FCC Measurement/Technical Report on

Telematic Unit
CONBOX-HIGH

FCC ID: T8GP114
IC: 6434A-P114

Test Report Reference: MDE_HARMAN_1736_FCCa_rev1

Test Laboratory:
7layers GmbH
Borsigstrasse 11
40880 Ratingen
Germany

Deutsche Akkreditierungsstelle D-PL-12140-01-00

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1 APPLIED STANDARDS AND TEST SUMMARY

1.1 APPLIED STANDARDS

Type of Authorization
Certification for an Intentional Radiator.

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 (10-1-18 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, 2018-08-24". 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 FHSS (e.g. Bluetooth®) equipment from FCC and IC

FHSS equipment

Measurement	FCC reference	IC reference
Conducted emissions on AC Mains	§ 15.207	RSS-Gen Issue 5: 8.8
Occupied bandwidth	§ 15.247 (a) (1)	RSS-247 Issue 2: 5.1 (b)
Peak conducted output power	§ 15.247 (b) (1), (4)	RSS-247 Issue 2: 5.4 (b)
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
Dwell time	§ 15.247 (a) (1) (iii)	RSS-247 Issue 2: 5.1 (d)
Channel separation	§ 15.247 (a) (1)	RSS-247 Issue 2: 5.1 (b)
No. of hopping frequencies	§ 15.247 (a) (1) (iii)	RSS-247 Issue 2: 5.1 (d)
Hybrid systems (only)	§ 15.247 (f); § 15.247 (e)	RSS-247 Issue 2: 5.3
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 **§ 15.247 (a) (1)**

Occupied Bandwidth (20 dB)
The measurement was performed according to ANSI C63.10 **Final Result**

OP-Mode	**Setup**	**FCC**	**IC**
Radio Technology, Operating Frequency			
Bluetooth BDR, high	S01_AB01	Passed	Passed
Bluetooth BDR, low	S01_AB01	Passed	Passed
Bluetooth BDR, mid	S01_AB01	Passed	Passed
Bluetooth EDR 2, high	S01_AB01	Passed	Passed
Bluetooth EDR 2, low	S01_AB01	Passed	Passed
Bluetooth EDR 2, mid	S01_AB01	Passed	Passed
Bluetooth EDR 3, high	S01_AB01	Passed	Passed
Bluetooth EDR 3, low	S01_AB01	Passed	Passed
Bluetooth EDR 3, mid	S01_AB01	Passed	Passed

47 CFR CHAPTER I FCC PART 15 Subpart C §15.247 **§ 15.247 (b) (1) (2)**

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 BDR, high, conducted	S01_AB01	Passed	Passed
Bluetooth BDR, low, conducted	S01_AB01	Passed	Passed
Bluetooth BDR, mid, conducted	S01_AB01	Passed	Passed
Bluetooth EDR 2, high, conducted	S01_AB01	Passed	Passed
Bluetooth EDR 2, low, conducted	S01_AB01	Passed	Passed
Bluetooth EDR 2, mid, conducted	S01_AB01	Passed	Passed
Bluetooth EDR 3, high, conducted	S01_AB01	Passed	Passed
Bluetooth EDR 3, low, conducted	S01_AB01	Passed	Passed
Bluetooth EDR 3, mid, conducted	S01_AB01	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	**Setup**	**FCC**	**IC**
Radio Technology, Operating Frequency			
Bluetooth BDR, high	S01_AB01	Passed	Passed
Bluetooth BDR, low	S01_AB01	Passed	Passed
Bluetooth BDR, mid	S01_AB01	Passed	Passed
Bluetooth EDR 2, high	S01_AB01	Passed	Passed
Bluetooth EDR 2, low	S01_AB01	Passed	Passed
Bluetooth EDR 2, mid	S01_AB01	Passed	Passed
Bluetooth EDR 3, high	S01_AB01	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 EDR 3, low	S01_AB01	Passed	Passed
Bluetooth EDR 3, mid	S01_AB01	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 BDR, high, 1 GHz - 26 GHz	S01_AE02	Passed	Passed
Bluetooth BDR, high, 30 MHz - 1 GHz	S01_AE02	Passed	Passed
Bluetooth BDR, low, 1 GHz - 26 GHz	S01_AE02	Passed	Passed
Bluetooth BDR, low, 30 MHz - 1 GHz	S01_AE02	Passed	Passed
Bluetooth BDR, mid, 1 GHz - 26 GHz	S01_AE02	Passed	Passed
Bluetooth BDR, mid, 30 MHz - 1 GHz	S01_AE02	Passed	Passed
Bluetooth BDR, mid, 9 kHz - 30 MHz	S01_AE02	Passed	Passed
Bluetooth EDR 2, high, 1 GHz - 26 GHz Remark: 1-8GHz	S01_AE02	Passed	Passed
Bluetooth EDR 2, low, 1 GHz - 26 GHz Remark: 1-8GHz	S01_AE02	Passed	Passed
Bluetooth EDR 2, mid, 1 GHz - 26 GHz Remark: 1-8GHz	S01_AE02	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 BDR, high, high	S01_AB01	Passed	Passed
Bluetooth BDR, hopping, high	S01_AB01	Passed	Passed
Bluetooth BDR, hopping, low	S01_AB01	Passed	Passed
Bluetooth BDR, low, low	S01_AB01	Passed	Passed
Bluetooth EDR 2, high, high	S01_AB01	Passed	Passed
Bluetooth EDR 2, hopping, high	S01_AB01	Passed	Passed
Bluetooth EDR 2, hopping, low	S01_AB01	Passed	Passed
Bluetooth EDR 2, low, low	S01_AB01	Passed	Passed
Bluetooth EDR 3, high, high	S01_AB01	Passed	Passed
Bluetooth EDR 3, hopping, high	S01_AB01	Passed	Passed
Bluetooth EDR 3, hopping, low	S01_AB01	Passed	Passed
Bluetooth EDR 3, low, low	S01_AB01	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 BDR, high, high	S01_AE02	Passed	Passed
Bluetooth EDR 2, high, high	S01_AE02	Passed	Passed
Bluetooth EDR 3, high, high	S01_AE02	Passed	Passed

47 CFR CHAPTER I FCC PART 15 Subpart C §15.247	§ 15.247 (a) (1)		
Channel Separation The measurement was performed according to ANSI C63.10		**Final Result**	
OP-Mode Radio Technology	**Setup**	**FCC**	**IC**
Bluetooth BDR	S01_AB01	Passed	Passed

47 CFR CHAPTER I FCC PART 15 Subpart C §15.247	§ 15.247 (a) (1) (i) (ii) (iii)		
Dwell Time The measurement was performed according to ANSI C63.10		**Final Result**	
OP-Mode Radio Technology	**Setup**	**FCC**	**IC**
Bluetooth BDR	S01_AB01	Passed	Passed

47 CFR CHAPTER I FCC PART 15 Subpart C §15.247	§ 15.247 (a) (1) (i) (ii) (iii)		
Number of Hopping Frequencies The measurement was performed according to ANSI C63.10		**Final Result**	
OP-Mode Radio Technology	**Setup**	**FCC**	**IC**
Bluetooth BDR	S01_AB01	Passed	Passed

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

2 REVISION HISTORY

Report version control			
Version	**Release date**	**Change Description**	**Version validity**
initial	2019-04-12	--	valid
rev1	2019-05-14	Changed referenced version of 47 CFR Ch.1 Parts 2 and 15 edition to 2018	valid

COMMENT: -

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

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

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40880 Ratingen, Germany
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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. Marco Kullik
Report Template Version:	2019-02-12

3.2 PROJECT DATA

Responsible for testing and report:	Dipl.-Ing. Daniel Gall
Employees who performed the tests:	documented internally at 7Layers
Date of Report:	2019-05-14
Testing Period:	2018-11-21 to 2019-03-11

3.3 APPLICANT DATA

Company Name:	HARMAN BECKER Automotive Systems GmbH
Address:	Becker-Goering-Str. 16 76307 Karlsbad Germany
Contact Person:	Stefan Blaschek

3.4 MANUFACTURER DATA

Company Name:	HARMAN BECKER Automotive Systems GmbH
Address:	Becker-Goering-Str. 16 76307 Karlsbad Germany
Contact Person:	Stefan Blaschek

4 TEST OBJECT DATA

4.1 GENERAL EUT DESCRIPTION

Kind of Device product description	Telematic system with wireless technologies
Product name	CONBOX-HIGH
Type	CONBOX-HIGH
Declared EUT data by the supplier	
Voltage Type	DC
Voltage Level	12 V
Tested Modulation Type	BDR (DHx Packets): GFSK EDR (2-DHx Packets): π/4 DQPSK EDR (3-DHx Packets): 8-DPSK
Specific product description for the EUT	In the 2.4 GHz band the EUT has integrated Bluetooth, Bluetooth Low Energy and WLAN functionality. Relevant for this report is the Bluetooth Classic transmitter supporting BDR and EDR datarates. One antenna is used for Bluetooth Classic. The antenna gain for 2.4 GHz band is: -0.1 dBi
The EUT provides the following ports:	Enclosure Cable Harness incl. DC (unshielded) Antenna Port Cellular (4 Antennas, shielded) Antenna Port WLAN/BT/BT LE (3 Antennas, shielded) Antenna Port GNSS (1 Antenna, shielded)
Tested datarates	BDR (DHx Packets): 1 Mbps EDR (2-DHx Packets): 2 Mbps EDR (3-DHx Packets): 3 Mbps

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_ae02	ae02	Sample used for radiated tests
Sample Parameter	**Value**	
Serial No.	A975J20JB000071	
HW Version	EC995	
SW Version	Y025	
Comment		
Integral Antenna	None	

Sample Name	Sample Code	Description
EUT_ab01	ab01	Sample used for conducted tests
Sample Parameter	**Value**	
Serial No.	P114H00JB001124	
HW Version	EC983	
SW Version	Z025	
Comment		
Integral Antenna	None	

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
-	-	-

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**
AUX1	4M0.035.507, 09/18, - , 00052/00056/00191/00037	4 external cellular antennas
AUX2	4N0 035 500, 47/17, -, -	3 external WLAN/BT antennas
AUX3	Hirschmann, -	External GNSS antenna

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**
S01_AE02	EUT_ae02, AUX 1 +AUX 2 + AUX3	Radiated Setup
S01_AB01	EUT_ab01	Conducted Setup

4.6 OPERATING MODES

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

4.6.1 TEST CHANNELS

	2.4 GHz ISM 2400 - 2483.5 MHz		
BT Test Channels:	**low**	**mid**	**high**
Channel:	0	39	78
Frequency [MHz]	2402	2441	2480

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 OCCUPIED BANDWIDTH (20 DB)

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.1.1 TEST DESCRIPTION

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

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

Analyzer settings:
- Resolution Bandwidth (RBW): 1% to 5 % of the OBW
- Video Bandwidth (VBW): 3 x RBW
- Span: 2 to 5 times the OBW
- Trace: Maxhold
- Detector: Peak

For more details see result plots.

The technology depending measurement parameters can be found in the measurement plot.

5.1.2 TEST REQUIREMENTS / LIMITS

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

For the band: 902 – 928 MHz
FCC Part 15, Subpart C, §15.247 (a) (1) (i)

The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz

For the band: 5725 – 5850 MHz
FCC Part 15, Subpart C, §15.247 (a) (1) (ii)

The maximum allowed 20 dB bandwidth of the hopping channel is 1 MHz

For the frequency band 2400 – 2483.5 MHz:

FCC Part 15, Subpart C, §15.247 (a) (1) (iii)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

Implication by the test laboratory:
Since the Bluetooth technology defines a fixed channel separation of 1 MHz this design parameter defines the maximum allowed occupied bandwidth depending on the EUT's output power:
1. Under the provision that the system operates with an output power not greater than 125 mW (21.0 dBm):
Implicit Limit: Max. 20 dB BW = 1.0 MHz / 2/3 = 1.5 MHz

2. If the system output power exceeds 125 mW (21.0 dBm):
Implicit Limit: Max. 20 dB BW = 1.0 MHz

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

The measured output power of the system is below 125 mW (21.0 dBm). For the results, please refer to the related chapter of this report.
Therefore the limit is determined as 1.5 MHz.

5.1.3 TEST PROTOCOL

Ambient temperature: 25 °C
Air Pressure: 1010 hPa
Humidity: 37 %

BT GFSK (1-DH1)

Band	Channel No.	Frequency [MHz]	20 dB Bandwidth [MHz]	Limit [MHz]	Margin to Limit [MHz]
2.4 GHz ISM	0	2402	1.148	1.515	0.367
	39	2441	1.148	1.515	0.367
	78	2480	1.148	1.515	0.367

BT π/4 DQPSK (2-DH1)

Band	Channel No.	Frequency [MHz]	20 dB Bandwidth [MHz]	Limit [MHz]	Margin to Limit [MHz]
2.4 GHz ISM	0	2402	1.425	1.515	0.090
	39	2441	1.425	1.515	0.090
	78	2480	1.445	1.515	0.070

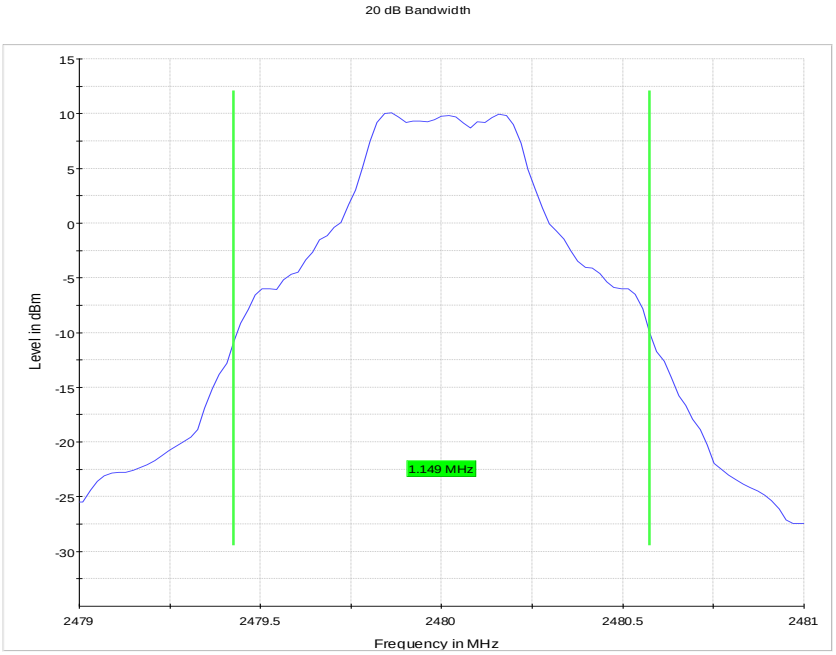
BT 8-DPSK (3-DH1)

Band	Channel No.	Frequency [MHz]	20 dB Bandwidth [MHz]	Limit [MHz]	Margin to Limit [MHz]
2.4 GHz ISM	0	2402	1.425	1.515	0.090
	39	2441	1.426	1.515	0.089
	78	2480	1.426	1.515	0.089

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

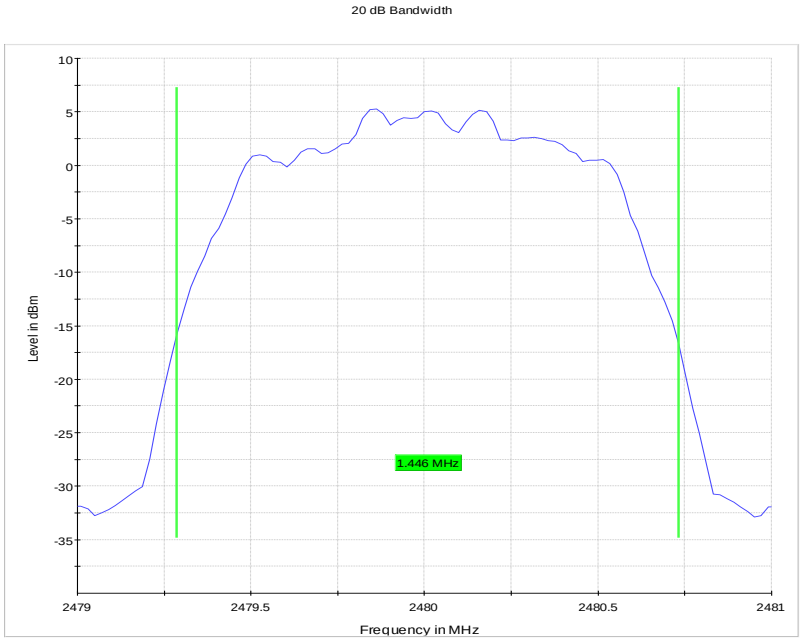
5.1.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

Radio Technology = Bluetooth BDR, Operating Frequency = high
(S01_AB01)



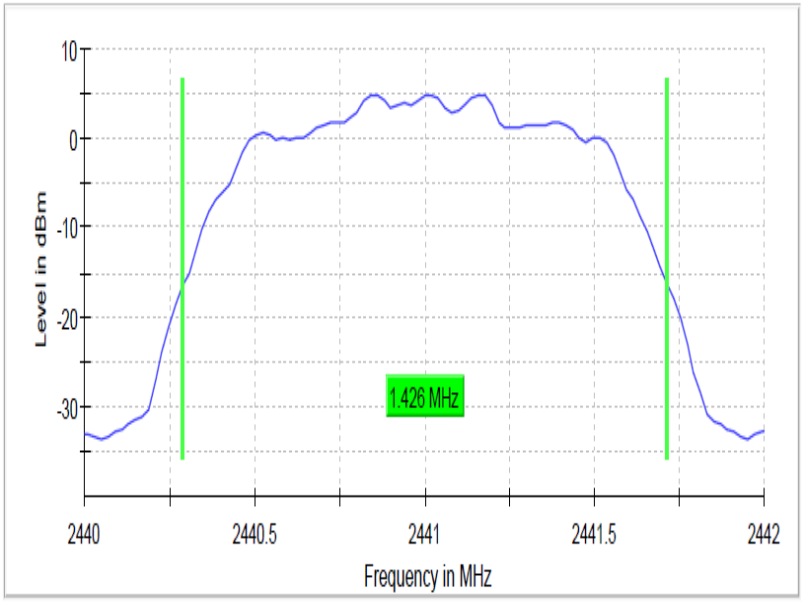
Setting	Instrument Value
Start Frequency	2.47900 GHz
Stop Frequency	2.48100 GHz
Span	2.000 MHz
RBW	100.000 kHz
VBW	300.000 kHz
SweepPoints	101
Sweeptime	18.938 µs
Reference Level	0.000 dBm
Attenuation	20.000 dB
Detector	MaxPeak
SweepCount	200
Filter	3 dB
Trace Mode	Max Hold
Sweeptype	FFT
Preamp	off
Stablemode	Trace
Stablevalue	0.50 dB
Run	7 / max. 150
Stable	5 / 5
Max Stable Difference	0.06 dB

Radio Technology = Bluetooth EDR 2, Operating Frequency = high
(S01_AB01)



Setting	Instrument Value
Start Frequency	2.47900 GHz
Stop Frequency	2.48100 GHz
Span	2.000 MHz
RBW	100.000 kHz
VBW	300.000 kHz
SweepPoints	101
Sweeptime	18.938 µs
Reference Level	0.000 dBm
Attenuation	20.000 dB
Detector	MaxPeak
SweepCount	200
Filter	3 dB
Trace Mode	Max Hold
Sweeptype	FFT
Preamp	off
Stablemode	Trace
Stablevalue	0.50 dB
Run	13 / max. 150
Stable	5 / 5
Max Stable Difference	0.23 dB

Radio Technology = Bluetooth EDR 3, Operating Frequency = mid
(S01_AB01)



Setting	Instrument Value
Start Frequency	2.44000 GHz
Stop Frequency	2.44200 GHz
Span	2.000 MHz
RBW	100.000 kHz
VBW	300.000 kHz
SweepPoints	101
Sweeptime	18.938 µs
Reference Level	0.000 dBm
Attenuation	20.000 dB
Detector	MaxPeak
SweepCount	200
Filter	3 dB
Trace Mode	Max Hold
Sweeptype	FFT
Preamp	off
Stablemode	Trace
Stablevalue	0.50 dB
Run	12 / max. 150
Stable	5 / 5
Max Stable Difference	0.04 dB

5.1.5 TEST EQUIPMENT USED

- R&S TS8997

5.2 PEAK POWER OUTPUT

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.2.1 TEST DESCRIPTION

FHSS EQUIPMENT:
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): 2 MHz
- Video Bandwidth (VBW): 10 MHz
- Trace: Maxhold
- Detector: Peak

For more details see result plots.

DTS EQUIPMENT:
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)

5.2.2 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)

5.2.3 TEST PROTOCOL

Ambient temperature: 25 °C
Air Pressure: 1010 hPa
Humidity: 37 %
BT GFSK (1-DH1)

Band	Channel No.	Frequency [MHz]	Peak Power [dBm]	Limit [dBm]	Margin to Limit [dB]
2.4 GHz ISM	0	2402	8.2	21.0	12.8
	39	2441	9.2	21.0	11.8
	78	2480	10.2	21.0	10.8

BT π/4 DQPSK (2-DH1)

Band	Channel No.	Frequency [MHz]	Peak Power [dBm]	Limit [dBm]	Margin to Limit [dB]
2.4 GHz ISM	0	2402	6.1	21.0	14.9
	39	2441	7.0	21.0	14.0
	78	2480	7.7	21.0	13.3

BT 8-DPSK (3-DH1)

Band	Channel No.	Frequency [MHz]	Peak Power [dBm]	Limit [dBm]	Margin to Limit [dB]
2.4 GHz ISM	0	2402	6.4	21.0	14.6
	39	2441	7.2	21.0	13.8
	78	2480	7.6	21.0	13.4

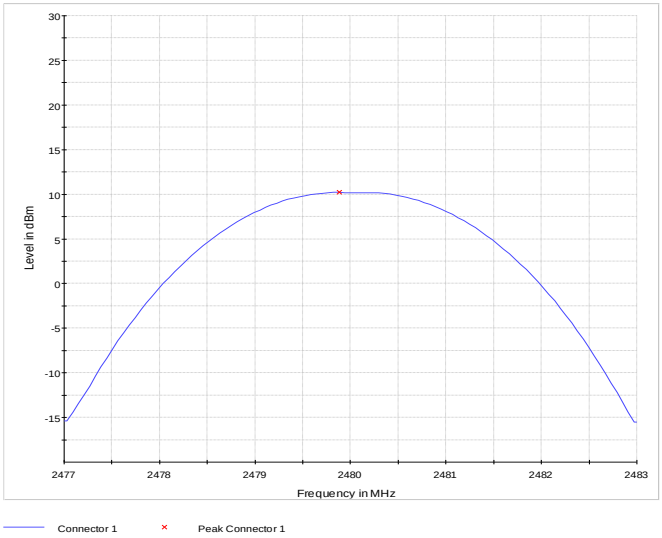
Remark: Please see next sub-clause for the measurement plot.

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

Radio Technology = Bluetooth BDR, Operating Frequency = high, Measurement method = conducted
(S01_AB01)

DUT Frequency (MHz)	Peak Power (dBm)	Limit Max (dBm)	Result
2480.000000	10.2	21.0	PASS

Peak Power

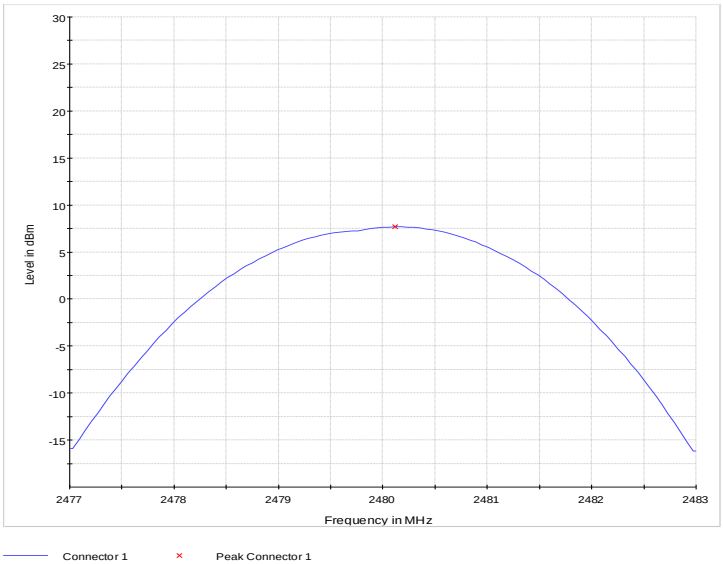


Setting	Instrument Value
Start Frequency	2.47700 GHz
Stop Frequency	2.48300 GHz
Span	6.000 MHz
RBW	2.000 MHz
VBW	10.000 MHz
SweepPoints	101
Sweeptime	953.450 ns
Reference Level	10.000 dBm
Attenuation	30.000 dB
Detector	MaxPeak
SweepCount	100
Filter	3 dB
Trace Mode	Max Hold
Sweeptype	FFT
Preamp	off
Stablemode	Trace
Stablevalue	0.50 dB
Run	4 / max. 150
Stable	3 / 3
Max Stable Difference	0.02 dB

Radio Technology = Bluetooth EDR 2, Operating Frequency = high, Measurement method = conducted
(S01_AB01)

DUT Frequency (MHz)	Peak Power (dBm)	Limit Max (dBm)
2480.000000	7.7	21.0

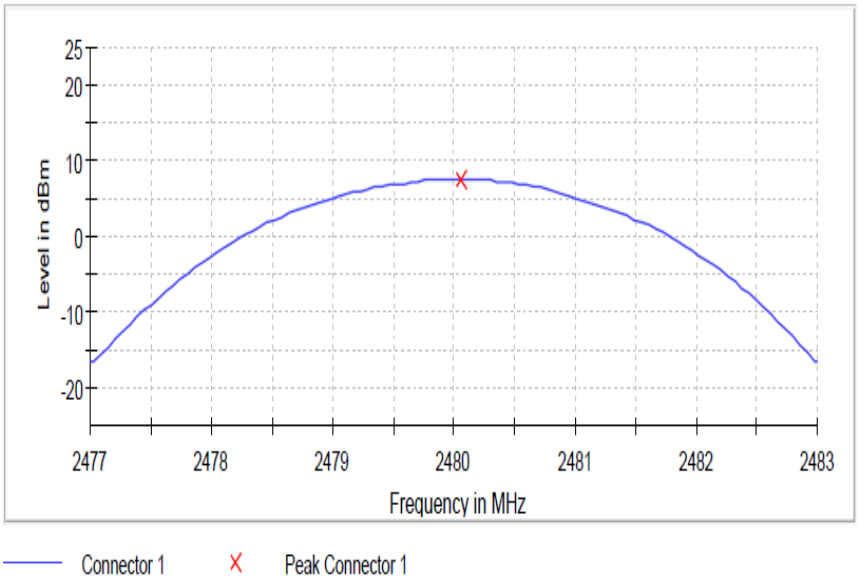
Peak Power



Setting	Instrument Value
Start Frequency	2.47700 GHz
Stop Frequency	2.48300 GHz
Span	6.000 MHz
RBW	2.000 MHz
VBW	10.000 MHz
SweepPoints	101
Sweeptime	953.450 ns
Reference Level	10.000 dBm
Attenuation	30.000 dB
Detector	MaxPeak
SweepCount	100
Filter	3 dB
Trace Mode	Max Hold
Sweeptype	FFT
Preamp	off
Stablemode	Trace
Stablevalue	0.50 dB
Run	8 / max. 150
Stable	3 / 3
Max Stable Difference	0.00 dB

Radio Technology = Bluetooth EDR 3, Operating Frequency = high, Measurement method = conducted
(S01_AB01)

DUT Frequency (MHz)	Peak Power (dBm)	Limit Max (dBm)	Result
2480.000000	7.6	21.0	PASS



Setting	Instrument Value
Start Frequency	2.47700 GHz
Stop Frequency	2.48300 GHz
Span	6.000 MHz
RBW	2.000 MHz
VBW	10.000 MHz
SweepPoints	101
Sweeptime	953.450 ns
Reference Level	10.000 dBm
Attenuation	30.000 dB
Detector	MaxPeak
SweepCount	100
Filter	3 dB
Trace Mode	Max Hold
Sweeptype	FFT
Preamp	off
Stablemode	Trace
Stablevalue	0.50 dB
Run	5 / max. 150
Stable	3 / 3
Max Stable Difference	0.43 dB

5.2.5 TEST EQUIPMENT USED

- R&S TS8997

5.3 SPURIOUS RF CONDUCTED EMISSIONS

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 spurious emissions measurements. The EUT was connected to spectrum analyzer via a short coax cable with a known loss.
Analyzer settings:

- Frequency range: 30 – 26000 MHz
- Resolution Bandwidth (RBW): 100 kHz below 1 GHz, 1 MHz above 1 GHz
- Video Bandwidth (VBW): 300 kHz below 1 GHz, 3 MHz above 1 GHz
- Trace: Maxhold
- Sweeps: till stable
- Sweep Time: coupled
- Detector: Peak

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

5.3.2 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.

5.3.3 TEST PROTOCOL

Ambient temperature: 25 °C
Air Pressure: 1010 hPa
Humidity: 37 %

BT GFSK (1-DH1)

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	-	-	PEAK	100	8.1	-11.9	>20
39	2441	-	-	PEAK	100	9.1	-10.9	>20
78	2480	-	-	PEAK	100	9.7	-10.3	>20

BT π/4 DQPSK (2-DH1)

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	-	-	PEAK	100	3.8	-16.2	>20
39	2441	-	-	PEAK	100	4.8	-15.2	>20
78	2480	-	-	PEAK	100	5.2	-14.8	>20

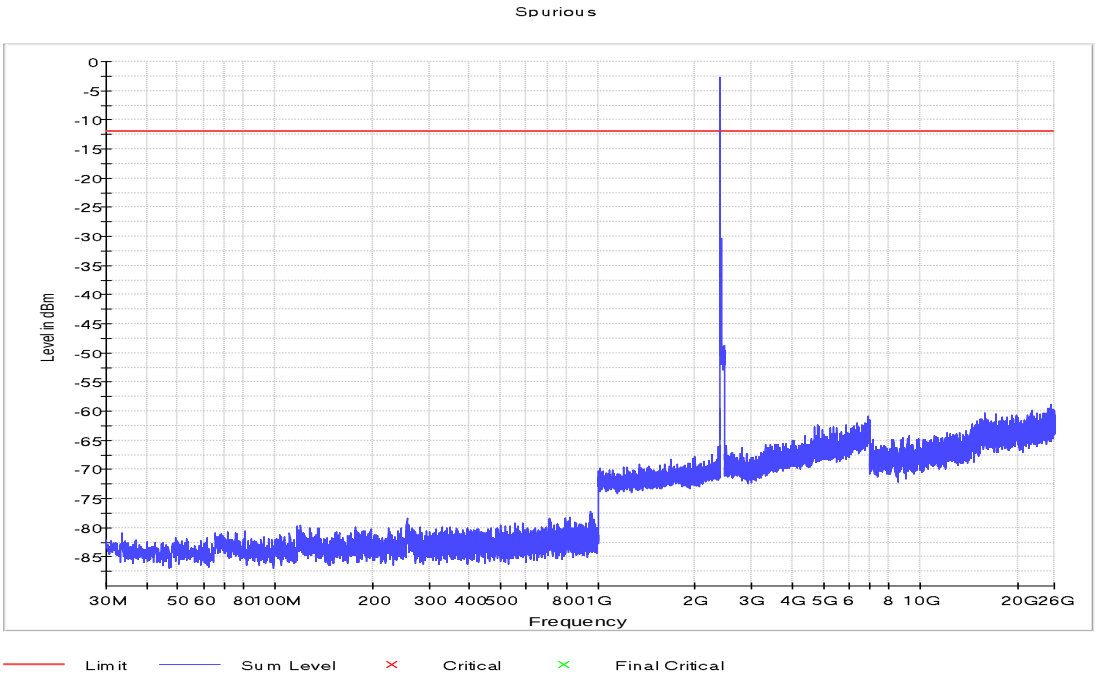
BT 8-DPSK (3-DH1)

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	-	-	PEAK	100	3.8	-16.2	>20
39	2441	-	-	PEAK	100	4.8	-15.2	>20
78	2480	-	-	PEAK	100	5.2	-14.8	>20

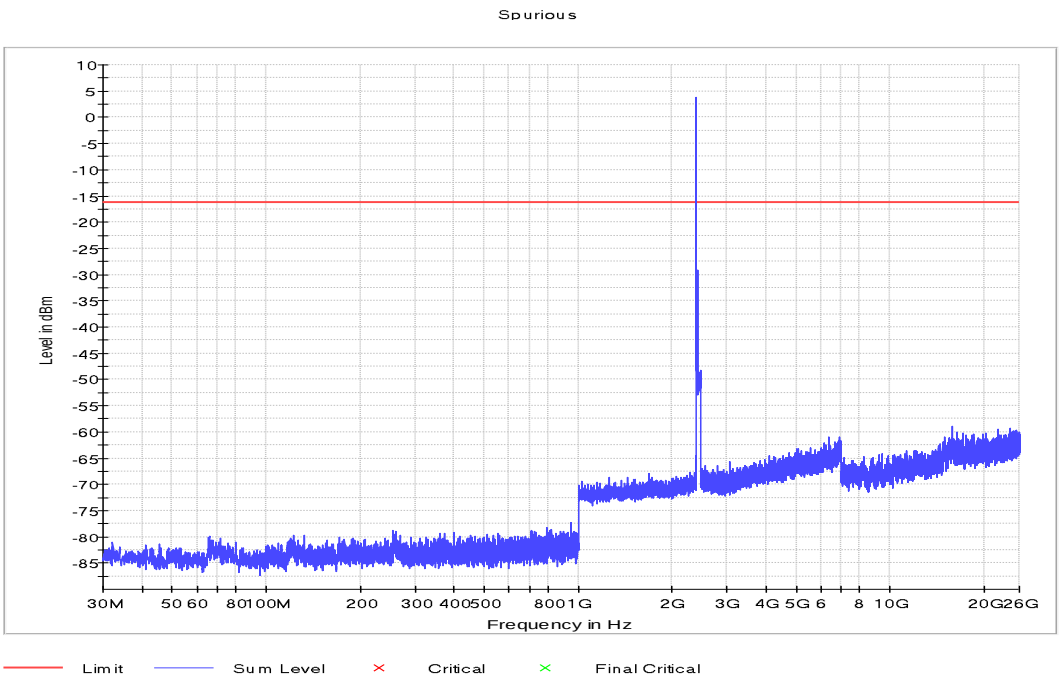
Remark: Please see next sub-clause for the measurement plot.

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

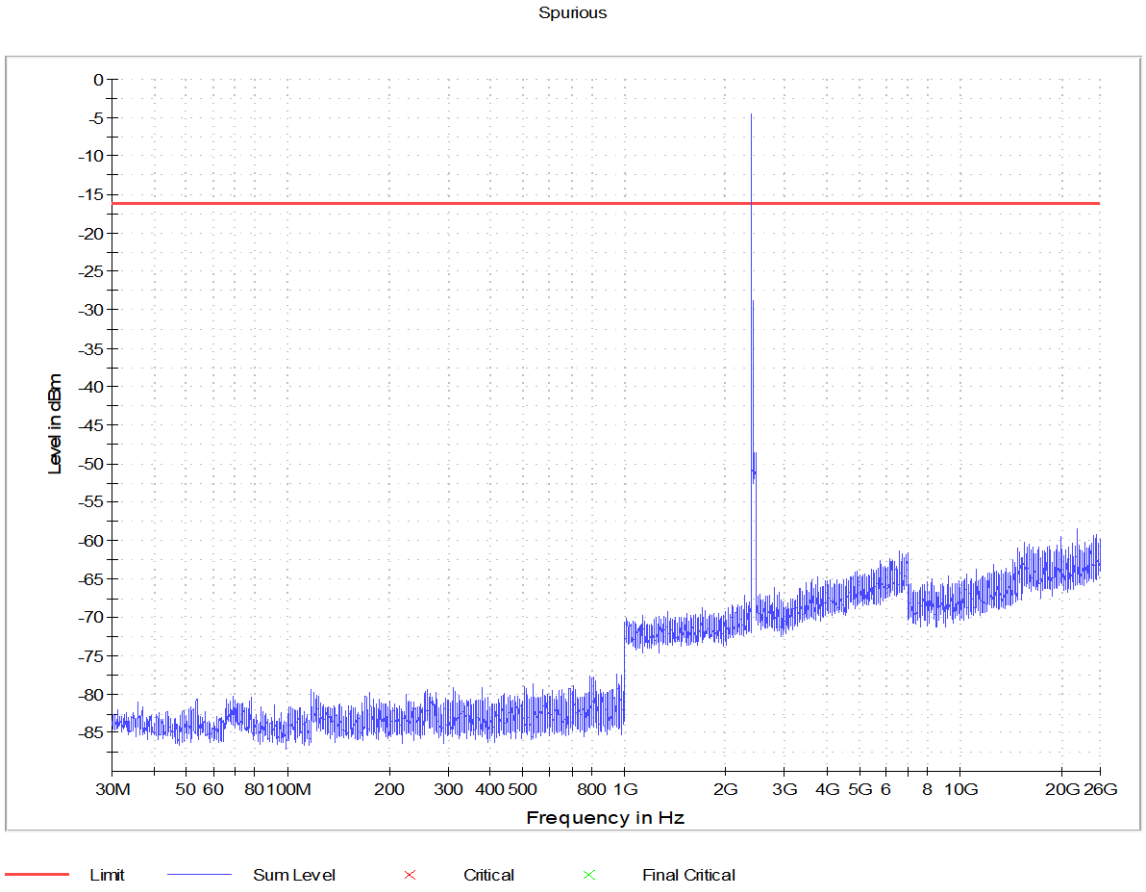
Radio Technology = Bluetooth BDR, Operating Frequency = low (S01_AB01)



Radio Technology = Bluetooth EDR 2, Operating Frequency = low (S01_AB01)



Radio Technology = Bluetooth EDR 3, Operating Frequency = low (S01_AB01)



5.3.5 TEST EQUIPMENT USED

- R&S TS8997

5.4 TRANSMITTER SPURIOUS RADIATED EMISSIONS

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.4.1 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

5.4.2 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)

5.4.3 TEST PROTOCOL

Ambient temperature: **23 - 24 °C**
Air Pressure: **1006–1018 hPa**
Humidity: **28–33 %**

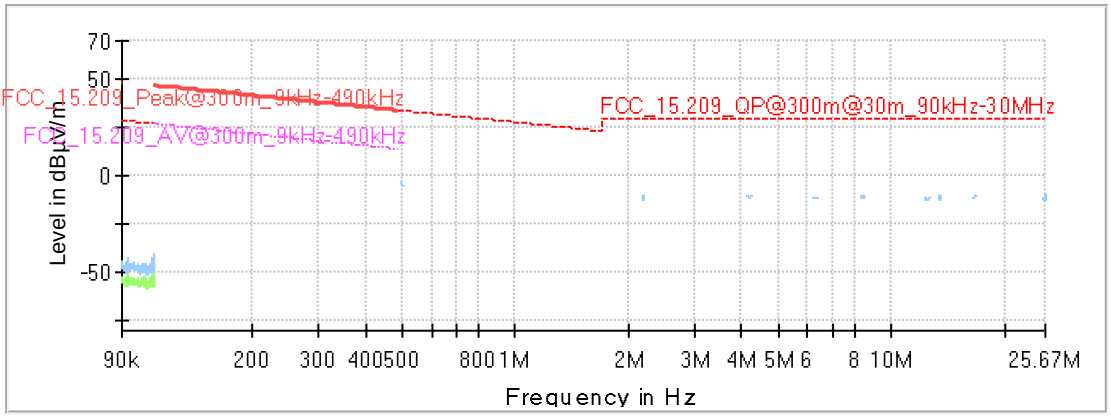
BT GFSK (1-DH1)								
Applied duty cycle correction (AV): 0 dB								
Ch. No.	**Ch. Center Freq. [MHz]**	**Spurious Freq. [MHz]**	**Spurious Level [dBµV/m]**	**Detec -tor**	**RBW [kHz]**	**Limit [dBµV/m]**	**Margin to Limit [dB]**	**Limit Type**
0	2402	-	-	- - -	1000	-	-	RB
39	2441	-	-	- - -	1000	-	-	RB
78	2480	-	-	- - -	1000	-	-	RB

BT π/4 DQPSK (2-DH1)								
Applied duty cycle correction (AV): 0 dB								
Ch. No.	**Ch. Center Freq. [MHz]**	**Spurious Freq. [MHz]**	**Spurious Level [dBµV/m]**	**Detec -tor**	**RBW [kHz]**	**Limit [dBµV/m]**	**Margin to Limit [dB]**	**Limit Type**
0	2402	-	-	- - -	1000	-	-	RB
39	2441	-	-	- - -	1000	-	-	RB
78	2480	-	-	- - -	1000	-	-	RB

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

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

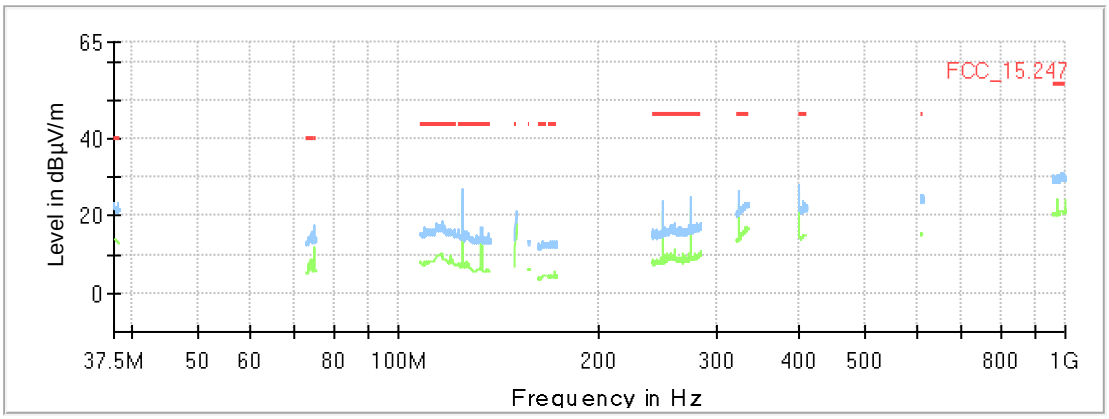
Radio Technology = Bluetooth BDR, Range 9kHz to 30 MHz, Operating Frequency = mid (S01_AE02)



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
---	---	---	---	---	---	---	---		---	---	

Radio Technology = Bluetooth BDR, Range 30 MHz to 1 GHz, Operating Frequency = mid (S01_AE02)



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
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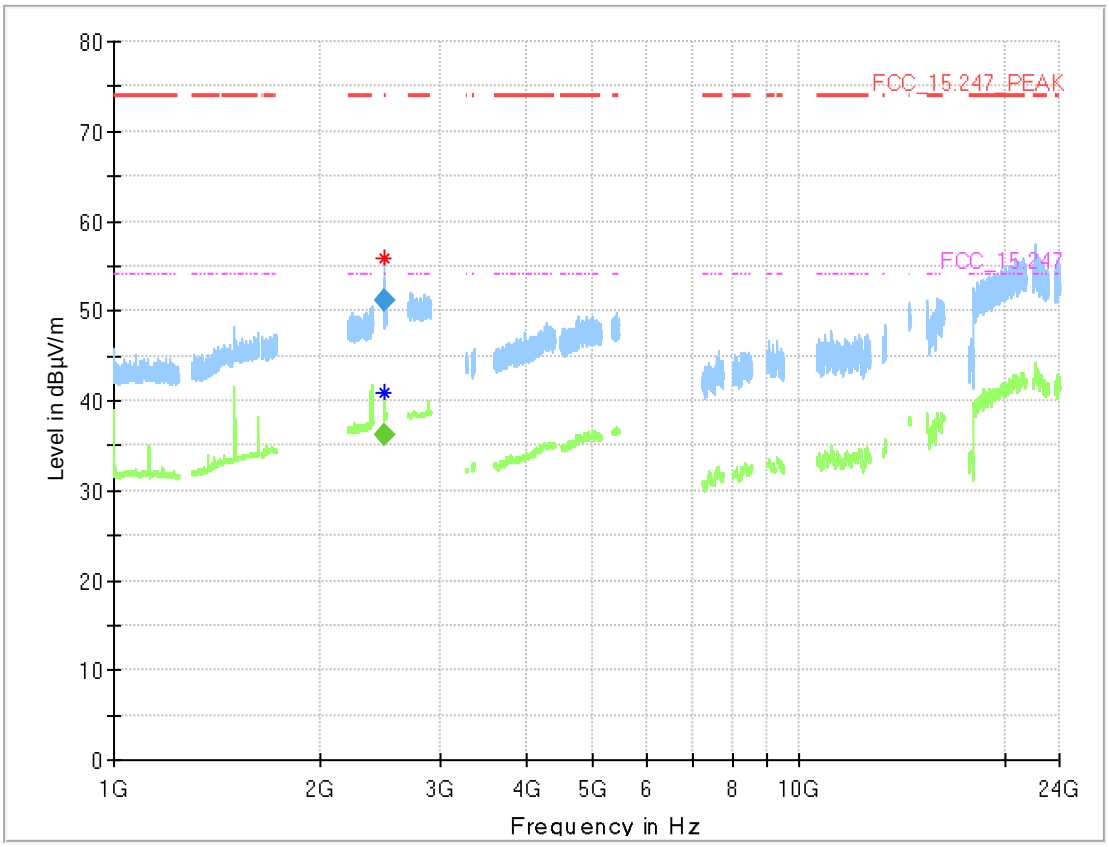
Radio Technology = Bluetooth BDR, Range 1 GHz to 26 GHz, Operating Frequency = high (S01_AE02)



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)
2483.500	55.8	---	74.00	18.16	---	---	150.0	V	49.0	84.0
2483.500	---	41.0	54.00	13.03	---	---	150.0	H	80.0	-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)
2483.500	---	36.3	54.00	17.74	1000.0	1000.000	150.0	H	80.0	-15.0
2483.500	51.2	---	74.00	22.83	1000.0	1000.000	150.0	V	49.0	84.0

5.4.5 TEST EQUIPMENT USED

- Radiated Emissions

5.5 BAND EDGE COMPLIANCE CONDUCTED

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.5.1 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:

- Lower Band Edge:
  Minimum frequency: 2310.0 MHz till upper band edge
  Upper Band Edge
  Maximum frequency: 2500.0 MHz from lower band edge
- Detector: Peak
- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Sweeptime: coupled
- Sweeps: till stable
- Trace: Maxhold

5.5.2 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..."

5.5.3 TEST PROTOCOL

Ambient temperature: 25 °C
Air Pressure: 1010 hPa
Humidity: 37 %

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	-47.0	PEAK	100	8.1	-11.9	35.1
78	2480	2483.5	-48.1	PEAK	100	9.7	-10.3	37.8
hopping	hopping	2400.0	-47.5	PEAK	100	9.6	-10.4	37.1
hopping	hopping	2483.5	-46.8	PEAK	100	9.6	-10.4	36.4

BT π/4 DQPSK (2-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	-47.3	PEAK	100	5.4	-14.6	32.7
78	2480	2483.5	-47.0	PEAK	100	5.2	-14.8	32.2
hopping	hopping	2400.0	-47.3	PEAK	100	5.4	-14.6	32.7
hopping	hopping	2483.5	-47.5	PEAK	100	5.4	-14.6	32.9

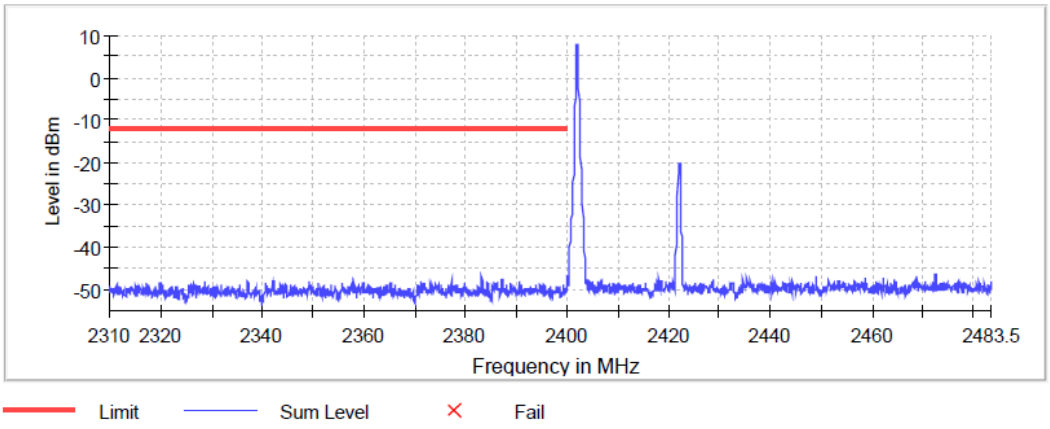
BT 8-DPSK (3-DH1)

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	-47.8	PEAK	100	3.8	-16.2	31.6
78	2480	2483.5	-47.6	PEAK	100	5.2	-14.8	32.8
hopping	hopping	2400.0	-47.1	PEAK	100	8.3	-11.7	35.4
hopping	hopping	2483.5	-48.0	PEAK	100	8.3	-11.7	36.3

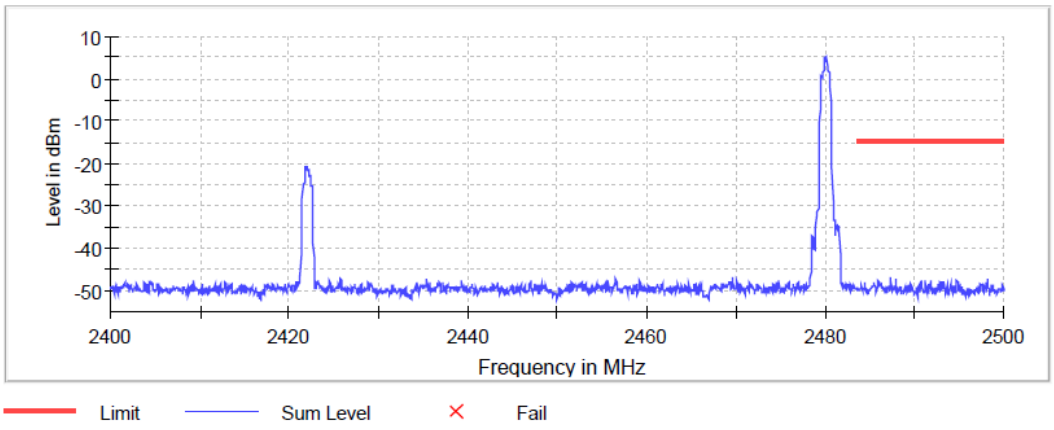
Remark: Please see next sub-clause for the measurement plot.

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

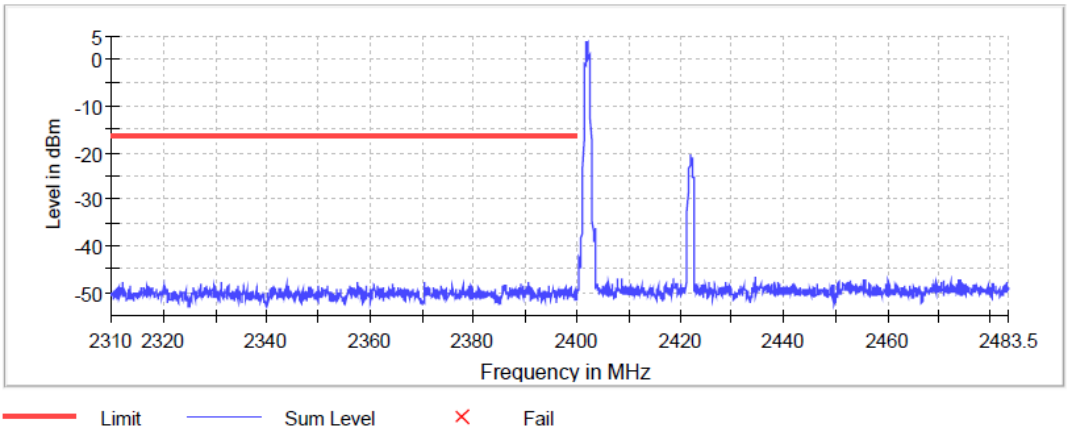
Radio Technology = Bluetooth BDR, Operating Frequency = low, Band Edge = low (S01_AB01)



Radio Technology = Bluetooth EDR 2, Operating Frequency = high, Band Edge = high (S01_AB01)



Radio Technology = Bluetooth EDR 3, Operating Frequency = low, Band Edge = low (S01_AB01)



5.5.5 TEST EQUIPMENT USED

- R&S TS8997

5.6 BAND EDGE COMPLIANCE RADIATED

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.6.1 TEST DESCRIPTION

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

5.6.2 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)

5.6.3 TEST PROTOCOL

Ambient temperature: 23 - 24 °C
Air Pressure: 1006–1018 hPa
Humidity: 28–33 %
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]	Detec-tor	RBW [kHz]	Limit [dBµV/m]	Margin to Limit [dB]	Limit Type
78	2480	2483.5	55.8	PEAK	1000	74.0	18.2	BE
78	2480	2483.5	36.3	AV	1000	54.0	17.7	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]	Detec-tor	RBW [kHz]	Limit [dBµV/m]	Margin to Limit [dB]	Limit Type
78	2480	2483.5	54.5	PEAK	1000	74.0	19.5	BE
78	2480	2483.5	36.4	AV	1000	54.0	17.6	BE

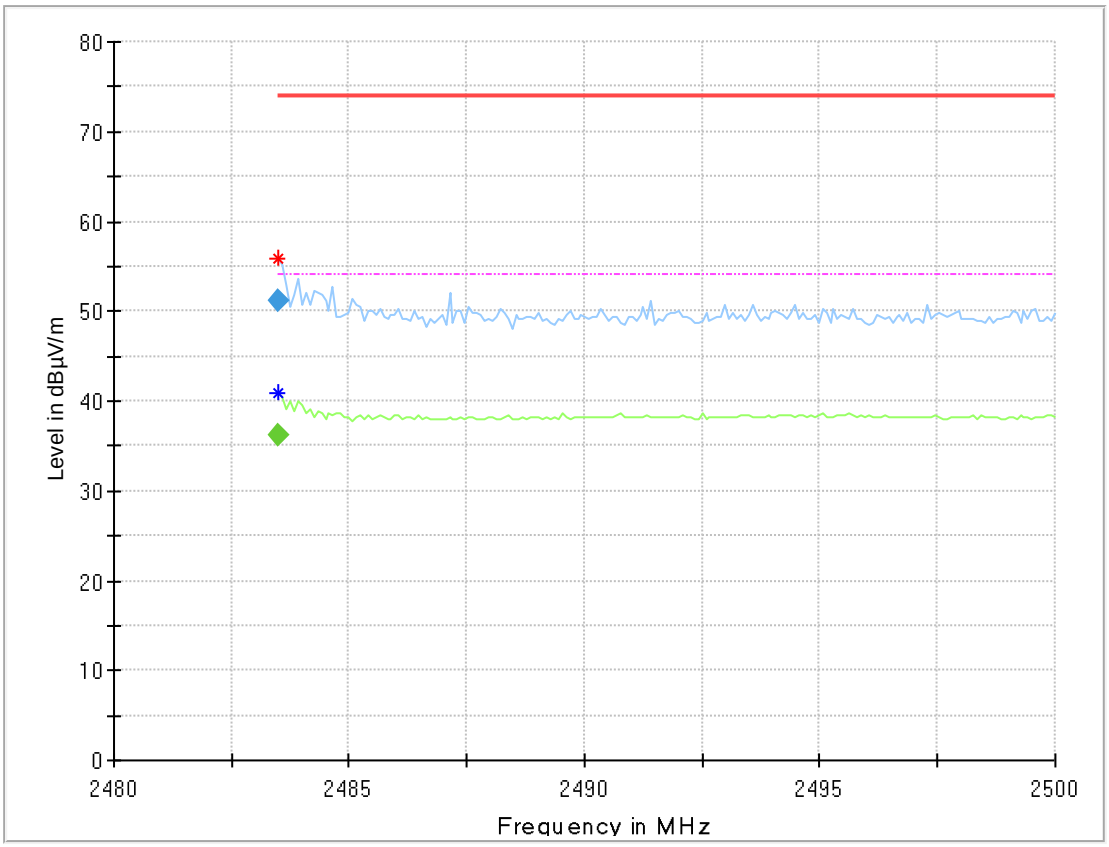
BT 8-DPSK (3-DH1)
Applied duty cycle correction (AV): 0 dB

Ch. No.	Ch. Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBµV/m]	Detec-tor	RBW [kHz]	Limit [dBµV/m]	Margin to Limit [dB]	Limit Type
78	2480	2483.5	55.5	PEAK	1000	74.0	18.5	BE
78	2480	2483.5	35.7	AV	1000	54.0	18.3	BE

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

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

Radio Technology = Bluetooth BDR, Operating Frequency = high, Band Edge = high (S01_AE02)



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)
2483.500	55.8	---	74.00	18.16	---	---	150.0	V	49.0	84.0
2483.500	---	41.0	54.00	13.03	---	---	150.0	H	80.0	-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)
2483.500	---	36.3	54.00	17.74	1000.0	1000.000	150.0	H	80.0	-15.0
2483.500	51.2	---	74.00	22.83	1000.0	1000.000	150.0	V	49.0	84.0

5.6.5 TEST EQUIPMENT USED

- Radiated Emissions

5.7 CHANNEL SEPARATION

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.7.1 TEST DESCRIPTION

The Equipment Under Test (EUT) was set up to perform the channel separation measurements. The channel separation is independent from the modulation pattern.

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

Analyzer settings:
See plot.

The technology depending measurement parameters can be found in the measurement plot.

5.7.2 TEST REQUIREMENTS / LIMITS

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

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

5.7.3 TEST PROTOCOL

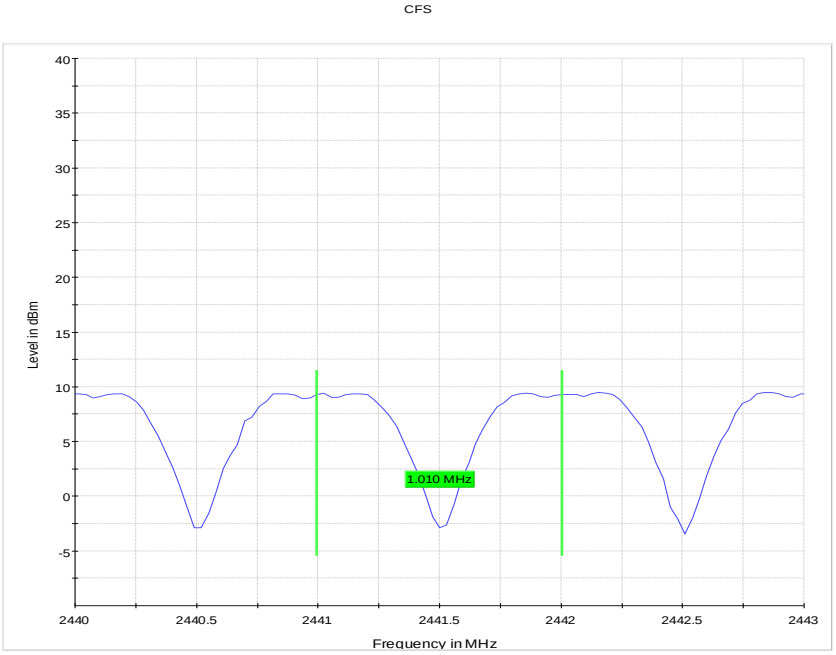
Ambient temperature: 25 °C
Air Pressure: 1010 hPa
Humidity: 37 %

Radio Technology	Channel Separation [MHz]	Limit [MHz]	Margin to Limit [MHz]
BT GFSK (1-DH1)	1.010	0.765	0.245

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

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

Radio Technology = Bluetooth BDR
(S01_AB01)



Setting	Instrument Value
Start Frequency	2.44000 GHz
Stop Frequency	2.44300 GHz
Span	3.000 MHz
RBW	300.000 kHz
VBW	300.000 kHz
SweepPoints	101
Sweeptime	1.000 ms
Reference Level	0.000 dBm
Attenuation	20.000 dB
Detector	MaxPeak
SweepCount	200
Filter	3 dB
Trace Mode	Max Hold
Sweeptype	Sweep
Preamp	off
Stablemode	Trace
Stablevalue	0.50 dB
Run	17 / max. 150
Stable	10 / 10
Max Stable Difference	0.00 dB

5.7.5 TEST EQUIPMENT USED

- Regulatory Bluetooth RF Test Solution

5.8 DWELL TIME

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.8.1 TEST DESCRIPTION

The Equipment Under Test (EUT) was set up to perform the dwell time measurements. The dwell time is independent from the modulation pattern. The dwell time is calculated by:

The EUT was connected to the spectrum analyzer via a short coax cable with a known loss. In parallel a power meter was connected for higher accuracy.

The highest value of the dwell time is reported.

Analyzer settings:
- Center Frequency: mid channel frequency
- Span: Zero span
- Detector: Peak
- Trace: Maxhold
- Resolution Bandwidth (RBW): ≤ channel separation
- Trigger: External

For more details see plot.

5.8.2 TEST REQUIREMENTS / LIMITS

For the band: 902 – 928 MHz
FCC Part 15, Subpart C, §15.247 (a) (1) (i)

If the 20 dB bandwidth of the hopping channel is less than 250 kHz the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period.

For the band: 5725 – 5850 MHz
FCC Part 15, Subpart C, §15.247 (a) (1) (ii)

The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 second period.

For the frequency band 2400 – 2483.5 MHz:
FCC Part 15, Subpart C, §15.247 (a) (1) (iii)

…The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Since the Bluetooth technology uses 79 channels this period is calculated to be 31.6 seconds.

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 frequency hopping operation of the hybrid system, with the direct sequence or digital modulation operation turned-off, shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4.
…

5.8.3 TEST PROTOCOL

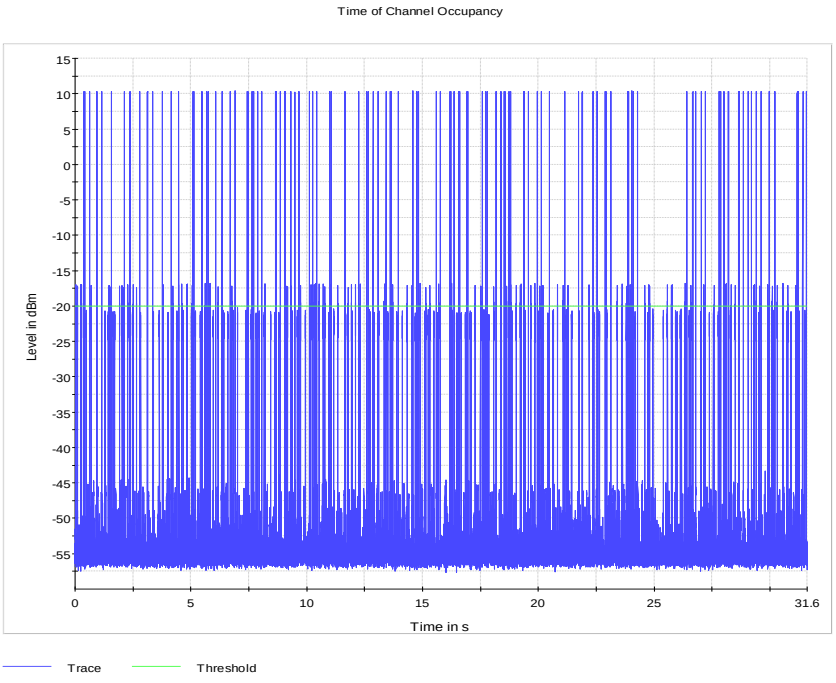
Ambient temperature: 25 °C
Air Pressure: 1015 hPa
Humidity: 30%

Radio Technology	Dwell Time [ms]	Limit [s]	Margin to Limit [ms]
BT GFSK (1-DH5)	333.150	0.4	66.850

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

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

Radio Technology = Bluetooth BDR
(S01_AB01)



Setting	Instrument Value
Center Frequency	2.44100 GHz
Span	ZeroSpan
RBW	500.000 kHz
VBW	1.000 MHz
SweepPoints	30001
Sweeptime	31.600 s
Reference Level	-20.000 dBm
Attenuation	0.000 dB
Detector	MaxPeak
SweepCount	1
Filter	Channel
Trace Mode	Clear Write
Sweeptype	Sweep
Preamp	off
Trigger	External
Trigger Offset	0.000 s

OSP

Setting	Instrument Value
Measurement Time	31.600 s
Tracepoints	31600000
Time resolution	1.000 µs
Detector	RMS

5.8.5 TEST EQUIPMENT USED

- Regulatory Bluetooth RF Test Solution

5.9 NUMBER OF HOPPING FREQUENCIES

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 to perform the number of hopping frequencies measurement. The number of hopping frequencies is independent from the modulation pattern.

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

Analyzer settings:

- Detector: Peak
- Trace: Maxhold
- Frequency span: Frequency band of operation
- Resolution Bandwidth (RBW): < 30 % of channel spacing or 20 dB bandwidth (whichever is smaller)
- Video Bandwidth (VBW): = RBW
- Sweep Time: coupled
- Sweeps: till stable

The technology depending measurement parameters can be found in the measurement plot.

5.9.2 TEST REQUIREMENTS / LIMITS

For the band: 902 – 928 MHz
FCC Part 15, Subpart C, §15.247 (a) (1) (i)

If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies.
If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies

For the band: 5725 – 5850 MHz
FCC Part 15, Subpart C, §15.247 (a) (1) (ii)

Frequency hopping systems operating in the 5725-5850 MHz band shall use at least 75 hopping frequencies.

For the band: 2400 – 2483.5 MHz
FCC Part 15, Subpart C, §15.247 (a) (1) (iii)

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

5.9.3 TEST PROTOCOL

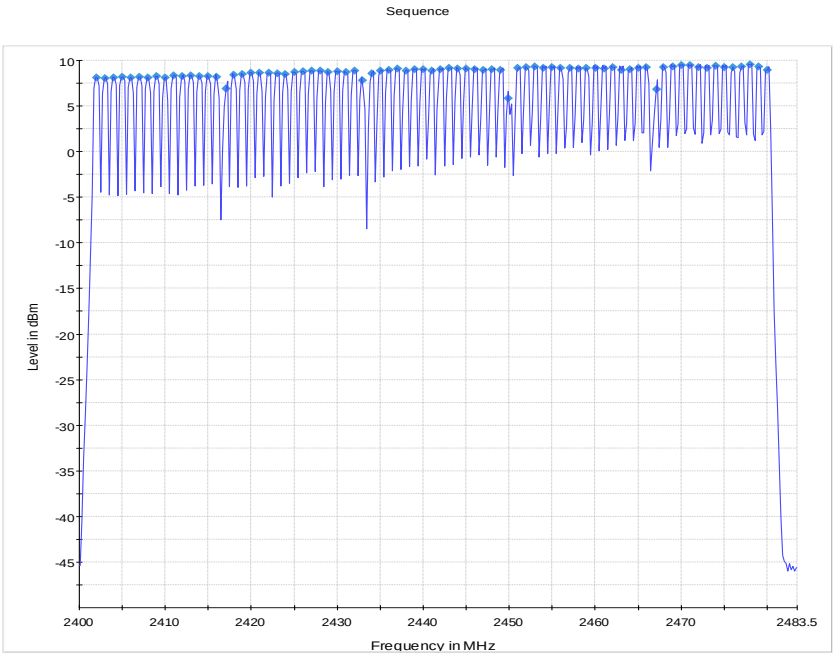
Ambient temperature: 25 °C
Air Pressure: 1015 hPa
Humidity: 30%

Radio Technology	Number of Hopping Frequencies	Limit	Margin to Limit
BT GFSK (1-DH1)	79	15	64

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

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

Radio Technology = Bluetooth BDR
(S01_AB01)



Setting	Instrument Value
Start Frequency	2.40000 GHz
Stop Frequency	2.48350 GHz
Span	83.500 MHz
RBW	200.000 kHz
VBW	200.000 kHz
SweepPoints	418
Sweeptime	47.405 µs
Reference Level	0.000 dBm
Attenuation	20.000 dB
Detector	MaxPeak
SweepCount	100
Filter	3 dB
Trace Mode	Max Hold
Sweeptype	FFT
Preamp	off
Stablemode	Trace
Stablevalue	0.50 dB
Run	65 / max. 150
Stable	3 / 3
Max Stable Difference	0.04 dB

5.9.5 TEST EQUIPMENT USED

- Regulatory Bluetooth RF Test Solution

6 TEST EQUIPMENT

1 R&S TS8997
EN300328/301893 Test Lab

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
1.1	SMB100A	Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz	107695	2017-07	2020-07
1.2	MFS	Rubidium Frequency Standard	Datum-Beverly	5489/001	2018-07	2019-07
1.3	1515 / 93459	Broadband Power Divider SMA (Aux)	Weinschel Associates	LN673		
1.4	FSV30	Signal Analyzer 10 Hz - 30 GHz	Rohde & Schwarz	103005	2018-04	2020-04
1.5	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2018-04	2020-04
1.6	VHF-3100+	High Pass Filter		-		
1.7	VT 4002	Temperature Chamber	Vötsch	58566002150010	2018-04	2020-04
1.8	A8455-4	4 Way Power Divider (SMA)		-		
1.9	Opus10 THI (8152.00)	ThermoHygro Datalogger 03 (Environ)	Lufft Mess- und Regeltechnik GmbH	7482	2017-03	2019-03
1.10	SMBV100A	Vector Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz	259291	2016-10	2019-10
1.11	OSP120	Switching Unit with integrated power meter	Rohde & Schwarz	101158	2018-05	2021-05

2 Radiated Emissions
Lab to perform radiated emission tests

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
2.1	NRV-Z1	Sensor Head A	Rohde & Schwarz GmbH & Co. KG	827753/005	2018-07	2019-07
2.2	MFS	Rubidium Frequency Normal MFS	Datum GmbH	002	2018-10	2020-10
2.3	Opus10 TPR (8253.00)	ThermoAirpressure Datalogger 13 (Environ)	Lufft Mess- und Regeltechnik GmbH	13936	2017-04	2019-04
2.4	ESW44	EMI Test Receiver	Rohde & Schwarz GmbH & Co. KG	101603	2018-05	2019-05
2.5	Anechoic Chamber	10.58 x 6.38 x 6.00 m³	Frankonia	none	2018-06	2020-06
2.6	FS-Z60	Harmonic Mixer 40 - 60 GHz	Rohde & Schwarz Messgerätebau GmbH	100178	2016-12	2019-12

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
2.7	FS-Z220	Harmonic Mixer 140 - 220 GHz	Rohde & Schwarz Messgerätebau GmbH	101005	2017-03	2020-03
2.8	SGH-05	Standard Gain / Pyramidal Horn Antenna (140 - 220 GHz)	RPG-Radiometer Physics GmbH	075		
2.9	HL 562	Ultralog new biconicals	Rohde & Schwarz	830547/003	2018-07	2021-07
2.10	5HC2700/12750 -1.5-KK	High Pass Filter	Trilithic	9942012		
2.11	ASP 1.2/1.8-10 kg	Antenna Mast	Maturo GmbH	-		
2.12	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
2.13	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2018-04	2020-04
2.14	NRVD	Power Meter	Rohde & Schwarz GmbH & Co. KG	828110/016	2018-07	2019-07
2.15	HF 906	Double-ridged horn	Rohde & Schwarz	357357/002	2018-09	2021-09
2.16	JS4-18002600-32-5P	Broadband Amplifier 18 GHz - 26 GHz	Miteq	849785		
2.17	FSW 43	Spectrum Analyzer	Rohde & Schwarz	103779		
2.18	3160-09	Standard Gain / Pyramidal Horn Antenna 26.5 GHz	EMCO Elektronic GmbH	00083069		
2.19	SGH-19	Standard Gain / Pyramidal Horn Antenna (40 - 60 GHz)	RPG-Radiometer Physics GmbH	093		
2.20	WHKX 7.0/18G-8SS	High Pass Filter	Wainwright	09		
2.21	4HC1600/12750 -1.5-KK	High Pass Filter	Trilithic	9942011		
2.22	Chroma 6404	AC Power Source	Chroma ATE INC.	64040001304		
2.23	JS4-00102600-42-5A	Broadband Amplifier 30 MHz - 26 GHz	Miteq	619368		
2.24	TT 1.5 WI	Turn Table	Maturo GmbH	-		
2.25	HL 562 Ultralog	Log.-per. Antenna	Rohde & Schwarz	100609	2016-04	2019-04
2.26	HF 906	Double-ridged horn	Rohde & Schwarz	357357/001	2018-03	2021-03
2.27	FS-Z325	Harmonic Mixer 220 - 325 GHz	Rohde & Schwarz Messgerätebau GmbH	101006	2017-03	2020-03

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
2.28	3160-10	Standard Gain / Pyramidal Horn Antenna 40 GHz	EMCO Elektronic GmbH	00086675		
2.29	SGH-08	Standard Gain / Pyramidal Horn Antenna (90 - 140 GHz)	RPG-Radiometer Physics GmbH	064		
2.30	SGH-12	Standard Gain / Pyramidal HornAntenna (60 - 90 GHz)	RPG-Radiometer Physics GmbH	326		
2.31	5HC3500/18000-1.2-KK	High Pass Filter	Trilithic	200035008		
2.32	FS-Z140	Harmonic Mixer 90 -140 GHz	Rohde & Schwarz Messgerätebau GmbH	101007	2017-02	2020-02
2.33	HFH2-Z2	Loop Antenna	Rohde & Schwarz	829324/006	2018-01	2021-01
2.34	Opus10 THI (8152.00)	ThermoHygro Datalogger 12 (Environ)	Lufft Mess- und Regeltechnik GmbH	12482	2017-03	2019-03
2.35	ESR 7	EMI Receiver / Spectrum Analyzer	Rohde & Schwarz	101424		
2.36	JS4-00101800-35-5P	Broadband Amplifier 30 MHz - 18 GHz	Miteq	896037		
2.37	AS 620 P	Antenna mast	HD GmbH	620/37		
2.38	Tilt device Maturo (Rohacell)	Antrieb TD1.5-10kg	Maturo GmbH	TD1.5-10kg/024/3790709		
2.39	SGH-03	Standard Gain / Pyramidal Horn Antenna (220 - 325 GHz)	RPG-Radiometer Physics GmbH	060		
2.40	FS-Z90	Harmonic Mixer 60 - 90 GHz	Rohde & Schwarz Messgerätebau GmbH	101686	2017-03	2020-03
2.41	ESIB 26	Spectrum Analyzer	Rohde & Schwarz	830482/004	2018-01	2020-01
2.42	PAS 2.5 - 10 kg	Antenna Mast	Maturo GmbH	-		
2.43	AFS42-00101800-25-S-42	Broadband Amplifier 25 MHz - 18 GHz	Miteq	2035324		
2.44	AM 4.0	Antenna mast	Maturo GmbH	AM4.0/180/11920513		
2.45	HF 907	Double-ridged horn	Rohde & Schwarz	102444	2018-07	2021-07

3 Regulatory Bluetooth RF Test Solution
Regulatory Bluetooth RF Tests

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
3.1	MFS	Rubidium Frequency Normal MFS	Datum GmbH	002	2018-10	2020-10
3.2	EX520	Digital Multimeter 12 (Multimeter)	Extech Instruments Corp	05157876	2018-04	2020-04
3.3	NRV Z1 A	Power Sensor	Rohde & Schwarz	832279/013		
3.4	Opus10 THI (8152.00)	T/H Logger 15	Lufft Mess- und Regeltechnik GmbH	13985	2017-04	2019-04
3.5	TOCT Switching Unit		7layers, Inc.	040107		
3.6	ADU 200 Relay Box 7	used for automated testing (EMMI) only	Ontrak Control Systems Inc	A04380		
3.7	NRVD	Power Meter	Rohde & Schwarz	832025/059	2018-09	2019-09
3.8	FSIQ26	Signal Analyser	Rohde & Schwarz	832695/007	2018-10	2020-10
3.9	Shielded Room 07	Shielded Room 4m x 6m				
3.10	SMP02	Signal Generator SMP	Rohde & Schwarz	833286/0014	2018-10	2021-10
3.11	SMIQ 03B	Signal Generator	Rohde & Schwarz GmbH & Co. KG	832870/017	2016-06	2019-06
3.12	NGSM 32/10	Power Supply	Rohde & Schwarz	2725	2017-06	2019-06
3.13	CMW500	CMW500-SUW	Rohde & Schwarz GmbH & Co. KG	156000	2018-10	2019-10

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_{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.

7.2 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

7.3 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.

7.4 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.

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 (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.

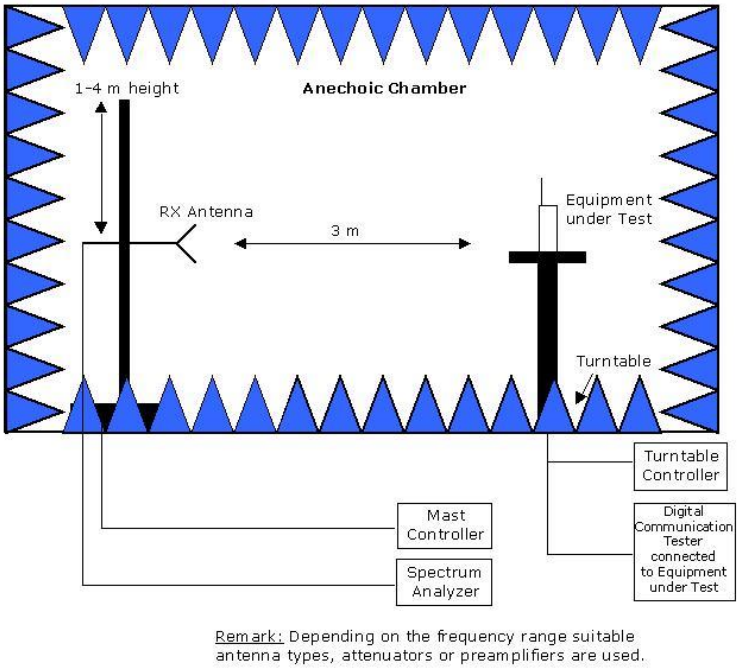
7.6 ANTENNA EMCO 3160-10 (26.5 GHZ – 40 GHZ)

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

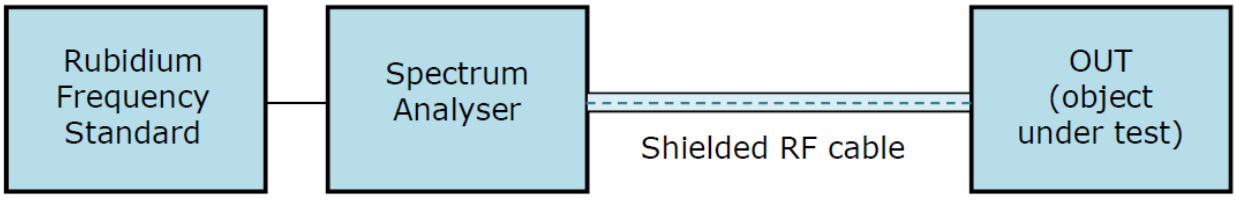
Sample calculation

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

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.