FCC Measurement/Technical Report on

Bluetooth Low Energy Module with passive NFC Tag functionality

NINA-B1

FCC ID: XPYNINAB1
IC: 8595A-NINAB1

Test Report Reference: MDE_UBLOX_1625_FCCa

Test Laboratory:
7layers GmbH
Borsigstrasse 11
40880 Ratingen
Germany

DAkkS Deutsche Akkreditierungsstelle D-PL-12140-01-01

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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 (10-1-15 Edition). The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

Part 15, Subpart C – Intentional Radiators

§ 15.201 Equipment authorization requirement

§ 15.207 Conducted limits

§ 15.209 Radiated emission limits; general requirements

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

Note 1: (DTS Equipment)
The tests were selected and performed with reference to the FCC Public Notice "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247, 558074 D01 DTS Meas Guidance v03r05, 2016-04-08".

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 4: 8.8
Occupied bandwidth	§ 15.247 (a) (2)	RSS-247 Issue 1: 5.2 (1)
Peak conducted output power	§ 15.247 (b) (3), (4)	RSS-247 Issue 1: 5.4 (4)
Transmitter spurious RF conducted emissions	§ 15.247 (d)	RSS-Gen Issue 4: 6.13 / 8.9/8.10; RSS-247 Issue 1: 5.5
Transmitter spurious radiated emissions	§ 15.247 (d); § 15.209 (a)	RSS-Gen Issue 4: 6.13 / 8.9/8.10; RSS-247 Issue 1: 5.5
Band edge compliance	§ 15.247 (d)	RSS-247 Issue 1: 5.5
Power density	§ 15.247 (e)	RSS-247 Issue 1: 5.2 (2)
Antenna requirement	§ 15.203 / 15.204	RSS-Gen Issue 4: 8.3
Receiver spurious emissions	–	–

1.3 MEASUREMENT SUMMARY / SIGNATURES

47 CFR CHAPTER I FCC PART 15 Subpart C §15.247 **§ 15.207**

Conducted Emissions at AC Mains
The measurement was performed according to ANSI C63.10 **Final Result**

OP-Mode	Setup	FCC	IC
Operating mode			
worst case	S01_AA01	Passed	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	Setup	FCC	IC
Radio Technology, Operating Frequency			
Bluetooth LE, high	S07_BD01	Passed	Passed
Bluetooth LE, low	S07_BD01	Passed	Passed
Bluetooth LE, mid	S07_BD01	Passed	Passed

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

Occupied Bandwidth (99%)
The measurement was performed according to ANSI C63.10 **Final Result**

OP-Mode	Setup	FCC	IC
Radio Technology, Operating Frequency			
Bluetooth LE, high	S07_BD01	N/A	Passed
Bluetooth LE, low	S07_BD01	N/A	Passed
Bluetooth LE, mid	S07_BD01	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	Setup	FCC	IC
Radio Technology, Operating Frequency, Measurement method			
Bluetooth LE, high, conducted	S07_BD01	Passed	Passed
Bluetooth LE, low, conducted	S07_BD01	Passed	Passed
Bluetooth LE, mid, conducted	S07_BD01	Passed	Passed

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

Spurious RF Conducted Emissions

The measurement was performed according to ANSI C63.10 **Final Result**

OP-Mode Radio Technology, Operating Frequency	Setup	FCC	IC
Bluetooth LE, high	S07_BD01	Passed	Passed
Bluetooth LE, low	S07_BD01	Passed	Passed
Bluetooth LE, mid	S07_BD01	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	Setup	FCC	IC
Bluetooth LE, high, 30 MHz - 1 GHz Remark: integral antenna [ANT1]	S01_AA01	Passed	Passed
Bluetooth LE, high, 1 GHz - 26 GHz Remark: integral antenna [ANT1]	S01_AA01	Passed	Passed
Bluetooth LE, high, 30 MHz - 1 GHz Remark: external antenna "Inside 2400" [ANT2]	S01_BD01	Passed	Passed
Bluetooth LE, high, 1 GHz - 26 GHz Remark: external antenna "Inside 2400" [ANT2]	S01_BD01	Passed	Passed
Bluetooth LE, high, 1 GHz - 26 GHz Remark: external antenna "GW26.0111.HT" [ANT6]	S02_BD01	Passed	Passed
Bluetooth LE, high, 1 GHz - 26 GHz Remark: external antenna "Ex-IT 2400" [ANT3]	S03_BD01	Passed	Passed
Bluetooth LE, high, 1 GHz - 26 GHz Remark: external antenna "ANT-2.4-CW-RH" [ANT7]	S04_BD01	Passed	Passed
Bluetooth LE, high, 1 GHz - 26 GHz Remark: external antenna "Ex-IT 2400 with ground plane" [ANT5]	S05_BD01	Passed	Passed
Bluetooth LE, high, 1 GHz - 26 GHz Remark: external antenna "FlatWhip-2400" [ANT4]	S06_BD01	Passed	Passed
Bluetooth LE, low, 30 MHz - 1 GHz Remark: integral antenna [ANT1]	S01_AA01	Passed	Passed
Bluetooth LE, low, 1 GHz - 26 GHz Remark: integral antenna [ANT1]	S01_AA01	Passed	Passed
Bluetooth LE, low, 30 MHz - 1 GHz Remark: external antenna "Inside 2400" [ANT2]	S01_BD01	Passed	Passed
Bluetooth LE, low, 1 GHz - 26 GHz Remark: external antenna "Inside 2400" [ANT2]	S01_BD01	Passed	Passed
Bluetooth LE, mid, 9 kHz - 30 MHz Remark: integral antenna [ANT1]	S01_AA01	Passed	Passed
Bluetooth LE, mid, 30 MHz - 1 GHz Remark: integral antenna [ANT1]	S01_AA01	Passed	Passed
Bluetooth LE, mid, 1 GHz – 26 GHz Remark: integral antenna [ANT1]	S01_AA01	Passed	Passed
Bluetooth LE, mid, 9 kHz - 30 MHz Remark: external antenna "Inside 2400" [ANT2]	S01_BD01	Passed	Passed
Bluetooth LE, mid, 30 MHz - 1 GHz Remark: external antenna "Inside 2400" [ANT2]	S01_BD01	Passed	Passed

Bluetooth LE, mid, 1 GHz – 26 GHz Remark: external antenna "Inside 2400" [ANT2]	S01_BD01	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	**Setup**	**FCC**	**IC**
Bluetooth LE, high, high	S07_BD01	Passed	Passed
Bluetooth LE, low, low	S07_BD01	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	**Setup**	**FCC**	**IC**
Bluetooth LE, high, high Remark: integral antenna [ANT1]	S01_AA01	Passed	Passed
Bluetooth LE, high, high Remark: external antenna "Inside 2400" [ANT2]	S01_BD01	Passed	Passed
Bluetooth LE, high, high Remark: external antenna "GW26.0111.HT" [ANT6]	S02_BD01	Passed	Passed
Bluetooth LE, high, high Remark: external antenna "Ex-IT 2400" [ANT3]	S03_BD01	Passed	Passed
Bluetooth LE, high, high Remark: external antenna "ANT-2.4-CW-RH" [ANT7]	S04_BD01	Passed	Passed
Bluetooth LE, high, high Remark: external antenna "Ex-IT 2400 with ground plane" [ANT5]	S05_BD01	Passed	Passed
Bluetooth LE, high, high Remark: external antenna "FlatWhip-2400" [ANT4]	S06_BD01	Passed	Passed

47 CFR CHAPTER I FCC PART 15 Subpart C §15.247 § 15.247 (e)

Power Density
The measurement was performed according to ANSI C63.10 **Final Result**

OP-Mode Radio Technology, Operating Frequency	**Setup**	**FCC**	**IC**
Bluetooth LE, high	S07_BD01	Passed	Passed
Bluetooth LE, low	S07_BD01	Passed	Passed
Bluetooth LE, mid	S07_BD01	Passed	Passed

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

MARCO KULLIK
2016.07.29
17:56:32 +02'00'

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

DANIEL GALL
2016.07.29
17:51:50 +02'00'

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

2 ADMINISTRATIVE DATA

2.1 TESTING LABORATORY

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

This facility has been fully described in a report submitted to the FCC and accepted under the registration number 96716.

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

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

Laboratory accreditation no:	DAkkS D-PL-12140-01-01
Responsible for accreditation scope:	Dipl.-Ing. Marco Kullik
Report Template Version:	2016-06-07

2.2 PROJECT DATA

Responsible for testing and report:	Dipl.-Ing Daniel Gall
Employees who performed the tests:	documented internally at 7Layers
Date of Report:	2016-07-29
Testing Period:	2016-06-29 to 2016-07-26

2.3 APPLICANT DATA

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

2.4 MANUFACTURER DATA

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

3 TEST OBJECT DATA

3.1 GENERAL EUT DESCRIPTION

Kind of Device product description	Module supporting BTLE and NFC (passive)
Product name	NINA-B1
Type	NINA-B111/NINA-B112
Declared EUT data by the supplier	
Voltage Type	DC
Voltage Level	Evaluation board: 5.0 V Module: 3.3 V
Tested Modulation Type	GFSK Modulation, 1-DH1 packets
General product description	The EUT is an intentional radiator in the license-free 2.4 GHz ISM band.
Specific product description for the EUT	The NINA-B1 series are small stand-alone Bluetooth low energy modules working in 2.4 GHz band only. They are offered in two versions; a version with an RF pin, and a version with an internal PIFA antenna. The only supported data rate is 1Mbps.
The EUT provides the following ports:	Evaluation board: - Enclosure - USB (1m, shielded USB cable connected for radiated tests) - DC in (AUX 1 connected for all tests) - 50 Ohm Antenna Port (only NINA-B111)
Tested data rates:	1 Mbps
Duty Cycle:	The duty cycle in the used test modes for all tests was 100 %.
Special software used for testing:	The EUT was flashed with a special software which allowed to set the required operating mode via three buttons on the evaluation board (EVK1 / EVK2)

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

3.2 EUT MAIN COMPONENTS

Sample Name	Sample Code	Description
aa01	DE1015042aa01	Sample with integral antenna
Sample Parameter	**Value**	
HW Version	2.0	
Integral Antenna	Yes (ANT1)	
Serial No.	684D4CA6EB011840200	
SW Version	modified radio_test application from nRF5 SDK_v11.0.0.89	
Comment		

Sample Name	Sample Code	Description
bd01	DE1015042bd01	Sample with permanent 50 Ohm connector
Sample Parameter	**Value**	
HW Version	2.0	
Integral Antenna	No	
Serial No.	683D4CA6EB00AC70200	
SW Version	modified radio_test application from nRF5 SDK_v11.0.0.89	
Comment		

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

3.3 ANCILLARY EQUIPMENT

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

Sample Name	**Detailed Description**	
Device	**Details (Manufacturer, Type Model, OUT Code)**	**Description**
ANT1	Integral Antenna	
Integral Antenna u-blox LILY antenna	ProAnt, u-blox LILY antenna, -	Integral antenna for NINA-B112
ANT2	External Antenna	
External Antenna Inside-2400	ProAnt, Inside-2400, -	External antenna for NINA-B111
ANT3	External Antenna	
External Antenna Ex-IT 2400	ProAnt, Ex-IT 2400, -	External antenna for NINA-B111
ANT4	External Antenna	
External Antenna FlatWhip-2400	ProAnt, FlatWhip-2400, -	External antenna for NINA-B111
ANT5	External Antenna	
External Antenna Ex-IT 2400 with ground plane	ProAnt, Ex-IT 2400 with ground plane, -	External antenna for NINA-B111

Sample Name	Detailed Description	
Device	**Details (Manufacturer, Type Model, OUT Code)**	**Description**
ANT6	External Antenna	
External Antenna GW26.0111.HT	Taoglas, GW26.0111.HT, -	External antenna for NINA-B111
ANT7	External Antenna	
External Antenna ANT-2.4-CW-RH-RPS	Linx, ANT-2.4-CW-RH, -	External antenna for NINA-B111
EVK1	EVK for NINA-B111 (external antenna)	
EVK-NINA-B111	u-blox Malmo, EVK-NINA-B111, S/N: 10000000598229000000, HW: 2.0; SW: J-Link OB-SAM3U128 V3	Evaluation board for NINA-B111
EVK2	EVK for NINA-B112 (integral antenna)	
EVK-NINA-B112	u-blox Malmo, EVK-NINA-B112, S/N: 10000000598230000000, HW: 2.0; SW: J-Link OB-SAM3U128 V3	Evaluation board for NINA-B112

3.4 AUXILIARY EQUIPMENT

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

Device	**Details (Manufacturer, HW, SW, S/N)**	**Description**
Power Supply	Nordic Power, -, -, -	9820A-120090

3.5 EUT SETUPS

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

Setup	**Combination of EUTs**	**Description and Rationale**
S05_BD01	ANT5, bd01, EVK1, Power Supply,	NINA-B111 with external antenna "Ex-IT 2400 Groundplane" (radiated tests)
S01_BD01	ANT2, bd01, EVK1, Power Supply,	NINA-B111 with external antenna "Inside 2400" (radiated tests)
S02_BD01	ANT6, bd01, EVK1, Power Supply,	NINA-B111 with external antenna "GW 26.011" (radiated tests)
S06_BD01	bd01, ANT4, EVK1, Power Supply,	NINA-B111 with external antenna "Flatwhip-2400" (radiated tests)
S01_AA01	aa01, EVK2, ANT1, Power Supply,	NINA-B112 with integral antenna (radiated tests)
S04_BD01	ANT7, bd01, EVK1, Power Supply,	NINA-B111 with external antenna "ANT-2.4-CW-RH" (radiated tests)
S03_BD01	ANT3, bd01, EVK1, Power Supply,	NINA-B111 with external antenna "Ex-IT2400" (radiated tests)
S07_BD01	bd01, EVK1, Power Supply,	NINA-B111 without external antenna (conducted tests)

3.6 OPERATING MODES

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

3.6.1 TEST CHANNELS

	2.4 GHz ISM 2400 - 2483.5 MHz		
BT LE Test Channels:	**low**	**mid**	**high**
Channel:	0	19	39
Frequency [MHz]	2402	2440	2480

3.7 PRODUCT LABELLING

3.7.1 FCC ID LABEL

Please refer to the documentation of the applicant.

3.7.2 LOCATION OF THE LABEL ON THE EUT

Please refer to the documentation of the applicant.

4 TEST RESULTS

4.1 CONDUCTED EMISSIONS AT AC MAINS

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

4.1.1 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 50µH || 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.

4.1.2TEST 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).

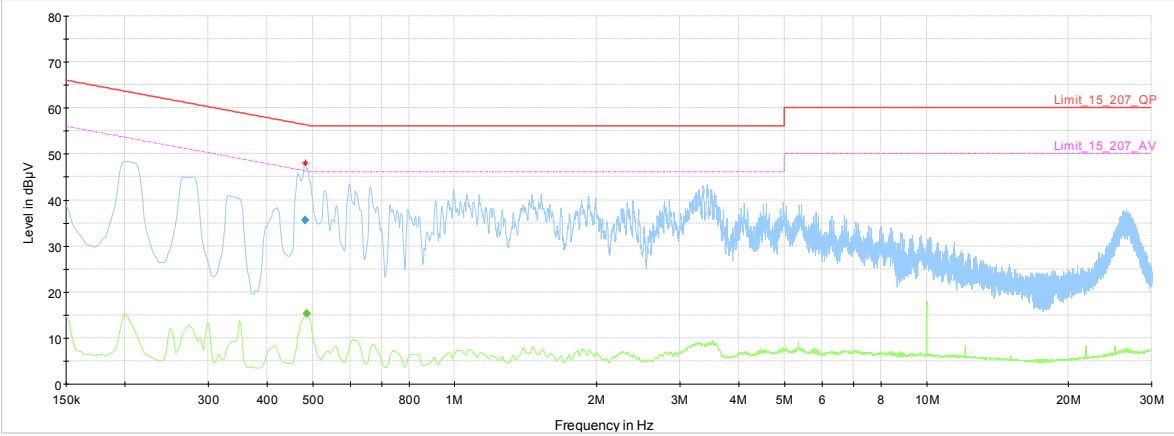
4.1.3TEST PROTOCOL

Temperature: 27 °C
Air Pressure: 1014 hPa
Humidity: 51 %

Power line	**Frequency [MHz]**	**Measured value QP [dBµV]**	**Measured value AV [dBµV]**	**QP Limit [dBµV]**	**AV Limit [dBµV]**	**Margin QP [dB]**	**Margin AV [dB]**
L	0.48300	35.5		56.3		20.8	
L	0.48525		15.3		46.3		31.0

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

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



4.1.5 TEST EQUIPMENT USED

Conducted Emissions

4.2 OCCUPIED BANDWIDTH (6 DB)

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

4.2.1 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:

- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Span: 3 MHz
- Trace: Maxhold
- Sweeps: 2000
- Sweeptime: 5 ms
- Detector: Peak

4.2.2 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.

4.2.3 TEST PROTOCOL

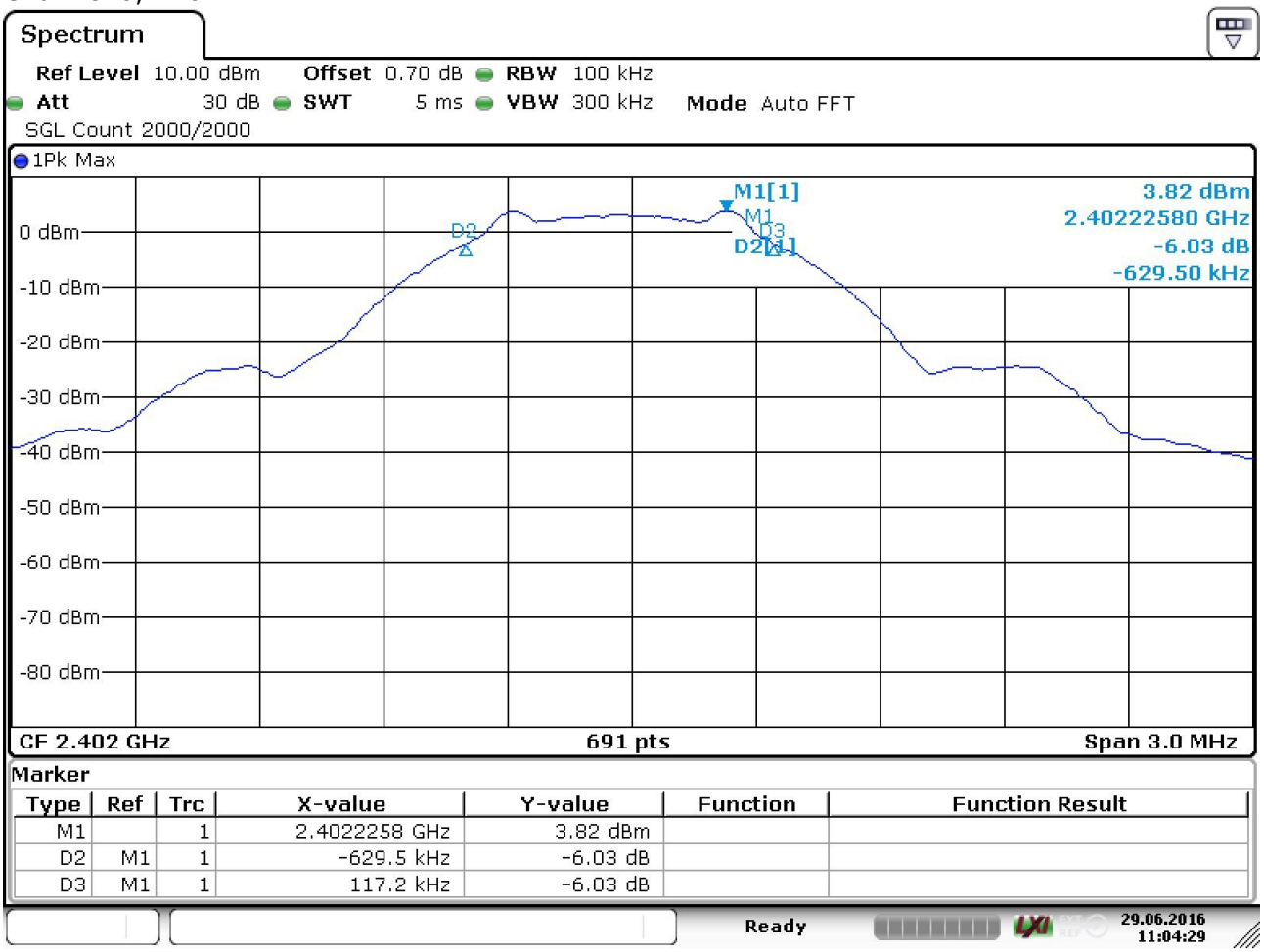
Ambient temperature: 23 °C
Air Pressure: 1007 hPa
Humidity: 45 %
BT LE GFSK

Band	Channel No.	Frequency [MHz]	6 dB Bandwidth [MHz]	Limit [MHz]	Margin to Limit [MHz]
2.4 GHz ISM	0	2402.0	0.7	0.5	0.2
	19	2440.0	0.7	0.5	0.2
	39	2480.0	0.8	0.5	0.3

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

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

Channel 0, 2402 MHz



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4.2.5 TEST EQUIPMENT USED

R&S TS8997

4.3 OCCUPIED BANDWIDTH (99%)

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

4.3.1 TEST DESCRIPTION

The Equipment Under Test (EUT) was set up to perform the occupied bandwidth measurements.
The reference level is the level of the highest amplitude signal observed from the transmitter at either the fundamental frequency or first-order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical.
The EUT was connected to spectrum analyzer via a short coax cable with a known loss.
Analyzer settings:

- Resolution Bandwidth (RBW): 10 kHz
- Video Bandwidth (VBW): 30 kHz
- Span: 30 MHz
- Trace: Maxhold
- Sweeps: 2000
- Sweeptime: 20 ms
- Detector: Sample

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

4.3.2 TEST REQUIREMENTS / LIMITS

No applicable limit:

4.3.3 TEST PROTOCOL

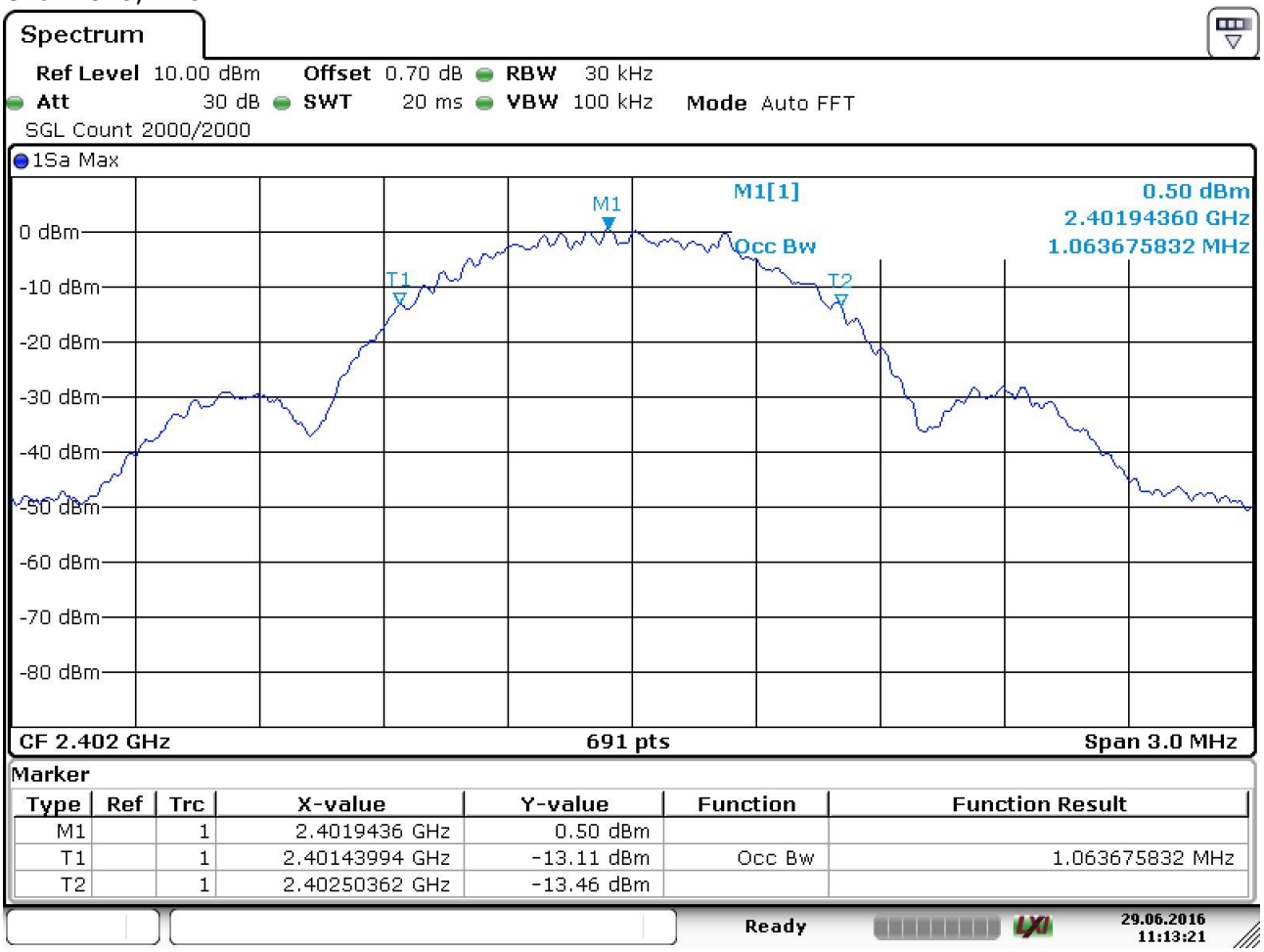
Ambient temperature: 23 °C
Air Pressure: 1007 hPa
Humidity: 45 %
BT LE

Band	Channel No.	Frequency [MHz]	99 % Bandwidth [MHz]
2.4 GHz ISM	0	2402.0	1.1
	19	2440.0	1.1
	39	2480.0	1.1

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

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

Channel 0, 2402 MHz



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4.3.5 TEST EQUIPMENT USED

R&S TS8997

4.4 PEAK POWER OUTPUT

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

4.4.1 TEST DESCRIPTION

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

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

Analyzer settings:
- Resolution Bandwidth (RBW): 1 MHz
- Video Bandwidth (VBW): 3 MHz
- Trace: Maxhold
- Sweeps: 2000
- Sweeptime: 5 ms
- Detector: Peak

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

4.4.2 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)

4.4.3 TEST PROTOCOL

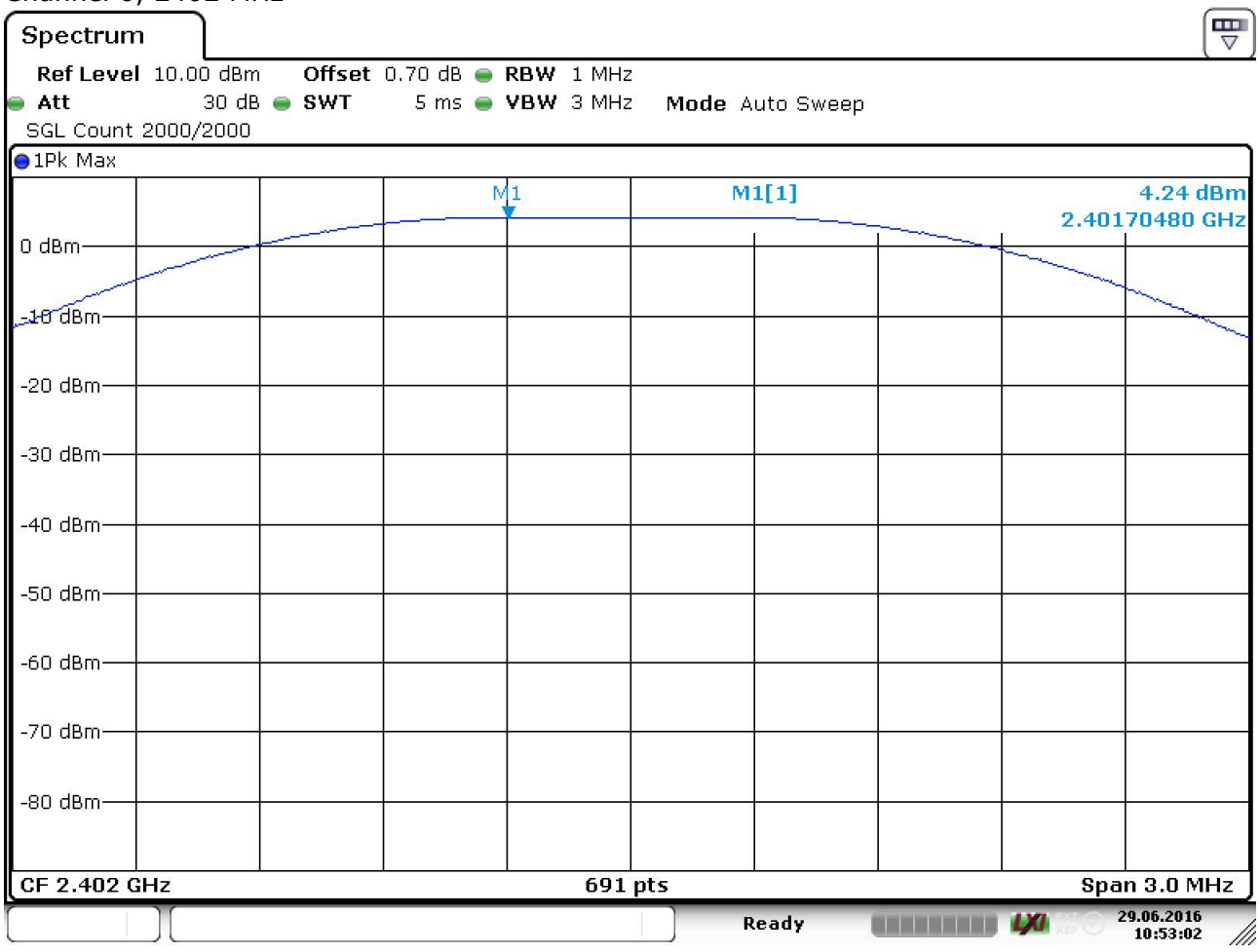
Ambient temperature: 23 °C
Air Pressure: 1007 hPa
Humidity: 45 %
BT LE

Band	Channel No.	Frequency [MHz]	Peak Power [dBm]	Limit [dBm]	Margin to Limit [dB]
2.4 GHz ISM	0	2402.0	4.2	30.0	25.8
	19	2440.0	4.1	30.0	25.9
	39	2480.0	4.0	30.0	26.0

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

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

Channel 0, 2402 MHz



Date: 29.JUN.2016 10:53:03

4.4.5 TEST EQUIPMENT USED

R&S TS8997

4.5 SPURIOUS RF CONDUCTED EMISSIONS

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

4.5.1 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:

- Frequency range: 30 – 25000 MHz
- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Trace: Maxhold
- Sweeps: 2
- Sweep Time: 330 s
- Detector: Peak

The reference value for the measurement of the spurious RF conducted emissions is determined during the test "band edge compliance conducted". This value is used to calculate the 20 dBc limit.

4.5.2 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.

4.5.3 TEST PROTOCOL

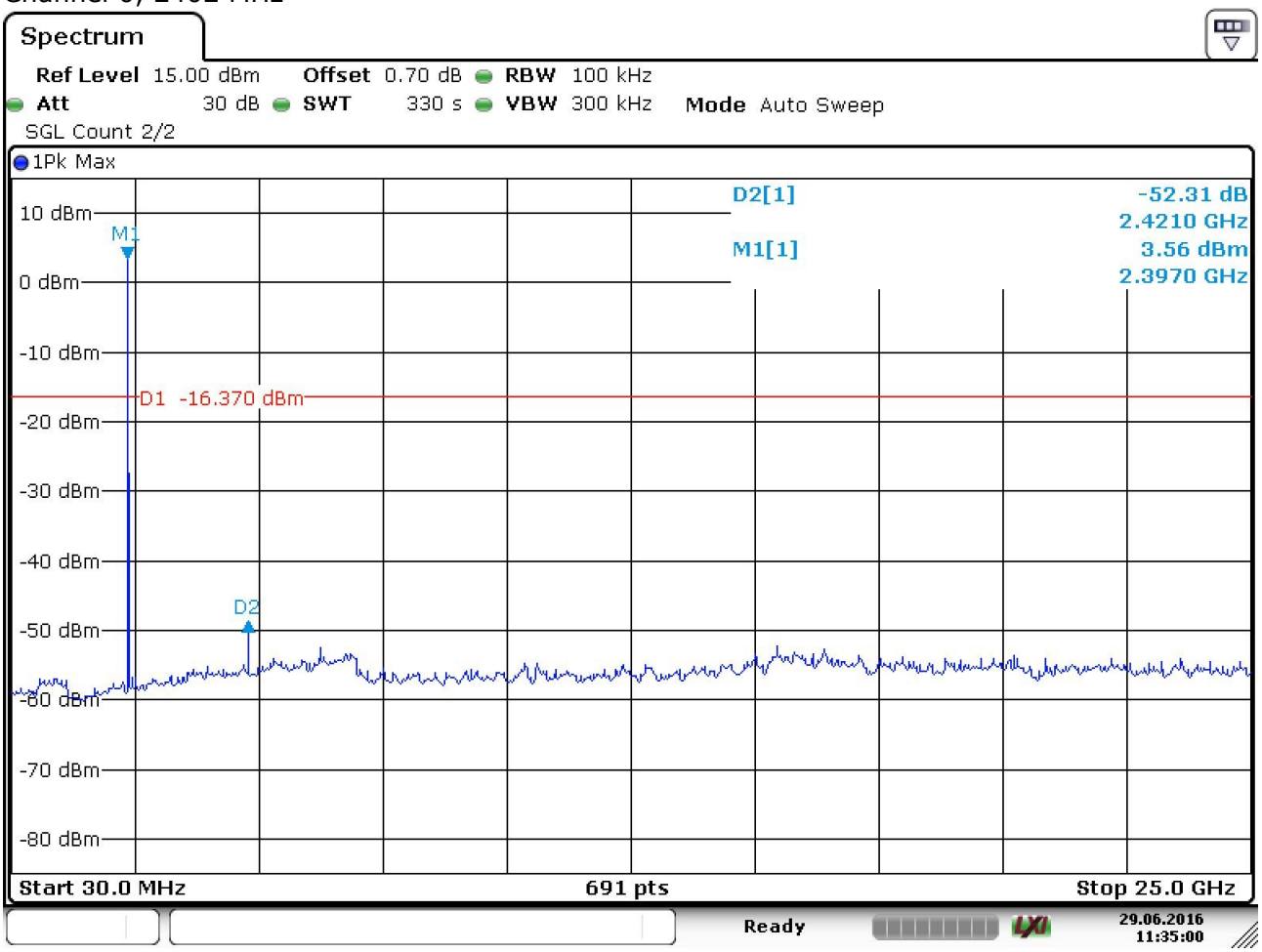
Ambient temperature: 23 °C
Air Pressure: 1007 hPa
Humidity: 45 %
BT LE GFSK

Channel No	Channel Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Ref. Level [dBm]	Limit [dBm]	Margin to Limit [dB]
0	2402.0	---	---	PEAK	100.0	3.6	-16.4	---
19	2440.0	---	---	PEAK	100.0	3.7	-16.2	---
39	2480.0	---	---	PEAK	100.0	3.2	-16.1	---

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

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

Channel 0, 2402 MHz



Date: 29.JUN.2016 11:35:01

4.5.5 TEST EQUIPMENT USED

R&S TS8997

4.6 TRANSMITTER SPURIOUS RADIATED EMISSIONS

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

4.6.1 TEST DESCRIPTION

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

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

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

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

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

2. Measurement above 30 MHz and up to 1 GHz

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

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

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

Step 2: Adjustment measurement

In this step the accuracy of the turntable azimuth and antenna height will be improved. This is necessary to find out the maximum value of every frequency.

For each frequency, which was determined the turntable azimuth and antenna height will be adjusted. The turntable azimuth will slowly vary by ± 45° around this value. During this action, the value of emission is continuously measured. The turntable azimuth at the highest emission will be recorded and adjusted. In this position, the antenna height will also slowly vary by ± 100 cm around the antenna height determined. During this action, the value of emission is also continuously measured. The antenna height of the highest emission will also be recorded and adjusted.

- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range: ± 45 ° around the determined value
- Height variation range: ± 100 cm around the determined value
- Antenna Polarisation: max. value determined in step 1

Step 3: Final measurement with QP detector

With the settings determined in step 3, the final measurement will be performed:

EMI receiver settings for step 4:

- Detector: Quasi-Peak (< 1 GHz)
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 1 s

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

3. Measurement above 1 GHz

The following modifications apply to the measurement procedure for the frequency range above 1 GHz:

Step 1:

The Equipment Under Test (EUT) was set up on a non-conductive support (tilt device) at 1.5 m height in the fully-anechoic chamber.

All steps were performed with one height (1.5 m) of the receiving antenna only.

The EUT is turned during the preliminary measurement across the elevation axis, with a step size of 90 °.

The turn table step size (azimuth angle) for the preliminary measurement is 45 °.

Step 2:

Due to the fact, that in this frequency range the test is performed in a fully anechoic room, the height scan of the receiving antenna instep 2 is omitted. Instead of this, a maximum search with a step size ± 45° for the elevation axis is performed.

The turn table azimuth will slowly vary by ± 22.5°.
The elevation angle will slowly vary by ± 45°
EMI receiver settings (for all steps):
- Detector: Peak, Average
- IF Bandwidth = 1 MHz

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

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

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

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

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

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

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

4.6.3 TEST PROTOCOL

Ambient temperature: 24–27 °C
Air Pressure: 1006–1007 hPa
Humidity: 43–47 %

BT low Energy; Setup: S01_AA01				Applied duty cycle correction (AV) [dB]: 0.0				
Ch. No.	**Ch. Center Freq. [MHz]**	**Spurious Freq. [MHz]**	**Spurious Level [dBµV/m]**	**Detec-tor**	**RBW [kHz]**	**Limit [dBµV/m]**	**Margin to Limit [dB]**	**Limit Type**
0	2402	---	- - -		---	---	- - -	---
19	2440	---	- - -		---	---	- - -	---
39	2480	---	- - -		---	---	- - -	---

Ambient temperature: 24–27 °C
Air Pressure: 1006–1007 hPa
Humidity: 43–47 %

BT low Energy; Setup: S01_BD01				Applied duty cycle correction (AV) [dB]: 0.0				
Ch. No.	**Ch. Center Freq. [MHz]**	**Spurious Freq. [MHz]**	**Spurious Level [dBµV/m]**	**Detec-tor**	**RBW [kHz]**	**Limit [dBµV/m]**	**Margin to Limit [dB]**	**Limit Type**
0	2402	4803.9	55.7	PEAK	1000	74.0	18.3	RB
0	2402	4803.6	50.3	AV	1000	54.0	3.7	RB
19	2440	---	- - -		---	---	- - -	---
39	2480	---	- - -		---	---	- - -	---

Ambient temperature: 24–27 °C
Air Pressure: 1006–1007 hPa
Humidity: 43–47 %

BT low Energy; Setup: S02_BD01				Applied duty cycle correction (AV) [dB]: 0.0				
Ch. No.	**Ch. Center Freq. [MHz]**	**Spurious Freq. [MHz]**	**Spurious Level [dBµV/m]**	**Detec-tor**	**RBW [kHz]**	**Limit [dBµV/m]**	**Margin to Limit [dB]**	**Limit Type**
39	2480	---	- - -		---	---	- - -	---

Ambient temperature: 24–27 °C
Air Pressure: 1006–1007 hPa
Humidity: 43–47 %

BT low Energy; Setup: S03_BD01				Applied duty cycle correction (AV) [dB]:0.0				
Ch. No.	**Ch. Center Freq. [MHz]**	**Spurious Freq. [MHz]**	**Spurious Level [dBµV/m]**	**Detec-tor**	**RBW [kHz]**	**Limit [dBµV/m]**	**Margin to Limit [dB]**	**Limit Type**
39	2480	---	- - -		---	---	- - -	---

Ambient temperature: 24–27 °C
Air Pressure: 1006–1007 hPa
Humidity: 43–47 %

BT low Energy; Setup: S04_BD01				Applied duty cycle correction (AV) [dB]: 0.0				
Ch. No.	**Ch. Center Freq. [MHz]**	**Spurious Freq. [MHz]**	**Spurious Level [dBµV/m]**	**Detec-tor**	**RBW [kHz]**	**Limit [dBµV/m]**	**Margin to Limit [dB]**	**Limit Type**
39	2480	---	- - -		---	---	- - -	---

Ambient temperature: 24–27 °C
Air Pressure: 1006–1007 hPa
Humidity: 43–47 %

BT low Energy; Setup: S05_BD01				Applied duty cycle correction (AV) [dB] :0.0				
Ch. No.	**Ch. Center Freq. [MHz]**	**Spurious Freq. [MHz]**	**Spurious Level [dBµV/m]**	**Detec-tor**	**RBW [kHz]**	**Limit [dBµV/m]**	**Margin to Limit [dB]**	**Limit Type**
39	2480	4959.4	54.5	PEAK	1000	74.0	19.5	RB
39	2480	4960.0	48.3	AV	1000	54.0	5.7	RB

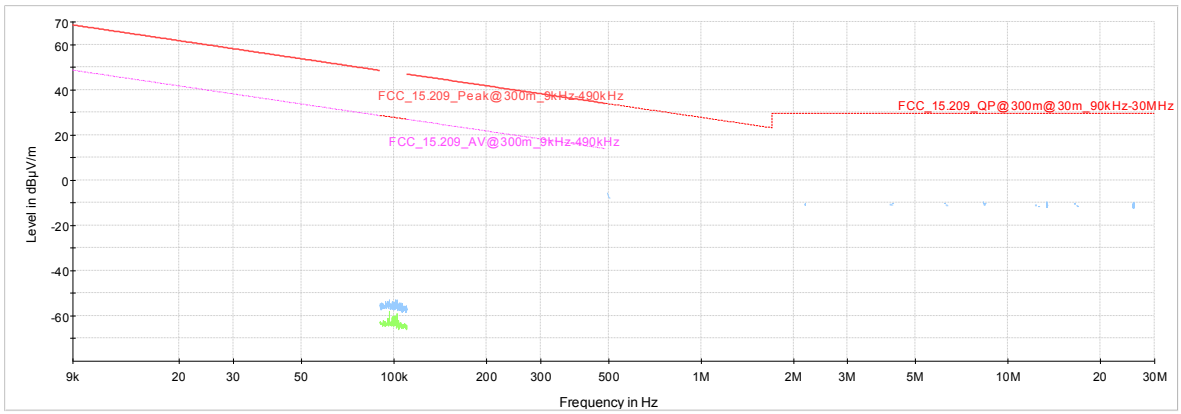
Ambient temperature: 24–27 °C
Air Pressure: 1006–1007 hPa
Humidity: 43–47 %

BT low Energy; Setup: S06_BD01				Applied duty cycle correction (AV) [dB]: 0.0				
Ch. No.	**Ch. Center Freq. [MHz]**	**Spurious Freq. [MHz]**	**Spurious Level [dBµV/m]**	**Detec-tor**	**RBW [kHz]**	**Limit [dBµV/m]**	**Margin to Limit [dB]**	**Limit Type**
39	2480	---	- - -		---	---	- - -	---

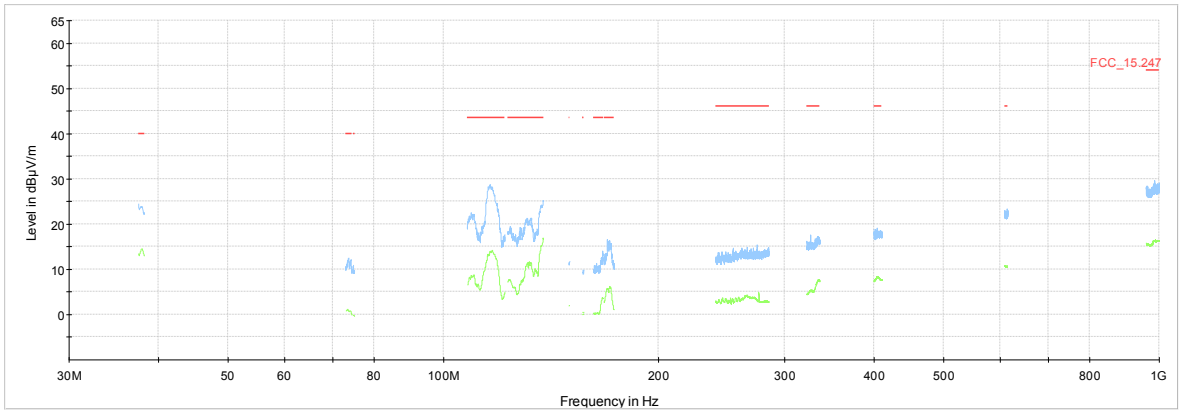
Remark: Please see next sub-clause for the measurement plot.

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

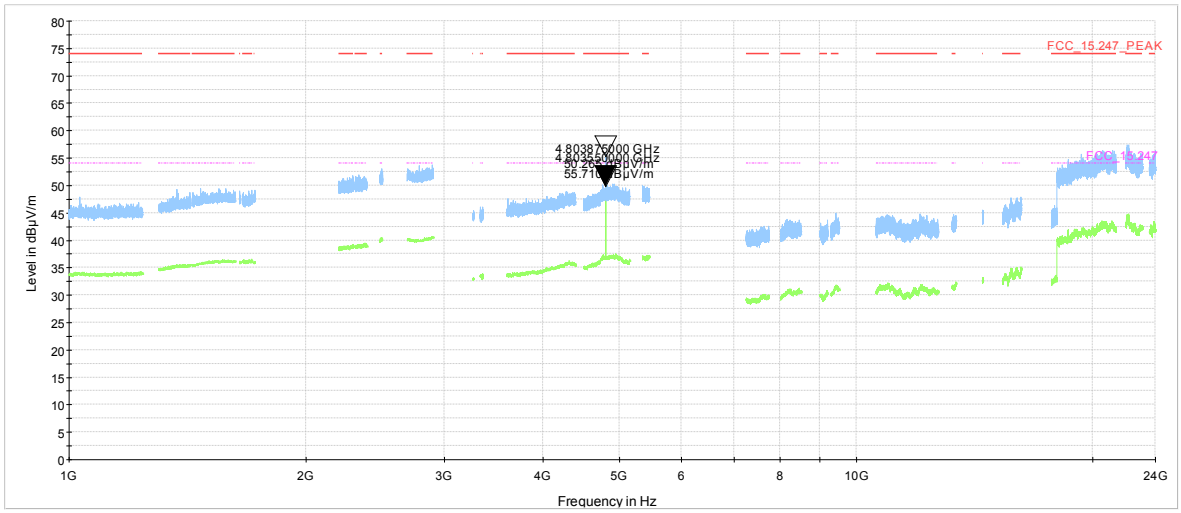
Setup S01_BD01, Channel 0, 2402 MHz, 9 kHz – 30 MHz



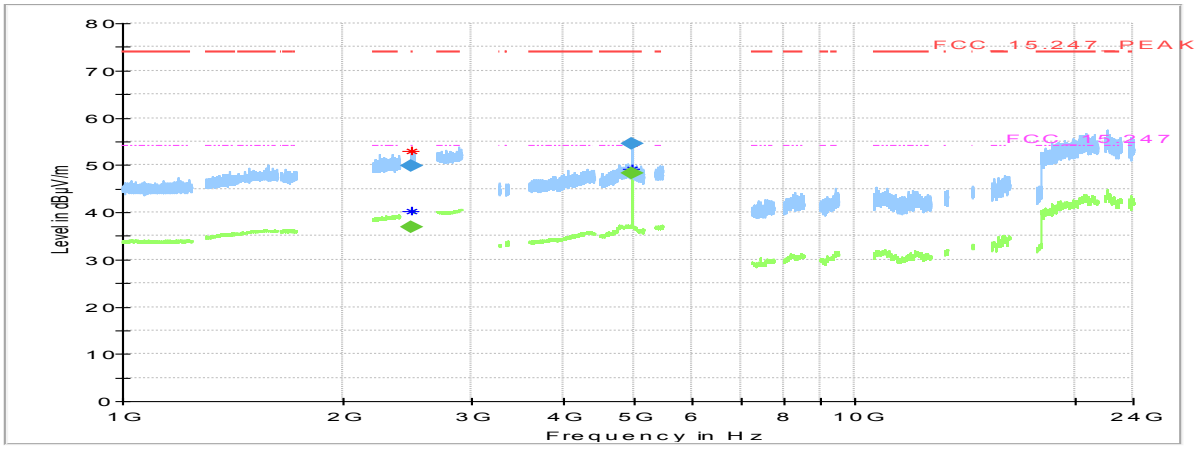
Setup S01_BD01, Channel 0, 2402 MHz, 30 MHz – 1 GHz



Setup S01_BD01, Channel 0, 2402 MHz, 1 GHz – 24 GHz



Setup S05_BD01, Channel 39, 2480 MHz



4.6.5 TEST EQUIPMENT USED

Radiated Emissions

4.7 BAND EDGE COMPLIANCE CONDUCTED

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

4.7.1 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:

- Frequency Range 2397 MHz – 2406 MHz, 2479 MHz – 2485 MHz
- Detector: Peak
- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Sweeptime: 5 ms
- Sweeps: 2000
- Trace: Maxhold

4.7.2 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..."

4.7.3 TEST PROTOCOL

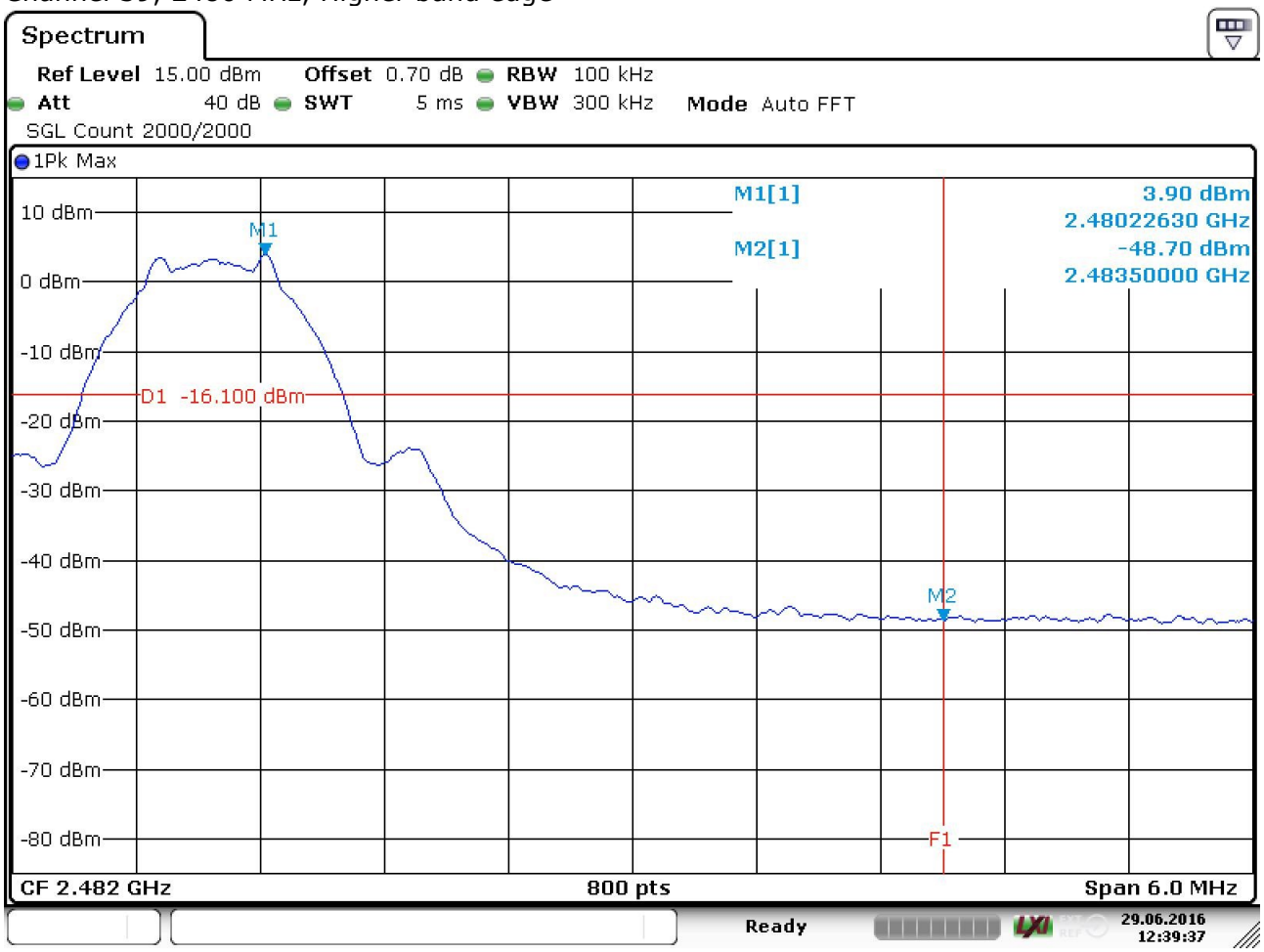
Ambient temperature: 23 °C
Air Pressure: 1007 hPa
Humidity: 45 %
BT LE GFSK

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	2402.0	2400.0	-44.5	PEAK	100.0	3.6	-16.4	28.1
39	2480.0	2483.5	-48.7	PEAK	100.0	3.9	-16.1	32.6

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

4.7.4 MEASUREMENT PLOT

Channel 39, 2480 MHz, Higher band edge



Date: 29.JUN.2016 12:39:37

4.7.5 TEST EQUIPMENT USED

R&S TS8997

4.8 BAND EDGE COMPLIANCE RADIATED

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

4.8.1 TEST DESCRIPTION

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

4.8.2 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: Limit (dBµV/m) = 20 log (Limit (µV/m)/1µV/m)

4.8.3 TEST PROTOCOL

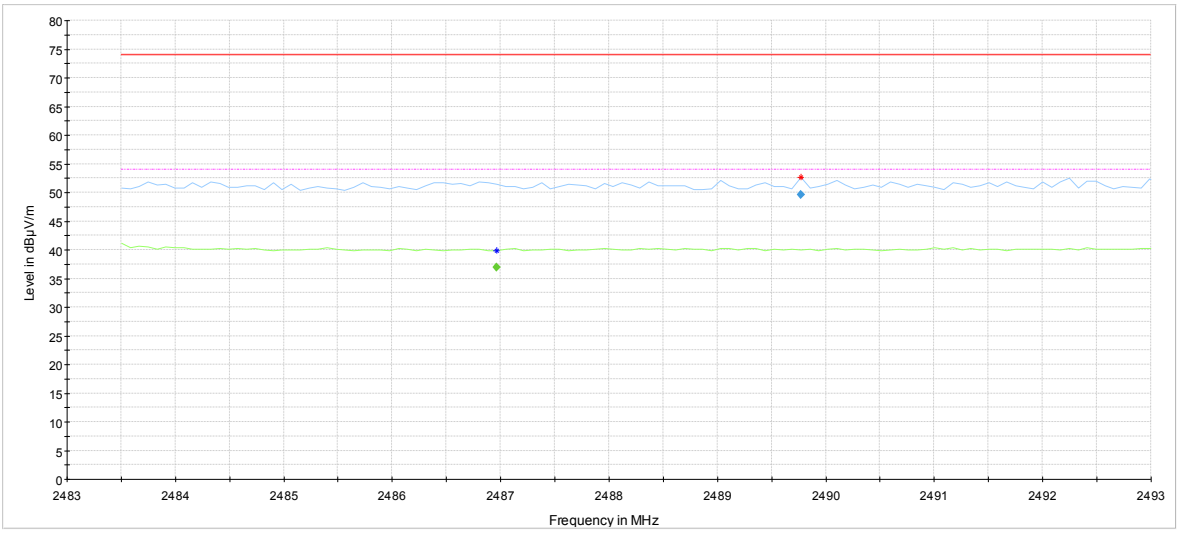
Ambient temperature: 24–27 °C
Air Pressure: 1006–1007 hPa
Humidity: 43–47 %

BT LE GFSK				Applied duty cycle correction (AV) [dB]: 0.0					
Ch. No.	**Ch. Center Freq. [MHz]**	**Band Edge Freq. [MHz]**	**Spurious Level [dBµV/m]**	**Detec -tor**	**RBW [kHz]**	**Limit [dBµV/m]**	**Margin to Limit [dB]**	**Limit Type**	Setup
39	2480	2483.5	49.6	PEAK	1000	74.0	24.4	BE	S01_AA01
39	2480	2483.5	37.0	AV	1000	54.0	17.0	BE	S01_AA01
39	2480	2483.5	48.8	PEAK	1000	74.0	25.2	BE	S01_BD01
39	2480	2483.5	36.8	AV	1000	54.0	17.2	BE	S01_BD01
39	2480	2483.5	49.9	PEAK	1000	74.0	24.1	BE	S02_BD01
39	2480	2483.5	37.9	AV	1000	54.0	16.1	BE	S02_BD01
39	2480	2483.5	49.6	PEAK	1000	74.0	24.4	BE	S03_BD01
39	2480	2483.5	36.9	AV	1000	54.0	17.1	BE	S03_BD01
39	2480	2483.5	49.7	PEAK	1000	74.0	24.3	BE	S04_BD01
39	2480	2483.5	36.7	AV	1000	54.0	17.4	BE	S04_BD01
39	2480	2483.5	49.7	PEAK	1000	74.0	24.3	BE	S05_BD01
39	2480	2483.5	36.9	AV	1000	54.0	17.1	BE	S05_BD01
39	2480	2483.5	49.6	PEAK	1000	74.0	24.4	BE	S06_BD01
39	2480	2483.5	36.9	AV	1000	54.0	17.1	BE	S06_BD01

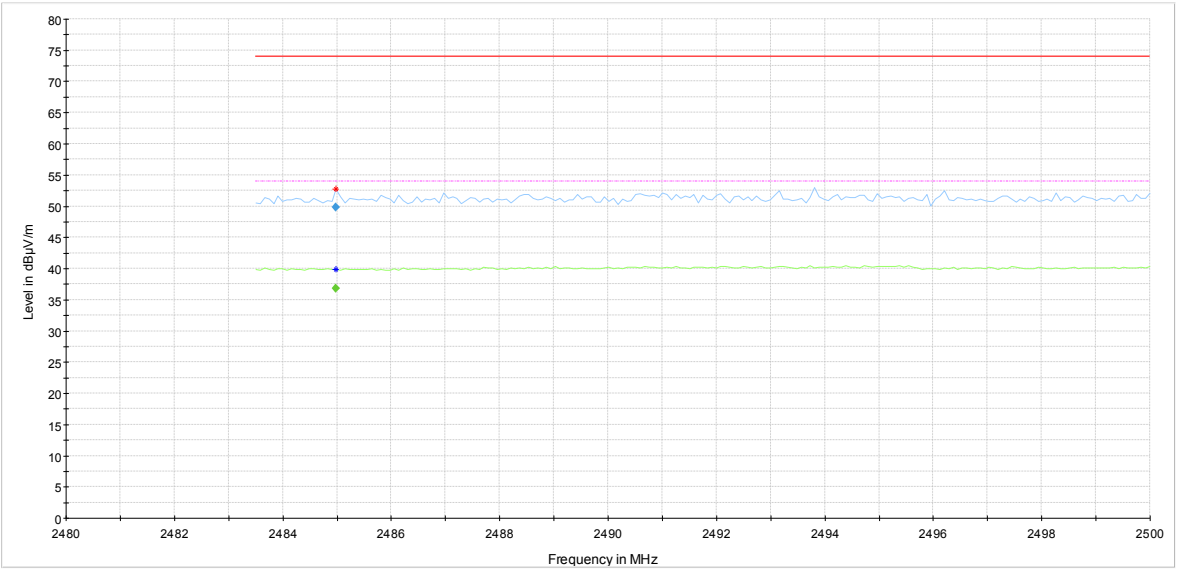
Remark: Please see next sub-clause for the measurement plot.

4.8.4MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

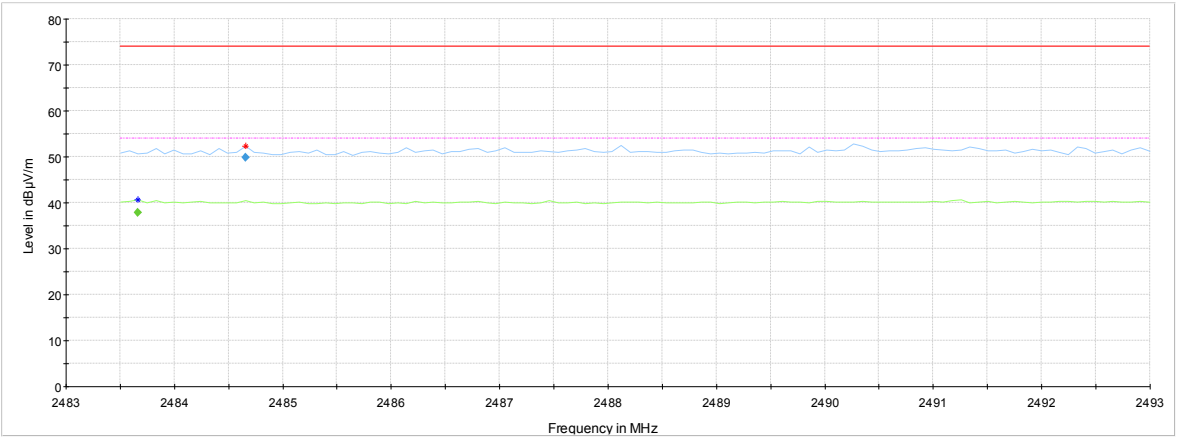
Setup: S01_AA01



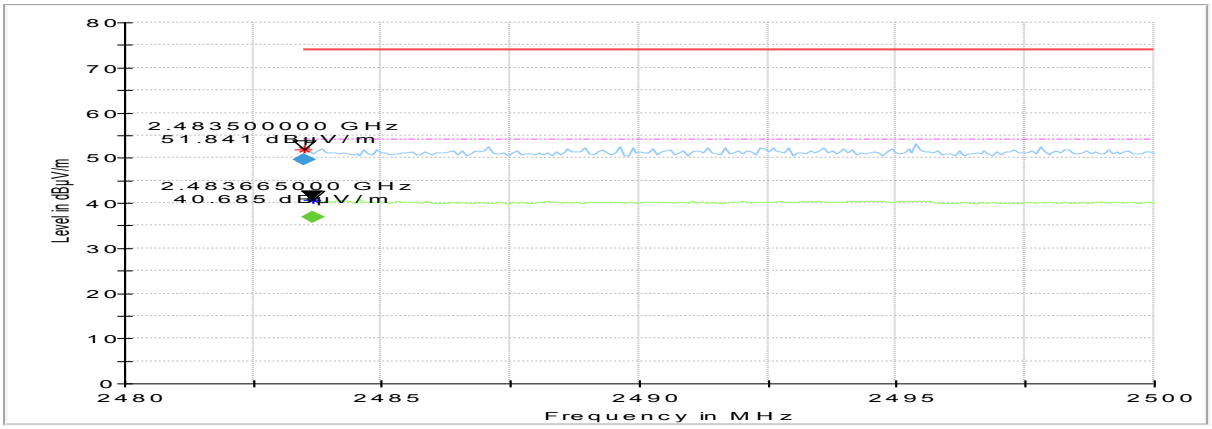
Setup: S01_BD01



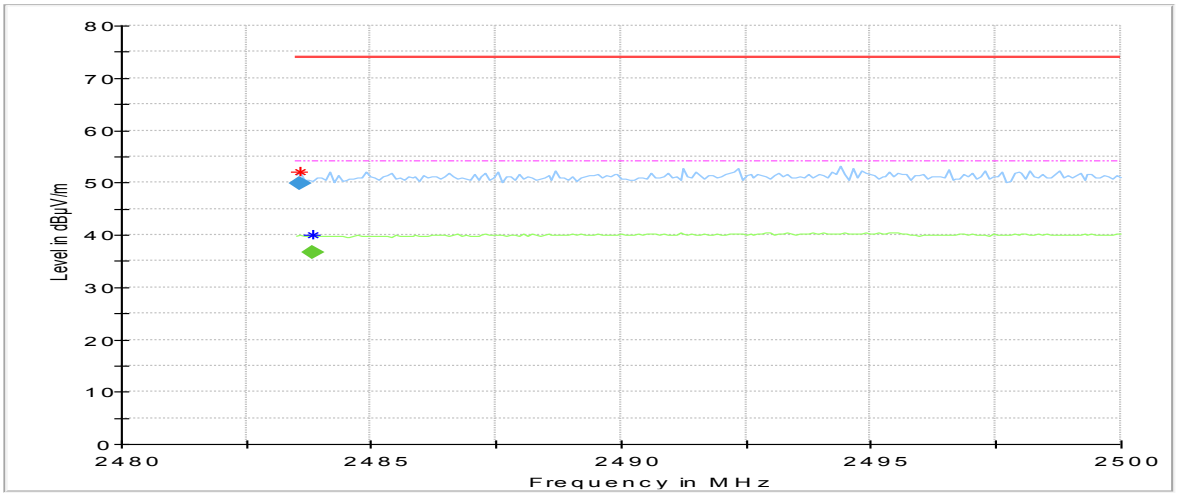
Setup: S02_BD01



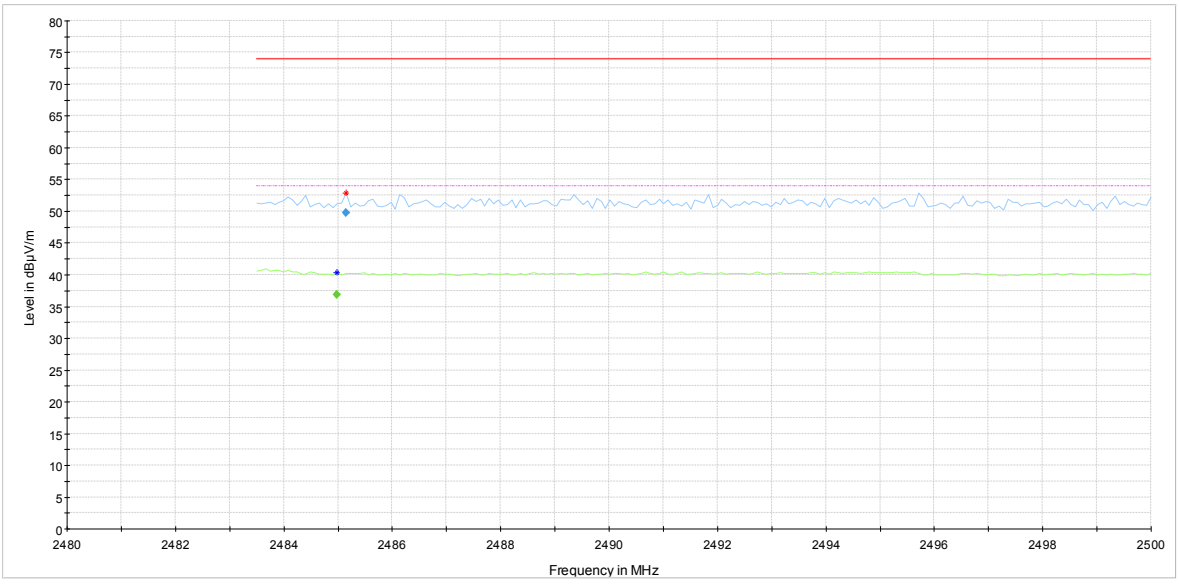
Setup: S03_BD01



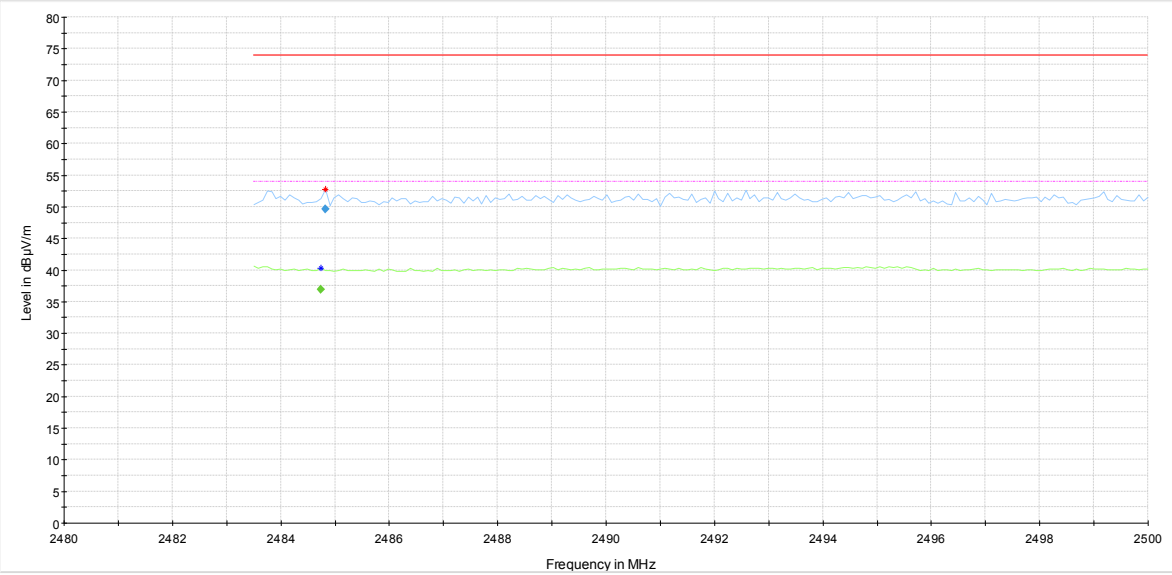
Setup: S04_BD01



Setup: S05_BD01



Setup: S06_BD01



4.8.5 TEST EQUIPMENT USED

Radiated Emissions

4.9 POWER DENSITY

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

4.9.1 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): 3 kHz
- Video Bandwidth (VBW): 10 kHz
- Trace: Maxhold
- Sweeps: 2000
- Sweeptime: 420 ms
- Detector: Peak

4.9.2 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.

4.9.3 TEST PROTOCOL

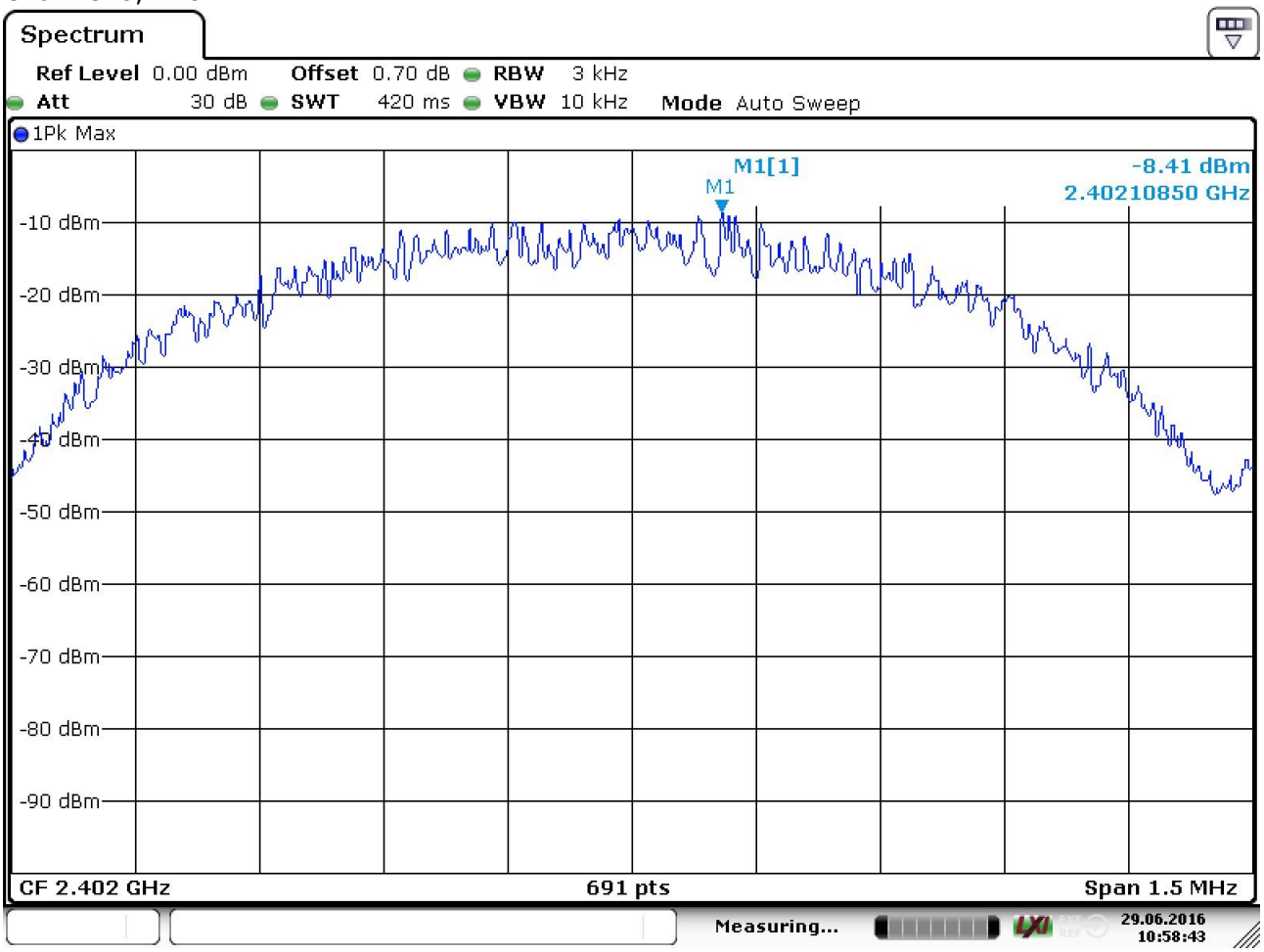
Ambient temperature: 23 °C
Air Pressure: 1007 hPa
Humidity: 45 %
BT LE

Band	Channel No.	Frequency [MHz]	Power Density [dBm/3kHz]	Limit [dBm/3kHz]	Margin to Limit [dB]
2.4 GHz ISM	0	2402.0	-8.4	8.0	16.4
	19	2440.0	-9.8	8.0	17.8
	39	2480.0	-10.1	8.0	18.1

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

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

Channel 0, 2402 MHz



Date: 29.JUN.2016 10:58:43

4.9.5 TEST EQUIPMENT USED

R&S TS8997

5 TEST EQUIPMENT

1 Conducted Emissions
Shielded Room 02

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
1.1	ESH 3-Z5	Two-Line V-Network	Rohde & Schwarz	828304/029	2015-03	2017-03
1.2	ESR 7	EMI Receiver / Spectrum Analyzer	Rohde & Schwarz	101424	2014-11	2016-11
1.3	EP 1200/B, NA/B1	Amplifier with integrated variable Oscillator	Spitzenberger & Spieß	B6278	2015-07	2018-07
1.4	ESIB 26	Spectrum Analyzer	Rohde & Schwarz	830482/004	2015-12	2017-12
1.5	Opus10 THI (8152.00)	ThermoHygro Datalogger 02 (Environ)	Lufft Mess- und Regeltechnik GmbH	7489	2015-02	2017-02
1.6	ESH 3-Z5	Two-Line V-Network	Rohde & Schwarz	829996/002	2015-03	2017-03
1.7	CMU 200	Universal Radio Communication Tester	Rohde & Schwarz	102366	2016-06	2019-05
1.8	Opus10 TPR (8253.00)	ThermoAirpressure Datalogger 13 (Environ)	Lufft Mess- und Regeltechnik GmbH	13936	2015-02	2017-02
1.9	CMD 55	Digital Radio Communication Tester	Rohde & Schwarz	831050/020	2014-12	2017-12
1.10	ESH 3-Z6	One-Line V-Network	Rohde & Schwarz	100489	2014-06	2017-11
1.11	ESH 3-Z6	One-Line V-Network	Rohde & Schwarz	100570	2013-11	2016-11
1.12	Chroma 6404	AC Power Source	Chroma ATE INC.	64040001304		
1.13	CMW 500	CMW 500	Rohde & Schwarz	107500	2015-07	2017-07

2 Radiated Emissions

Lab to perform radiated emission tests

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
2.1	3160-09	Standard Gain / Pyramidal Horn Antenna 26.5 GHz	EMCO Elektronic GmbH	00083069		
2.2	WHKX 7.0/18G-8SS	High Pass Filter	Wainwright	09		
2.3	5HC3500/18000-1.2-KK	High Pass Filter	Trilithic	200035008		
2.4	Fully Anechoic Room	8.80m x 4.60m x 4.05m (l x w x h)	Albatross Projects	P26971-647-001-PRB		
2.5	AM 4.0	Antenna mast	Maturo GmbH	AM4.0/180/11920513		
2.6	ESR 7	EMI Receiver / Spectrum Analyzer	Rohde & Schwarz	101424	2014-11	2016-11
2.7	TT 1.5 WI	Turn Table	Maturo GmbH	-		
2.8	Anechoic Chamber	10.58 x 6.38 x 6.00 m³	Frankonia	none	2014-01	2017-01
2.9	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2016-02	2018-02
2.10	ESIB 26	Spectrum Analyzer	Rohde & Schwarz	830482/004	2015-12	2017-12
2.11	Tilt device Maturo (Rohacell)	Antrieb TD1.5-10kg	Maturo GmbH	TD1.5-10kg/024/3790709		
2.12	5HC2700/12750-1.5-KK	High Pass Filter	Trilithic	9942012		
2.13	AS 620 P	Antenna mast	HD GmbH	620/37		
2.14	NRV-Z1	Sensor Head A	Rohde & Schwarz	827753/005	2016-05	2017-05
2.15	4HC1600/12750-1.5-KK	High Pass Filter	Trilithic	9942011		
2.16	ASP 1.2/1.8-10 kg	Antenna Mast	Maturo GmbH	-		
2.17	JS4-18002600-32-5P	Broadband Amplifier 18 GHz - 26 GHz	Miteq	849785		
2.18	JS4-00101800-35-5P	Broadband Amplifier 30 MHz - 18 GHz	Miteq	896037		

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
2.19	HL 562	Ultralog new biconicals	Rohde & Schwarz	830547/003	2015-06	2018-06
2.20	Opus10 THI (8152.00)	ThermoHygro Datalogger 12 (Environ)	Lufft Mess- und Regeltechnik GmbH	12482	2015-03	2017-03
2.21	JS4-00102600-42-5A	Broadband Amplifier 30 MHz - 26 GHz	Miteq	619368		
2.22	HFH2-Z2	Loop Antenna	Rohde & Schwarz	829324/006	2014-11	2017-11
2.23	FSW 43	Spectrum Analyzer	Rohde & Schwarz	103779	2014-11	2016-11
2.24	Opus10 TPR (8253.00)	ThermoAirpressure Datalogger 13 (Environ)	Lufft Mess- und Regeltechnik GmbH	13936	2015-02	2017-02
2.25	Chroma 6404	AC Power Source	Chroma ATE INC.	64040001304		
2.26	3160-10	Standard Gain / Pyramidal Horn Antenna 40 GHz	EMCO Elektronic GmbH	00086675		
2.27	HL 562 Ultralog	Log.-per. Antenna	Rohde & Schwarz	100609	2016-04	2019-04
2.28	PAS 2.5 - 10 kg	Antenna Mast	Maturo GmbH	-		
2.29	HF 907	Double-ridged horn	Rohde & Schwarz	102444	2015-05	2018-05

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Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
3.1	OSP120	Switching Unit with integrated power meter	Rohde & Schwarz	101158	2015-08	2016-08
3.2	A8455-4	4 Way Power Divider (SMA)		-		
3.3	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2016-02	2018-02
3.4	Opus10 THI (8152.00)	ThermoHygro Datalogger 03 (Environ)	Lufft Mess- und Regeltechnik GmbH	7482	2015-02	2017-02
3.5	SMB100A	Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz	107695	2014-06	2017-06

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
3.6	VT 4002	Climatic Chamber	Vötsch	58566002150010	2016-03	2018-03
3.7	FSV30	Signal Analyzer 10 Hz - 30 GHz	Rohde & Schwarz	103005	2016-02	2018-02
3.8	SMBV100A	Vector Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz	259291	2013-08	2016-08
3.9	1515 / 93459	Broadband Power Divider SMA (Aux)	Weinschel Associates	LN673		
3.10	Datum, Model: MFS	Rubidium Frequency Standard	Datum-Beverly	5489/001	2016-06	2017-06

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

6 ANTENNA FACTORS, CABLE LOSS AND SAMPLE CALCULATIONS

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

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

Frequency		Corr.	LISN insertion loss ESH3-Z5	cable loss (incl. 10 dB atten-uator)
MHz		dB	dB	dB
0,15		10,1	0,1	10,0
5		10,3	0,1	10,2
7		10,5	0,2	10,3
10		10,5	0,2	10,3
12		10,7	0,3	10,4
14		10,7	0,3	10,4
16		10,8	0,4	10,4
18		10,9	0,4	10,5
20		10,9	0,4	10,5
22		11,1	0,5	10,6
24		11,1	0,5	10,6
26		11,2	0,5	10,7
28		11,2	0,5	10,7
30		11,3	0,5	10,8

Sample calculation

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

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

Frequency	AF HFH-Z2)	Corr.	cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-40 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	m	m
0,009	20,50	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,01	20,45	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,015	20,37	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,02	20,36	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,025	20,38	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,03	20,32	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,05	20,35	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,08	20,30	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,1	20,20	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,2	20,17	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,3	20,14	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,49	20,12	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,490001	20,12	-39,6	0,1	0,1	0,1	0,1	-40	30	3
0,5	20,11	-39,6	0,1	0,1	0,1	0,1	-40	30	3
0,8	20,10	-39,6	0,1	0,1	0,1	0,1	-40	30	3
1	20,09	-39,6	0,1	0,1	0,1	0,1	-40	30	3
2	20,08	-39,6	0,1	0,1	0,1	0,1	-40	30	3
3	20,06	-39,6	0,1	0,1	0,1	0,1	-40	30	3
4	20,05	-39,5	0,2	0,1	0,1	0,1	-40	30	3
5	20,05	-39,5	0,2	0,1	0,1	0,1	-40	30	3
6	20,02	-39,5	0,2	0,1	0,1	0,1	-40	30	3
8	19,95	-39,5	0,2	0,1	0,1	0,1	-40	30	3
10	19,83	-39,4	0,2	0,1	0,2	0,1	-40	30	3
12	19,71	-39,4	0,2	0,1	0,2	0,1	-40	30	3
14	19,54	-39,4	0,2	0,1	0,2	0,1	-40	30	3
16	19,53	-39,3	0,3	0,1	0,2	0,1	-40	30	3
18	19,50	-39,3	0,3	0,1	0,2	0,1	-40	30	3
20	19,57	-39,3	0,3	0,1	0,2	0,1	-40	30	3
22	19,61	-39,3	0,3	0,1	0,2	0,1	-40	30	3
24	19,61	-39,3	0,3	0,1	0,2	0,1	-40	30	3
26	19,54	-39,3	0,3	0,1	0,2	0,1	-40	30	3
28	19,46	-39,2	0,3	0,1	0,3	0,1	-40	30	3
30	19,73	-39,1	0,4	0,1	0,3	0,1	-40	30	3

Sample calculation

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

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

(d_{Limit} = 3 m)

Frequency	AF R&S HL562	Corr.	cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-20 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	m	m
30	18,6	0,6	0,29	0,04	0,23	0,02	0,0	3	3
50	6,0	0,9	0,39	0,09	0,32	0,08	0,0	3	3
100	9,7	1,2	0,56	0,14	0,47	0,08	0,0	3	3
150	7,9	1,6	0,73	0,20	0,59	0,12	0,0	3	3
200	7,6	1,9	0,84	0,21	0,70	0,11	0,0	3	3
250	9,5	2,1	0,98	0,24	0,80	0,13	0,0	3	3
300	11,0	2,3	1,04	0,26	0,89	0,15	0,0	3	3
350	12,4	2,6	1,18	0,31	0,96	0,13	0,0	3	3
400	13,6	2,9	1,28	0,35	1,03	0,19	0,0	3	3
450	14,7	3,1	1,39	0,38	1,11	0,22	0,0	3	3
500	15,6	3,2	1,44	0,39	1,20	0,19	0,0	3	3
550	16,3	3,5	1,55	0,46	1,24	0,23	0,0	3	3
600	17,2	3,5	1,59	0,43	1,29	0,23	0,0	3	3
650	18,1	3,6	1,67	0,34	1,35	0,22	0,0	3	3
700	18,5	3,6	1,67	0,42	1,41	0,15	0,0	3	3
750	19,1	4,1	1,87	0,54	1,46	0,25	0,0	3	3
800	19,6	4,1	1,90	0,46	1,51	0,25	0,0	3	3
850	20,1	4,4	1,99	0,60	1,56	0,27	0,0	3	3
900	20,8	4,7	2,14	0,60	1,63	0,29	0,0	3	3
950	21,1	4,8	2,22	0,60	1,66	0,33	0,0	3	3
1000	21,6	4,9	2,23	0,61	1,71	0,30	0,0	3	3

(d_{Limit} = 10 m)

30	18,6	-9,9	0,29	0,04	0,23	0,02	-10,5	10	3
50	6,0	-9,6	0,39	0,09	0,32	0,08	-10,5	10	3
100	9,7	-9,2	0,56	0,14	0,47	0,08	-10,5	10	3
150	7,9	-8,8	0,73	0,20	0,59	0,12	-10,5	10	3
200	7,6	-8,6	0,84	0,21	0,70	0,11	-10,5	10	3
250	9,5	-8,3	0,98	0,24	0,80	0,13	-10,5	10	3
300	11,0	-8,1	1,04	0,26	0,89	0,15	-10,5	10	3
350	12,4	-7,9	1,18	0,31	0,96	0,13	-10,5	10	3
400	13,6	-7,6	1,28	0,35	1,03	0,19	-10,5	10	3
450	14,7	-7,4	1,39	0,38	1,11	0,22	-10,5	10	3
500	15,6	-7,2	1,44	0,39	1,20	0,19	-10,5	10	3
550	16,3	-7,0	1,55	0,46	1,24	0,23	-10,5	10	3
600	17,2	-6,9	1,59	0,43	1,29	0,23	-10,5	10	3
650	18,1	-6,9	1,67	0,34	1,35	0,22	-10,5	10	3
700	18,5	-6,8	1,67	0,42	1,41	0,15	-10,5	10	3
750	19,1	-6,3	1,87	0,54	1,46	0,25	-10,5	10	3
800	19,6	-6,3	1,90	0,46	1,51	0,25	-10,5	10	3
850	20,1	-6,0	1,99	0,60	1,56	0,27	-10,5	10	3
900	20,8	-5,8	2,14	0,60	1,63	0,29	-10,5	10	3
950	21,1	-5,6	2,22	0,60	1,66	0,33	-10,5	10	3
1000	21,6	-5,6	2,23	0,61	1,71	0,30	-10,5	10	3

Sample calculation

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

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

Frequency	AF R&S HF907	Corr.	cable loss 1 (relay + cable inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit, atten-uator & pre-amp)	cable loss 4 (to receiver)		
MHz	dB (1/m)	dB	dB	dB	dB	dB		
1000	24,4	-19,4	0,99	0,31	-21,51	0,79		
2000	28,5	-17,4	1,44	0,44	-20,63	1,38		
3000	31,0	-16,1	1,87	0,53	-19,85	1,33		
4000	33,1	-14,7	2,41	0,67	-19,13	1,31		
5000	34,4	-13,7	2,78	0,86	-18,71	1,40		
6000	34,7	-12,7	2,74	0,90	-17,83	1,47		
7000	35,6	-11,0	2,82	0,86	-16,19	1,46		

Frequency	AF R&S HF907	Corr.	cable loss 1 (relay inside chamber)	cable loss 2 (inside chamber)	cable loss 3 (outside chamber)	cable loss 4 (switch unit, atten-uator & pre-amp)	cable loss 5 (to receiver)	used for FCC 15.247
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	
3000	31,0	-23,4	0,47	1,87	0,53	-27,58	1,33	
4000	33,1	-23,3	0,56	2,41	0,67	-28,23	1,31	
5000	34,4	-21,7	0,61	2,78	0,86	-27,35	1,40	
6000	34,7	-21,2	0,58	2,74	0,90	-26,89	1,47	
7000	35,6	-19,8	0,66	2,82	0,86	-25,58	1,46	

Frequency	AF R&S HF907	Corr.	cable loss 1 (relay inside chamber)	cable loss 2 (High Pass)	cable loss 3 (pre-amp)	cable loss 4 (inside chamber)	cable loss 5 (outside chamber)	cable loss 6 (to receiver)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	dB
7000	35,6	-57,3	0,56	1,28	-62,72	2,66	0,94	1,46
8000	36,3	-56,3	0,69	0,71	-61,49	2,84	1,00	1,53
9000	37,1	-55,3	0,68	0,65	-60,80	3,06	1,09	1,60
10000	37,5	-56,2	0,70	0,54	-61,91	3,28	1,20	1,67
11000	37,5	-55,3	0,80	0,61	-61,40	3,43	1,27	1,70
12000	37,6	-53,7	0,84	0,42	-59,70	3,53	1,26	1,73
13000	38,2	-53,5	0,83	0,44	-59,81	3,75	1,32	1,83
14000	39,9	-56,3	0,91	0,53	-63,03	3,91	1,40	1,77
15000	40,9	-54,1	0,98	0,54	-61,05	4,02	1,44	1,83
16000	41,3	-54,1	1,23	0,49	-61,51	4,17	1,51	1,85
17000	42,8	-54,4	1,36	0,76	-62,36	4,34	1,53	2,00
18000	44,2	-54,7	1,70	0,53	-62,88	4,41	1,55	1,91

Sample calculation

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

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

Frequency	AF EMCO 3160-09	Corr.	cable loss 1 (inside chamber)	cable loss 2 (pre-amp)	cable loss 3 (inside chamber)	cable loss 4 (switch unit)	cable loss 5 (to receiver)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB
18000	40,2	-23,5	0,72	-35,85	6,20	2,81	2,65
18500	40,2	-23,2	0,69	-35,71	6,46	2,76	2,59
19000	40,2	-22,0	0,76	-35,44	6,69	3,15	2,79
19500	40,3	-21,3	0,74	-35,07	7,04	3,11	2,91
20000	40,3	-20,3	0,72	-34,49	7,30	3,07	3,05
20500	40,3	-19,9	0,78	-34,46	7,48	3,12	3,15
21000	40,3	-19,1	0,87	-34,07	7,61	3,20	3,33
21500	40,3	-19,1	0,90	-33,96	7,47	3,28	3,19
22000	40,3	-18,7	0,89	-33,57	7,34	3,35	3,28
22500	40,4	-19,0	0,87	-33,66	7,06	3,75	2,94
23000	40,4	-19,5	0,88	-33,75	6,92	3,77	2,70
23500	40,4	-19,3	0,90	-33,35	6,99	3,52	2,66
24000	40,4	-19,8	0,88	-33,99	6,88	3,88	2,58
24500	40,4	-19,5	0,91	-33,89	7,01	3,93	2,51
25000	40,4	-19,3	0,88	-33,00	6,72	3,96	2,14
25500	40,5	-20,4	0,89	-34,07	6,90	3,66	2,22
26000	40,5	-21,3	0,86	-35,11	7,02	3,69	2,28
26500	40,5	-21,1	0,90	-35,20	7,15	3,91	2,36

Sample calculation

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

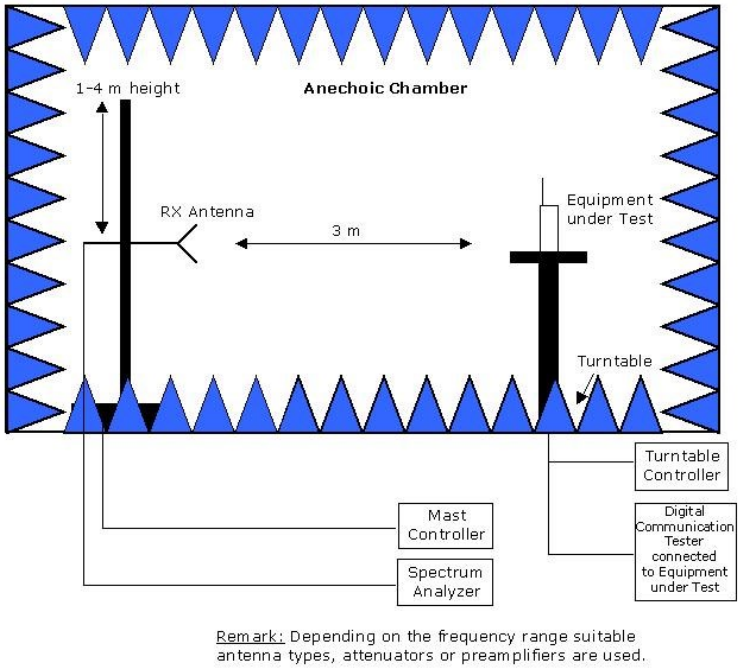
6.6 ANTENNA EMCO 3160-10 (18 GHZ – 26.5 GHZ)

Frequency	AF EMCO 3160-10	Corr.	cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-20 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
GHz	dB (1/m)	dB	dB	dB	dB	dB	dB	m	m
26,5	43,4	-11,2	4,4				-15,6	3	0,5
27,0	43,4	-11,2	4,4				-15,6	3	0,5
28,0	43,4	-11,1	4,5				-15,6	3	0,5
29,0	43,5	-11,0	4,6				-15,6	3	0,5
30,0	43,5	-10,9	4,7				-15,6	3	0,5
31,0	43,5	-10,8	4,7				-15,6	3	0,5
32,0	43,5	-10,7	4,8				-15,6	3	0,5
33,0	43,6	-10,7	4,9				-15,6	3	0,5
34,0	43,6	-10,6	5,0				-15,6	3	0,5
35,0	43,6	-10,5	5,1				-15,6	3	0,5
36,0	43,6	-10,4	5,1				-15,6	3	0,5
37,0	43,7	-10,3	5,2				-15,6	3	0,5
38,0	43,7	-10,2	5,3				-15,6	3	0,5
39,0	43,7	-10,2	5,4				-15,6	3	0,5
40,0	43,8	-10,1	5,5				-15,6	3	0,5

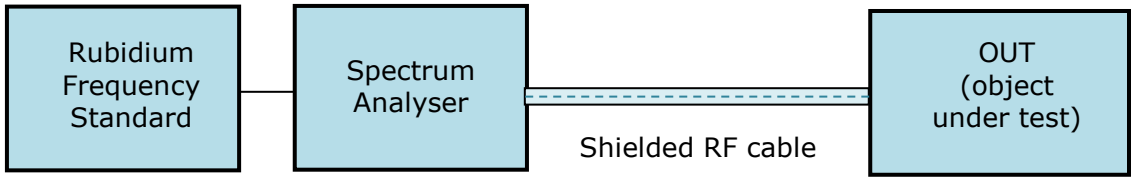
Sample calculation

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

7 SETUP DRAWINGS



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



Drawing 2: Setup for conducted radio tests.

8 MEASUREMENT UNCERTAINTIES

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

9 PHOTO REPORT

Please see separate photo report.