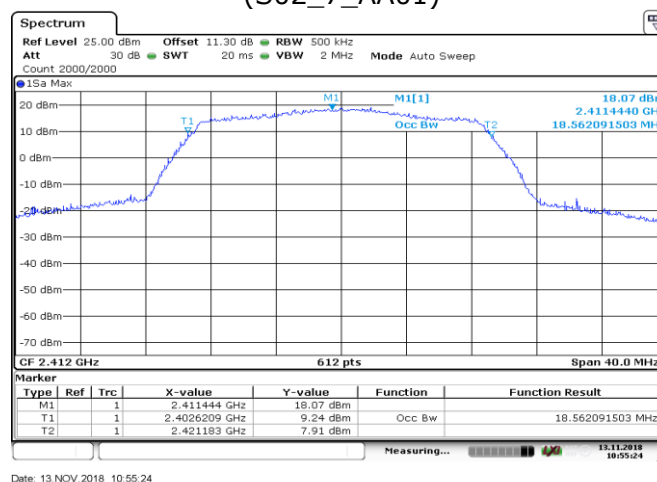
Radio Technology = BT 8-DPSK (3-DH1), Operating Frequency = low
(S02_7_AC02)



Radio Technology = Bluetooth LE, Operating Frequency = mid
(S02_7_AC02)



Radio Technology = WLAN n 20 MHz, Operating Frequency = low, Core 1
(S02_7_AA01)



5.3.5 TEST EQUIPMENT USED

- R&S TS8997

5.4 PEAK POWER OUTPUT

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.4.1 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.

Peak conducted power:

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

Analyzer settings:

- See analyser plots for BT and BT LE

Conducted power:

The EUT was connected to a power meter via a short coax cable with a known loss.

5.4.2 TEST REQUIREMENTS / LIMITS

DTS devices:

FCC Part 15, Subpart C, §15.247 (b) (3)

For systems using digital modulation techniques in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands: 1 watt.

=> Maximum conducted peak output power: 30 dBm (excluding antenna gain, if antennas with directional gains that do not exceed 6 dBi are used).

Frequency Hopping Systems:

FCC Part 15, Subpart C, §15.247 (b) (1)

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

FCC Part 15, Subpart C, §15.247 (b) (2)

For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

Used conversion factor: Limit (dBm) = 10 log (Limit (W)/1mW)

5.4.3 TEST PROTOCOL

Ambient temperature: 26 °C
Air Pressure: 1010 hPa
Humidity: 30 %

BT GFSK (1-DH1)

Band	Channel No.	Frequency [MHz]	Peak Power [dBm]	Limit [dBm]	Margin to Limit [dB]	E.I.R.P [dBm]
2.4 GHz ISM	0	2402	11.7	30.0	18.3	13.7
	39	2441	12.2	30.0	17.8	14.2
	78	2480	12.2	30.0	17.8	14.2

BT π/4 DQPSK (2-DH1)

Band	Channel No.	Frequency [MHz]	Peak Power [dBm]	Limit [dBm]	Margin to Limit [dB]	E.I.R.P [dBm]
2.4 GHz ISM	0	2402	9.3	21.0	11.7	11.3
	39	2441	10.0	21.0	11.0	12.0
	78	2480	10.1	21.0	10.9	12.1

BT 8-DPSK (3-DH1)

Band	Channel No.	Frequency [MHz]	Peak Power [dBm]	Limit [dBm]	Margin to Limit [dB]	E.I.R.P [dBm]
2.4 GHz ISM	0	2402	9.8	21.0	11.2	11.8
	39	2441	10.3	21.0	10.7	12.3
	78	2480	10.1	21.0	10.9	12.1

BT LE

Band	Channel No.	Frequency [MHz]	Peak Power [dBm]	Limit [dBm]	Margin to Limit [dB]	E.I.R.P [dBm]
2.4 GHz ISM	0	2402	6.8	30.0	23.2	8.8
	19	2440	7.4	30.0	22.6	9.4
	39	2480	7.7	30.0	22.3	9.7

WLAN b-Mode; 20 MHz; 1 Mbit/s

Band	Channel No.	Frequency [MHz]	RMS Power Core 1 [dBm]	RMS Power Core 2 [dBm]	Limit [dBm]	Margin to Limit [dB]	E.I.R.P [dBm]
2.4 GHz ISM	1	2412	17.5	16.9	30.0	12.5	19.5
	6	2437	17.2	17.1	30.0	12.8	19.2
	11	2462	16.9	17.5	30.0	12.5	19.5

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

Band	Channel No.	Frequency [MHz]	RMS Power Core 1 [dBm]	RMS Power Core 2 [dBm]	Limit [dBm]	Margin to Limit [dB]	E.I.R.P [dBm]
2.4 GHz ISM	1	2412	12.9	12.5	30.0	17.1	14.9
	2	2417	14.0	14.2	30.0	15.8	16.2
	6	2437	14.5	14.2	30.0	15.5	16.5
	10	2457	14.0	14.5	30.0	15.5	16.5
	11	2462	14.4	12.9	30.0	15.6	16.4

WLAN n-Mode; 20 MHz; MCS0

Band	Channel No.	Frequency [MHz]	RMS Power Core 1 [dBm]	RMS Power Core 2 [dBm]	Limit [dBm]	Margin to Limit [dB]	E.I.R.P [dBm]
2.4 GHz ISM	1	2412	12.9	12.3	30.0	17.1	14.9
	2	2417	13.9	14.2	30.0	15.8	16.2
	6	2437	14.8	14.2	30.0	15.2	16.8
	10	2457	14.4	14.4	30.0	15.6	16.4
	11	2462	12.7	12.7	30.0	17.3	14.7

WLAN n-Mode; 20 MHz; MCS0;
MIMO

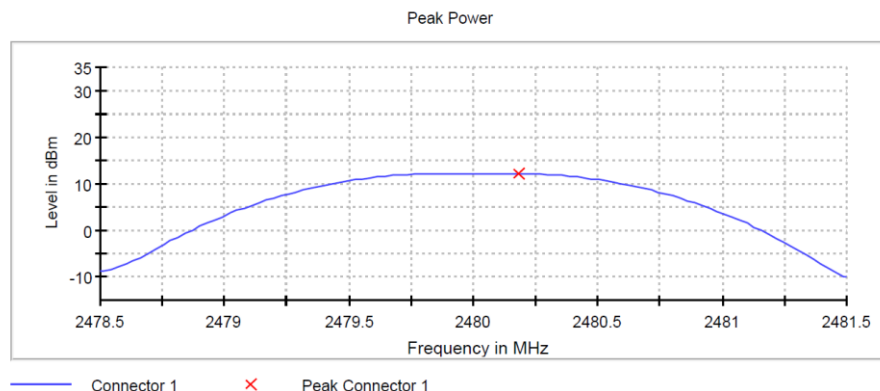
Band	Ch. No.	Freq. [MHz]	RMS Power [dBm]	Limit [dBm]	Margin to Limit [dB]	EIRP [dBm]
2.4 GHz ISM	1	2412	15.6	30.0	14.4	17.6
	2	2417	17.1	30.0	12.9	19.1
	6	2437	17.5	30.0	12.5	19.5
	10	2457	17.4	30.0	12.6	19.4
	11	2462	15.7	30.0	14.3	17.7

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

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

Radio Technology = BT GFSK (1-DH1), Operating Frequency = high
(S02_7_AC02)

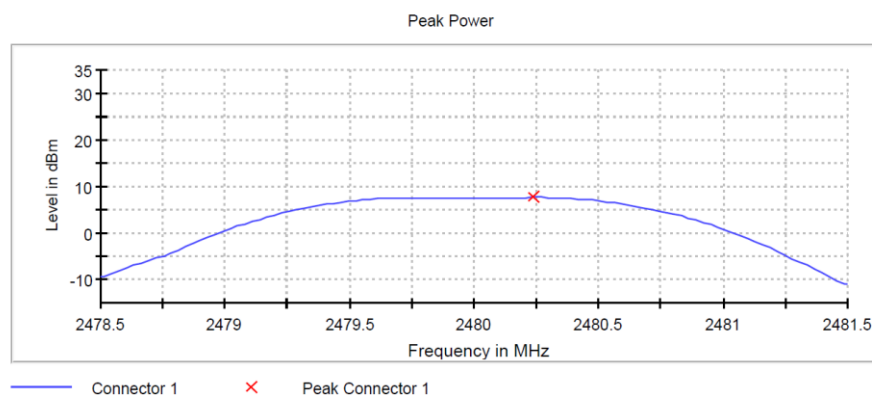
DUT Frequency (MHz)	Peak Power (dBm)	Limit Max (dBm)	Result
2480.000000	12.2	21.0	PASS



Setting	Instrument Value
Start Frequency	2.47850 GHz
Stop Frequency	2.48150 GHz
Span	3.000 MHz
RBW	1.000 MHz
VBW	3.000 MHz
SweepPoints	101
Sweeptime	1.907 μ s
Reference Level	10.000 dBm
Attenuation	30.000 dB
Detector	MaxPeak
SweepCount	100
Filter	3 dB
Trace Mode	Max Hold
SweepType	FFT
Preamplifier	off
Stablemode	Trace
Stablevalue	0.50 dB
Run	4 / max. 150
Stable	3 / 3
Max Stable Difference	0.06 dB

Radio Technology = Bluetooth LE, Operating Frequency = high, Measurement method = conducted
(S02_7_AC02)

DUT Frequency (MHz)	Peak Power (dBm)	Limit Max (dBm)	Result
2480.000000	7.7	30.0	PASS



Setting	Instrument Value
Start Frequency	2.47850 GHz
Stop Frequency	2.48150 GHz
Span	3.000 MHz
RBW	1.000 MHz
VBW	3.000 MHz
SweepPoints	101
Sweeptime	1.907 μ s
Reference Level	0.000 dBm
Attenuation	20.000 dB
Detector	MaxPeak
SweepCount	100
Filter	3 dB
Trace Mode	Max Hold
SweepType	FFT
Preamplifier	off
Stablemode	Trace
Stablevalue	0.50 dB
Run	4 / max. 150
Stable	3 / 3
Max Stable Difference	0.06 dB

5.4.5 TEST EQUIPMENT USED

- R&S TS8997

5.5 SPURIOUS RF CONDUCTED EMISSIONS AND CONDUCTED EMISSIONS IN RESTRICTED BANDS

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.5.1 TEST DESCRIPTION

The Equipment Under Test (EUT) was set up to perform the spurious emissions measurements. The EUT was connected to spectrum analyzer via a short coax cable with a known loss.

Analyzer settings conducted emissions (20 / 30 dBc):

- Frequency range: 30 – 26000 MHz
- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Trace: Maxhold
- Sweeps: till stable
- Sweep Time: Auto
- Detector: Peak

Analyzer settings conducted emissions in restricted bands:

- Frequency range: 0.009 – 30 MHz
 - Resolution Bandwidth (RBW): 10 kHz
 - Video Bandwidth (VBW): 30 kHz
 - Trace: Maxhold
 - Sweeps: 200
 - Sweep Time: coupled
 - Detector: Peak
-
- Frequency range: 30 – 1000 MHz
 - Resolution Bandwidth (RBW): 100 kHz
 - Video Bandwidth (VBW): 300 kHz
 - Trace: Maxhold
 - Sweeps: 200
 - Sweep Time: coupled
 - Detector: Peak
-
- Frequency range: 1000 – 26000 MHz
 - Resolution Bandwidth (RBW): 1000 kHz
 - Video Bandwidth (VBW): 3000 kHz
 - Trace: Maxhold
 - Sweeps: 200
 - Sweep Time: coupled
 - Detector: Peak

For further details in restricted bands measurements see measurement plots.

The reference value for the measurement of the spurious RF conducted emissions is determined during the test "band edge compliance conducted" for low and high channel and 6 dB BW for mid channel. This value is used to calculate the 20 dBc or 30 dBc limit.

For the conducted emissions in restricted bands the Value is measured in dBm and then converted to dB μ V/m as given in KDB 558074:

1. Measure the conducted output power in dBm.
2. Add the maximum antenna gain in dBi
3. Add the appropriate ground reflection factor
 - 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).
4. Convert the resultant EIRP level to an equivalent electric field strength level using the following relationship:
$$E = \text{EIRP} - 20 \log D + 104.8$$
Where E is the electric field strength in dB μ V/m,
EIRP is the equivalent isotropically radiated power in dBm
D is the specified measurement distance in m

Value [dB μ V/m] = Measured value [dBm] + Maximum Antenna Gain [dBi] + Ground reflection factor - 20 log D + 104.8

5.5.2 TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart C, §15.247 (c)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

5.5.3 TEST PROTOCOL

Ambient temperature: 25 °C
 Air Pressure: 1010 hPa
 Humidity: 40 %
 BT GFSK (1-DH1)

Channel No	Channel Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Ref. Level [dBm]	20 dBc Limit [dBm]	Margin to Limit [dB]
0	2402	-	-	PEAK	100	11.6	-8.4	>10
39	2441	-	-	PEAK	100	12.2	-7.8	>10
78	2480	-	-	PEAK	100	11.9	-8.1	>10

Channel No	Channel Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBm]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	Restricted bands limit [dBμV/m]	Margin to Limit [dB]
0	2402	4804	-41.8	53.4	PEAK	1000	74.0	20.6
0	2402	4804	-53.3	41.9	RMS	1000	54.0	12.1
39	2441	4882	-42.0	53.2	PEAK	1000	74.0	20.8
39	2441	4882	-53.2	42.0	RMS	1000	54.0	12.0
78	2480	4960	-40.9	54.3	PEAK	1000	74.0	19.7
78	2480	4960	-53.2	42.0	RMS	1000	54.0	12.0

BT π/4 DQPSK (2-DH1)

Channel No	Channel Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Ref. Level [dBm]	20 dBc Limit [dBm]	Margin to Limit [dB]
0	2402	-	-	PEAK	100	6.7	-13.3	>10
39	2441	-	-	PEAK	100	7.7	-12.3	>10
78	2480	-	-	PEAK	100	7.7	-12.3	>10

Channel No	Channel Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBm]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	Restricted bands limit [dBμV/m]	Margin to Limit [dB]
0	2402	-	-	-	PEAK	1000	74.0	>10
0	2402	-	-	-	RMS	1000	54.0	>10
39	2441	-	-	-	PEAK	1000	74.0	>10
39	2441	-	-	-	RMS	1000	54.0	>10
78	2480	-	-	-	PEAK	1000	74.0	>10
78	2480	-	-	-	RMS	1000	54.0	>10

BT 8-DPSK (3-DH1)

Channel No	Channel Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Ref. Level [dBm]	20 dBc Limit [dBm]	Margin to Limit [dB]
0	2402	-	-	PEAK	100	6.8	-13.2	>10
39	2441	-	-	PEAK	100	7.8	-12.2	>10
78	2480	-	-	PEAK	100	7.8	-12.2	>10

Channel No	Channel Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBm]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	Restricted bands limit [dBμV/m]	Margin to Limit [dB]
0	2402	-	-	-	PEAK	1000	74.0	>10
0	2402	-	-	-	RMS	1000	54.0	>10
39	2441	-	-	-	PEAK	1000	74.0	>10
39	2441	-	-	-	RMS	1000	54.0	>10
78	2480	-	-	-	PEAK	1000	74.0	>10
78	2480	-	-	-	RMS	1000	54.0	>10

BT LE GFSK

Channel No	Channel Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Ref. Level [dBm]	20 dBc Limit [dBm]	Margin to Limit [dB]
0	2402	-	-	PEAK	100	6.2	-13.8	>10
19	2440	-	-	PEAK	100	6.8	-13.2	>10
39	2480	-	-	PEAK	100	6.9	-13.1	>10

Channel No	Channel Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBm]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	Restricted bands limit [dBμV/m]	Margin to Limit [dB]
0	2402	-	-	-	PEAK	1000	74.0	>10
0	2402	-	-	-	RMS	1000	54.0	>10
39	2441	-	-	-	PEAK	1000	74.0	>10
39	2441	-	-	-	RMS	1000	54.0	>10
78	2480	-	-	-	PEAK	1000	74.0	>10
78	2480	-	-	-	RMS	1000	54.0	>10

WLAN b-Mode; 20 MHz; 1 Mbit/s

Channel No	Channel Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Ref. Level [dBm]	30 dBc Limit [dBm]	Margin to Limit [dB]
1	2412	-	-	PEAK	100	9.1	-20.9	>10
1	2412	-	-	PEAK	100	8.7	-21.3	>10
6	2437	-	-	PEAK	100	9.0	-21.0	>10
6	2437	-	-	PEAK	100	9.3	-20.7	>10
11	2462	-	-	PEAK	100	8.7	-21.3	>10
11	2462	-	-	PEAK	100	9.5	-20.5	>10

Channel No	Channel Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBm]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	Restricted bands limit [dBμV/m]	Margin to Limit [dB]
1	2412	4824	-50.3	44.9	PEAK	1000	74.0	29.1
1	2412	4824	-55.9	39.3	RMS	1000	54.0	14.7
1	2412	4824	-50.0	45.2	PEAK	1000	74.0	28.8
1	2412	4824	-55.3	39.9	RMS	1000	54.0	14.1
6	2437	4874	-50.0	45.2	PEAK	1000	74.0	28.8
6	2437	4874	-54.7	40.5	RMS	1000	54.0	13.5
6	2437	4874	-49.8	45.4	PEAK	1000	74.0	28.6
6	2437	4874	-54.6	40.6	RMS	1000	54.0	13.4
11	2462	4924	-51.6	43.6	PEAK	1000	74.0	30.4
11	2462	4924	-57.5	37.7	RMS	1000	54.0	16.3
11	2462	4924	-50.8	44.4	PEAK	1000	74.0	29.6
11	2462	4924	-57.0	38.2	RMS	1000	54.0	15.8

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

Channel No	Channel Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Ref. Level [dBm]	30 dBc Limit [dBm]	Margin to Limit [dB]	
1	2412	-	-	PEAK	100	0.8	-19.2	>10	1)
1	2412	-	-	PEAK	100	0.6	-19.4	>10	2)
2	2417	-	-	PEAK	100	1.9	-18.1	>10	1)
2	2417	-	-	PEAK	100	2.2	-17.8	>10	2)
6	2437	-	-	PEAK	100	2.7	-17.3	>10	1)
6	2437	-	-	PEAK	100	2.4	-17.6	>10	2)
10	2457	-	-	PEAK	100	1.8	-18.2	>10	1)
10	2457	-	-	PEAK	100	2.4	-17.6	>10	2)
11	2462	-	-	PEAK	100	2.2	-17.8	>10	1)
11	2462	-	-	PEAK	100	0.6	-19.4	>10	2)

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

Channel No	Channel Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBm]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	Restricted bands limit [dBμV/m]	Margin to Limit [dB]	
1	2412	-	-	-	PEAK	1000	74.0	>10	1)
1	2412	-	-	-	RMS	1000	54.0	>10	1)
1	2412	-	-	-	PEAK	1000	74.0	>10	2)
1	2412	-	-	-	RMS	1000	54.0	>10	2)
2	2417	4832	-53.4	41.8	PEAK	1000	74.0	32.2	1)
2	2417	4832	-64.7	30.5	RMS	1000	54.0	23.5	1)
2	2417	4832	-52.9	42.3	PEAK	1000	74.0	31.7	2)
2	2417	4832	-64.4	30.8	RMS	1000	54.0	23.2	2)
6	2437	4872	-52.3	42.9	PEAK	1000	74.0	31.1	1)
6	2437	4874	-64.1	31.1	RMS	1000	54.0	22.9	1)
6	2437	4876	-53.1	42.1	PEAK	1000	74.0	31.9	2)
6	2437	4876	-64.1	31.1	RMS	1000	54.0	22.9	2)
10	2457	4914	-53.5	41.7	PEAK	1000	74.0	32.3	1)
10	2457	4915	-64.7	30.5	RMS	1000	54.0	23.5	1)
10	2457	4908	-53.1	42.1	PEAK	1000	74.0	31.9	2)
10	2457	4917	-64.6	30.6	RMS	1000	54.0	23.4	2)
11	2462	-	-	-	PEAK	1000	74.0	>10	1)
11	2462	-	-	-	RMS	1000	54.0	>10	1)
11	2462	-	-	-	PEAK	1000	74.0	>10	2)
11	2462	-	-	-	RMS	1000	54.0	>10	2)

WLAN n-Mode; 20 MHz; MCS0

Channel No	Channel Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Ref. Level [dBm]	30 dBc Limit [dBm]	Margin to Limit [dB]	
1	2412	-	-	PEAK	100	0.6	-19.4	>10	1)
1	2412	-	-	PEAK	100	0.4	-19.6	>10	2)
2	2417	-	-	PEAK	100	1.9	-18.1	>10	1)
2	2417	-	-	PEAK	100	2.1	-17.9	>10	2)
6	2437	-	-	PEAK	100	2.6	-17.4	>10	1)
6	2437	-	-	PEAK	100	2.2	-17.8	>10	2)
10	2457	-	-	PEAK	100	2.3	-17.7	>10	1)
10	2457	-	-	PEAK	100	2.1	-17.9	>10	2)
11	2462	-	-	PEAK	100	0.6	-19.4	>10	1)
11	2462	-	-	PEAK	100	0.8	-19.2	>10	2)

Channel No	Channel Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBm]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	Restricted bands limit [dBμV/m]	Margin to Limit [dB]	
1	2412	-	-	-	PEAK	1000	74.0	>10	1)
1	2412	-	-	-	RMS	1000	54.0	>10	1)
1	2412	-	-	-	PEAK	1000	74.0	>10	2)
1	2412	-	-	-	RMS	1000	54.0	>10	2)
2	2417	4838	-53.7	41.5	PEAK	1000	74.0	32.5	1)
2	2417	4832	-64.8	30.4	RMS	1000	54.0	23.6	1)
2	2417	4835	-52.7	42.5	PEAK	1000	74.0	31.5	2)
2	2417	4835	-64.5	30.7	RMS	1000	54.0	23.3	2)
6	2437	4869	-52.4	42.8	PEAK	1000	74.0	31.2	1)
6	2437	4874	-64.2	31.0	RMS	1000	54.0	23.0	1)
6	2437	4871	-52.3	42.9	PEAK	1000	74.0	31.1	2)
6	2437	4872	-64.2	31.0	RMS	1000	54.0	23.0	2)
10	2457	4913	-52.9	42.3	PEAK	1000	74.0	31.7	1)
10	2457	4912	-64.8	30.4	RMS	1000	54.0	23.6	1)
10	2457	4912	-53.8	41.4	PEAK	1000	74.0	32.6	2)
10	2457	4912	-64.7	30.5	RMS	1000	54.0	23.5	2)
11	2462	-	-	-	PEAK	1000	74.0	>10	1)
11	2462	-	-	-	RMS	1000	54.0	>10	1)
11	2462	-	-	-	PEAK	1000	74.0	>10	2)
11	2462	-	-	-	RMS	1000	54.0	>10	2)

WLAN n-Mode; 20 MHz; MCS0; MIMO

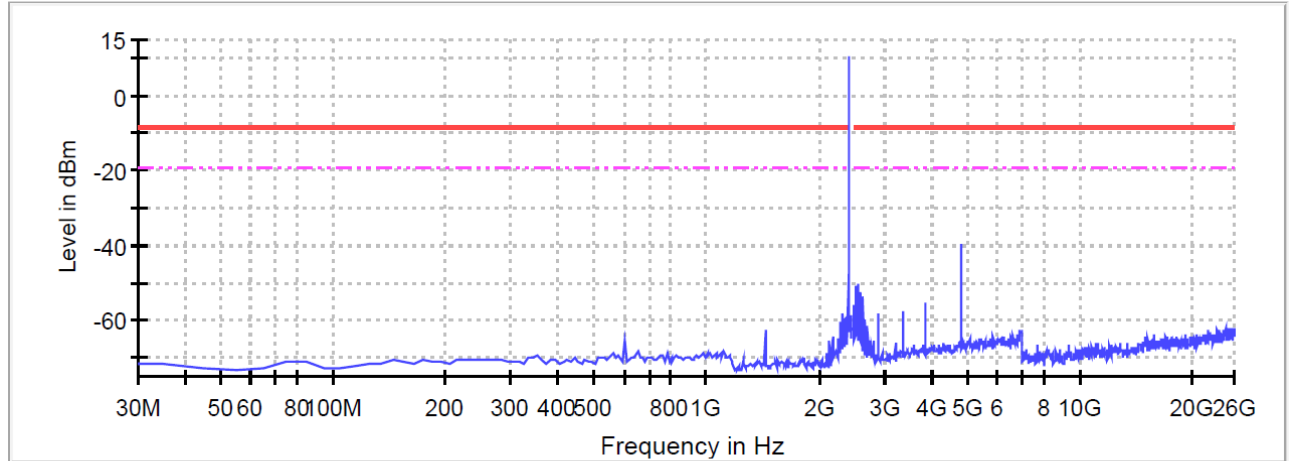
Channel No	Channel Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBm]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	30 dBc Limit [dBm]	Margin to Limit [dB]
1	2412	-	-	-	PEAK	1000	74.0	>10
1	2412	-	-	-	RMS	1000	54.0	>10
2	2417	4834	-50.2	45.0	PEAK	1000	74.0	29.0
2	2417	4834	-61.6	33.6	RMS	1000	54.0	20.4
6	2437	4874	-49.3	45.9	PEAK	1000	74.0	28.1
6	2437	4874	-61.2	34.0	RMS	1000	54.0	20.0
10	2457	4914	-50.3	44.9	PEAK	1000	74.0	29.1
10	2457	4914	-61.7	33.5	RMS	1000	54.0	20.5
11	2462	-	-	-	PEAK	1000	74.0	>10
11	2462	-	-	-	RMS	1000	54.0	>10

- 1) Result of Core 1
2) Result of Core 2

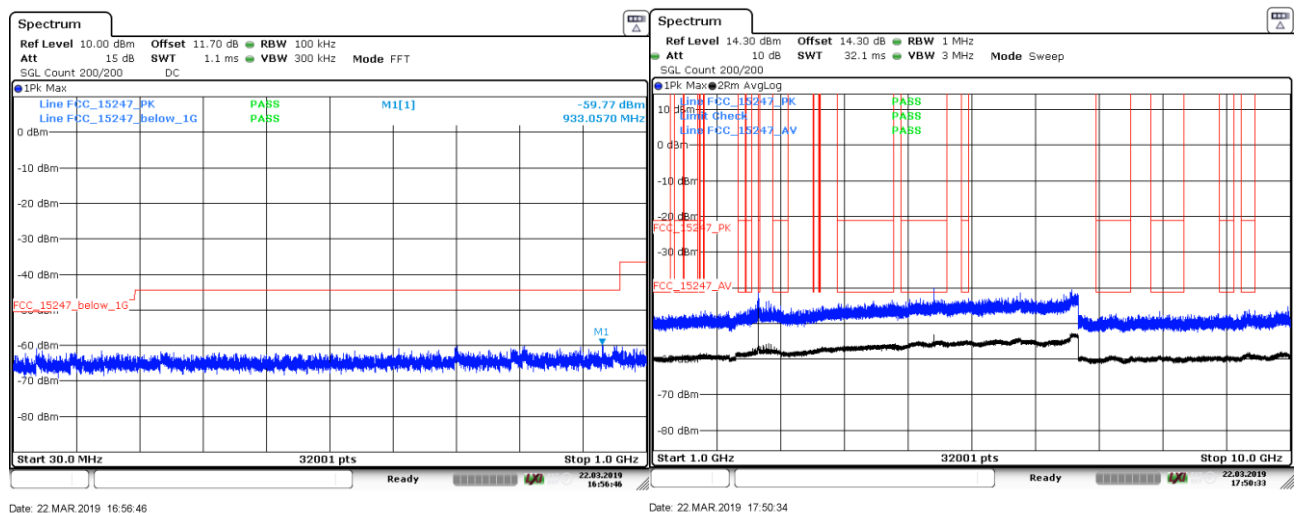
Remark: The MIMO values were calculated from the SISO values.

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

Radio Technology = BT GFSK (1-DH1), Operating Frequency = high
(S02_7_AC02)

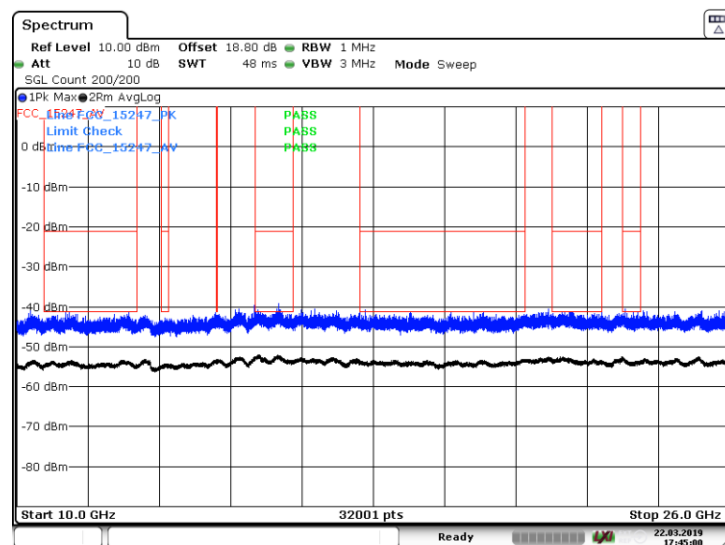


— Limit — Sum Level - - - Threshold × Critical × Final Critical



Date: 22 MAR 2019 16:56:46

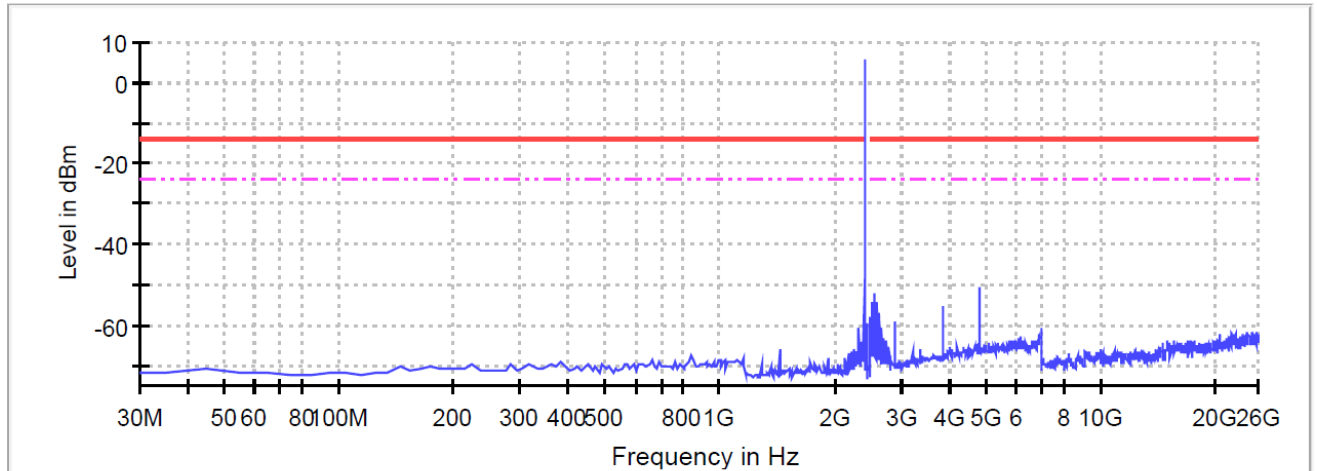
Date: 22 MAR 2019 17:50:34



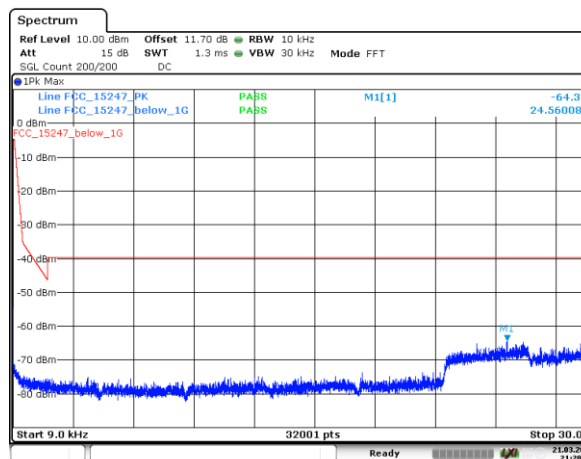
Date: 22 MAR 2019 17:45:00

Traces of restricted bands plots include 2 dBi antenna gain in offset

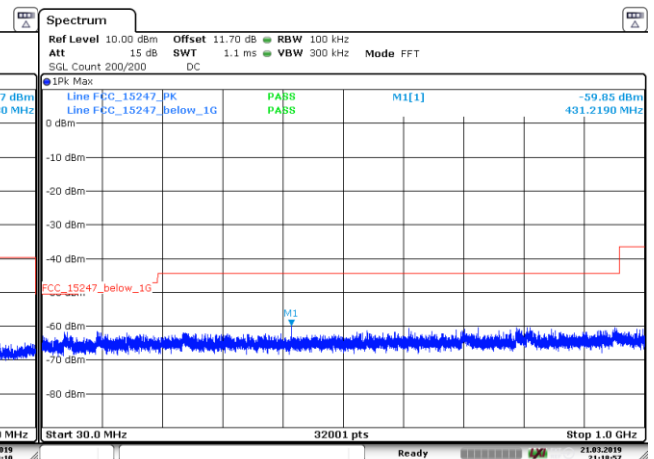
Radio Technology = Bluetooth LE, Operating Frequency = low
(S02_7_AC02)



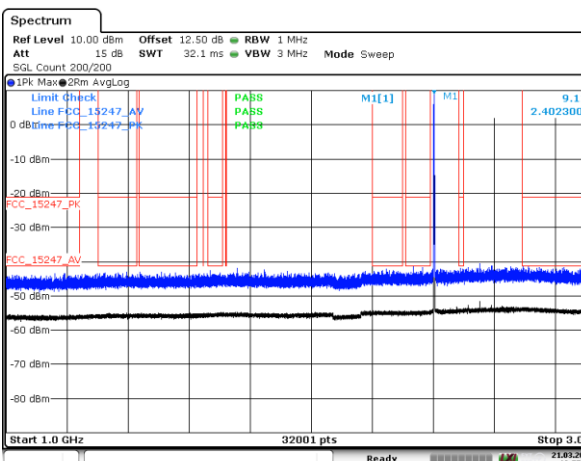
— Limit — Sum Level - - - Threshold × Critical × Final Critical



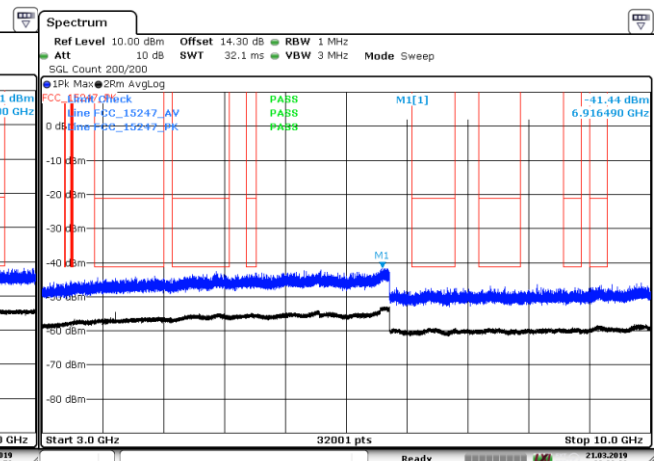
Date: 21.MAR.2019 21:20:10



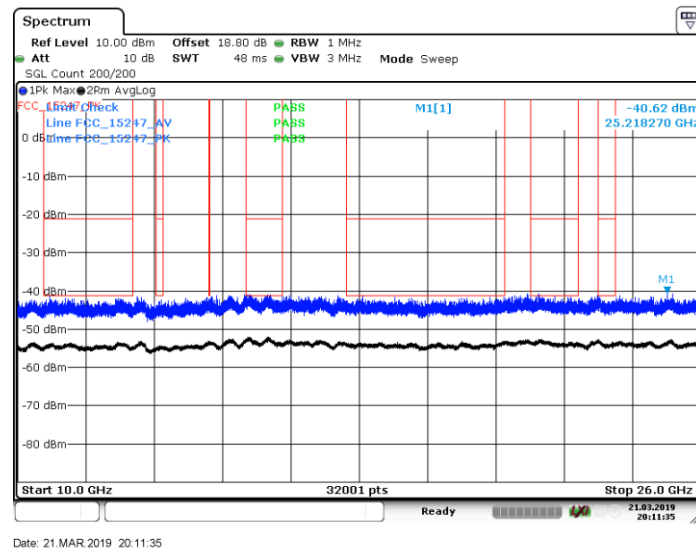
Date: 21.MAR.2019 21:18:57



Date: 21.MAR.2019 19:57:51

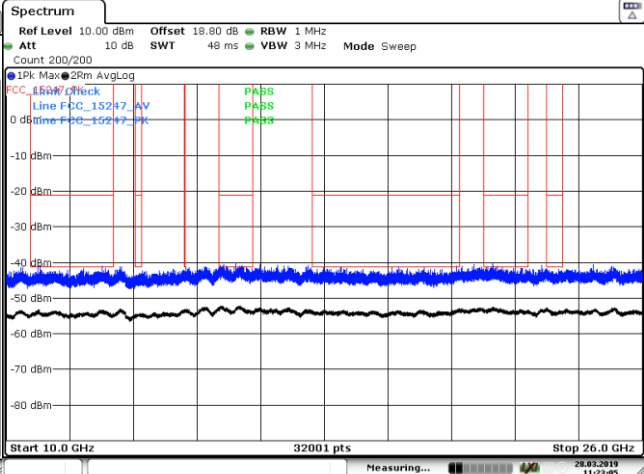
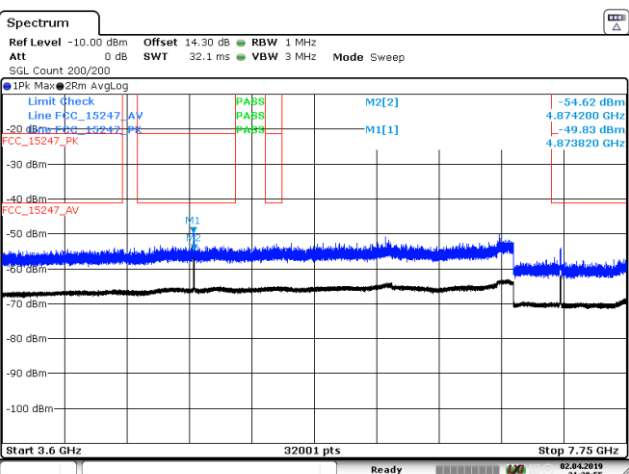
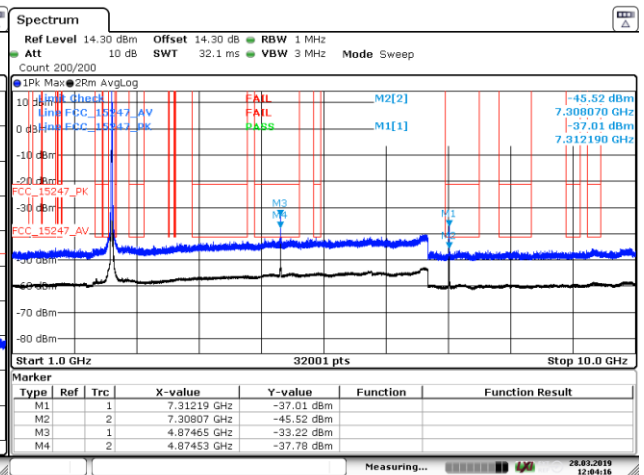
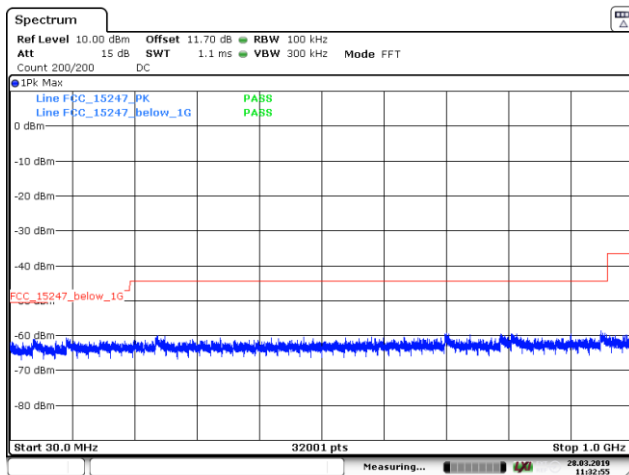
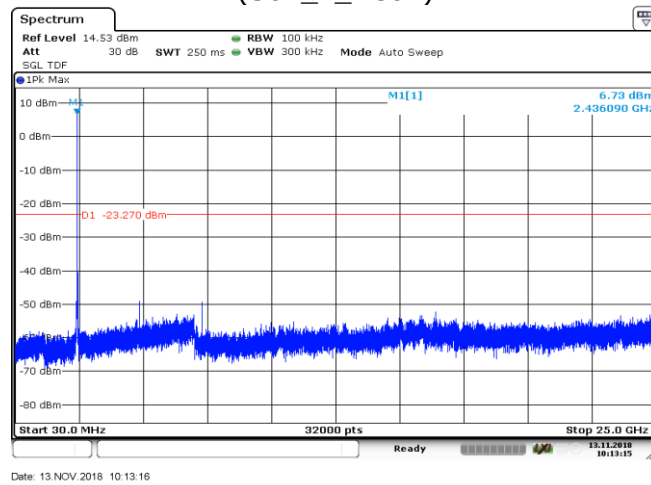


Date: 21.MAR.2019 20:09:20



Traces of restricted bands plots include 2 dBi antenna gain in offset

Radio Technology = WLAN b, Operating Frequency = mid, Core 2
(S02_7_AC02)



Traces of restricted bands plots include 2 dBi antenna gain in offset
The range 3.6 to 7.75 GHz was repeated using a High Pass filter to get more accurate results.

5.5.5 TEST EQUIPMENT USED

- R&S TS8997

5.6 TRANSMITTER SPURIOUS RADIATED EMISSIONS

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.6.1 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° .

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 $\pm 45^{\circ}$ 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

5.6.2 TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart C, §15.247 (d)

... In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

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

Frequency in MHz	Limit ($\mu\text{V}/\text{m}$)	Measurement distance (m)	Limits ($\text{dB}\mu\text{V}/\text{m}$)
0.009 – 0.49	$2400/F(\text{kHz})@300\text{m}$	3	$(48.5 - 13.8)@300\text{m}$
0.49 – 1.705	$24000/F(\text{kHz})@30\text{m}$	3	$(33.8 - 23.0)@30\text{m}$
1.705 – 30	$30@30\text{m}$	3	$29.5@30\text{m}$

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

Frequency in MHz	Limit ($\mu\text{V}/\text{m}$)	Measurement distance (m)	Limits ($\text{dB}\mu\text{V}/\text{m}$)
30 – 88	$100@3\text{m}$	3	$40.0@3\text{m}$
88 – 216	$150@3\text{m}$	3	$43.5@3\text{m}$
216 – 960	$200@3\text{m}$	3	$46.0@3\text{m}$
960 – 26000	$500@3\text{m}$	3	$54.0@3\text{m}$
26000 – 40000	$500@3\text{m}$	1	$54.0@3\text{m}$

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: $\text{Limit} (\text{dB}\mu\text{V}/\text{m}) = 20 \log (\text{Limit} (\mu\text{V}/\text{m})/1\mu\text{V}/\text{m})$

5.6.3 TEST PROTOCOL

Ambient temperature: 25 °C
 Air Pressure: 1026 hPa
 Humidity: 38 %
 BT GFSK (1-DH1)
 Applied duty cycle correction (AV): 0 dB

Ch. No.	Ch. Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	Limit [dBμV/m]	Margin to Limit [dB]	Limit Type
0	2402	-	-	- - -	-	-	>20	RB
39	2441	-	-	- - -	-	-	>20	RB
78	2480	-	-	- - -	-	-	>20	RB

BT GFSK (2-DH1)
 Applied duty cycle correction (AV): 0 dB

Ch. No.	Ch. Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	Limit [dBμV/m]	Margin to Limit [dB]	Limit Type
0	2402	-	-	- - -	-	-	>20	RB
39	2441	-	-	- - -	-	-	>20	RB
78	2480	-	-	- - -	-	-	>20	RB

WLAN b-Mode; 20 MHz; 1 Mbit/s
 Applied duty cycle correction (AV): 0 dB

Ch. No.	Ch. Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	Limit [dBμV/m]	Margin to Limit [dB]	Limit Type
0	2402	-	-	- - -	-	-	>20	RB
39	2441	-	-	- - -	-	-	>20	RB
78	2480	-	-	- - -	-	-	>20	RB

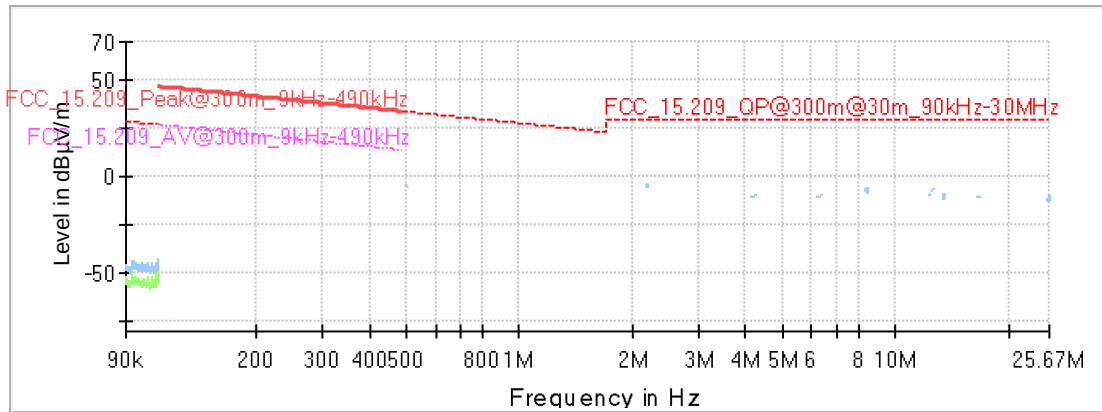
WLAN g-Mode; 20 MHz; 6 Mbit/s
 Applied duty cycle correction (AV): 0 dB

Ch. No.	Ch. Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	Limit [dBμV/m]	Margin to Limit [dB]	Limit Type
0	2402	-	-	- - -	-	-	>20	RB
39	2441	-	-	- - -	-	-	>20	RB
78	2480	-	-	- - -	-	-	>20	RB

Remark: Tests were performed with 50 Ohm termination at antenna port (enclosure emissions only). For emissions in restricted bands at the antenna port see test case "5.5 SPURIOUS RF CONDUCTED EMISSIONS AND CONDUCTED EMISSIONS IN RESTRICTED BANDS"

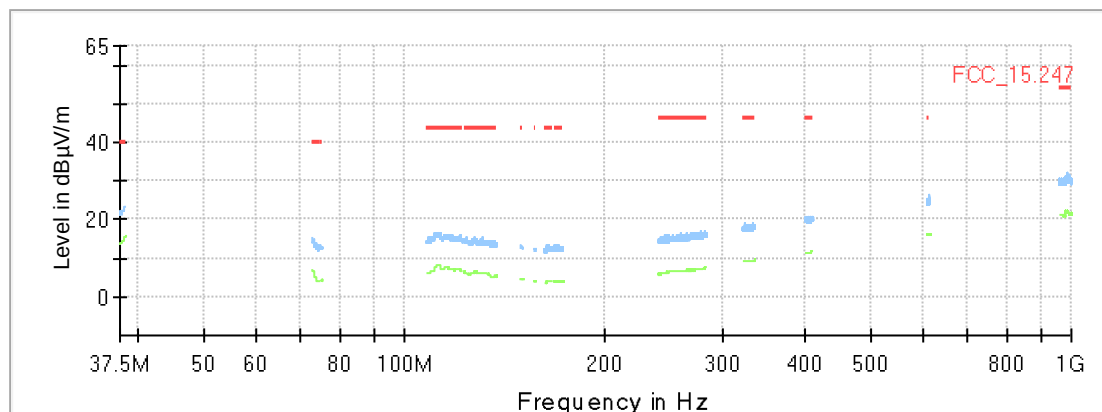
5.6.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

Radio Technology = WLAN b, Operating Frequency = mid, Core 1
(S02_7_AC02)



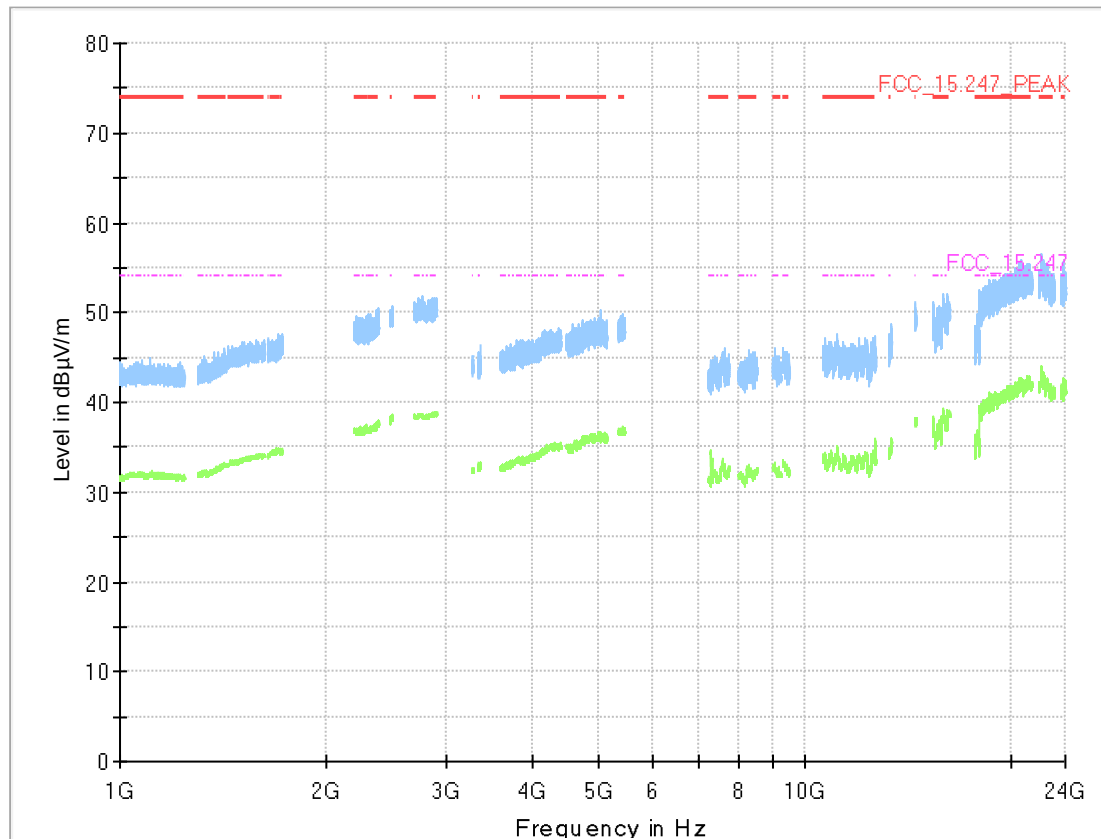
Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	QuasiPeak (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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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)
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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)
---	---	---	---	---	---	---	---	---	---	---

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)
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5.6.5 TEST EQUIPMENT USED

- Radiated Emissions

5.7 BAND EDGE COMPLIANCE CONDUCTED AND BAND EDGE AT RESTRICTED BANDS CONDUCTED

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.7.1 TEST DESCRIPTION

For the conducted measurement, the Equipment Under Test (EUT) is placed in a shielded room. The reference power was measured in the test case "Spurious RF Conducted Emissions". The EUT was connected to the spectrum analyzer via a short coax cable with a known loss.

Analyzer settings conducted band edge (20/30 dBc):

- Start / Stop Frequency:
See plots
- Detector: Peak
- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Sweptime: coupled
- Sweeps: till stable
- Trace: Maxhold

Analyzer settings band edge in restricted bands:
See worst case plots.

5.7.2 TEST REQUIREMENTS / LIMITS

FCC Part 15.247 (d)

"In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. ...

If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c))."

For the conducted measurement the RF power at the band edge shall be "at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power..."

5.7.3 TEST PROTOCOL

Ambient temperature: 25 °C
 Air Pressure: 1010 hPa
 Humidity: 40 %
 BT GFSK (1-DH1)

Channel No.	Channel Center Frequency [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Ref. Level [dBm]	Limit [dBm]	Margin to Limit [dB]
0	2402	2400.0	-45.3	PEAK	100	11.6	-8.4	36.9
78	2480	2483.5	-44.8	PEAK	100	11.9	-8.1	36.7

Channel No	Channel Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBm]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	Limit [dBm]	Margin to Limit [dB]
78	2480	2483.5	-43.2	52.0	PEAK	1000	74.0	22.0
78	2480	2483.5	-54.7	40.5	RMS	1000	54.0	13.5

BT n/4 DQPSK (2-DH1)

Channel No.	Channel Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Ref. Level [dBm]	Limit [dBm]	Margin to Limit [dB]
0	2402	2400.0	-44.9	PEAK	100	6.7	-13.3	31.6
78	2480	2483.5	-45.6	PEAK	100	7.7	-12.3	33.3

Channel No	Channel Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBm]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	Ref. Level [dBm]	Margin to Limit [dB]
78	2480	2483.5	-44.5	50.7	PEAK	1000	74.0	23.3
78	2480	2483.5	-56.0	39.2	RMS	1000	54.0	14.8

BT 8-DPSK (3-DH1)

Channel No.	Channel Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Ref. Level [dBm]	Limit [dBm]	Margin to Limit [dB]
0	2402	2400.0	-45.0	PEAK	100	6.8	-13.2	31.8
78	2480	2483.5	-45.0	PEAK	100	7.8	-12.2	32.8

Channel No	Channel Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBm]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	Ref. Level [dBm]	Margin to Limit [dB]
78	2480	2483.5	-43.4	51.8	PEAK	1000	74.0	22.2
78	2480	2483.5	-55.9	39.3	RMS	1000	54.0	14.7

BT LE GFSK

Channel No.	Channel Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Ref. Level [dBm]	Limit [dBm]	Margin to Limit [dB]
0	2402	2400.0	-49.0	PEAK	100	6.2	-13.8	35.2
39	2480	2483.5	-54.1	PEAK	100	6.9	-13.1	41.0

Channel No	Channel Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBm]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	Ref. Level [dBm]	Margin to Limit [dB]
78	2480	2483.5	-51.6	43.6	PEAK	1000	74.0	30.4
78	2480	2483.5	-62.8	32.4	RMS	1000	54.0	21.6

WLAN b-Mode; 20 MHz; 1 Mbit/s

Channel No.	Channel Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Ref. Level [dBm]	Limit [dBm]	Margin to Limit [dB]	
1	2412	2400.0	-36.1	PEAK	100	9.1	-20.9	15.2	1)
1	2412	2400.0	-36.0	PEAK	100	8.7	-22.3	13.7	2)
11	2462	2483.5	-45.1	PEAK	100	8.6	-21.4	23.7	1)
11	2462	2483.5	-45.0	PEAK	100	9.5	-20.5	24.5	2)

Channel No	Channel Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBm]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	Ref. Level [dBm]	Margin to Limit [dB]	
11	2462	2483.5	-37.8	57.4	PEAK	1000	74.0	16.6	1)
11	2462	2483.5	-47.8	47.4	RMS	1000	54.0	6.6	1)
11	2462	2483.5	-36.9	58.3	PEAK	1000	74.0	15.7	2)
11	2462	2483.5	-45.5	49.7	RMS	1000	54.0	4.3	2)

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

Channel No.	Channel Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Ref. Level [dBm]	Limit [dBm]	Margin to Limit [dB]	
1	2412	2400.0	-33.1	PEAK	100	0.8	-29.2	3.9	1)
1	2412	2400.0	-32.4	PEAK	100	0.6	-29.4	3.0	2)
2	2417	2400.0	-38.8	PEAK	100	1.9	-28.1	10.7	1)
2	2417	2400.0	-37.7	PEAK	100	2.2	-27.8	9.9	2)
10	2457	2483.5	-46.0	PEAK	100	1.8	-28.2	17.8	1)
10	2457	2483.5	-45.0	PEAK	100	2.4	-27.6	17.4	2)
11	2462	2483.5	-43.4	PEAK	100	2.2	-27.8	15.6	1)
11	2462	2483.5	-44.8	PEAK	100	0.6	-29.4	15.4	2)

Channel No	Channel Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBm]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	Ref. Level [dBm]	Margin to Limit [dB]	
10	2457	2483.5	-35.6	59.6	PEAK	1000	74.0	14.4	1)
10	2457	2483.5	-47.5	47.7	RMS	1000	54.0	6.3	1)
10	2457	2483.5	-34.2	61.0	PEAK	1000	74.0	13.0	2)
10	2457	2483.5	-46.4	48.8	RMS	1000	54.0	5.2	2)
11	2462	2483.5	-33.8	61.4	PEAK	1000	74.0	12.6	1)
11	2462	2483.5	-46.6	48.6	RMS	1000	54.0	5.4	1)
11	2462	2483.5	-32.7	62.5	PEAK	1000	74.0	11.5	2)
11	2462	2483.5	-46.2	49.0	RMS	1000	54.0	5.0	2)

WLAN n-Mode; 20 MHz; MCS0

Channel No.	Channel Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Ref. Level [dBm]	Limit [dBm]	Margin to Limit [dB]	
1	2412	2400.0	-33.1	PEAK	100	0.6	-29.4	3.7	1)
1	2412	2400.0	-34.2	PEAK	100	0.4	-29.6	4.7	2)
2	2417	2400.0	-36.6	PEAK	100	1.9	-28.1	8.5	1)
2	2417	2400.0	-37.3	PEAK	100	2.1	-27.9	9.4	2)
10	2457	2483.5	-44.8	PEAK	100	2.3	-27.7	17.1	1)
10	2457	2483.5	-44.5	PEAK	100	2.1	-27.9	16.6	2)
11	2462	2483.5	-44.5	PEAK	100	0.6	-29.4	15.1	1)
11	2462	2483.5	-44.8	PEAK	100	0.8	-29.2	15.7	2)

Channel No	Channel Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBm]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	Ref. Level [dBm]	Margin to Limit [dB]	
10	2457	2483.5	-34.6	60.6	PEAK	1000	74.0	13.4	1)
10	2457	2483.5	-46.9	48.3	RMS	1000	54.0	5.7	1)
10	2457	2483.5	-33.4	61.8	PEAK	1000	74.0	12.2	2)
10	2457	2483.5	-46.5	48.7	RMS	1000	54.0	5.3	2)
11	2462	2483.5	-33.2	62.0	PEAK	1000	74.0	12.0	1)
11	2462	2483.5	-46.0	49.2	RMS	1000	54.0	4.8	1)
11	2462	2483.5	-32.3	62.9	PEAK	1000	74.0	11.1	2)
11	2462	2483.5	-45.1	50.1	RMS	1000	54.0	3.9	2)

WLAN n-Mode; 20 MHz; MCS0; MIMO

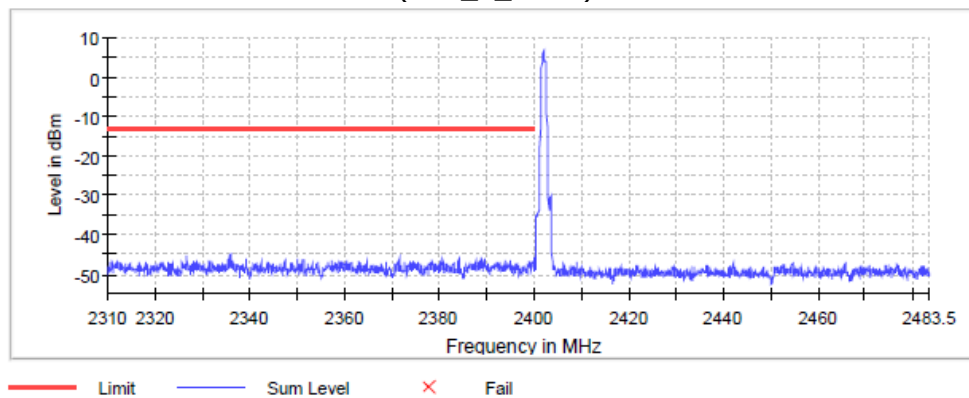
Channel No	Channel Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBm]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	Ref. Level [dBm]	Margin to Limit [dB]
10	2457	2483.5	-30.9	64.3	PEAK	1000	74.0	9.7
10	2457	2483.5	-43.7	51.5	RMS	1000	54.0	2.5
11	2462	2483.5	-29.7	65.5	PEAK	1000	74.0	8.5
11	2462	2483.5	-42.5	52.7	RMS	1000	54.0	1.3

- 1) Result of Core 1
- 2) Result of Core 2

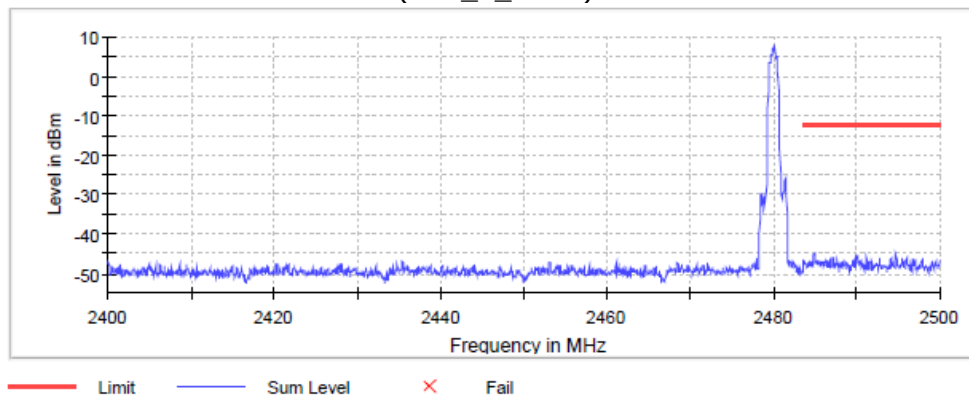
Remark: Please see next sub-clause for the measurement plot.

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

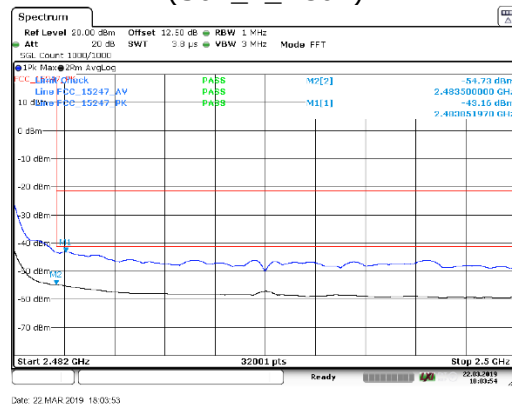
Radio Technology = BT GFSK (2-DH1), Operating Frequency = low (S02_7_AC02)



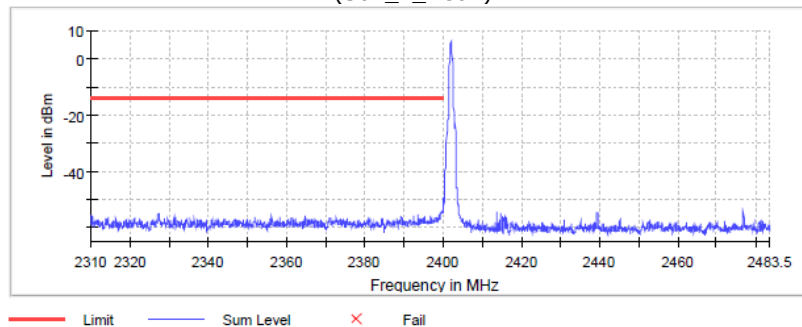
Radio Technology = BT GFSK (3-DH1), Operating Frequency = high (S02_7_AC02)



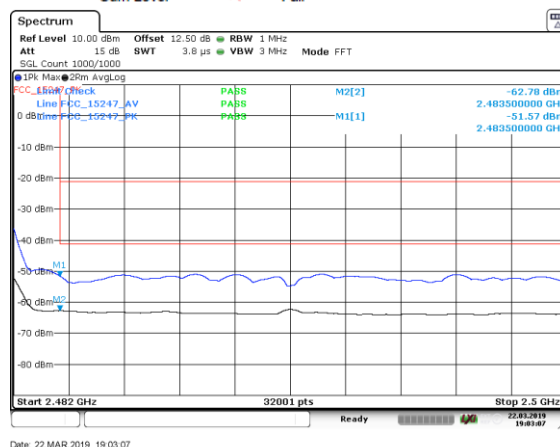
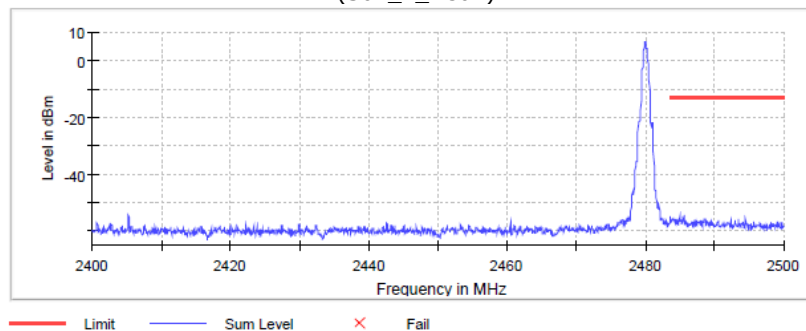
Radio Technology = BT GFSK (1-DH1), Operating Frequency = high
(S02_7_AC02)



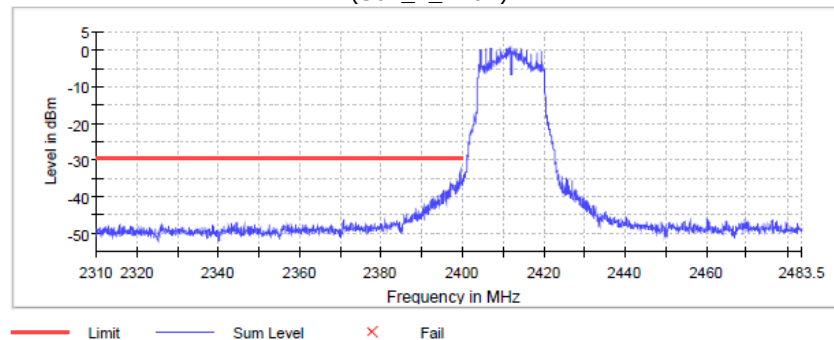
Radio Technology = Bluetooth LE, Operating Frequency = low
(S02_7_AC02)



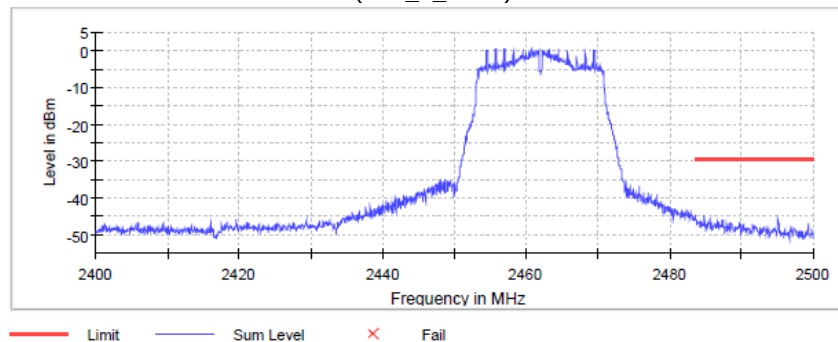
Radio Technology = Bluetooth LE, Operating Frequency = high
(S02_7_AC02)



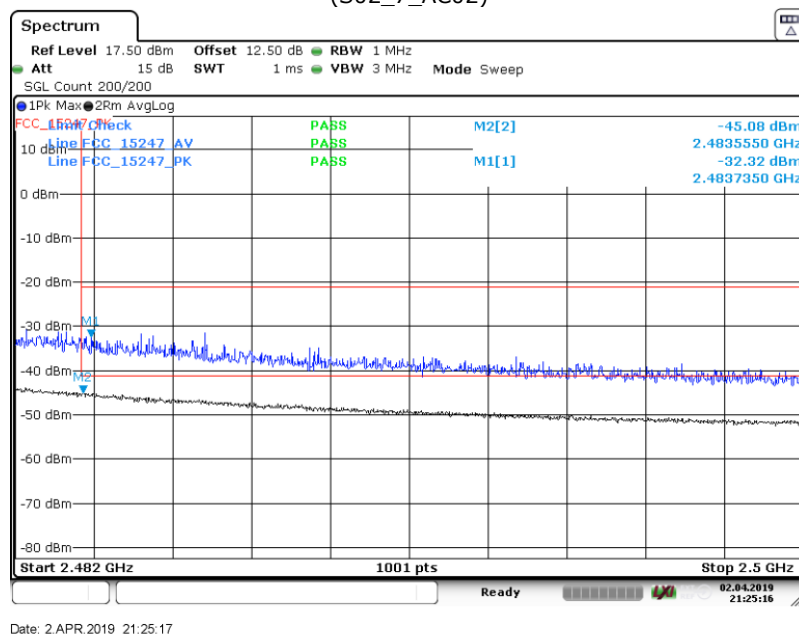
Radio Technology = WLAN g, Operating Frequency = low, Core 2
(S02_7_AA01)



Radio Technology = WLAN n, Operating Frequency = high, Core 1
(S02_7_AA01)



Radio Technology = WLAN n, Operating Frequency = high, Core 2
(S02_7_AC02)



5.7.5 TEST EQUIPMENT USED

- R&S TS8997

5.8 BAND EDGE COMPLIANCE RADIATED

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.8.1 TEST DESCRIPTION

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

5.8.2 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: $\text{Limit (dB}\mu\text{V/m)} = 20 \log (\text{Limit } (\mu\text{V/m})/1\mu\text{V/m})$

5.8.3 TEST PROTOCOL

Ambient temperature: 26 °C
 Air Pressure: 1010 hPa
 Humidity: 30 %
 BT GFSK (1-DH1)
 Applied duty cycle correction (AV): 0 dB

Ch. No.	Ch. Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	Limit [dBμV/m]	Margin to Limit [dB]	Limit Type
78	2480	2483.5	48.4	PEAK	1000	74.0	25.6	BE
78	2480	2483.5	35.6	AV	1000	54.0	18.4	BE

BT π/4 DQPSK (2-DH1)
 Applied duty cycle correction (AV): 0 dB

Ch. No.	Ch. Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	Limit [dBμV/m]	Margin to Limit [dB]	Limit Type
78	2480	2483.5	49.1	PEAK	1000	74.0	24.9	BE
78	2480	2483.5	35.6	AV	1000	54.0	18.4	BE

BT 8-DPSK (3-DH1)
 Applied duty cycle correction (AV): 0 dB

Ch. No.	Ch. Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	Limit [dBμV/m]	Margin to Limit [dB]	Limit Type
78	2480	2483.5	48.4	PEAK	1000	74.0	25.6	BE
78	2480	2483.5	35.5	AV	1000	54.0	18.5	BE

WLAN b-Mode; 20 MHz; 1 Mbit/s
 Applied duty cycle correction (AV): 0 dB

Ch. No.	Ch. Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	Limit [dBμV/m]	Margin to Limit [dB]	Limit Type	
11	2462	2483.5	50.1	PEAK	1000	74.0	23.9	BE	1)
11	2462	2483.5	32.9	AV	1000	54.0	21.1	BE	1)
11	2462	2483.5	50.7	PEAK	1000	74.0	23.3	BE	2)
11	2462	2483.5	35.6	AV	1000	54.0	18.4	BE	2)

WLAN g-Mode; 20 MHz; 6 Mbit/s
 Applied duty cycle correction (AV): 0 dB

Ch. No.	Ch. Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	Limit [dBμV/m]	Margin to Limit [dB]	Limit Type	
11	2462	2483.5	50.0	PEAK	1000	74.0	24.0	BE	1)
11	2462	2483.5	35.5	AV	1000	54.0	18.5	BE	1)
11	2462	2483.5	50.3	PEAK	1000	74.0	23.7	BE	2)
11	2462	2483.5	35.6	AV	1000	54.0	18.4	BE	2)

WLAN n-Mode; 20 MHz; MCS0
 Applied duty cycle correction (AV): 0 dB

Ch. No.	Ch. Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	Limit [dBμV/m]	Margin to Limit [dB]	Limit Type	
11	2462	2483.5	48.2	PEAK	1000	74.0	25.8	BE	1)
11	2462	2483.5	35.5	AV	1000	54.0	18.5	BE	1)
11	2462	2483.5	49.4	PEAK	1000	74.0	24.6	BE	2)
11	2462	2483.5	35.6	AV	1000	54.0	18.4	BE	2)

WLAN n-Mode; 20 MHz; MCS0; MIMO
Applied duty cycle correction (AV): 0 dB

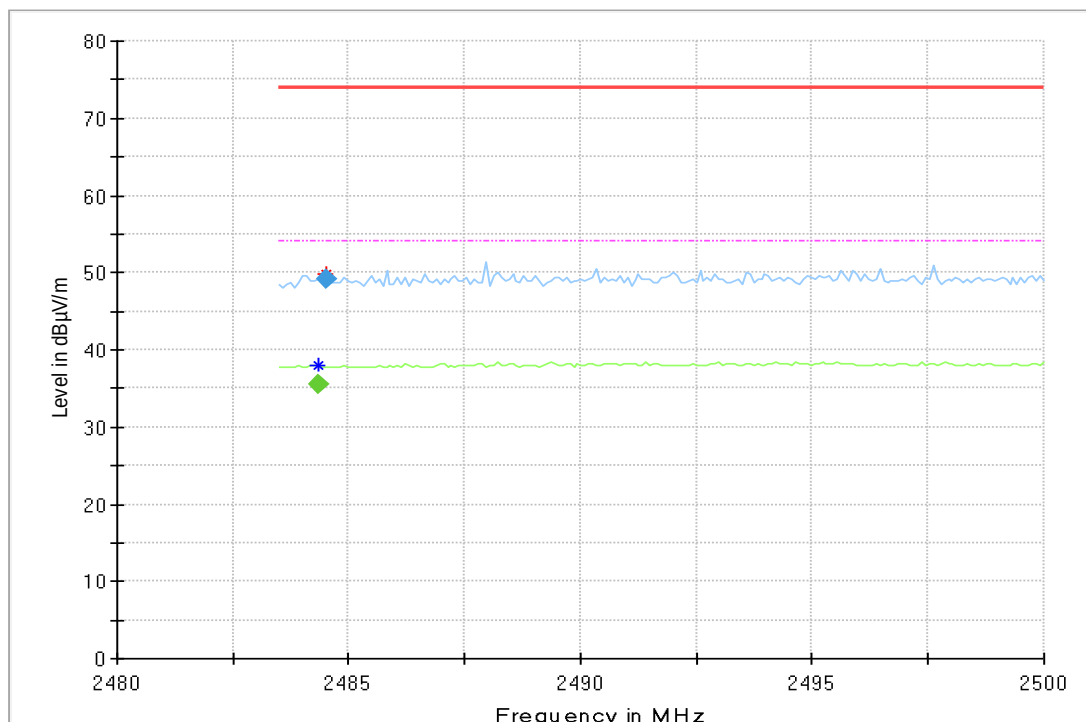
Ch. No.	Ch. Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBμV/m]	Detector	RBW [kHz]	Limit [dBμV/m]	Margin to Limit [dB]	Limit Type
11	2462	2483.5	51.9	PEAK	1000	74.0	22.1	BE
11	2462	2483.5	38.6	AV	1000	54.0	15.4	BE

- 1) Result of Core 1
- 2) Result of Core 2

Remark: The MIMO value was calculated from the SISO values.
Measurements were performed with 50 Ohm termination at the antenna connectors.

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

Radio Technology = BT GFSK (2-DH1), Operating Frequency = high
(S01_7_AA01)



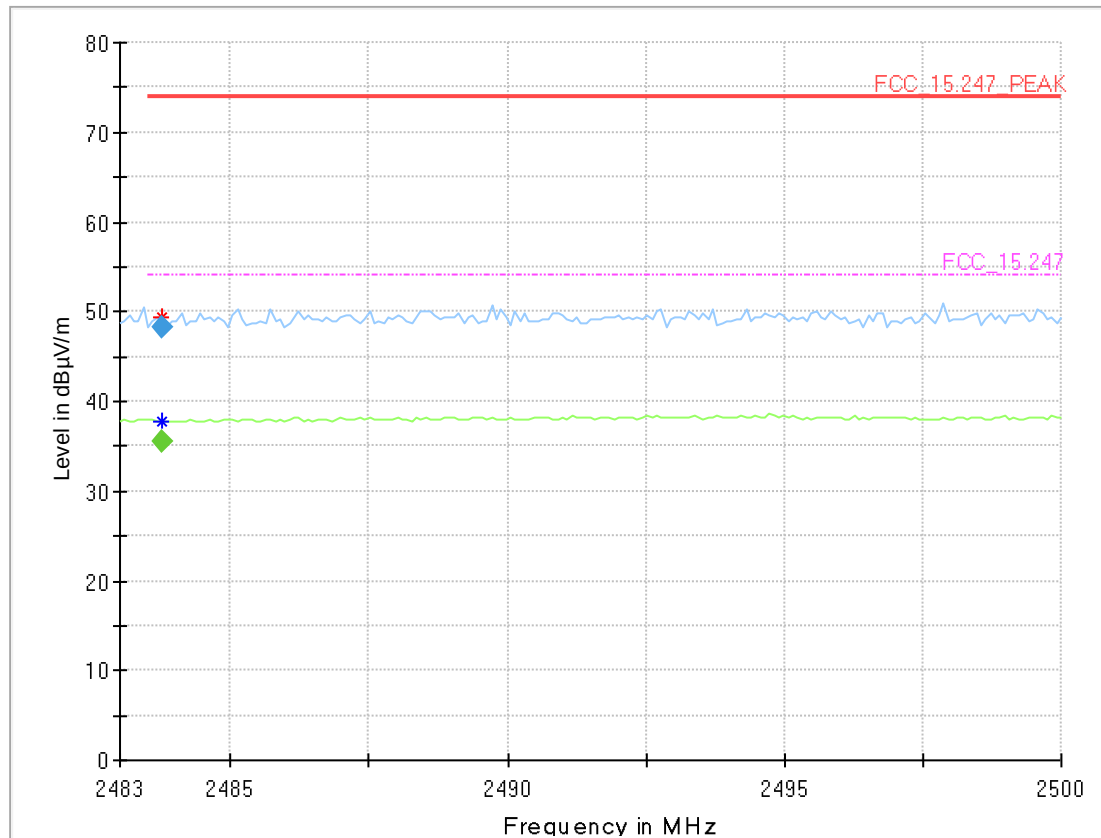
Critical_Freqs

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)
2484.325	---	38.0	54.00	16.00	---	---	150.0	H	-175.0	15.0
2484.490	49.9	---	74.00	24.06	---	---	150.0	H	11.0	15.0

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)
2484.325	---	35.6	54.00	18.43	1000.0	1000.000	150.0	H	-175.0	15.0
2484.490	49.1	---	74.00	24.85	1000.0	1000.000	150.0	H	11.0	15.0

Radio Technology = WLAN n, Operating Frequency = high, Core 2
(S01_7_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)
2483.765	49.4	---	74.00	24.57	---	---	150.0	H	-118.0	105.0
2483.765	---	37.8	54.00	16.23	---	---	150.0	H	101.0	105.0

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)
2483.765	---	35.6	54.00	18.37	1000.0	1000.000	150.0	H	101.0	105.0
2483.765	48.3	---	74.00	25.73	1000.0	1000.000	150.0	H	-118.0	105.0

5.8.5 TEST EQUIPMENT USED

- Radiated Emissions

5.9 POWER DENSITY

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.9.1 TEST DESCRIPTION

The Equipment Under Test (EUT) was set up in a shielded room to perform the Power Density measurements.

The results recorded were measured with the modulation which produces the worst-case (highest) power density.

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

Analyzer settings:

- Resolution Bandwidth (RBW): 10 kHz (BT/BT LE), 100 kHz (WLAN)
- Video Bandwidth (VBW): 30 kHz (BT/BT LE), 300 kHz (WLAN)
- Trace: Maxhold
- Sweeps: till stable
- Detector: Peak (BT/BT LE), RMS (WLAN)

See worst case plots for further details.

5.9.2 TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart C, §15.247 (e)

For digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

...

The same method of determining the conducted output power shall be used to determine the power spectral density.

FCC Part 15, Subpart C, §15.247 (f)

(f) For the purposes of this section, hybrid systems are those that employ a combination of both frequency hopping and digital modulation techniques.

...

The power spectral density conducted from the intentional radiator to the antenna due to the digital modulation operation of the hybrid system, with the frequency hopping operation turned off, shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission

5.9.3 TEST PROTOCOL

Ambient temperature: 25 °C
Air Pressure: 1010 hPa
Humidity: 40 %

BT GFSK (1-DH1)

Band	Channel No.	Frequency [MHz]	Power Density [dBm/10kHz]	Limit [dBm/3kHz]	Margin to Limit [dB]
2.4 GHz	0	2402	6.1	8.0	1.9
ISM	39	2441	6.8	8.0	1.2
	78	2480	6.8	8.0	1.2

BT π/4 QPSK (2-DH1)

Band	Channel No.	Frequency [MHz]	Power Density [dBm/10kHz]	Limit [dBm/3kHz]	Margin to Limit [dB]
2.4 GHz	0	2402	0.1	8.0	7.9
ISM	39	2441	1.0	8.0	7.0
	78	2480	1.1	8.0	6.9

BT 8-DPSK (3-DH1)

Band	Channel No.	Frequency [MHz]	Power Density [dBm/10kHz]	Limit [dBm/3kHz]	Margin to Limit [dB]
2.4 GHz	0	2402	-0.3	8.0	8.3
ISM	39	2441	1.0	8.0	7.0
	78	2480	1.1	8.0	6.9

BT LE

Band	Channel No.	Frequency [MHz]	Power Density [dBm/10kHz]	Limit [dBm/3kHz]	Margin to Limit [dB]
2.4 GHz	0	2402	7.3	8.0	0.7
ISM	19	2440	6.8	8.0	1.2
	39	2480	7.1	8.0	0.9

WLAN b-Mode; 20 MHz; 1 Mbit/s

Band	Channel No.	Frequency [MHz]	Power Density Core 1 [dBm/100kHz]	Power Density Core 2 [dBm/100kHz]	Limit [dBm/3kHz]	Margin to Limit [dB]
2.4 GHz	1	2412	1.1	0.3	8.0	6.9
ISM	6	2437	0.8	0.8	8.0	7.2
	11	2462	0.7	1.1	8.0	6.9

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

Band	Channel No.	Frequency [MHz]	Power Density Core 1 [dBm/100kHz]	Power Density Core 2 [dBm/100kHz]	Limit [dBm/3kHz]	Margin to Limit [dB]
2.4 GHz	1	2412	-5.2	-5.3	8.0	13.2
ISM	6	2437	-3.6	-3.7	8.0	11.6
	11	2462	-3.6	-5.0	8.0	11.6

WLAN n-Mode; 20 MHz; MCS0

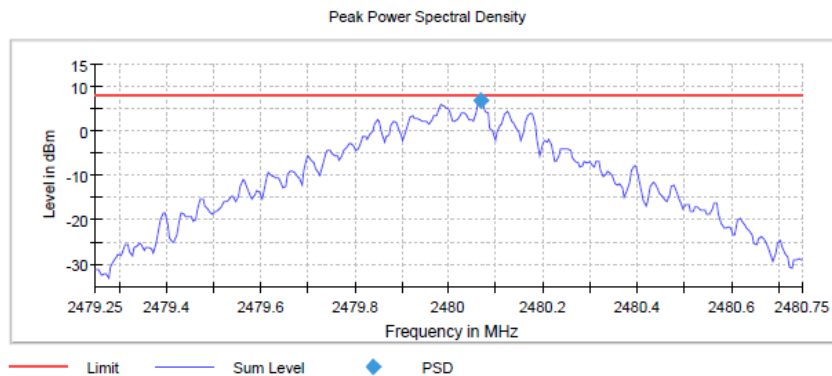
Band	Channel No.	Frequency [MHz]	Power Density Core 1 [dBm/100kHz]	Power Density Core 2 [dBm/100kHz]	Limit [dBm/3kHz]	Margin to Limit [dB]
2.4 GHz	1	2412	-5.4	-5.9	8.0	13.4
ISM	6	2437	-3.3	-4.1	8.0	11.3
	11	2462	-5.5	-5.4	8.0	13.4

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

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

Radio Technology = BT GFSK (1-DH1), Operating Frequency = high
(S02_7_AC02)

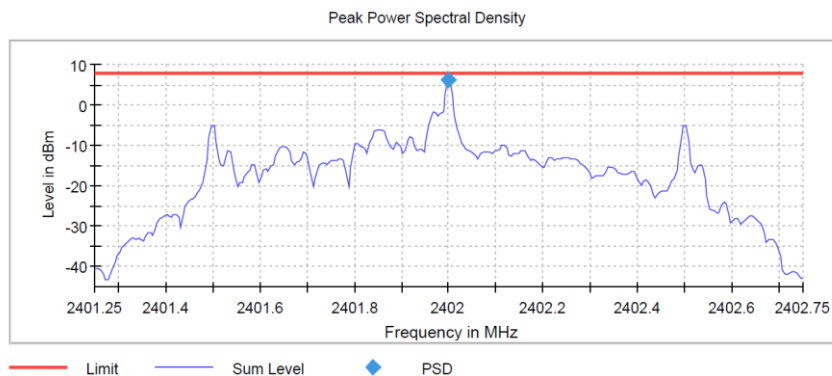
DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
2480.000000	2480.067500	6.785	8.0	PASS



Setting	Instrument Value
Start Frequency	2.47925 GHz
Stop Frequency	2.48075 GHz
Span	1.500 MHz
RBW	10.000 kHz
VBW	30.000 kHz
SweepPoints	300
Sweeptime	1.500 ms
Reference Level	0.000 dBm
Attenuation	20.000 dB
Detector	MaxPeak
SweepCount	100
Filter	3 dB
Trace Mode	Max Hold
SweepType	Sweep
Preamplifier	off
Stablemode	Trace
Stablevalue	0.50 dB
Run	7 / max. 150
Stable	2 / 2
Max Stable Difference	0.15 dB

Radio Technology = Bluetooth LE, Operating Frequency = low
(S02_7_AC02)

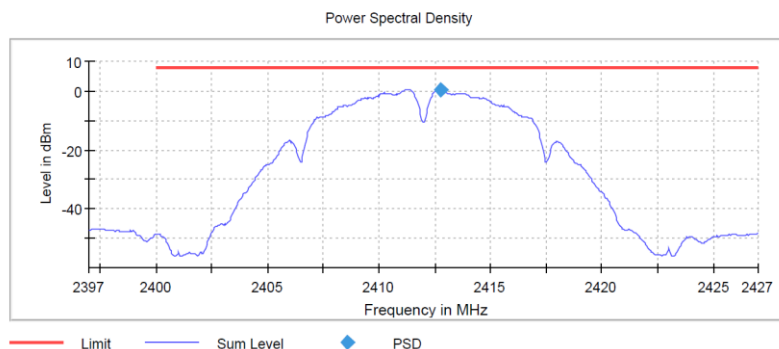
DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
2402.000000	2401.997500	6.299	8.0	PASS



Setting	Instrument Value
Start Frequency	2.40125 GHz
Stop Frequency	2.40275 GHz
Span	1.500 MHz
RBW	10.000 kHz
VBW	30.000 kHz
SweepPoints	300
Sweeptime	1.500 ms
Reference Level	-10.000 dBm
Attenuation	10.000 dB
Detector	MaxPeak
SweepCount	100
Filter	3 dB
Trace Mode	Max Hold
SweepType	Sweep
Preamplifier	off
Stablemode	Trace
Stablevalue	0.50 dB
Run	3 / max. 150
Stable	2 / 2
Max Stable Difference	0.02 dB

Radio Technology = WLAN b, Operating Frequency = low, Core 2
(S02_7_AA01)

DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
2412.000000	2412.775000	0.345	8.0	PASS



Setting	Instrument Value
Start Frequency	2.39700 GHz
Stop Frequency	2.42700 GHz
Span	30.000 MHz
RBW	100.000 kHz
VBW	300.000 kHz
SweepPoints	600
Sweeptime	3.000 s
Reference Level	0.000 dBm
Attenuation	20.000 dB
Detector	RMS
SweepCount	1
Filter	3 dB
Trace Mode	Max Hold
SweepType	Sweep
Preamplifier	off
Stablemode	Trace
Stablevalue	0.50 dB
Run	4 / max. 150
Stable	3 / 3
Max Stable Difference	0.37 dB

5.9.5 TEST EQUIPMENT USED

- R&S TS8997

6 TEST EQUIPMENT

- 1 Conducted Emissions FCC
Conducted Emissions power line for FCC standards

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
1.1	Opus10 TPR (8253.00)	ThermoAirpressure Datalogger 13 (Environ)	Lufft Mess- und Regeltechnik GmbH	13936	2017-04	2019-04
1.2	ESW44	EMI Test Receiver	Rohde & Schwarz GmbH & Co. KG	101603	2018-05	2019-05
1.3	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2018-04	2020-04
1.4	ESH3-Z5	Two-Line V-Network	Rohde & Schwarz	828304/029	2017-05	2019-05
1.5	EP 1200/B, NA/B1	Amplifier with integrated variable Oscillator	Spitzenberger & Spieß	B6278		
1.6	Chroma 6404	AC Power Source	Chroma ATE INC.	64040001304		
1.7	Shielded Room 02	Shielded Room for conducted testing, 12qm	Frankonia	-		
1.8	ESH3-Z5	Two-Line V-Network	Rohde & Schwarz	829996/002	2017-05	2019-05
1.9	ESR 7	EMI Receiver / Spectrum Analyzer	Rohde & Schwarz	101424	2016-11	2018-11
1.10	Opus10 THI (8152.00)	ThermoHygro Datalogger 02 (Environ)	Lufft Mess- und Regeltechnik GmbH	7489	2017-04	2019-04

- 2 R&S TS8997
EN300328/301893 Test Lab

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
2.1	SMB100A	Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz	107695	2017-07	2020-07
2.2	MFS	Rubidium Frequency Standard	Datum-Beverly	5489/001	2018-07	2019-07
2.3	1515 / 93459	Broadband Power Divider SMA (Aux)	Weinschel Associates	LN673		
2.4	FSV30	Signal Analyzer 10 Hz - 30 GHz	Rohde & Schwarz	103005	2018-04	2020-04
2.5	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2018-04	2020-04
2.6	VHF-3100+	High Pass Filter		-		
2.7	VT 4002	Temperature Chamber	Vötsch	58566002150010	2018-04	2020-04

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
2.8	A8455-4	4 Way Power Divider (SMA)		-		
2.9	Opus10 THI (8152.00)	ThermoHygro Datalogger 03 (Environ)	Lufft Mess- und Regeltechnik GmbH	7482	2017-03	2019-03
2.10	SMBV100A	Vector Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz	259291	2016-10	2019-10
2.11	OSP120	Switching Unit with integrated power meter	Rohde & Schwarz	101158	2018-05	2021-05

3 Radiated Emissions

Lab to perform radiated emission tests

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
3.1	NRV-Z1	Sensor Head A	Rohde & Schwarz GmbH & Co. KG	827753/005	2018-07	2019-07
3.2	MFS	Rubidium Frequency Normal MFS	Datum GmbH	002	2018-10	2020-10
3.3	Opus10 TPR (8253.00)	ThermoAirpressure Datalogger 13 (Environ)	Lufft Mess- und Regeltechnik GmbH	13936	2017-04	2019-04
3.4	ESW44	EMI Test Receiver	Rohde & Schwarz GmbH & Co. KG	101603	2018-05	2019-05
3.5	Anechoic Chamber	10.58 x 6.38 x 6.00 m ³	Frankonia	none	2018-06	2020-06
3.6	FS-Z60	Harmonic Mixer 40 - 60 GHz	Rohde & Schwarz Messgerätebau GmbH	100178	2016-12	2019-12
3.7	FS-Z220	Harmonic Mixer 140 - 220 GHz	Rohde & Schwarz Messgerätebau GmbH	101005	2017-03	2020-03
3.8	SGH-05	Standard Gain / Pyramidal Horn Antenna (140 - 220 GHz)	RPG-Radiometer Physics GmbH	075		
3.9	HL 562	Ultralog new biconicals	Rohde & Schwarz	830547/003	2018-07	2021-07
3.10	5HC2700/12750-1.5-KK	High Pass Filter	Trilithic	9942012		
3.11	ASP 1.2/1.8-10 kg	Antenna Mast	Maturo GmbH	-		
3.12	Fully Anechoic Room	8.80m x 4.60m x 4.05m (l x w x h)	Albatross Projects	P26971-647-001-PRB	2018-06	2020-06
3.13	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2018-04	2020-04
3.14	NRVD	Power Meter	Rohde & Schwarz GmbH & Co. KG	828110/016	2018-07	2019-07

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
3.15	HF 906	Double-ridged horn	Rohde & Schwarz	357357/002	2018-09	2021-09
3.16	JS4-18002600-32-5P	Broadband Amplifier 18 GHz - 26 GHz	Miteq	849785		
3.17	FSW 43	Spectrum Analyzer	Rohde & Schwarz	103779	2016-12	2018-12
3.18	3160-09	Standard Gain / Pyramidal Horn Antenna 26.5 GHz	EMCO Elektronik GmbH	00083069		
3.19	SGH-19	Standard Gain / Pyramidal Horn Antenna (40 - 60 GHz)	RPG-Radiometer Physics GmbH	093		
3.20	WHKX 7.0/18G-8SS	High Pass Filter	Wainwright	09		
3.21	4HC1600/12750-1.5-KK	High Pass Filter	Trilithic	9942011		
3.22	Chroma 6404	AC Power Source	Chroma ATE INC.	64040001304		
3.23	JS4-00102600-42-5A	Broadband Amplifier 30 MHz - 26 GHz	Miteq	619368		
3.24	TT 1.5 WI	Turn Table	Maturo GmbH	-		
3.25	HL 562 Ultralog	Log.-per. Antenna	Rohde & Schwarz	100609	2016-04	2019-04
3.26	HF 906	Double-ridged horn	Rohde & Schwarz	357357/001	2018-03	2021-03
3.27	FS-Z325	Harmonic Mixer 220 - 325 GHz	Rohde & Schwarz Messgerätebau GmbH	101006	2017-03	2020-03
3.28	3160-10	Standard Gain / Pyramidal Horn Antenna 40 GHz	EMCO Elektronik GmbH	00086675		
3.29	SGH-08	Standard Gain / Pyramidal Horn Antenna (90 - 140 GHz)	RPG-Radiometer Physics GmbH	064		
3.30	SGH-12	Standard Gain / Pyramidal HornAntenna (60 - 90 GHz)	RPG-Radiometer Physics GmbH	326		
3.31	5HC3500/18000-1.2-KK	High Pass Filter	Trilithic	200035008		
3.32	FS-Z140	Harmonic Mixer 90 -140 GHz	Rohde & Schwarz Messgerätebau GmbH	101007	2017-02	2020-02
3.33	HFH2-Z2	Loop Antenna	Rohde & Schwarz	829324/006	2018-01	2021-01
3.34	Opus10 THI (8152.00)	ThermoHygro Datalogger 12 (Environ)	Lufft Mess- und Regeltechnik GmbH	12482	2017-03	2019-03
3.35	ESR 7	EMI Receiver / Spectrum Analyzer	Rohde & Schwarz	101424	2016-11	2018-11

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
3.36	JS4-00101800-35-5P	Broadband Amplifier 30 MHz - 18 GHz	Miteq	896037		
3.37	AS 620 P	Antenna mast	HD GmbH	620/37		
3.38	Tilt device Maturo (Rohacell)	Antrieb TD1.5-10kg	Maturo GmbH	TD1.5-10kg/024/3790709		
3.39	SGH-03	Standard Gain / Pyramidal Horn Antenna (220 - 325 GHz)	RPG-Radiometer Physics GmbH	060		
3.40	FS-Z90	Harmonic Mixer 60 - 90 GHz	Rohde & Schwarz Messgerätebau GmbH	101686	2017-03	2020-03
3.41	ESIB 26	Spectrum Analyzer	Rohde & Schwarz	830482/004	2018-01	2020-01
3.42	PAS 2.5 - 10 kg	Antenna Mast	Maturo GmbH	-		
3.43	AFS42-00101800-25-S-42	Broadband Amplifier 25 MHz - 18 GHz	Miteq	2035324		
3.44	AM 4.0	Antenna mast	Maturo GmbH	AM4.0/180/11920513		
3.45	HF 907	Double-ridged horn	Rohde & Schwarz	102444	2018-07	2021-07

The calibration interval is the time interval between "Last Calibration" and "Calibration Due"

7 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.

7.1 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

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

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.

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

Frequency	AF	Corr.	cable loss 1	cable loss 2	cable loss 3	cable loss 4	distance corr.	d _{Limit}	d _{used}
MHz	dB (1/m)	dB	(inside chamber)	(outside chamber)	(switch unit)	(to receiver)	(-40 dB/decade)	(meas. distance (limit))	(meas. distance (used))
			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

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

U = Receiver reading

AF = Antenna factor

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

distance correction = $-40 * \text{LOG}(d_{\text{Limit}}/d_{\text{used}})$

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

Table shows an extract of values

7.3 ANTENNA R&S HL562 (30 MHz – 1 GHz)

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

Frequency	AF R&S HL562	Corr.
MHz	dB (1/m)	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)	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
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

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

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 = $-20 * \text{LOG} (d_{\text{Limit}} / d_{\text{used}})$
Linear interpolation will be used for frequencies in between the values in the table.
Tables show an extract of values.

7.4 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, atten- uator & 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, atten- uator & 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

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

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.

Tables show an extract of values.

7.5 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

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

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.

Table shows an extract of values.

7.6 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				-9.5	3	1.0
27.0	43.4	-11.2	4.4				-9.5	3	1.0
28.0	43.4	-11.1	4.5				-9.5	3	1.0
29.0	43.5	-11.0	4.6				-9.5	3	1.0
30.0	43.5	-10.9	4.7				-9.5	3	1.0
31.0	43.5	-10.8	4.7				-9.5	3	1.0
32.0	43.5	-10.7	4.8				-9.5	3	1.0
33.0	43.6	-10.7	4.9				-9.5	3	1.0
34.0	43.6	-10.6	5.0				-9.5	3	1.0
35.0	43.6	-10.5	5.1				-9.5	3	1.0
36.0	43.6	-10.4	5.1				-9.5	3	1.0
37.0	43.7	-10.3	5.2				-9.5	3	1.0
38.0	43.7	-10.2	5.3				-9.5	3	1.0
39.0	43.7	-10.2	5.4				-9.5	3	1.0
40.0	43.8	-10.1	5.5				-9.5	3	1.0

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)

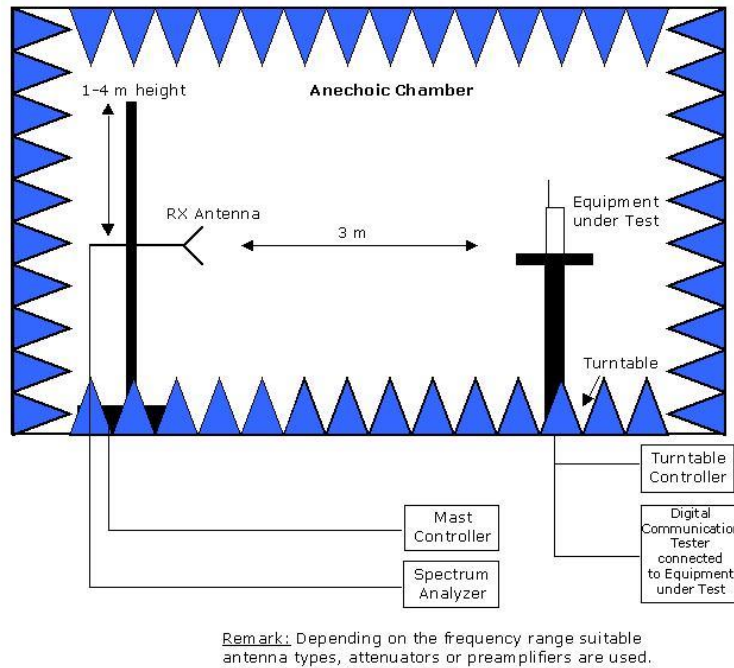
Linear interpolation will be used for frequencies in between the values in the table.

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

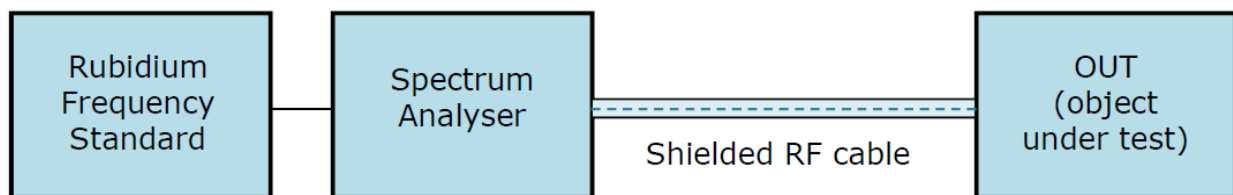
Linear interpolation will be used for frequencies in between the values in the table.

Table shows an extract of values.

8 SETUP DRAWINGS



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



Drawing 2: Setup for conducted radio tests.

9 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

10 PHOTO REPORT

Please see separate photo report.