FCC Measurement/Technical Report on

Hearing protection Headset with Bluetooth

Peltor WS Alert XPI / XP

FCC ID: Y9ZMRX21AWS6
IC: 4406A-MRX21AWS6

Test Report Reference: MDE_3M_1601_FCCa

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 (10-1-16 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 v04, 2017-04-05”. ANSI C63.10–2013 is applied.

Note 2: (FHSS Equipment)
The tests were selected and performed with reference to the FCC Public Notice DA 00-705, released March 30, 2000. Instead of applying ANSI C63.4-1992 which is referenced in the FCC Public Note, the newer 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 4: 8.8
Occupied bandwidth	§ 15.247 (a) (1)	RSS-247 Issue 1: 5.1 (2)
Peak conducted output power	§ 15.247 (b) (1), (4)	RSS-247 Issue 1: 5.4 (2)
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
Dwell time	§ 15.247 (a) (1) (iii)	RSS-247 Issue 1: 5.1 (4)
Channel separation	§ 15.247 (a) (1)	RSS-247 Issue 1: 5.1 (2)
No. of hopping frequencies	§ 15.247 (a) (1) (iii)	RSS-247 Issue 1: 5.1 (4)
Hybrid systems (only)	§ 15.247 (f); § 15.247 (e)	RSS-247 Issue 1: 5.3
Antenna requirement	§ 15.203 / 15.204	RSS-Gen Issue 4: 8.3
Receiver spurious emissions	–	-

1.3 MEASUREMENT SUMMARY / SIGNATURES

47 CFR CHAPTER I FCC PART 15 Subpart 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	Setup_AC01_ACDC	Passed	Passed

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	Setup_AA01	Passed	Passed
Bluetooth BDR, low	Setup_AA01	Passed	Passed
Bluetooth BDR, mid	Setup_AA01	Passed	Passed
Bluetooth EDR 2, high	Setup_AD01	Passed	Passed
Bluetooth EDR 2, low	Setup_AD01	Passed	Passed
Bluetooth EDR 2, mid	Setup_AD01	Passed	Passed
Bluetooth EDR 3, high	Setup_AD01	Passed	Passed
Bluetooth EDR 3, low	Setup_AD01	Passed	Passed
Bluetooth EDR 3, mid	Setup_AD01	Passed	Passed

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

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	Setup_AA01	Passed	Passed
Bluetooth BDR, low, conducted	Setup_AA01	Passed	Passed
Bluetooth BDR, mid, conducted	Setup_AA01	Passed	Passed
Bluetooth EDR 2, high, conducted	Setup_AD01	Passed	Passed
Bluetooth EDR 2, low, conducted	Setup_AD01	Passed	Passed
Bluetooth EDR 2, mid, conducted	Setup_AD01	Passed	Passed
Bluetooth EDR 3, high, conducted	Setup_AD01	Passed	Passed
Bluetooth EDR 3, low, conducted	Setup_AD01	Passed	Passed
Bluetooth EDR 3, mid, conducted	Setup_AD01	Passed	Passed

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

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 BDR, high	Setup_AA01	Passed	Passed
Bluetooth BDR, low	Setup_AA01	Passed	Passed
Bluetooth BDR, mid	Setup_AA01	Passed	Passed
Bluetooth EDR 2, high	Setup_AD01	Passed	Passed
Bluetooth EDR 2, low	Setup_AD01	Passed	Passed
Bluetooth EDR 2, mid	Setup_AD01	Passed	Passed
Bluetooth EDR 3, high	Setup_AD01	Passed	Passed
Bluetooth EDR 3, low	Setup_AD01	Passed	Passed
Bluetooth EDR 3, mid	Setup_AD01	Passed	Passed

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

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	Setup_AC01	Passed	Passed
Bluetooth BDR, high, 30 MHz - 1 GHz	Setup_AC01	Passed	Passed
Bluetooth BDR, low, 1 GHz - 26 GHz	Setup_AC01	Passed	Passed
Bluetooth BDR, low, 30 MHz - 1 GHz	Setup_AC01	Passed	Passed
Bluetooth BDR, mid, 1 GHz - 26 GHz	Setup_AC01	Passed	Passed
Bluetooth BDR, mid, 30 MHz - 1 GHz	Setup_AC01	Passed	Passed
Bluetooth BDR, mid, 9 kHz - 30 MHz	Setup_AC01	Passed	Passed
Bluetooth EDR 2, high, 1 GHz - 26 GHz	Setup_AC01	Passed	Passed
Bluetooth EDR 2, low, 1 GHz - 26 GHz	Setup_AC01	Passed	Passed
Bluetooth EDR 2, mid, 1 GHz - 26 GHz	Setup_AC01	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	Setup_AA01	Passed	Passed
Bluetooth BDR, hopping, high	Setup_AD01	Passed	Passed
Bluetooth BDR, hopping, low	Setup_AD01	Passed	Passed
Bluetooth BDR, low, low	Setup_AA01	Passed	Passed
Bluetooth EDR 2, high, high	Setup_AD01	Passed	Passed
Bluetooth EDR 2, hopping, high	Setup_AD01	Passed	Passed
Bluetooth EDR 2, hopping, low	Setup_AD01	Passed	Passed
Bluetooth EDR 2, low, low	Setup_AD01	Passed	Passed
Bluetooth EDR 3, high, high	Setup_AD01	Passed	Passed
Bluetooth EDR 3, hopping, high	Setup_AD01	Passed	Passed
Bluetooth EDR 3, hopping, low	Setup_AD01	Passed	Passed
Bluetooth EDR 3, low, low	Setup_AD01	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	Setup_AC01	Passed	Passed
Bluetooth EDR 2, high, high	Setup_AC01	Passed	Passed
Bluetooth EDR 3, high, high	Setup_AC01	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	Setup_AA01	Passed	Passed

47 CFR CHAPTER I FCC PART 15 Subpart C §15.247 **§ 15.247 (a) (1) (iii)**

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

OP-Mode Radio Technology	Setup	FCC	IC
Bluetooth BDR	Setup_AA01	Passed	Passed

47 CFR CHAPTER I FCC PART 15 Subpart C §15.247 **§ 15.247 (a) (1) (iii)**

Number of Hopping Frequencies
The measurement was performed according to ANSI C63.10

OP-Mode	**Setup**	**Final Result**	
		FCC	**IC**
Radio Technology			
Bluetooth BDR	Setup_AA01	Passed	Passed

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

(responsible for accreditation scope)
Dipl.-Ing. Bernhard Retka

(responsible for testing and report)
Dipl.-Ing. Andreas Petz

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2 ADMINISTRATIVE DATA

2.1 TESTING LABORATORY

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

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

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

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

2.2 PROJECT DATA

Responsible for testing and report:	Dipl.-Ing. Andreas Petz
Employees who performed the tests:	documented internally at 7Layers
Date of Report:	2018-03-23
Testing Period:	2016-11-09 to 2018-01-04

2.3 APPLICANT DATA

Company Name:	3M Svenska AB
Address:	Malmstensg. 19 331 02 Värnamo Sweden
Contact Person:	Mr. Pär Rundqvist

2.4 MANUFACTURER DATA

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

3 TEST OBJECT DATA

3.1 GENERAL EUT DESCRIPTION

Kind of Device product description	Hearing protection Headset with Bluetooth and FM-radio
Product name	Peltor WS Alert XPI
Type	Peltor WS Alert XPI (tested) will be marketed also as models Peltor WS Alert XP and MRX21*WS6*
Declared EUT data by the supplier	
Voltage Type	DC and AC
Voltage Level	DC: 2 x 1.5 V (primary cells) and AC: 120 V / 60 Hz + 2 x 1.2 V DC (rechargeable batteries)
General product description	The EUT is a headset/handsfree which uses Bluetooth and Bluetooth Low Energy technology to be connected to other devices. It provides a function to listen to surrounding sound and is not only a closed audio headset. The headset is a hearing protection with level-dependent function for ambient listening.
Specific product description for the EUT	It is supplied by internal batteries (2x 1.5 V) or rechargeable batteries (2x 1.2 V). A 3.5 mm DC cable can be connected to recharge batteries of type NiMH, an unshielded cable of approx. 1.5 m length has been attached during the tests. The FM receiver is not scope of this test report.
The EUT provides the following ports:	Headset: DC Input; AC/DC adapter: AC Input; Charger cable: DC input and DC output
Tested Modulation Type	GFSK, π/4 DQPSK, 8-DPSK
Tested datarates	GFSK Modulation, 1-DHx packets, 1 Mbps π/4 DQPSK Modulation, 2-DHx packets, 2 Mbps 8-DPSK Modulation, 3-DHx packets, 3 Mbps
Antenna Type / Gain	Integral / 2.7 dBi

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

3.2 EUT MAIN COMPONENTS

Sample Name	Sample Code	Description
Conducted sample	DE1223000aa01	Sample with SMA connector
Sample Parameter	**Value**	
Serial No.	-	
HW Version	K388Ava05 and K396Ava00	
SW Version	Sw-k388-ie-release-9	
Comment		
Integral Antenna	yes	

Sample Name	Sample Code	Description
Conducted sample	DE1223000ad01	Sample with SMA connector
Sample Parameter	**Value**	
Serial No.	-	
HW Version	K388Ava05 and K396Ava00	
SW Version	Sw-k388-ie-release-9	
Comment		
Integral Antenna	yes	

Sample Name	Sample Code	Description
Radiated sample	DE1223000ac01	Sample without SMA connector
Sample Parameter	**Value**	
Serial No.	-	
HW Version	K388Ava05 and K396Ava00	
SW Version	Sw-k388-ie-release-9	
Comment		
Integral Antenna	yes	

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

3.3 ANCILLARY EQUIPMENT

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

Device	**Details (Manufacturer, Type Model, OUT Code)**	**Description**
FR09 Charger cable	3M Peltor, SE-33102, Input: 5 V DC, 500 mA, Output: 5 V DC, 300 mA DE1223000CCAB	Voltage / Current / Charge controller
Sample Name	**Description**	
Charger cable	current limiter	
AC/DC adapter	CUI INC, P/N: SMI5-5-V-I38-C2 Model_ 6A-054WP05B Input: 100-240 V, 50-60 Hz, 0.3 A, Output: 5 V, 1.0 A DE1223000ACDC	Switch-mode power supply
Sample Name	**Description**	
AC/DC adapter	power supply	

3.4 AUXILIARY EQUIPMENT

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

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

3.5 EUT SETUPS

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

Setup	**Combination of EUTs**	**Description and Rationale**
Setup_AC01_ACDC	AC/DC adapter, Radiated sample, Charger cable	Headset, AC Adapter, Charging cable
Setup_AD01	Conducted sample	with temporary SMA-connector
Setup_AA01	Conducted sample	with temporary SMA-connector
Setup_AC01	Radiated sample	with integral antenna

3.6 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

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 & CISPR-Average (linear)
- 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 & CISPR-Average (linear)
- 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.

4.1.2 TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart C, §15.207

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

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

4.1.3 TEST PROTOCOL

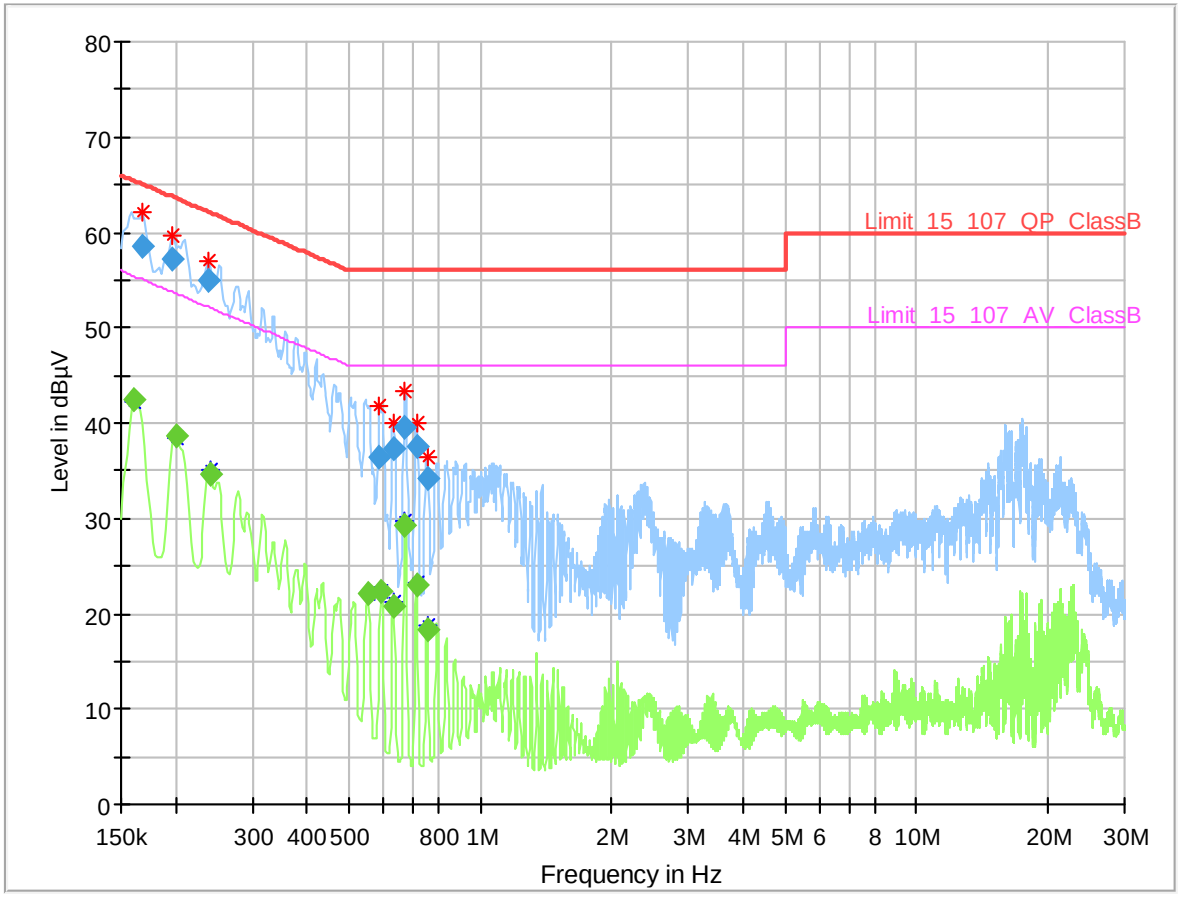
Temperature: 24 °C
Air Pressure: 987 hPa
Humidity: 38 %

Power line	PE	Frequency [MHz]	Measured value QP [dBµV]	Measured value AV [dBµV]	Limit [dBµV]	Margin [dB]
N	GND	0.161	---	42.5	55.4	12.9
N	GND	0.168	58.5	---	65.1	6.6
N	FLO	0.197	57.2	---	63.7	6.5
N	GND	0.202	---	38.6	53.5	14.9
L1	GND	0.238	54.9	---	62.2	7.3
N	GND	0.240	---	34.7	52.1	17.4
N	GND	0.553	---	22.2	46.0	23.8
L1	GND	0.587	36.5	---	56.0	19.5
N	GND	0.593	---	22.4	46.0	23.6
L1	FLO	0.632	37.3	---	56.0	18.7
N	GND	0.632	---	20.8	46.0	25.2
L1	GND	0.672	39.7	---	56.0	16.3
N	GND	0.672	---	29.4	46.0	16.6
L1	FLO	0.713	37.6	---	56.0	18.4
N	GND	0.713	---	22.9	46.0	23.1
N	FLO	0.755	---	18.4	46.0	27.6
L1	FLO	0.755	34.3	---	56.0	21.7

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

Common Information

Test Description:	Conducted Emissions
Test Standard:	FCC15 Subpart C, §15.207
EUT / Setup Code:	DE1223000ac01 + DE1223000ACDC + DE1223000CCAB
Operating Conditions:	GFSK, TX on 2440, max. RF power, MHz, 120 V / 60 Hz
Operator Name:	MER
Comment:	charging of batteries
Legend:	Trace: blue = PK, green = CISPR AV; Star: red or blue = critical frequency; Rhombus: blue = final QP, green = final CISPR AV
Tested Port / used LISN:	AC mains => ESH3-Z5
Termination of other ports:	N/A



4.1.5 TEST EQUIPMENT USED

- Conducted Emissions FCC

4.2 OCCUPIED BANDWIDTH (20 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 (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
- Sweeps: 2000
- Sweeptime: 8.5
- Detector: Peak

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

4.2.2 TEST REQUIREMENTS / LIMITS

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

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.

4.2.3 TEST PROTOCOL

Ambient temperature: 21-24 °C
Air Pressure: 997-1017 hPa
Humidity: 37-42 %

BT GFSK (1-DH1)

Band	Channel No.	Frequency [MHz]	20 dB Bandwidth [kHz]	Limit [kHz]	Margin to Limit [kHz]
2.4 GHz ISM	0	2402	926.4	1500	573.6
	39	2441	884.4	1500	615.6
	78	2480	890.4	1500	609.6

BT π/4 DQPSK (2-DH1)

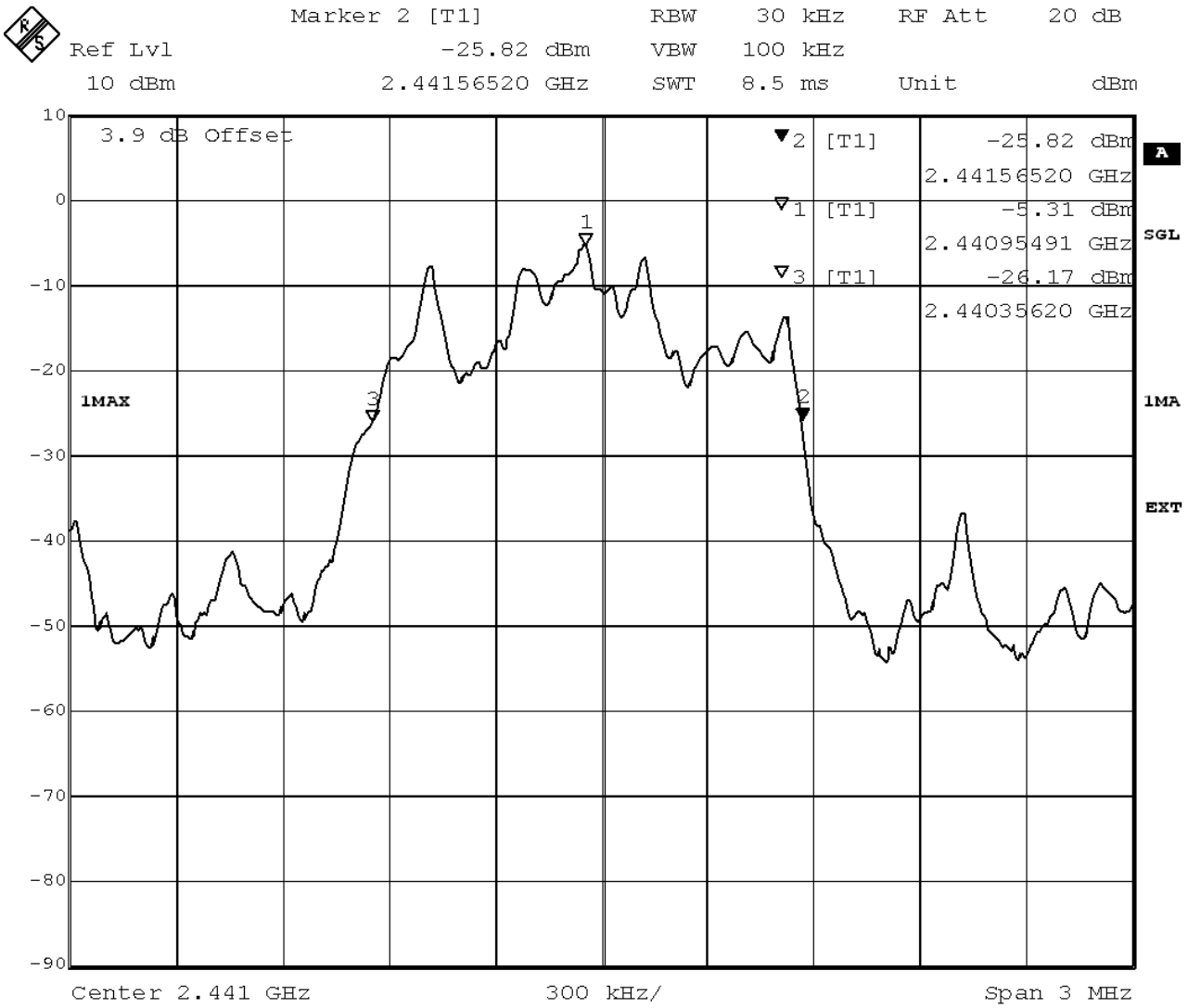
Band	Channel No.	Frequency [MHz]	20 dB Bandwidth [kHz]	Limit [kHz]	Margin to Limit [kHz]
2.4 GHz ISM	0	2402	1131.0	1500	369.0
	39	2441	1131.0	1500	369.0
	78	2480	1131.0	1500	369.0

BT 8-DPSK (3-DH1)

Band	Channel No.	Frequency [MHz]	20 dB Bandwidth [kHz]	Limit [kHz]	Margin to Limit [kHz]
2.4 GHz ISM	0	2402	1209.0	1500	291.0
	39	2441	1209.0	1500	291.0
	78	2480	1203.0	1500	297.0

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

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



Title: 20dB Bandwidth
Comment A: CH M: 2441 MHz; 20dB bandwidth (kHz):1209
Date: 29.NOV.2016 08:59:23

4.2.5 TEST EQUIPMENT USED

- Regulatory Bluetooth RF Test Solution

4.3 PEAK POWER OUTPUT

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

4.3.1 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): 3 MHz
- Video Bandwidth (VBW): 3 MHz
- Trace: Maxhold
- Sweeps: 2000
- Sweeptime: 5 ms
- Detector: Peak

4.3.2 TEST REQUIREMENTS / LIMITS

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.

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

4.3.3 TEST PROTOCOL

Ambient temperature: 21-24 °C
Air Pressure: 997-1017 hPa
Humidity: 37-42 %

BT GFSK (1-DH1)

Band	Channel No.	Frequency [MHz]	Peak Power [dBm]	Limit [dBm]	Margin to Limit [dB]
2.4 GHz ISM	0	2402	-0.9	30.0	30.9
	39	2441	0.9	30.0	29.1
	78	2480	1.4	30.0	28.6

BT π/4 DQPSK (2-DH1)

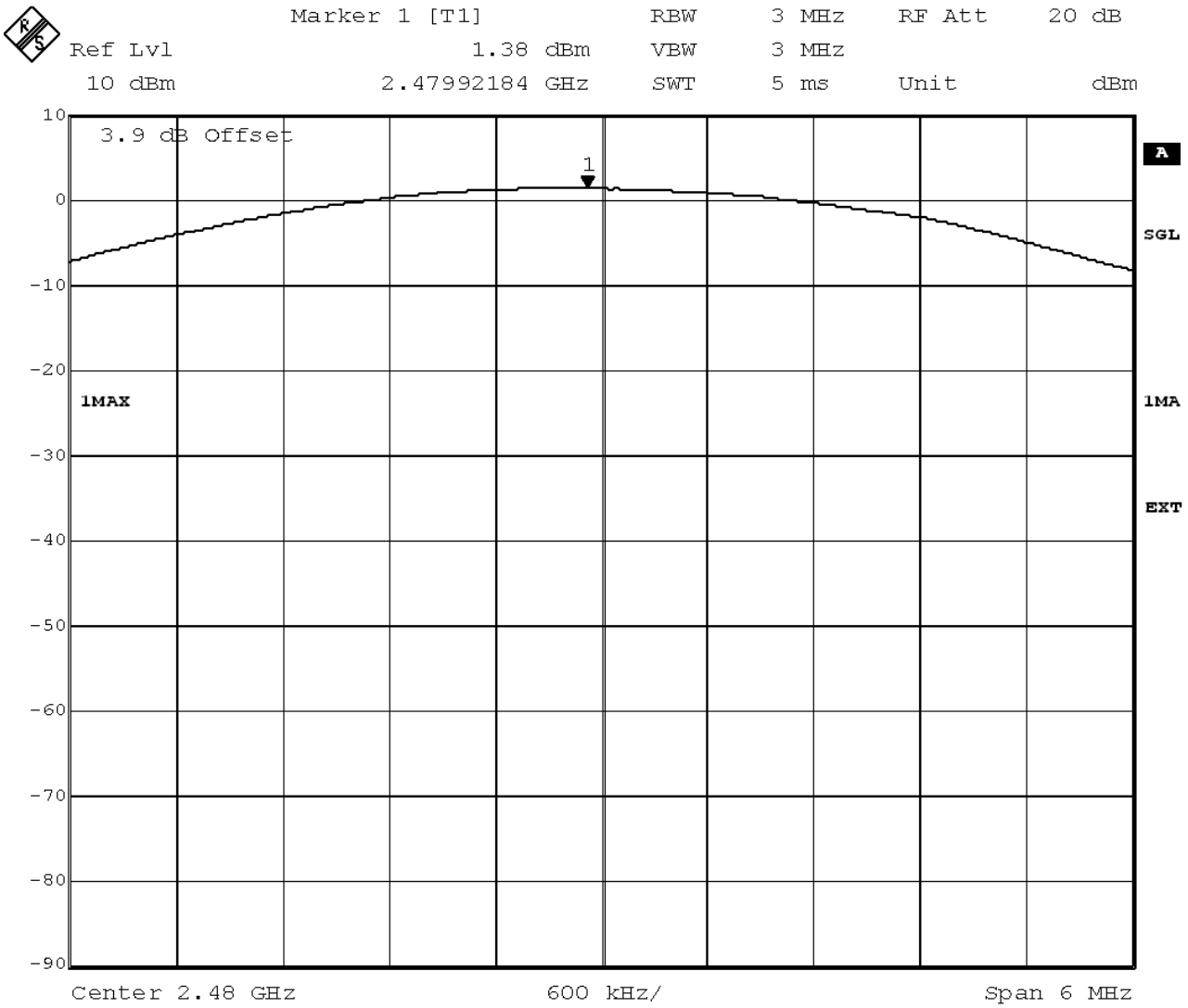
Band	Channel No.	Frequency [MHz]	Peak Power [dBm]	Limit [dBm]	Margin to Limit [dB]
2.4 GHz ISM	0	2402	-4.9	21.0	25.9
	39	2441	-2.5	21.0	23.5
	78	2480	-3.4	21.0	24.4

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	-4.8	21.0	25.8
	39	2441	-2.6	21.0	23.6
	78	2480	-3.6	21.0	24.6

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

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



Title: Peak outputpower Power
Comment A: CH T: 2480 MHz
Date: 15.NOV.2016 11:50:43

4.3.5 TEST EQUIPMENT USED

- Regulatory Bluetooth RF Test Solution

4.4 SPURIOUS RF CONDUCTED EMISSIONS

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 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.

4.4.2 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.

4.4.3 TEST PROTOCOL

Ambient temperature: 21-24 °C
Air Pressure: 997-1017 hPa
Humidity: 37-42 %

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	0	-1.2	-21.2	> 20 dB
39	2441	-	-	PEAK	100	0.5	-19.5	> 20 dB
78	2480	-	-	PEAK	100	1.1	-18.9	> 20 dB

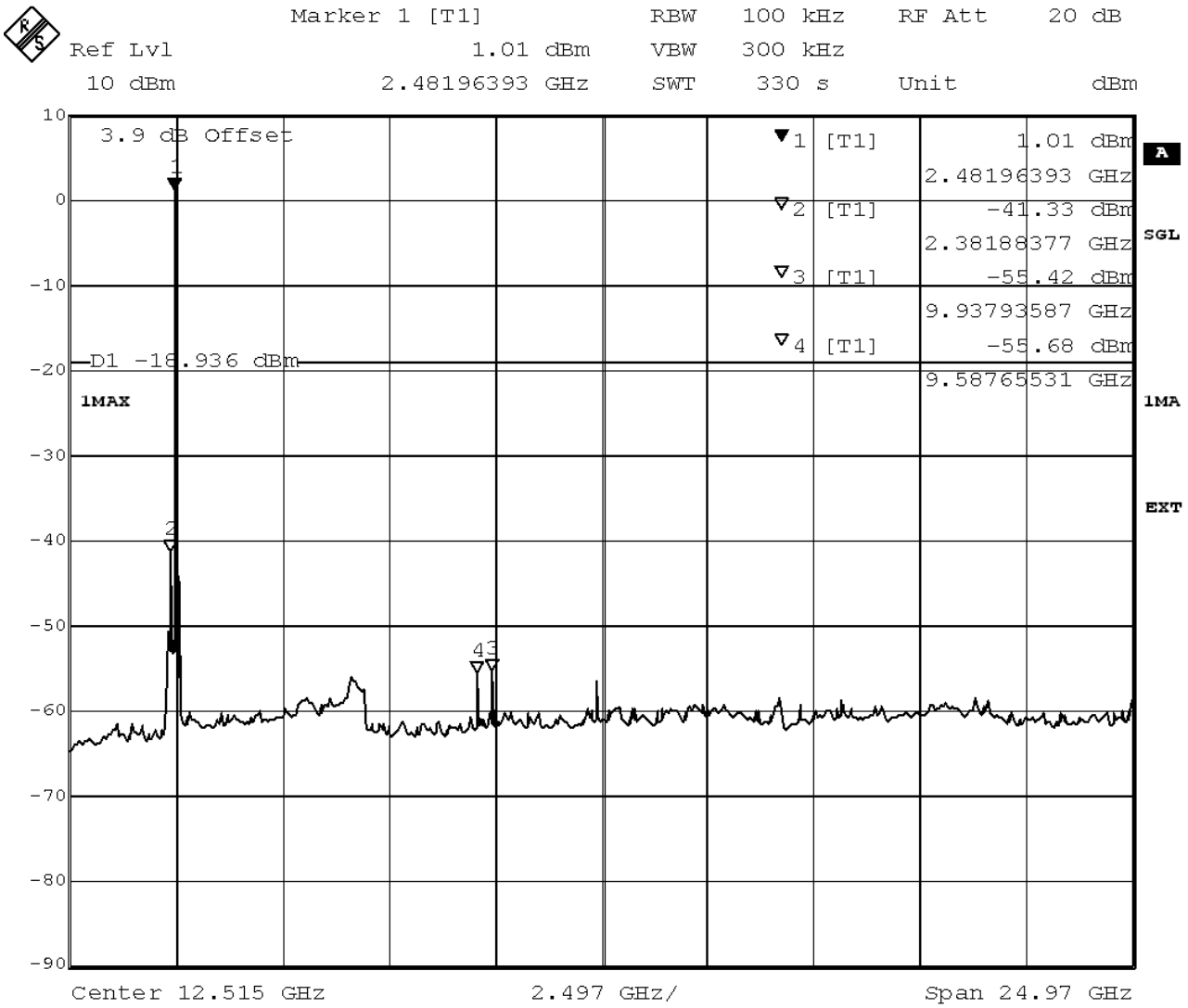
BT π/4 DQPSK (2-DH1)

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	-6.4	-26.4	> 20 dB
39	2441	-	-	PEAK	100	-4.2	-24.2	> 20 dB
78	2480	-	-	PEAK	100	-5.1	-25.1	> 20 dB

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	-6.5	-26.4	> 20 dB
39	2441	-	-	PEAK	100	-4.3	-24.3	> 20 dB
78	2480	-	-	PEAK	100	-5.2	-25.2	> 20 dB

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



Title: spurious emissions
Comment A: CH T: 2480 MHz
Date: 15.NOV.2016 11:46:45

4.4.5 TEST EQUIPMENT USED

- Regulatory Bluetooth RF Test Solution

4.5 TRANSMITTER SPURIOUS RADIATED EMISSIONS

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

4.5.1 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

4.5.2 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)

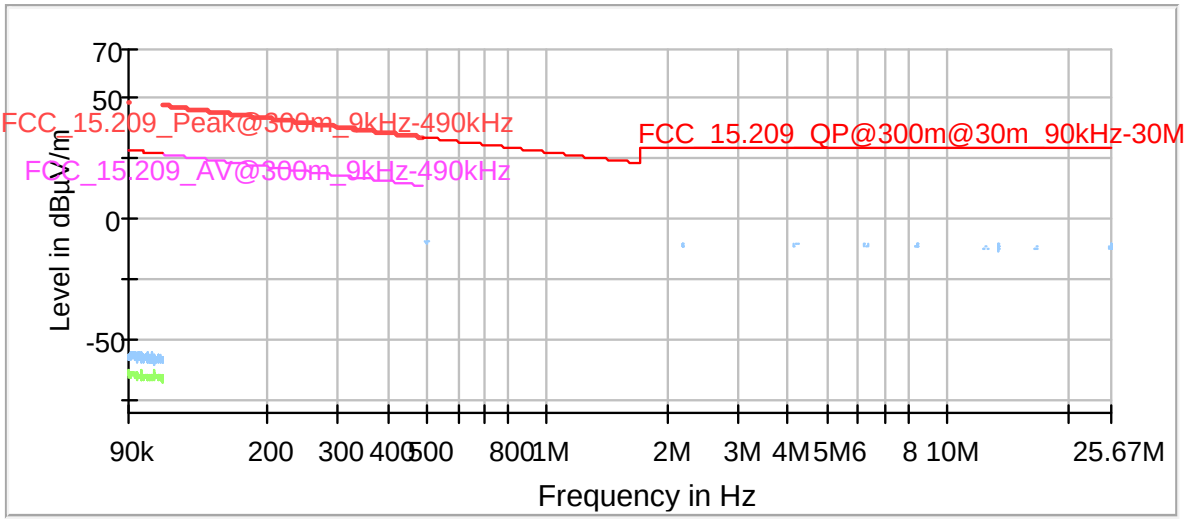
4.5.3 TEST PROTOCOL

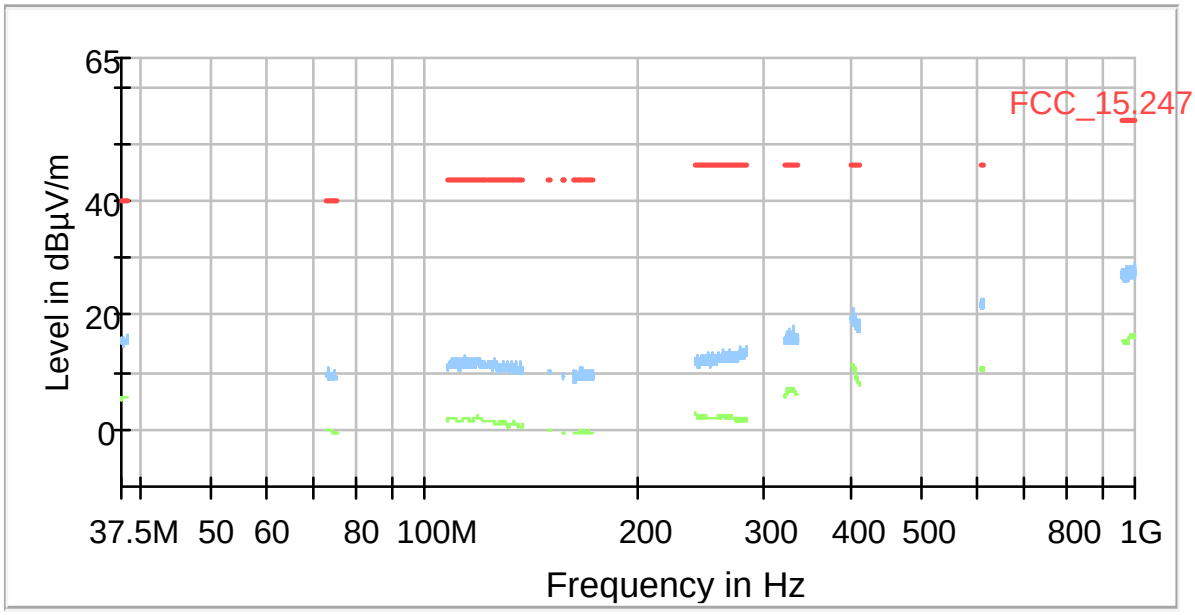
Ambient temperature:	21-22 °C
Air Pressure:	980-999 hPa
Humidity:	33-34 %

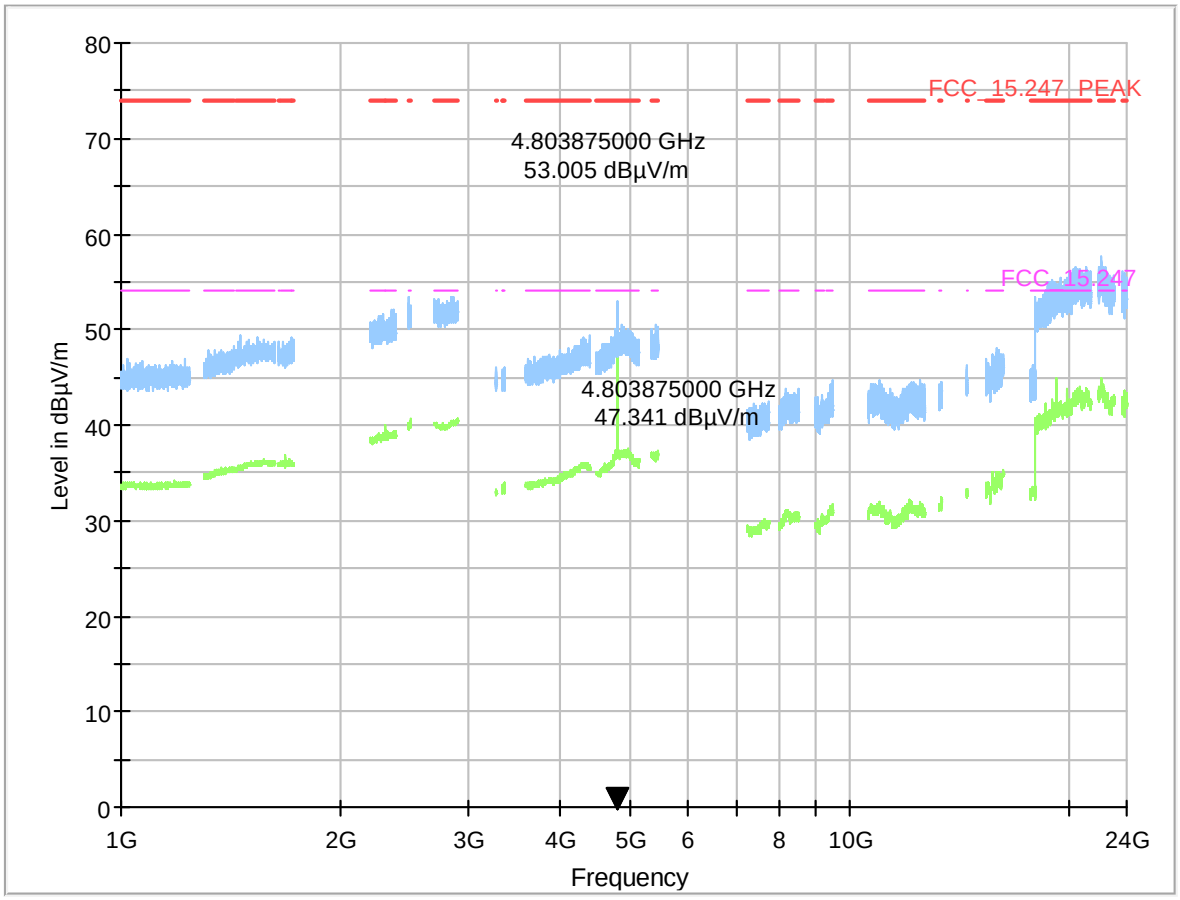
BT, all FHSS modes

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	-	-	PK	-	-	> 20 dB	-
39	2441	-	-	PK	-	-	> 20 dB	-
78	2480	-	-	PK	-	-	> 20 dB	-

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







4.5.5 TEST EQUIPMENT USED

- Radiated Emissions

4.6 BAND EDGE COMPLIANCE CONDUCTED

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

4.6.1 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 Span: 6 MHz
- Detector: Peak
- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Sweeptime: 5 ms
- Sweeps: 1000
- Trace: Maxhold

4.6.2 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...”

4.6.3 TEST PROTOCOL

Ambient temperature: 21-24 °C
Air Pressure: 997-1017 hPa
Humidity: 37-42 %

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	-53.8	PEAK	100	-1.2	-21.2	32.6
78	2480	2483.5	-63.1	PEAK	100	1.1	-18.9	44.2
hopping	hopping	2400.0	-52.4	PEAK	100	0.2	-19.8	32.5
hopping	hopping	2483.5	-61.1	PEAK	100	0.0	-20.0	41.1

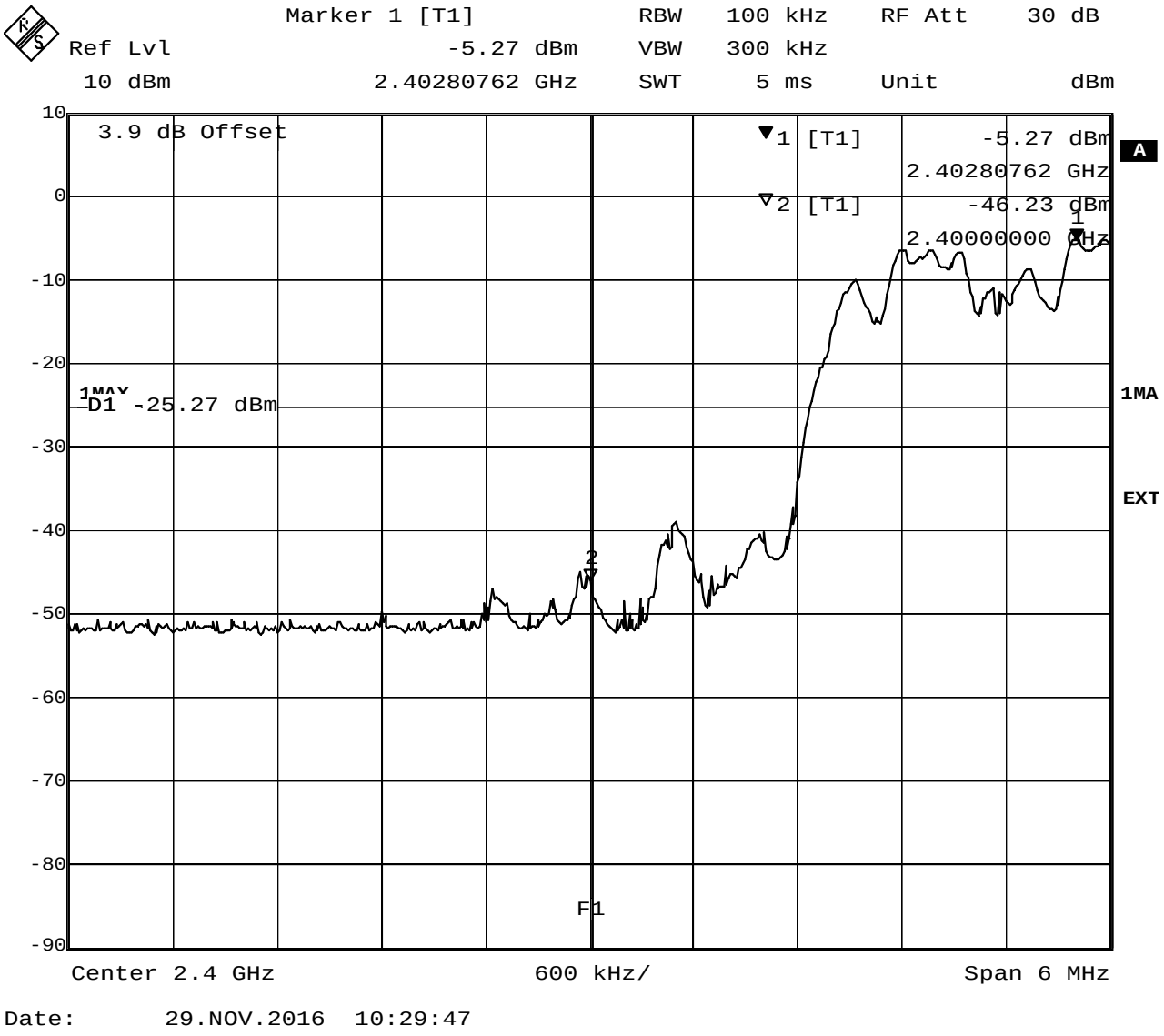
BT π/4 DQPSK (2-DH1)

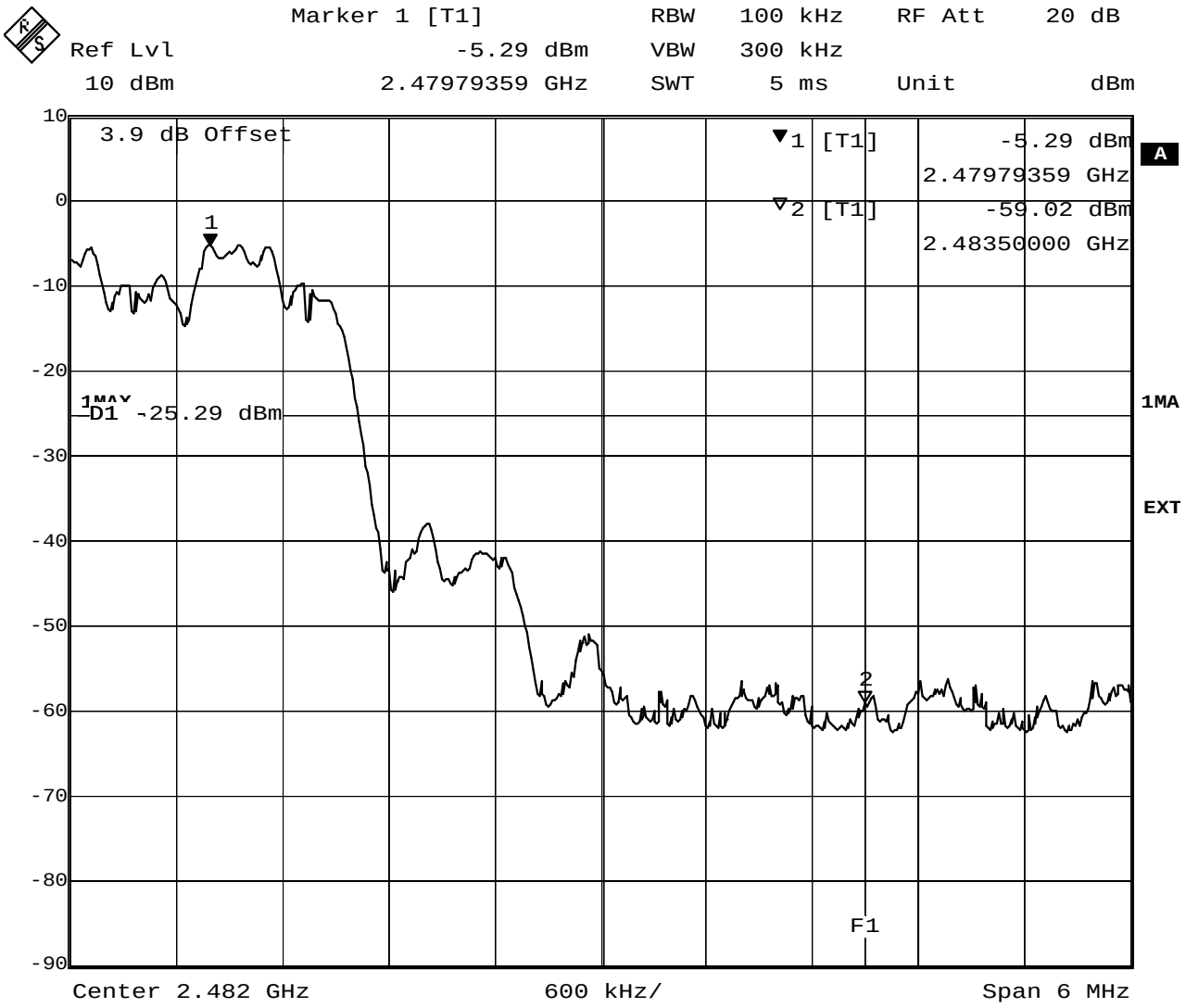
Channel No.	Channel Center Frequency [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Ref. Level [dBm]	Limit [dBm]	Margin to Limit [dB]
0	2402	2400.0	-46.3	PEAK	100	-5.1	-25.1	21.2
78	2480	2483.5	-63.7	PEAK	100	-6.4	-26.4	37.3
hopping	hopping	2400.0	-46.2	PEAK	100	-5.1	-25.1	21.1
hopping	hopping	2483.5	-62.6	PEAK	100	-5.3	-25.3	37.4

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	-47.0	PEAK	100	-5.2	-25.2	21.8
78	2480	2483.5	-62.5	PEAK	100	-6.5	-26.5	36.0
hopping	hopping	2400.0	-46.2	PEAK	100	-5.3	-25.3	21.0
hopping	hopping	2483.5	-59.0	PEAK	100	-5.3	-25.3	33.7

4.6.4 MEASUREMENT PLOT (SHOWING THE LOWEST MARGIN, “WORST CASE”)





4.6.5 TEST EQUIPMENT USED

- Regulatory Bluetooth RF Test Solution

4.7 BAND EDGE COMPLIANCE RADIATED

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

4.7.1 TEST DESCRIPTION

Please see test description for the test case “Spurious Radiated Emissions”

4.7.2 TEST REQUIREMENTS / LIMITS

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

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

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

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

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

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

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

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

4.7.3 TEST PROTOCOL

Ambient temperature: 21 °C
Air Pressure: 980 hPa
Humidity: 33 %

BT GFSK (1-DH1)

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	49.6	PEAK	1000	74.0	24.4	BE
78	2480	2483.5	46.6	AV	1000	54.0	7.4	BE

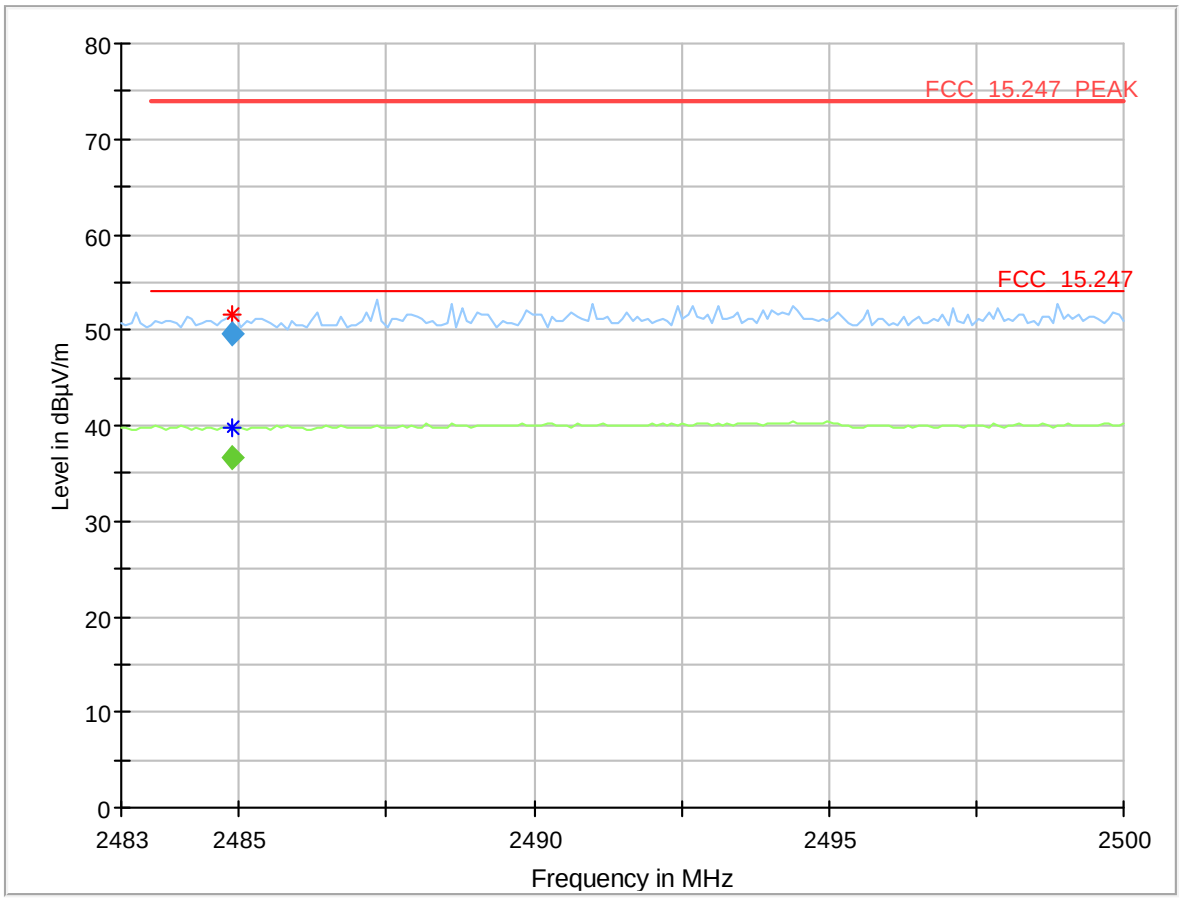
BT π/4 DQPSK (2-DH1)

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	49.3	PEAK	1000	74.0	24.7	BE
78	2480	2483.5	46.5	AV	1000	54.0	7.5	BE

BT 8-DPSK (3-DH1)

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	49.6	PEAK	1000	74.0	24.4	BE
78	2480	2483.5	46.6	AV	1000	54.0	7.4	BE

4.7.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, “WORST CASE”)



4.7.5 TEST EQUIPMENT USED

- Radiated Emissions

4.8 CHANNEL SEPARATION

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

4.8.1 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:
- Detector: Peak
- Trace: Maxhold
- Span: appr. 3 x OBW
- Centre Frequency: a mid frequency of the used band
- Resolution Bandwidth (RBW): appr. 3 % of channel spacing
- Video Bandwidth (VBW): 3 x RBW
- Sweep Time: 8.5 ms
- Sweeps: 2000

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

4.8.2 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.

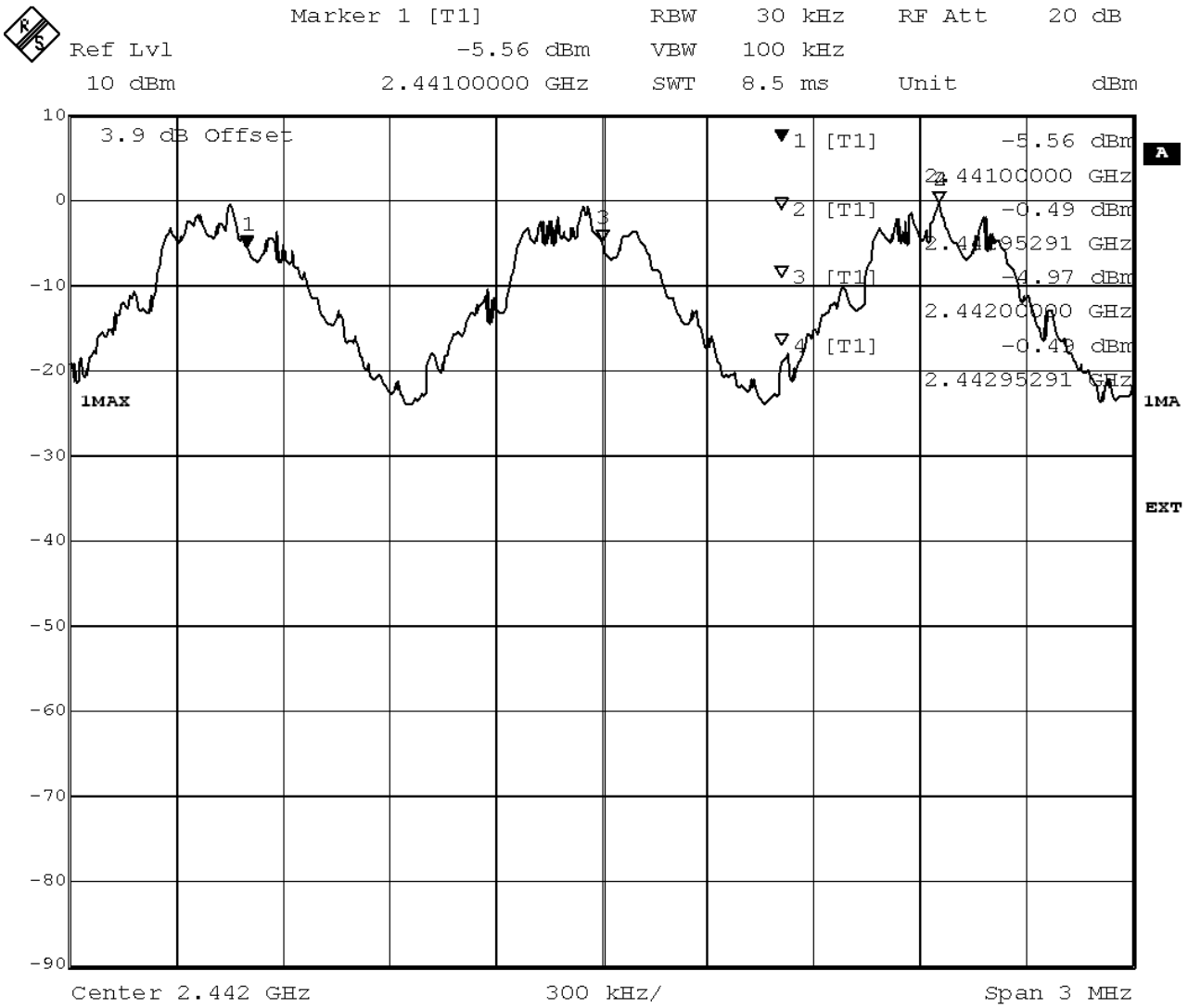
4.8.3 TEST PROTOCOL

Ambient temperature: 21 °C
Air Pressure: 1017 hPa
Humidity: 42 %

Radio Technology	Channel Separation [kHz]	Limit [kHz]	Margin to Limit [kHz]
BT GFSK (1-DH1)	1000.0	926.400	73.600

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

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



Title: Channel separation
Comment A: CH H: Hopping
Date: 15.NOV.2016 12:37:55

4.8.5 TEST EQUIPMENT USED

- Regulatory Bluetooth RF Test Solution

4.9 DWELL TIME

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 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.

Dwell time = time slot length * hop rate / number of hopping channels * 31.6 s

with:

- hop rate = 1600 * 1/s for DH1 packets= 1600 s^{-1}
- hop rate = 1600/3 * 1/s for DH3 packets= 533.33 s^{-1}
- hop rate = 1600/5 * 1/s for DH5 packets= 320 s^{-1}
- number of hopping channels = 79
- 31.6 s = 0.4 seconds multiplied by the number of hopping channels = 0.4 s * 79

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: Video

4.9.2 TEST REQUIREMENTS / LIMITS

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.

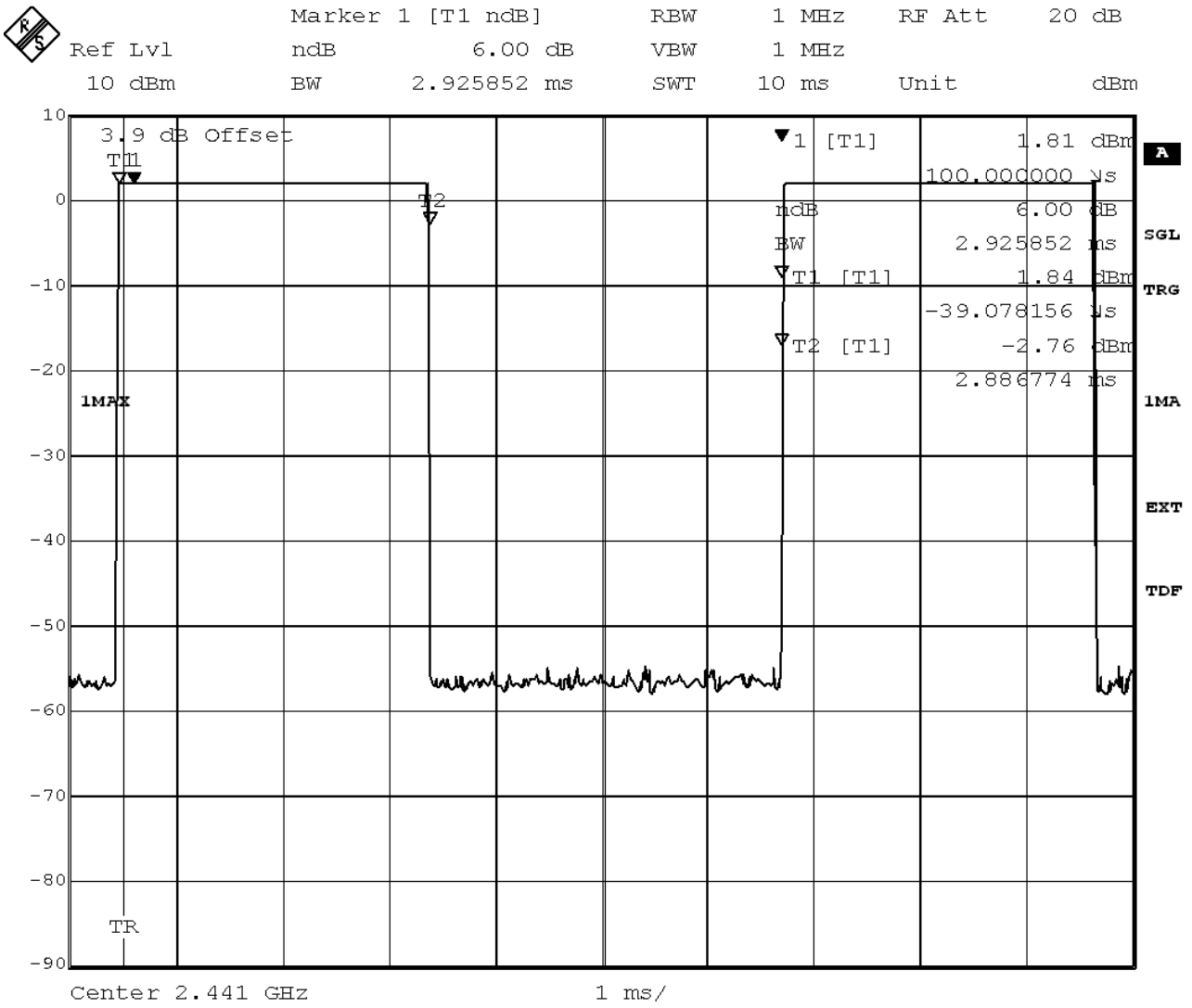
4.9.3 TEST PROTOCOL

Ambient temperature: 21 °C
Air Pressure: 1017 hPa
Humidity: 42 %

Radio Technology	Time Slot Length [ms]	Dwell Time [ms]	Limit [s]	Margin to Limit [ms]
BT GFSK (1-DH5)	2.926	374.5	0.4	25.5

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

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



Title: Dwell time
Comment A: CH M: 2441 MHz
Date: 15.NOV.2016 12:30:07

4.9.5 TEST EQUIPMENT USED

- Regulatory Bluetooth RF Test Solution

4.10 NUMBER OF HOPPING FREQUENCIES

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

4.10.1 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
- Centre frequency: 2442 MHz
- Frequency span: Frequency band of operation
- Resolution Bandwidth (RBW): < 30 % of channel spacing or 20 dB bandwidth (whichever is maller)
- Video Bandwidth (VBW): 3 x RBW
- Sweep Time: 21 ms
- Sweeps: 2000

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

4.10.2 TEST REQUIREMENTS / LIMITS

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.

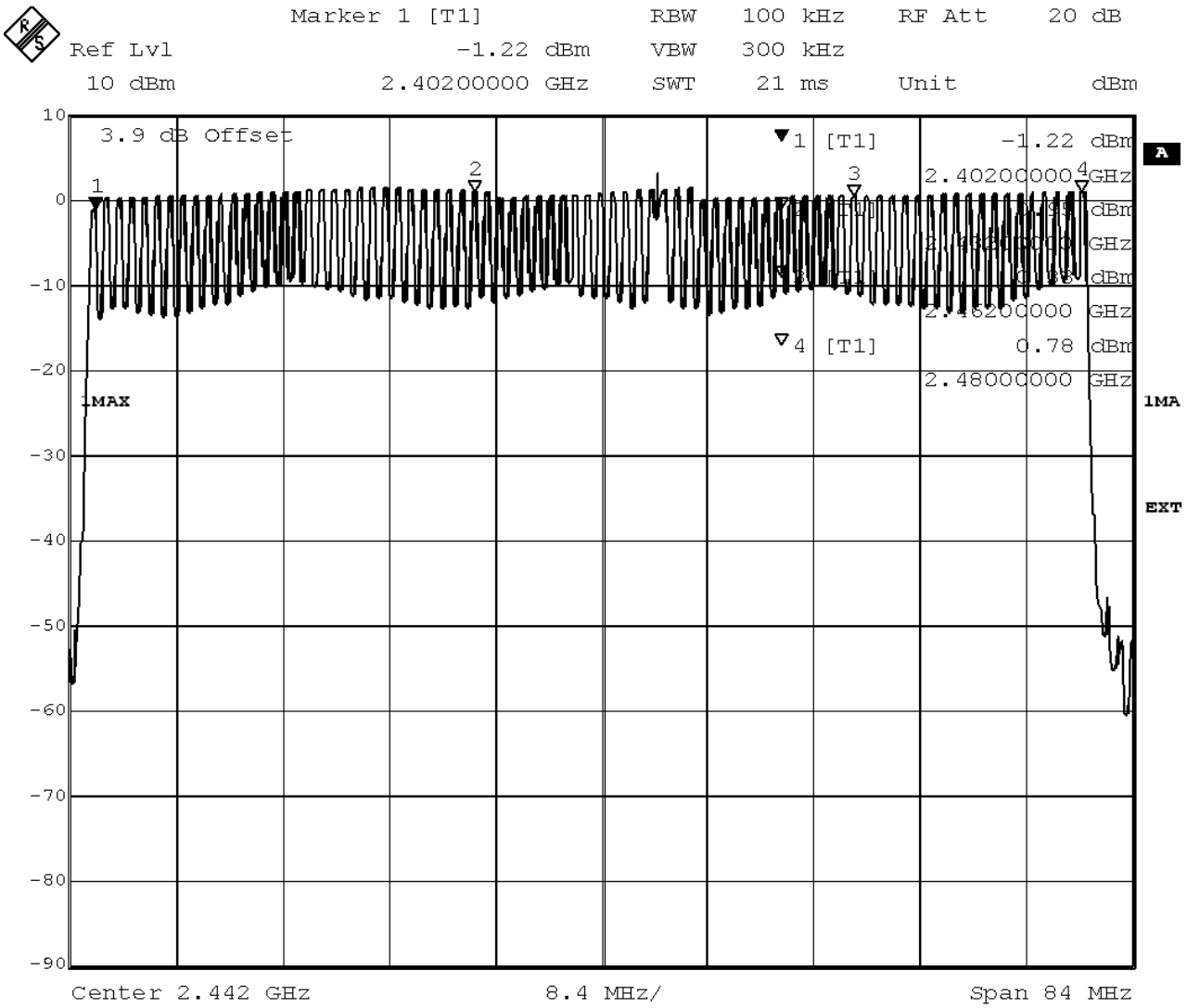
4.10.3 TEST PROTOCOL

Ambient temperature: 21 °C
Air Pressure: 1017 hPa
Humidity: 42 %

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.

4.10.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, “WORST CASE”)



Title: Number of hopping frequencies
Comment A: CH H: Hopping
Date: 15.NOV.2016 13:28:25

4.10.5 TEST EQUIPMENT USED

- Regulatory Bluetooth RF Test Solution

5 TEST EQUIPMENT

1 Conducted Emissions FCC

Conducted Emissions power line for FCC standards

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
1.1	Opus10 TPR (8253.00)	ThermoAirpressure Datalogger 13 (Environ)	Lufft Mess- und Regeltechnik GmbH	13936	2017-04	2019-04
1.2	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2016-02	2018-02
1.3	ESH3-Z5	Two-Line V-Network	Rohde & Schwarz	828304/029	2017-05	2019-05
1.4	EP 1200/B, NA/B1	Amplifier with integrated variable Oscillator	Spitzenberger & Spieß	B6278	2015-07	2018-07
1.5	Chroma 6404	AC Power Source	Chroma ATE INC.	64040001304		
1.6	Shielded Room 02	Shielded Room for conducted testing, 12qm	Frankonia	-		
1.7	ESH3-Z5	Two-Line V-Network	Rohde & Schwarz	829996/002	2017-05	2019-05
1.8	ESR 7	EMI Receiver / Spectrum Analyzer	Rohde & Schwarz	101424	2016-11	2018-11
1.9	Opus10 THI (8152.00)	ThermoHygro Datalogger 02 (Environ)	Lufft Mess- und Regeltechnik GmbH	7489	2017-04	2019-04
1.10	ESIB 26	Spectrum Analyzer	Rohde & Schwarz	830482/004	2015-12	2017-12

2 R&S TS8997

EN300328/301893 Test Lab

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
2.1	SMB100A	Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz	107695	2014-06	2017-06
2.2	MFS	Rubidium Frequency Standard	Datum-Beverly	5489/001	2016-06	2017-06
2.3	1515 / 93459	Broadband Power Divider SMA (Aux)	Weinschel Associates	LN673		
2.4	FSV30	Signal Analyzer 10 Hz - 30 GHz	Rohde & Schwarz	103005	2016-02	2018-02
2.5	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2016-02	2018-02
2.6	VT 4002	Temperature Chamber	Vötsch	58566002150010	2016-03	2018-03
2.7	A8455-4	4 Way Power Divider (SMA)		-		

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
2.8	Opus10 THI (8152.00)	ThermoHygro Datalogger 03 (Environ)	Lufft Mess- und Regeltechnik GmbH	7482	2015-02	2017-02
2.9	SMBV100A	Vector Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz	259291	2016-10	2019-10
2.10	OSP120	Switching Unit with integrated power meter	Rohde & Schwarz	101158	2016-11	2018-11

3 Radiated Emissions
Lab to perform radiated emission tests

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
3.1	NRV-Z1	Sensor Head A	Rohde & Schwarz	827753/005	2017-05	2018-05
3.2	MFS	Rubidium Frequency Normal MFS	Datum GmbH	002	2017-10	2018-10
3.3	Opus10 TPR (8253.00)	ThermoAirpressure Datalogger 13 (Environ)	Lufft Mess- und Regeltechnik GmbH	13936	2017-04	2019-04
3.4	Anechoic Chamber	10.58 x 6.38 x 6.00 m³	Frankonia	none	2016-05	2019-05
3.5	HL 562	Ultralog new biconicals	Rohde & Schwarz	830547/003	2015-06	2018-06
3.6	5HC2700/12750-1.5-KK	High Pass Filter	Trilithic	9942012		
3.7	ASP 1.2/1.8-10 kg	Antenna Mast	Maturo GmbH	-		
3.8	Fully Anechoic Room	8.80m x 4.60m x 4.05m (l x w x h)	Albatross Projects	P26971-647-001-PRB	2015-06	2018-06
3.9	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2016-02	2018-02
3.10	JS4-18002600-32-5P	Broadband Amplifier 18 GHz - 26 GHz	Miteq	849785		
3.11	FSW 43	Spectrum Analyzer	Rohde & Schwarz	103779	2016-12	2018-12
3.12	3160-09	Standard Gain / Pyramidal Horn Antenna 26.5 GHz	EMCO Elektronic GmbH	00083069		
3.13	WHKX 7.0/18G-8SS	High Pass Filter	Wainwright	09		
3.14	4HC1600/12750-1.5-KK	High Pass Filter	Trilithic	9942011		
3.15	Chroma 6404	AC Power Source	Chroma ATE INC.	64040001304		
3.16	JS4-00102600-42-5A	Broadband Amplifier 30 MHz - 26 GHz	Miteq	619368		
3.17	TT 1.5 WI	Turn Table	Maturo GmbH	-		

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
3.18	HL 562 Ultralog	Log.-per. Antenna	Rohde & Schwarz	100609	2016-04	2019-04
3.19	3160-10	Standard Gain / Pyramidal Horn Antenna 40 GHz	EMCO Elektronic GmbH	00086675		
3.20	5HC3500/18000-1.2-KK	High Pass Filter	Trilithic	200035008		
3.21	HFH2-Z2	Loop Antenna	Rohde & Schwarz	829324/006	2018-01	2021-01
3.22	Opus10 THI (8152.00)	ThermoHygro Datalogger 12 (Environ)	Lufft Mess- und Regeltechnik GmbH	12482	2017-03	2019-03
3.23	ESR 7	EMI Receiver / Spectrum Analyzer	Rohde & Schwarz	101424	2016-11	2018-11
3.24	JS4-00101800-35-5P	Broadband Amplifier 30 MHz - 18 GHz	Miteq	896037		
3.25	AS 620 P	Antenna mast	HD GmbH	620/37		
3.26	Tilt device Maturo (Rohacell)	Antrieb TD1.5-10kg	Maturo GmbH	TD1.5-10kg/024/3790709		
3.27	ESIB 26	Spectrum Analyzer	Rohde & Schwarz	830482/004	2015-12	2017-12
3.28	PAS 2.5 - 10 kg	Antenna Mast	Maturo GmbH	-		
3.29	AM 4.0	Antenna mast	Maturo GmbH	AM4.0/180/11920513		
3.30	HF 907	Double-ridged horn	Rohde & Schwarz	102444	2015-05	2018-05

4 Regulatory Bluetooth RF Test Solution
Regulatory Bluetooth RF Tests

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
4.1	MFS	Rubidium Frequency Normal MFS	Datum GmbH	002	2017-10	2018-10
4.2	EX520	Digital Multimeter 12 (Multimeter)	Extech Instruments Corp	05157876	2016-02	2018-02
4.3	NRV Z1 A	Power Sensor	Rohde & Schwarz	832279/013	2016-09	2017-09
4.4	Opus10 THI (8152.00)	T/H Logger 15	Lufft Mess- und Regeltechnik GmbH	13985	2015-03	2017-03
4.5	TOCT Switching Unit		7layers, Inc.	040107		
4.6	KWP 120/70	Temperature Chamber Weiss 01	Weiss	59226012190010	2016-03	2018-03
4.7	ADU 200 Relay Box 7	used for automated testing (EMMI) only	Ontrak Control Systems Inc	A04380		
4.8	CBT	IL BT RF Test Solution	Rohde & Schwarz	100302	2016-02	2017-02
4.9	NRVD	Power Meter	Rohde & Schwarz	832025/059	2016-08	2017-09
4.10	FSIQ26	Signal Analyser	Rohde & Schwarz	832695/007	2016-09	2018-09

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
4.11	SMP02	Signal Generator SMP	Rohde & Schwarz	833286/0014	2016-05	2019-05
4.12	SMIQ03B	Signal Generator	Rohde & Schwarz	832870/017	2016-06	2019-06
4.13	CBT	Bluetooth Tester	Rohde & Schwarz	100589	2015-01	2018-01
4.14	NGSM 32/10	Power Supply	Rohde & Schwarz	2725	2015-06	2017-06

5 Regulatory WLAN RF Test Solution
Regulatory WLAN RF Tests

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
5.1	MFS	Rubidium Frequency Normal MFS	Datum GmbH	002	2017-10	2018-10
5.2	TGA12101	Arbitrary Waveform Generator	Aim and Thurlby Thandar Instruments	284482		
5.3	EX520	Digital Multimeter 12 (Multimeter)	Extech Instruments Corp	05157876	2016-02	2018-02
5.4	NRV Z1 A	Power Sensor	Rohde & Schwarz	832279/013	2016-09	2017-09
5.5	Opus10 THI (8152.00)	T/H Logger 15	Lufft Mess- und Regeltechnik GmbH	13985	2015-03	2017-03
5.6	TOCT Switching Unit		7layers, Inc.	040107		
5.7	KWP 120/70	Temperature Chamber Weiss 01	Weiss	59226012190010	2016-03	2018-03
5.8	NRVD	Power Meter	Rohde & Schwarz	832025/059	2016-08	2017-09
5.9	FSIQ26	Signal Analyser	Rohde & Schwarz	832695/007	2016-09	2018-09
5.10	SMIQ03B	Signal Generator	Rohde & Schwarz	832870/017	2016-06	2019-06
5.11	NGSM 32/10	Power Supply	Rohde & Schwarz	2725	2015-06	2017-06

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

Please note that only calibration data is shown for periods where tests have been performed using the listed instrument, i.e. no test has been performed after the due date is outdated, tests with this instrument have been finished before.

6 ANTENNA FACTORS, CABLE LOSS AND SAMPLE CALCULATIONS

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

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

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

Sample calculation

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

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

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

Sample calculation

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

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

(d_{Limit} = 3 m)

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

(d_{Limit} = 10 m)

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

Sample calculation

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

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

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

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

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

Sample calculation

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

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

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

Sample calculation

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

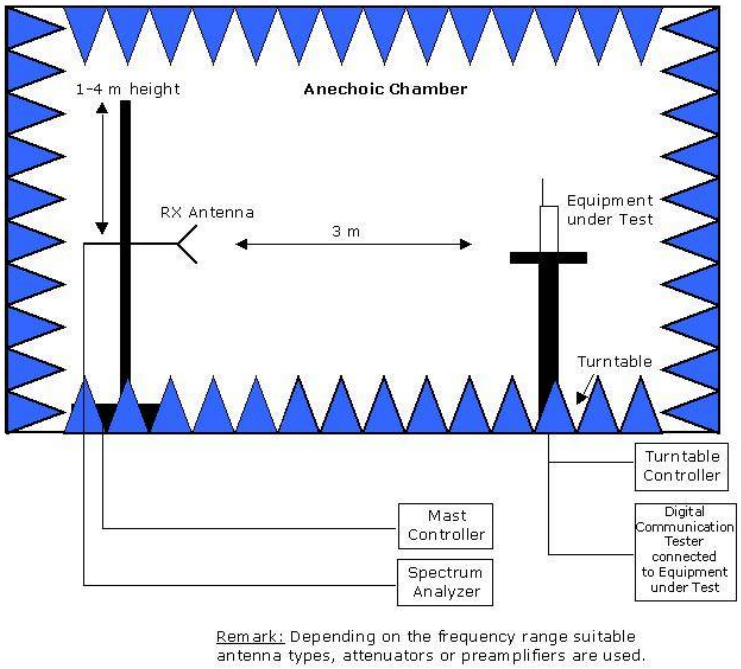
6.6 ANTENNA EMCO 3160-10 (26.5 GHZ – 40 GHZ)

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

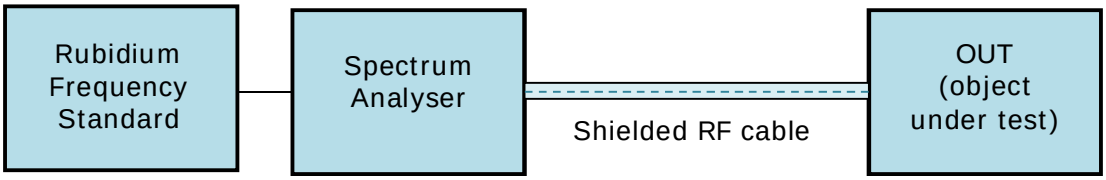
Sample calculation

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

7 SETUP DRAWINGS



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



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.