FCC Measurement/Technical Report on

LPWAN module
MYTHINGS module (uni)

FCC ID: 2ATF6-MY-UNIMODNA
IC: 25059-MYUNIMODNA

Test Report Reference: MDE_BEHRT_1901_FCC01

Test Laboratory:
7layers GmbH
Borsigstrasse 11
40880 Ratingen
Germany

Deutsche Akkreditierungsstelle
D-PL-12140-01-00

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

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1 APPLIED STANDARDS AND TEST SUMMARY

1.1 APPLIED STANDARDS

Type of Authorization
Certification for an Intentional Radiator.

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2 and 15 (10-1-18 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 v05r02, 2019-04-02". ANSI C63.10–2013 is applied.

Summary Test Results:

The EUT complied with all performed tests as listed in chapter 1.3 Measurement Summary / Signatures.

1.2 FCC-IC CORRELATION TABLE

Correlation of measurement requirements for 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 **§ 15.207**

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

OP-Mode	Setup	Date	FCC	IC
Operating mode, Connection to AC mains worst case, via ancillary/auxiliary equipment	S01_AD02	2019-10-15	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	Date	FCC	IC
Radio Technology, Operating Frequency				
Mioty (FHSS), high	S01_AC01	2019-10-14	Passed	Passed
Mioty (FHSS), low	S01_AC01	2019-10-14	Passed	Passed

47 CFR CHAPTER I FCC PART 15 Subpart C §15.247 **IC RSS-Gen & IC TRC-43; Ch. 6.7 & Ch. 8**

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

OP-Mode	Setup	Date	FCC	IC
Radio Technology, Operating Frequency				
Mioty (FHSS), high	S01_AC01	2019-10-14	N/A	Performed
Mioty (FHSS), low	S01_AC01	2019-10-14	N/A	Performed

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	Date	FCC	IC
Radio Technology, Operating Frequency, Measurement method				
Mioty (FHSS), high, conducted	S01_AC01	2019-10-14	Passed	Passed
Mioty (FHSS), low, conducted	S01_AC01	2019-10-14	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	Date	FCC	IC
Radio Technology, Operating Frequency				
Mioty (FHSS), high	S01_AC01	2019-10-14	Passed	Passed
Mioty (FHSS), low	S01_AC01	2019-10-14	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**	**Date**	**FCC**	**IC**
Mioty (FHSS), high, 1 GHz - 10 GHz	S01_AC01	2019-10-15	Passed	Passed
Mioty (FHSS), high, 30 MHz - 1 GHz	S01_AC01	2019-10-09	Passed	Passed
Mioty (FHSS), high, 9 kHz - 30 MHz	S01_AC01	2019-10-09	Passed	Passed
Mioty (FHSS), low, 1 GHz - 10 GHz	S01_AC01	2019-10-15	Passed	Passed
Mioty (FHSS), low, 30 MHz - 1 GHz	S01_AC01	2019-10-09	Passed	Passed
Mioty (FHSS), low, 9 kHz - 30 MHz	S01_AC01	2019-10-09	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**	**Date**	**FCC**	**IC**
Mioty (FHSS), high, high	S01_AC01	2019-10-14	Passed	Passed
Mioty (FHSS), hopping, high	S01_AD01	2019-10-14	Passed	Passed
Mioty (FHSS), hopping, low	S01_AD01	2019-10-14	Passed	Passed
Mioty (FHSS), low, low	S01_AC01	2019-10-14	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**	**Date**	**FCC**	**IC**
Mioty (FHSS)	S01_AD01	2019-10-14	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**	**Date**	**FCC**	**IC**
Mioty (FHSS)	S01_AD01	2019-10-16	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

OP-Mode	**Setup**	**Date**	**Final Result FCC**	**IC**
Radio Technology				
Mioty (FHSS)	S01_AD01	2019-10-15	Passed	Passed

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

2 REVISION HISTORY

Report version control			
Version	**Release date**	**Change Description**	**Version validity**
initial	2019-11-29	--	valid
--	--	--	--

COMMENT: -

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

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

7 layers GmbH, Borsigstr. 11
40880 Ratingen, Germany
Phone +49 (0)2102 749 0

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-12140-01-01| D-PL-12140-01-02 | D-PL-12140-01-03
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:	2019-06-18

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:	2019-11-29
Testing Period:	2019-10-09 to 2019-10-16

3.3 APPLICANT DATA

Company Name:	Behr Technologies Inc.
Address:	10 York Mills Road, Suite 610 Toronto ON, M2P 2G4 Canada
Contact Person:	Wolfgang Thieme

3.4 MANUFACTURER DATA

Company Name:	Behr Technologies Inc.
Address:	10 York Mills Road, Suite 610 Toronto ON, M2P 2G4 Canada
Contact Person:	Wolfgang Thieme

4 TEST OBJECT DATA

4.1 GENERAL EUT DESCRIPTION

Kind of Device product description	Mioty LPWAN module US version
Product name	MYTHINGS module (uni)
Type	MYTHINGS module (uni)
Declared EUT data by the supplier	
Voltage Type	DC
Voltage Level	5 V
Tested Modulation Type	MSK (CM in test mode on single frequency)
Antenna	External / 1.2 dBi
General product description	The EUT is a pre-configured rapid prototyping RF module featuring sub-GHz communication for robust and scalable Low Power Wide Area Networks (LPWAN) using Mioty® technology
Specific product description for the EUT	The Mioty® transmitter operates on 50 channels in the range 915 to 917 MHz using the 902 to 928 MHz band.
The EUT provides the following ports:	mikroBUS™ socket with pins for DC, GND, RST, RX, TX Antenna connector

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 C US	DE1390001ac02	
Sample Parameter	**Value**	
Serial No.	EUI:70-B3-D5-C1-F0-04-11-42	
HW Version	1.1	
SW Version	BehrTech_MYTHINGS_TDNEXT1508_v214; BehrTech_MYTHINGS_TDNEXT1508_CERT_v002	
Comment		

Sample Name	**Sample Code**	**Description**
EUT D US	DE1390001ad02	
Sample Parameter	**Value**	
Serial No.	EUI:70-B3-D5-C1-F0-04-11-38	
HW Version	1.1	
SW Version	BehrTech_MYTHINGS_TDNEXT1508_v214; BehrTech_MYTHINGS_TDNEXT1508_CERT_v002	
Comment		

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	I.T.E Power Supply, FW7712, -, - , -	AC/DC adapter

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_AD02	EUT D US, AUX1,	AC Mains Setup
S01_AC01	EUT C US,	Test Mode local TX CM
S01_AD01	EUT D US,	Normal hopping mode highest DC

4.6 OPERATING MODES

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

4.6.1 TEST CHANNELS

Mioty®	**900 MHz ISM 902 - 928 MHz**		
Test Channels:	**low**	**mid**	**high**
Channel:	1	-	50
Frequency [MHz]	915.2453	-	916.7547

4.7 PRODUCT LABELLING

4.7.1 FCC ID LABEL

Please refer to the documentation of the applicant.

4.7.2 LOCATION OF THE LABEL ON THE EUT

Please refer to the documentation of the applicant.

5 TEST RESULTS

5.1 CONDUCTED EMISSIONS AT AC MAINS

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.1.1 TEST DESCRIPTION

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

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

Step 1: Preliminary scan
Intention of this step is, to determine the conducted EMI-profile of the EUT.
EMI receiver settings:
- Detector: Peak – Maxhold & Average
- Frequency range: 150 kHz – 30 MHz
- Frequency steps: 2.5 kHz
- IF–Bandwidth: 9 kHz
- Measuring time / Frequency step: 100 ms (FFT-based)
- Measurement on phase + neutral lines of the power cords

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

Step 2: Final measurement
Intention of this step is, to determine the highest emissions with the settings defined in the test specification for the frequencies identified in step 1.
EMI receiver settings:
- Detector: Quasi-Peak
- IF Bandwidth: 9 kHz
- Measuring time: 1 s / frequency

At each frequency determined in step 1, four measurements are performed in the following combinations:
1) Neutral lead - reference ground (PE grounded)
2) Phase lead - reference ground (PE grounded)
3) Neutral lead - reference ground (PE floating)
4) Phase lead - reference ground (PE floating)

The highest value is reported.

5.1.2 TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart C, §15.207

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

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

5.1.3 TEST PROTOCOL

Temperature: 25 °C
Air Pressure: 1000 hPa
Humidity: 45 %
TX Hopping

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

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

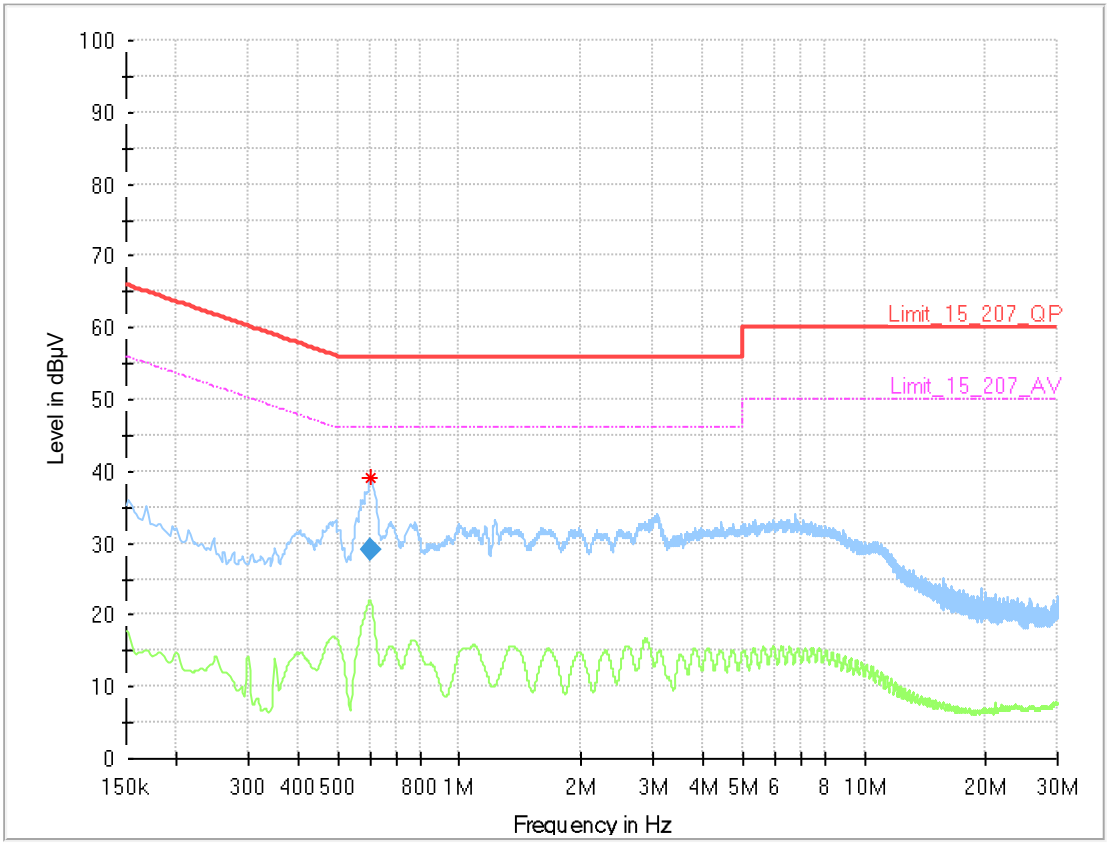
5.1.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

Operating mode = worst case, Connection to AC mains = via ancillary/auxiliary equipment (S01_AD02)

Diagram 1.01

Common Information

Test Description:	Conducted Emissions
Test Standard:	FCC §15.207, ANSI C63.10
Operating Conditions:	120 V 60 Hz, EUT hopping
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



Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.600000	28.96	---	56.00	27.04	1000.0	9.000	N	FLO	10.1

5.1.5 TEST EQUIPMENT USED

- Conducted Emissions FCC

5.2 OCCUPIED BANDWIDTH (20 DB)

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.2.1 TEST DESCRIPTION

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

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

Analyzer settings:
- See Plots

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

5.2.2 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.

5.2.3 TEST PROTOCOL

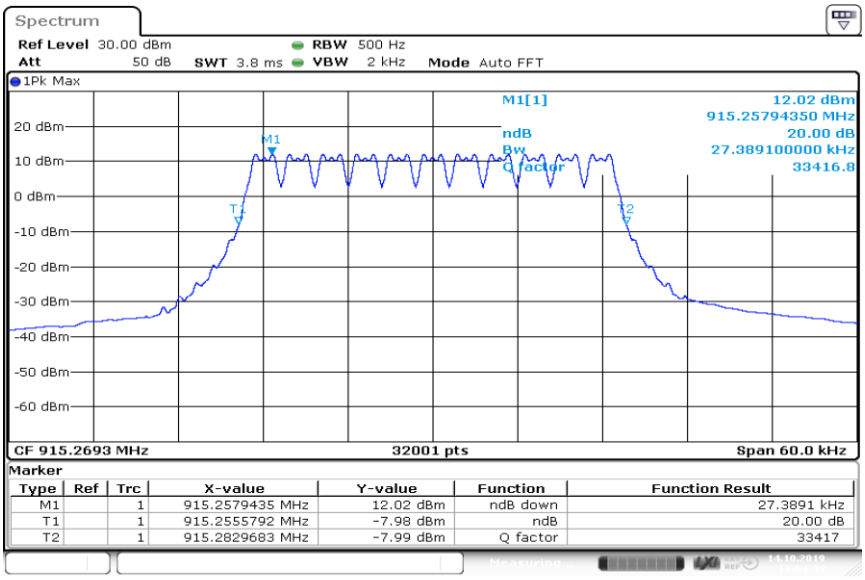
Ambient temperature: 25 °C
Air Pressure: 1000 hPa
Humidity: 45 %
Mioty; FHSS 28 kHz

Band	Channel No.	Frequency [MHz]	20 dB Bandwidth [kHz]	Limit [kHz]	Margin to Limit [MHz]
900 MHz ISM	1	915.3	27.4	500.0	472.611
	50	916.8	27.4	500.0	472.615

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

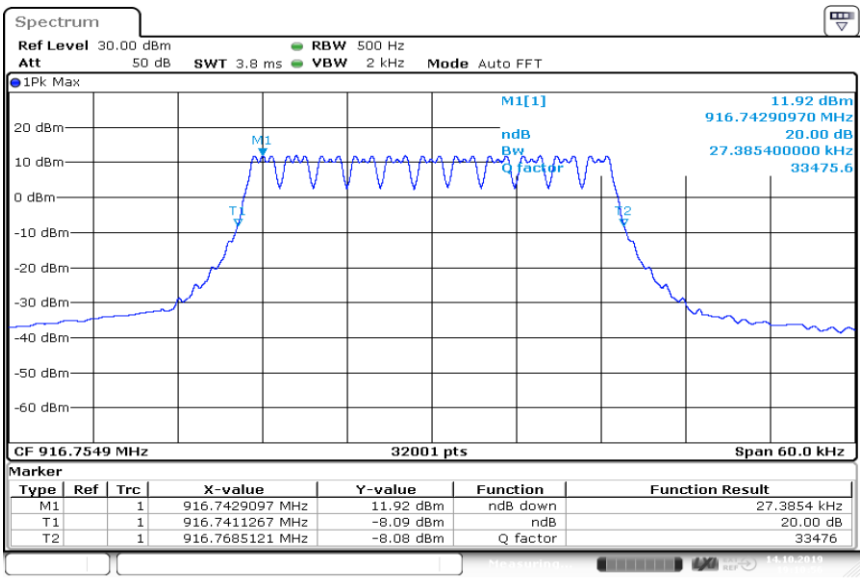
5.2.4 MEASUREMENT PLOTS

Radio Technology = Mioty (FHSS), Operating Frequency = low (S01_AC01)



Date: 14.OCT.2019 19:04:40

Radio Technology = Mioty (FHSS), Operating Frequency = high (S01_AC01)



Date: 14.OCT.2019 19:10:57

5.2.5 TEST EQUIPMENT USED

- Radio Lab

5.3 OCCUPIED BANDWIDTH (99%)

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.3.1 TEST DESCRIPTION

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

- See Plots

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

5.3.2 TEST REQUIREMENTS / LIMITS

No applicable limit:

5.3.3 TEST PROTOCOL

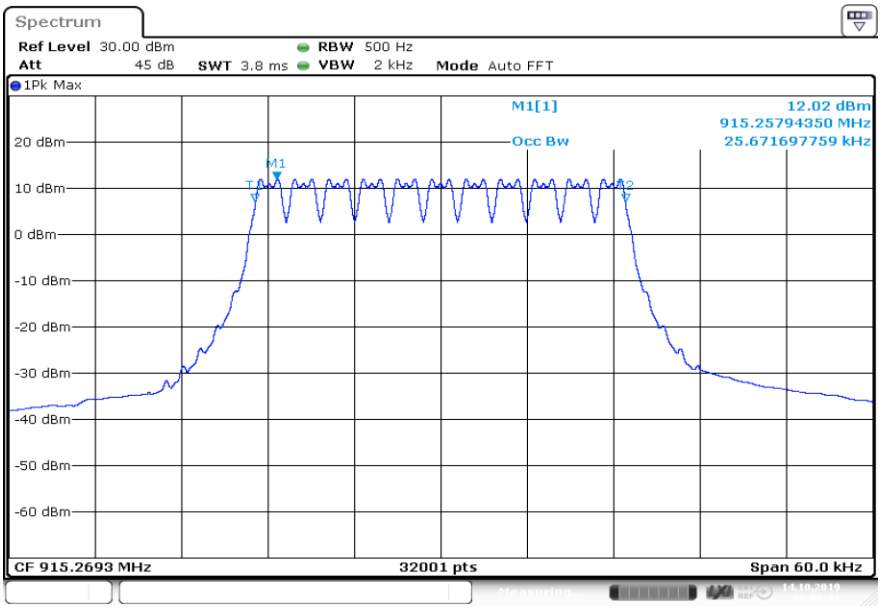
Ambient temperature: 25 °C
Air Pressure: 1000 hPa
Humidity: 45 %
Mioty; FHSS 28 kHz

Band	Channel No.	Frequency [MHz]	99 % Bandwidth [MHz]
900 MHz ISM	1	915.3	25.7
	50	916.8	25.7

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

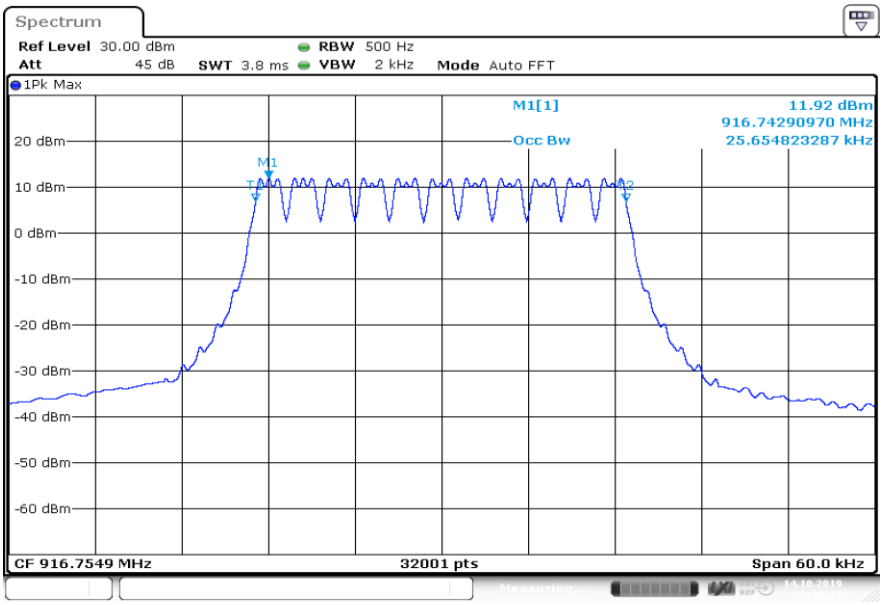
5.3.4 MEASUREMENT PLOTS

Radio Technology = Mioty (FHSS), Operating Frequency = low (S01_AC01)



Date: 14.OCT.2019 19:06:42

Radio Technology = Mioty (FHSS), Operating Frequency = high (S01_AC01)



Date: 14.OCT.2019 19:10:31

5.3.5 TEST EQUIPMENT USED

- Radio Lab

5.4 PEAK POWER OUTPUT

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.4.1 TEST DESCRIPTION

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:
- See 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:
- See plots

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

5.4.2 TEST REQUIREMENTS / LIMITS

DTS devices:
FCC Part 15, Subpart C, §15.247 (b) (3)
For systems using digital modulation techniques in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands: 1 watt.

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

Frequency Hopping Systems:
FCC Part 15, Subpart C, §15.247 (b) (1)
For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

FCC Part 15, Subpart C, §15.247 (b) (2)
For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

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

5.4.3 TEST PROTOCOL

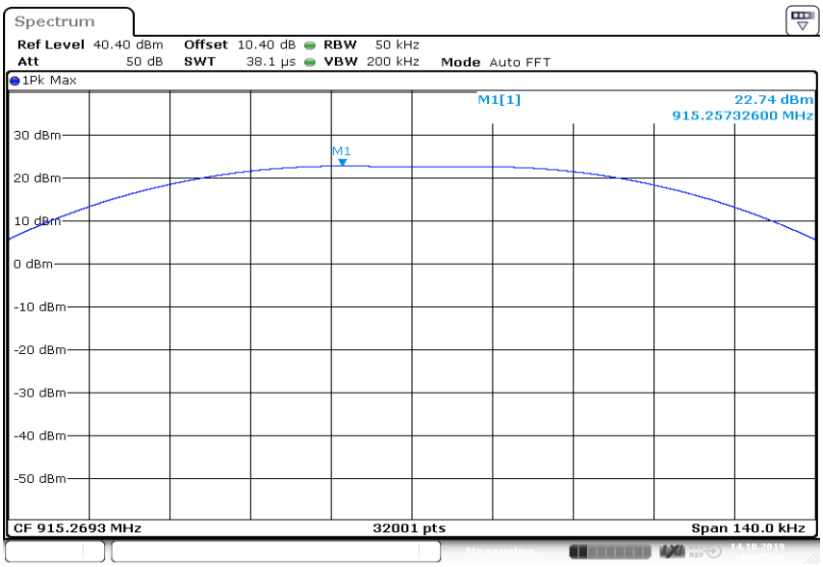
Ambient temperature: 25 °C
Air Pressure: 1000 hPa
Humidity: 45 %
Mioty; FHSS 28 kHz

Band	**Channel No.**	**Frequency [MHz]**	**Peak Power [dBm]**	**Limit [dBm]**	**Margin to Limit [dB]**	**E.I.R.P [dBm]**
900 MHz ISM	1	915.3	22.7	30.0	7.3	22.7
	50	916.8	22.8	30.0	7.2	22.8

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

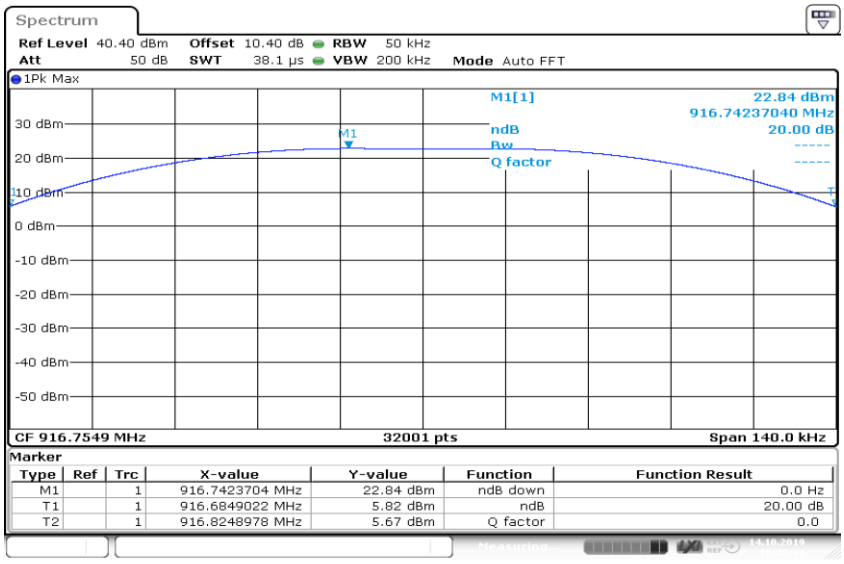
5.4.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

Radio Technology = Mioty (FHSS), Operating Frequency = low, Measurement method = conducted
(S01_AC01)



Date: 14.OCT.2019 19:35:26

Radio Technology = Mioty (FHSS), Operating Frequency = high, Measurement method = conducted
(S01_AC01)



Date: 14.OCT.2019 19:28:41

5.4.5 TEST EQUIPMENT USED

- Radio Lab

5.5 SPURIOUS RF CONDUCTED EMISSIONS

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.5.1 TEST DESCRIPTION

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

- Frequency range: 0.009 – 25000 MHz
- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Trace: Maxhold
- Sweeps: till stable
- Sweep Time: coupled
- Detector: Peak

5.5.2 TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart C, §15.247 (c)
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

5.5.3 TEST PROTOCOL

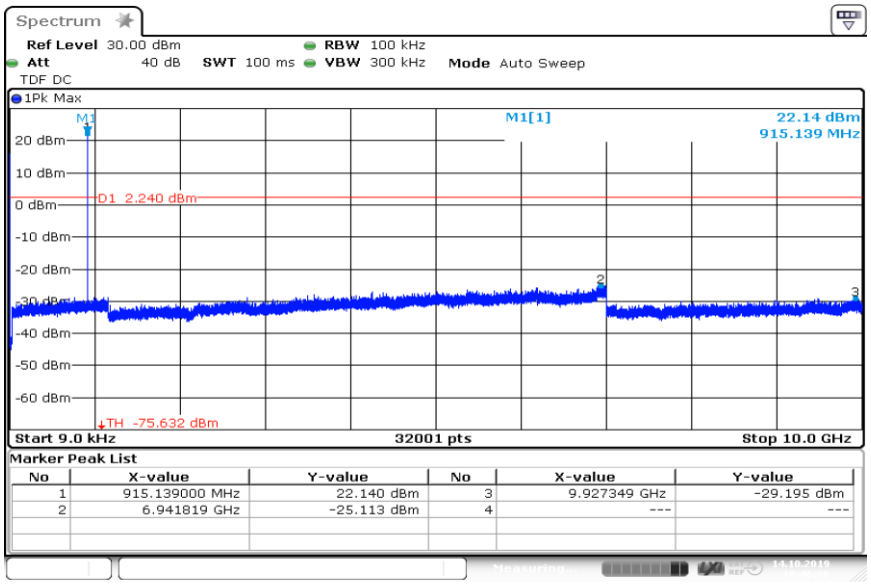
Ambient temperature: 25 °C
Air Pressure: 1000 hPa
Humidity: 45 %
Mioty; FHSS 28 kHz

Channel No	Channel Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Ref. Level [dBm]	Limit [dBm]	Margin to Limit [dB]
1	915.3	-	-	PEAK	100	22.1	2.1	>20
50	916.8	-	-	PEAK	100	22.1	2.1	>20

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

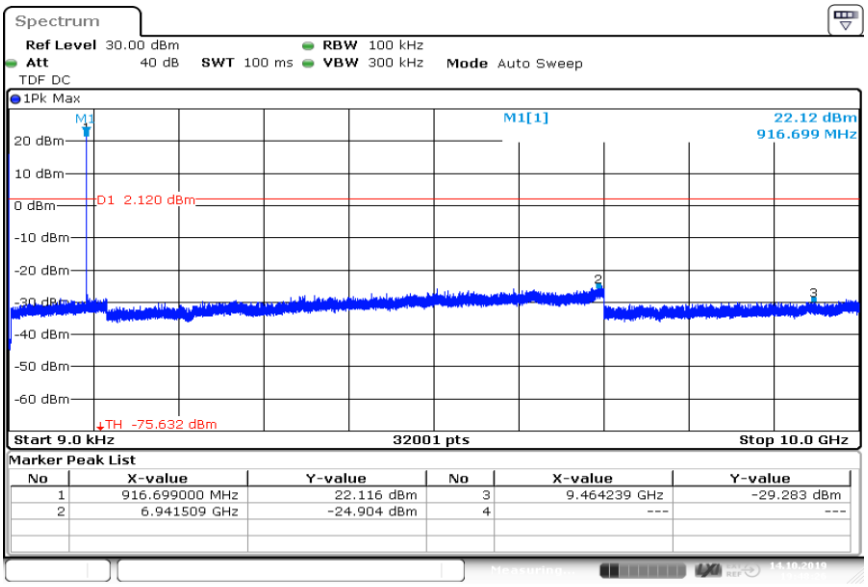
5.5.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

Radio Technology = Mioty (FHSS), Operating Frequency = low (S01_AC01)



Date: 14.OCT.2019 19:46:26

Radio Technology = Mioty (FHSS), Operating Frequency = high (S01_AC01)



Date: 14.OCT.2019 19:48:26

5.5.5 TEST EQUIPMENT USED

- Radio Lab

5.6 TRANSMITTER SPURIOUS RADIATED EMISSIONS

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.6.1 TEST DESCRIPTION

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

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

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

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

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

2. Measurement above 30 MHz and up to 1 GHz

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

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

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

Step 2: Adjustment measurement
In this step the accuracy of the turntable azimuth and antenna height will be improved. This is necessary to find out the maximum value of every frequency.
For each frequency, which was determined the turntable azimuth and antenna height will be adjusted. The turntable azimuth will slowly vary by ± 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

5.6.2 TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart C, §15.247 (d)
... In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

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

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

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

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

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

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

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

5.6.3 TEST PROTOCOL

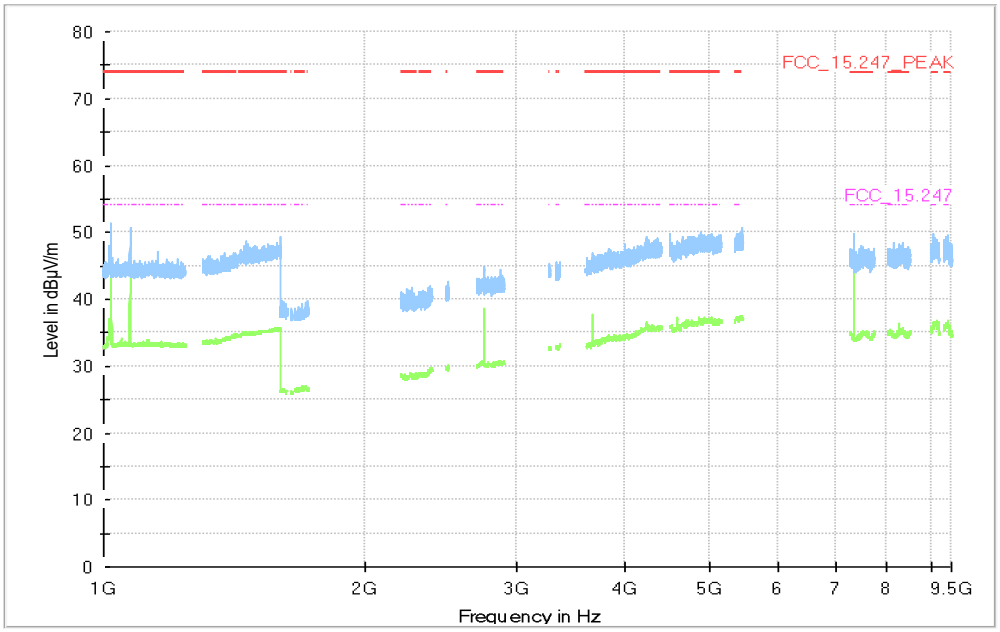
Ambient temperature: **24–26 °C**
Air Pressure: **1000–1000 hPa**
Humidity: **43–44 %**

Mioty; FHSS 28 kHz								
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**
1	915.3	38.0	26.5	QP	100	40.0	13.5	RB
1	915.3	967.3	48.4	QP	100	54.0	5.6	RB
50	916.8	38.0	27.7	QP	100	40.0	12.3	RB
50	916.8	968.8	49.5	QP	100	54.0	4.6	RB

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

5.6.4 MEASUREMENT PLOTS

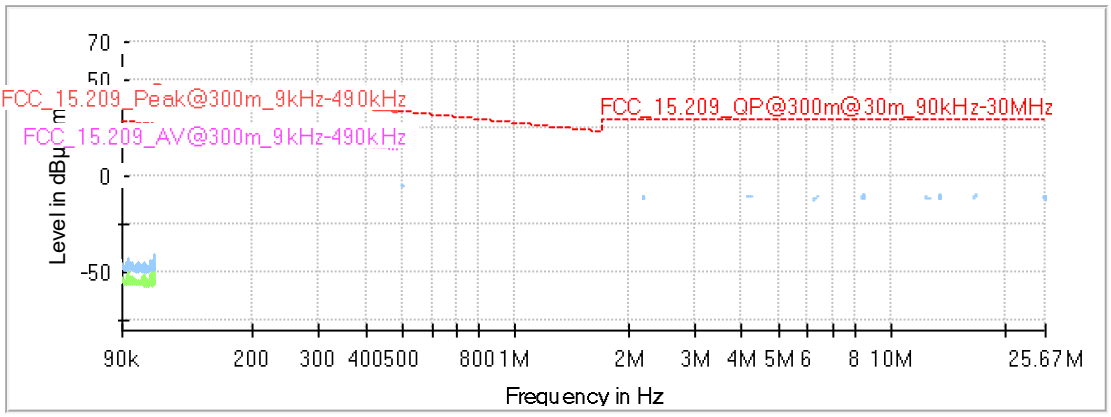
Radio Technology = Mioty (FHSS), Operating Frequency = high, Measurement range = 1 GHz - 10 GHz
(S01_AC01)



Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin	Meas. Time (ms)	Bandwidth	Height	Pol	Azimuth	Elevation
---	---	---	---	---	---	---	---		---	---

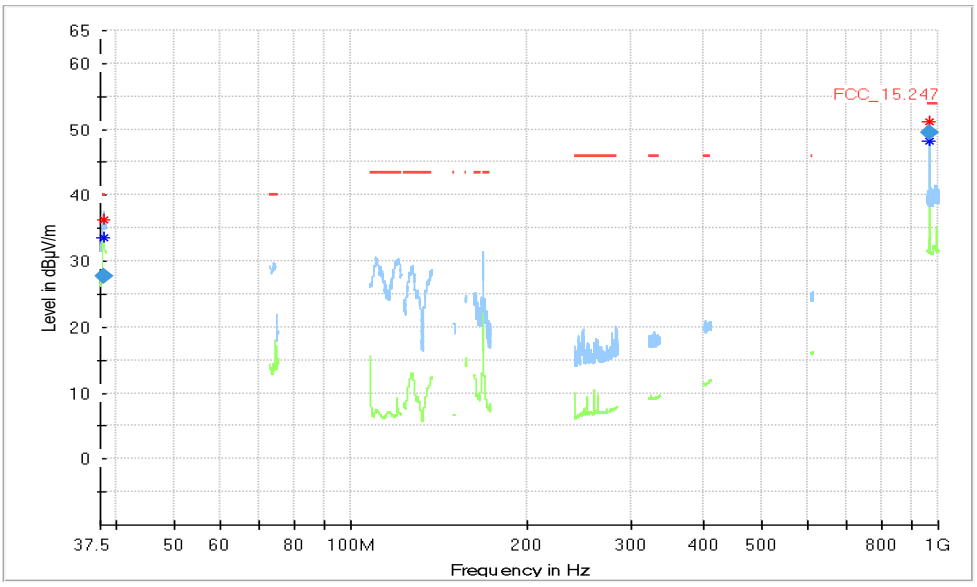
Radio Technology = Mioty (FHSS), Operating Frequency = low, Measurement range = 9 kHz - 30 MHz
(S01_AC01)



Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin	Meas. Time (ms)	Bandwidth	Height	Pol	Azimuth	Corr. (dB/m)
---	---	---	---	---	---	---	---		---	---

Radio Technology = Mioty (FHSS), Operating Frequency = high, Measurement range = 30 MHz - 1 GHz
(S01_AC01)



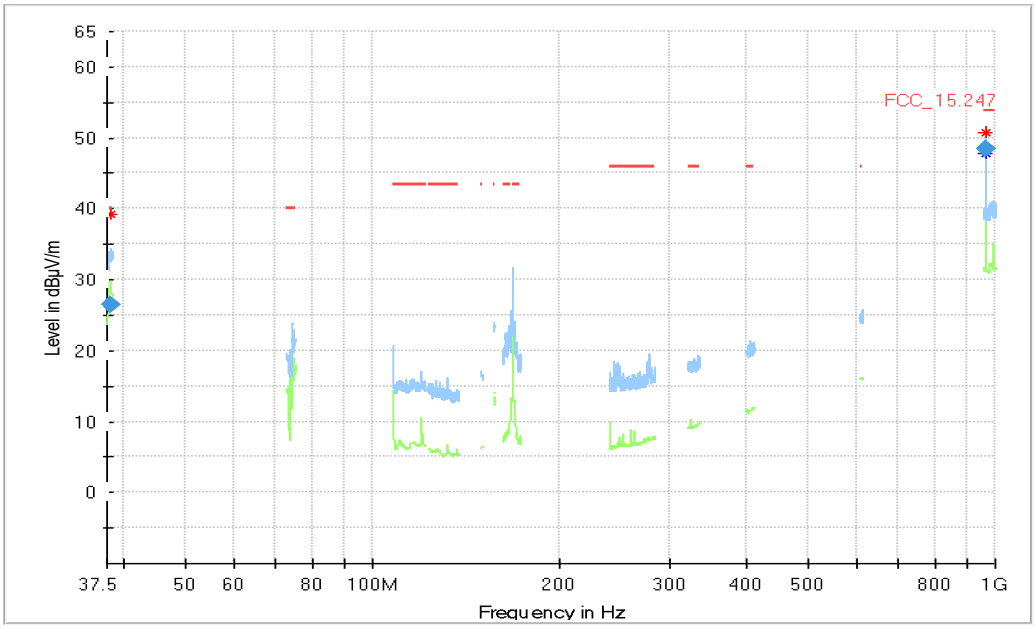
Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin	Meas. Time (ms)	Bandwidth	Height	Pol	Azimuth	Corr. (dB/m)
37.950000	---	33.62	40.00	6.38	---	---	100.0	V	90.0	15.1
38.010000	36.20	---	40.00	2.41	---	---	100.0	V	50.0	15.0
968.760000	51.18	---	54.00	3.82	---	---	110.0	V	-146.0	25.3
968.760000	---	48.17	54.00	5.83	---	---	100.0	V	-180.0	25.3

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin	Meas. Time (ms)	Bandwidth	Height	Pol	Azimuth	Corr. (dB/m)	Comment
38.010000	27.66	40.00	12.34	1000.0	120.000	100.0	V	50.0	15.0	
968.760000	49.45	54.00	4.55	1000.0	120.000	110.0	V	-146.0	25.3	

Radio Technology = Mioty (FHSS), Operating Frequency = low, Measurement range = 30 MHz - 1 GHz
(S01_AC01)



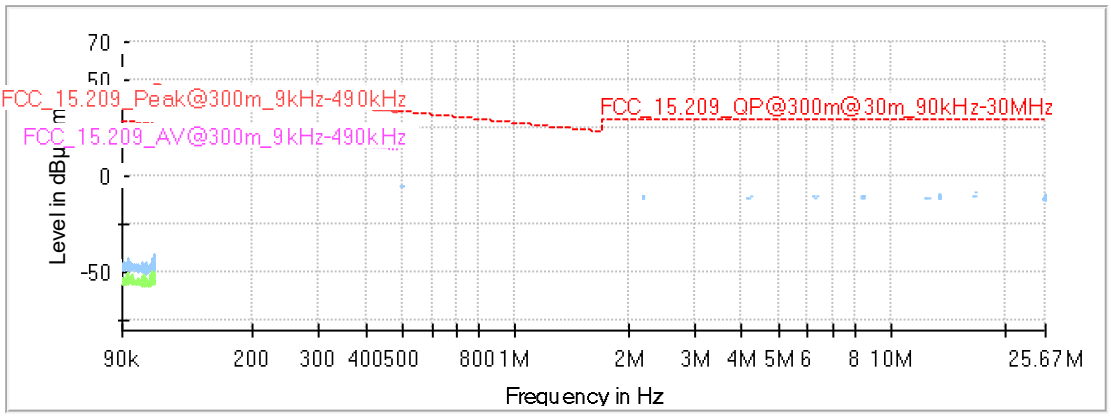
Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin	Meas. Time (ms)	Bandwidth	Height	Pol	Azimuth	Corr. (dB/m)
38.010000	39.20	---	40.00	5.64	---	---	100.0	V	106.0	15.0
967.260000	50.76	---	54.00	3.97	---	---	106.0	V	-143.0	25.2
967.260000	---	47.90	54.00	6.10	---	---	100.0	V	-180.0	25.2

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin	Meas. Time (ms)	Bandwidth	Height	Pol	Azimuth	Corr. (dB/m)	Comment
38.010000	26.53	40.00	13.47	1000.0	120.000	100.0	V	106.0	15.0	
967.260000	48.43	54.00	5.57	1000.0	120.000	106.0	V	-143.0	25.2	

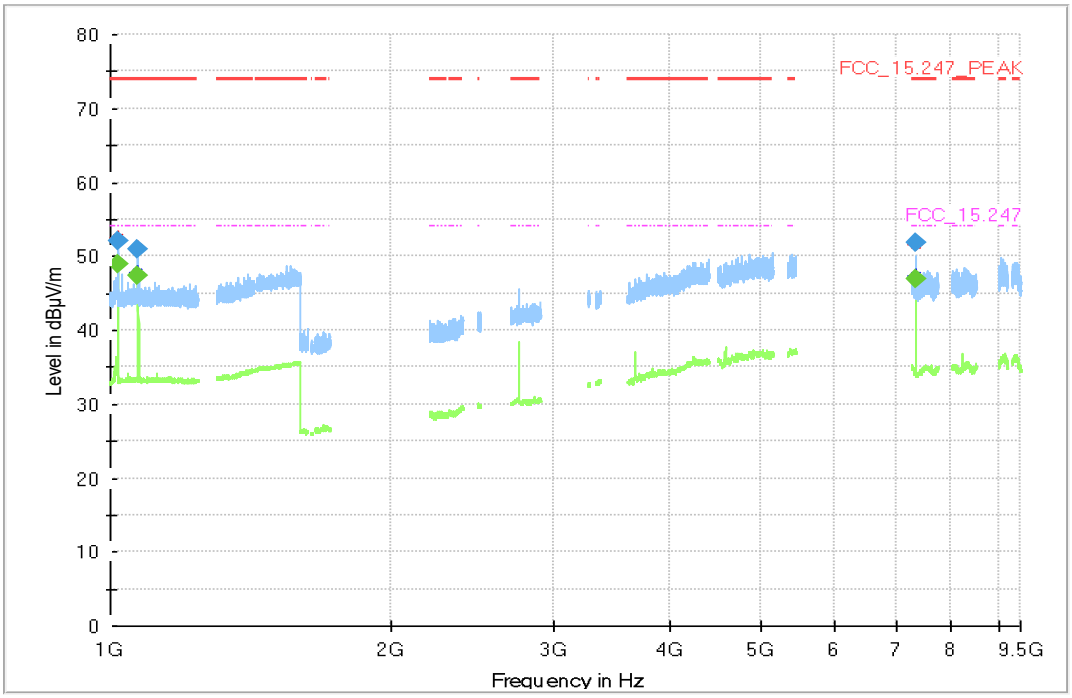
Radio Technology = Mioty (FHSS), Operating Frequency = high, Measurement range = 9 kHz - 30 MHz
(S01_AC01)



Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin	Meas. Time (ms)	Bandwidth	Height	Pol	Azimuth	Corr. (dB/m)
---	---	---	---	---	---	---	---		---	---

Radio Technology = Mioty (FHSS), Operating Frequency = low, Measurement range = 1 GHz - 10 GHz
(S01_AC01)



Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin	Meas. Time (ms)	Bandwidth	Height	Pol	Azimuth	Elevation
1019.200	---	49.2	54.00	5.60	---	---	150.0	V	149.0	11.0
1019.200	52.4	---	74.00	22.52	---	---	150.0	V	152.0	9.0
1071.280	---	47.8	54.00	6.30	---	---	150.0	H	85.0	93.0
1071.280	51.2	---	74.00	22.86	---	---	150.0	H	87.0	105.0
7322.000	---	47.4	54.00	8.61	---	---	150.0	H	35.0	78.0
7322.125	51.7	---	74.00	23.93	---	---	150.0	H	37.0	84.0

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin	Meas. Time (ms)	Bandwidth	Height	Pol	Azimuth	Elevation
1019.200	---	49.0	54.00	4.96	1000.0	1000.000	150.0	V	149.0	11.0
1019.200	52.2	---	74.00	21.83	1000.0	1000.000	150.0	V	152.0	9.0
1071.280	---	47.4	54.00	6.59	1000.0	1000.000	150.0	H	85.0	93.0
1071.280	51.0	---	74.00	22.96	1000.0	1000.000	150.0	H	87.0	105.0
7322.000	---	47.0	54.00	7.04	1000.0	1000.000	150.0	H	35.0	78.0
7322.125	51.9	---	74.00	22.12	1000.0	1000.000	150.0	H	37.0	84.0

5.6.5 TEST EQUIPMENT USED

- Radiated Emissions

5.7 BAND EDGE COMPLIANCE CONDUCTED

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.7.1 TEST DESCRIPTION

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

Analyzer settings:

- See Plots

5.7.2 TEST REQUIREMENTS / LIMITS

FCC Part 15.247 (d)
"In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. ...
If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c))."

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

5.7.3 TEST PROTOCOL

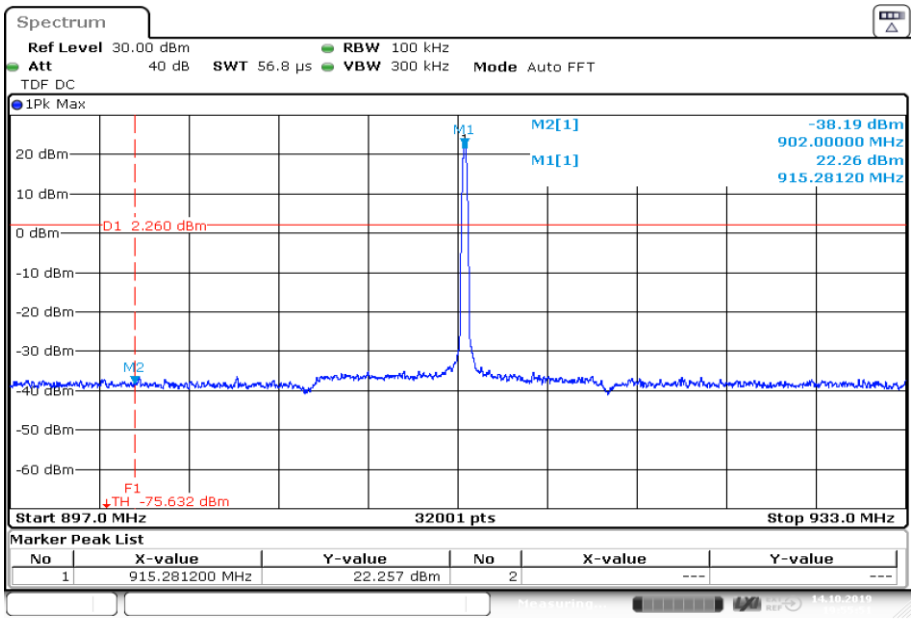
Ambient temperature: 25 °C
Air Pressure: 1000 hPa
Humidity: 45 %
Mioty; FHSS 28 kHz

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]
1	915.3	902	-38.2	PEAK	100	22.3	2.3	40.5
50	916.8	928	-39.4	PEAK	100	22.2	2.2	41.6
hopping	hopping	902	-39.4	PEAK	100	23.0	3.0	42.3
hopping	hopping	928	-38.3	PEAK	100	23.0	3.0	41.3

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

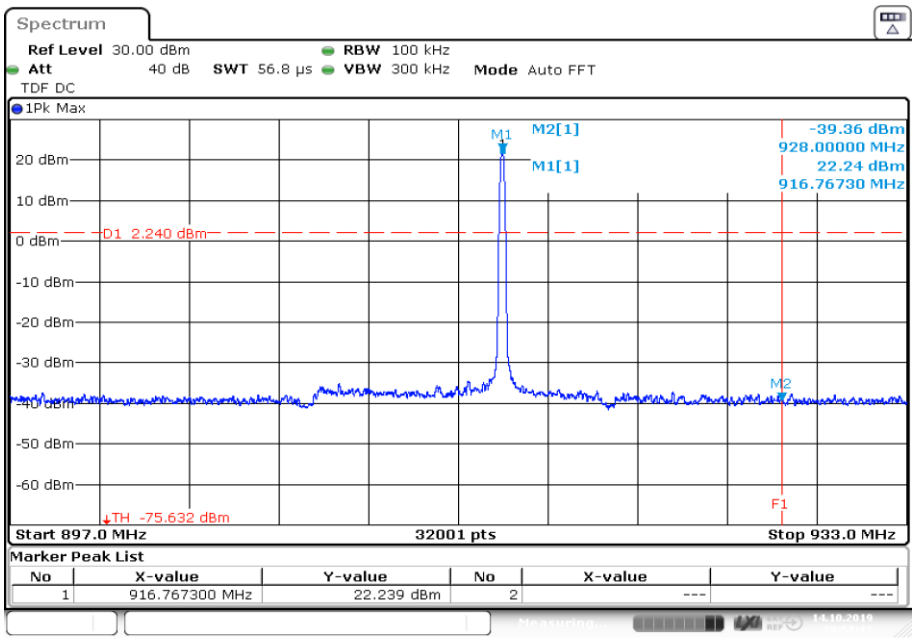
5.7.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

Radio Technology = Mioty (FHSS), Operating Frequency = low, Band Edge = low (S01_AC01)



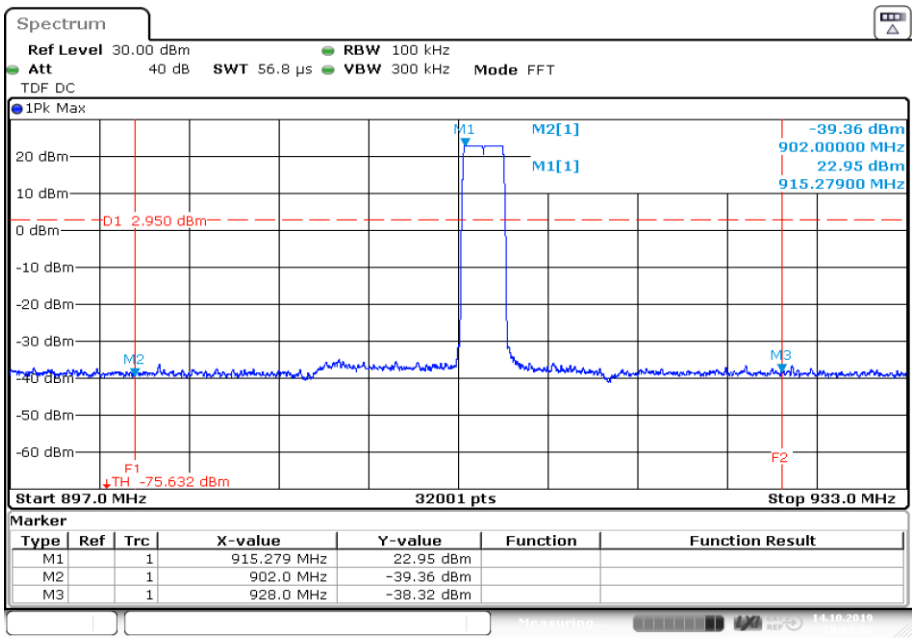
Date: 14.OCT.2019 19:55:51

Radio Technology = Mioty (FHSS), Operating Frequency = high, Band Edge = high (S01_AC01)



Date: 14.OCT.2019 19:57:11

Radio Technology = Mioty (FHSS), Operating Frequency = hopping, Band Edge = low and high (S01_AD01)



Date: 14.OCT.2019 20:01:50

5.7.5 TEST EQUIPMENT USED

- Radio Lab

5.8 CHANNEL SEPARATION

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 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.

5.8.2 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.

5.8.3 TEST PROTOCOL

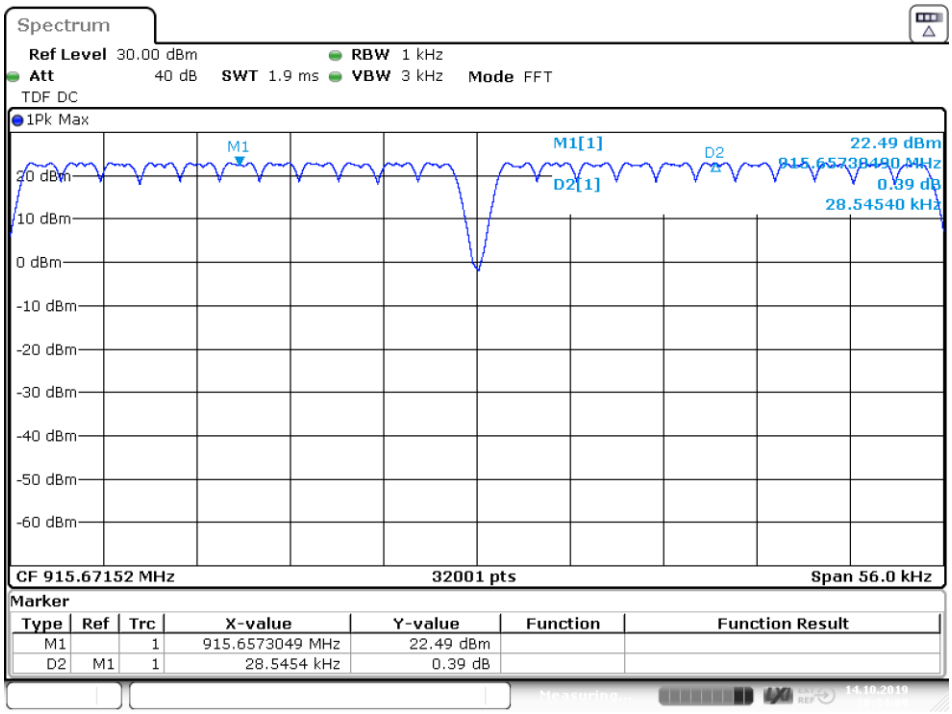
Ambient temperature: 25 °C
Air Pressure: 1000 hPa
Humidity: 45 %

Radio Technology	Channel Separation [kHz]	Limit [kHz]	Margin to Limit [kHz]
Mioty; FHSS 28 kHz	28.5	27.4	1.1

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

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

Radio Technology = Mioty (FHSS)
(S01_AD01)



Date: 14.OCT.2019 20:34:10

5.8.5 TEST EQUIPMENT USED

- Radio Lab

5.9 DWELL TIME

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 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 = number of hops x length of single hop

Analyzer settings:

- See plots

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 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.

5.9.3 TEST PROTOCOL

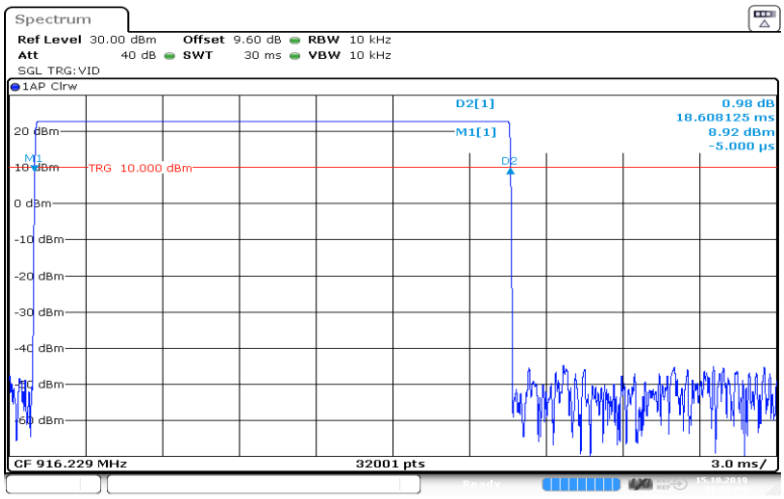
Ambient temperature: 25 °C
Air Pressure: 1000 hPa
Humidity: 45 %

Radio Technology	Time Slot Length [ms]	Dwell Time [ms]	Limit [s]	Margin to Limit [ms]
Mioty; FHSS 28 kHz	18.600	111.600	0.4	288.400

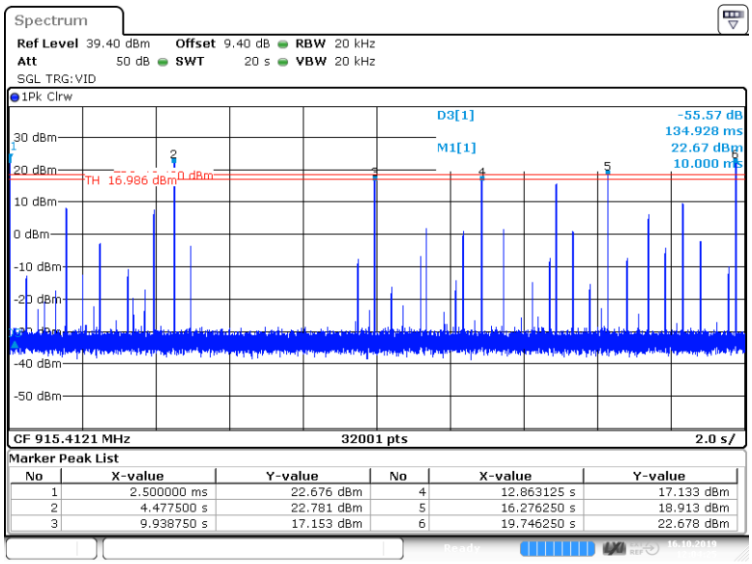
Remark: Please see next sub-clause for the measurement plot.

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

Radio Technology = Mioty (FHSS)
(S01_AD01)



Date: 15.OCT.2019 18:52:00



Date: 16.OCT.2019 12:04:25

5.9.5 TEST EQUIPMENT USED

- Radio Lab

5.10 NUMBER OF HOPPING FREQUENCIES

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.10.1TEST 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:
- See plot

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

5.10.2TEST 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.

5.10.3TEST PROTOCOL

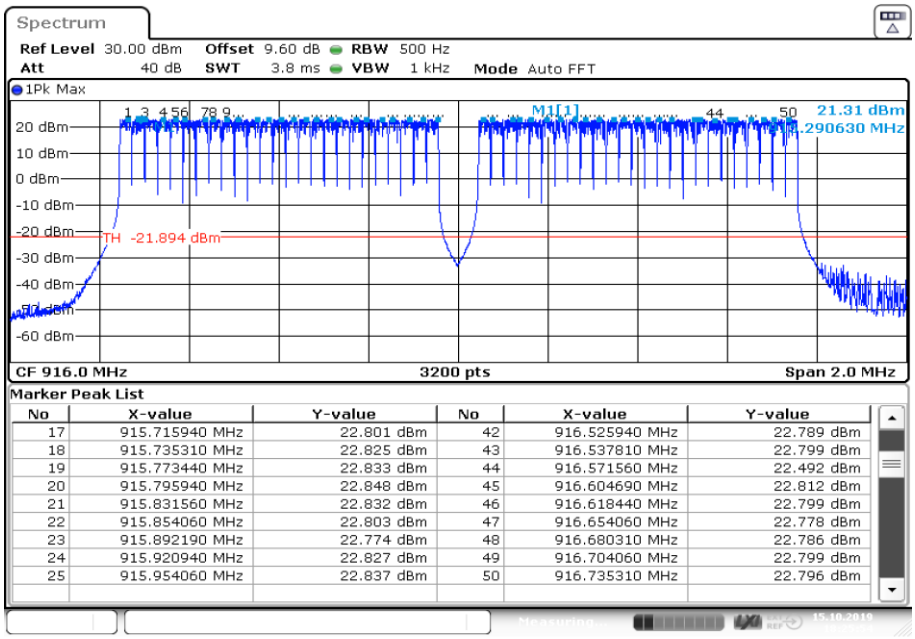
Ambient temperature: 25 °C
Air Pressure: 1000 hPa
Humidity: 45 %

Radio Technology	Number of Hopping Frequencies	Limit	Margin to Limit
Mioty; FHSS 28 kHz	50	50	0

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

5.10.4MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

Radio Technology = Mioty (FHSS)
(S01_AD01)



No	X-value	Y-value	No	X-value	Y-value
17	915.715940 MHz	22.801 dBm	42	916.525940 MHz	22.789 dBm
18	915.735310 MHz	22.825 dBm	43	916.537810 MHz	22.799 dBm
19	915.773440 MHz	22.833 dBm	44	916.571560 MHz	22.492 dBm
20	915.795940 MHz	22.848 dBm	45	916.604690 MHz	22.812 dBm
21	915.831560 MHz	22.832 dBm	46	916.618440 MHz	22.799 dBm
22	915.854060 MHz	22.803 dBm	47	916.654060 MHz	22.778 dBm
23	915.892190 MHz	22.774 dBm	48	916.680310 MHz	22.786 dBm
24	915.920940 MHz	22.827 dBm	49	916.704060 MHz	22.799 dBm
25	915.954060 MHz	22.837 dBm	50	916.735310 MHz	22.796 dBm

Date: 15.OCT.2019 18:25:55

5.10.5TEST EQUIPMENT USED

- Radio Lab

6 TEST EQUIPMENT

1 Conducted Emissions FCC
Conducted Emissions AC Mains for FCC standards

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
1.1	Opus10 TPR (8253.00)	ThermoAirpressure Datalogger 13	Lufft Mess- und Regeltechnik GmbH	ID 13936	2019-05	2021-05
1.2	ESH3-Z5	Two-Line V-Network (AUX)	Rohde & Schwarz GmbH & Co. KG	828304/029	2019-06	2021-06
1.3	EP 1200/B, NA/B1	AC Source, Amplifier with integrated variable Oscillator	Spitzenberger & Spies GmbH & Co. KG	B6278		
1.4	Shielded Room 02	Shielded Room 4 m x 3 m	Frankonia	-		
1.5	ESH3-Z5	Two-Line V-Network (EUT)	Rohde & Schwarz GmbH & Co. KG	829996/002	2019-06	2021-06
1.6	ESR 7	EMI Receiver / Spectrum Analyzer	Rohde & Schwarz	101424	2019-01	2020-01
1.7	Opus10 THI (8152.00)	ThermoHygro Datalogger 02	Lufft Mess- und Regeltechnik GmbH	7489	2019-05	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	MFS	Rubidium Frequency Normal MFS	Datum GmbH	002	2018-10	2020-10
2.2	N5000/NP	Filter for EUT, 2 Lines, 250 V, 16 A	ETS-LINDGREN	241515		
2.3	Opus10 TPR (8253.00)	ThermoAirpressure Datalogger 13	Lufft Mess- und Regeltechnik GmbH	ID 13936	2019-05	2021-05
2.4	Anechoic Chamber 01	SAC/FAR, 10.58 m x 6.38 m x 6.00 m	Frankonia	none	2018-06	2020-06
2.5	HL 562 ULTRALOG	Biconical-log-per antenna (30 MHz - 3 GHz) with HL 562E biconicals	Rohde & Schwarz GmbH & Co. KG	830547/003	2018-07	2021-07
2.6	AMF-7D00101800-30-10P-R	Broadband Amplifier 100 MHz - 18 GHz	Miteq			
2.7	5HC2700/12750-1.5-KK	High Pass Filter	Trilithic	9942012		
2.8	ASP 1.2/1.8-10 kg	Antenna Mast	Maturo GmbH	-		

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
2.9	Anechoic Chamber 03	FAR, 8.80m x 4.60m x 4.05m (l x w x h)	Albatross Projects	P26971-647-001-PRB	2018-06	2020-06
2.10	SMBV100A	Vector Signal Generator 9 kHz - 3.2 GHz (GNSS / Broadcast Signalling Unit)	Rohde & Schwarz GmbH & Co. KG	260001	2018-01	2021-01
2.11	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2018-04	2020-04
2.12	WRD1920/1980-5/22-5EESD	Tunable Band Reject Filter	Wainwright Instruments GmbH	11		
2.13	TDS 784C	Digital Oscilloscope [SA2] (Aux)	Tektronix	B021311		
2.14	foRS232 Unit 2	Fibre optic link RS232	PONTIS Messtechnik GmbH	4031516037		
2.15	PONTIS Con4101	PONTIS Camera Controller		6061510370		
2.16	NRVD	Power Meter	Rohde & Schwarz GmbH & Co. KG	828110/016	2019-08	2020-08
2.17	OLS-1 R	Fibre optic link USB 1.1	Ingenieurbüro Scheiba	018		
2.18	HF 906	Double-ridged horn	Rohde & Schwarz	357357/002	2018-09	2021-09
2.19	JS4-18002600-32-5P	Broadband Amplifier 18 GHz - 26 GHz	Miteq	849785		
2.20	FSW 43	Spectrum Analyzer	Rohde & Schwarz	103779	2019-02	2021-02
2.21	3160-09	Standard Gain / Pyramidal Horn Antenna 26.5 GHz	EMCO Elektronic GmbH	00083069		
2.22	foRS232 Unit 1	Fibre optic link RS232	PONTIS Messtechnik GmbH	4021516036		
2.23	FSP3	Spectrum Analyzer	Rohde & Schwarz GmbH & Co. KG	836722/011		
2.24	SGH-19	Standard Gain / Pyramidal Horn Antenna (40 - 60 GHz)	RPG-Radiometer Physics GmbH	093		
2.25	WHKX 7.0/18G-8SS	High Pass Filter	Wainwright Instruments GmbH	09		
2.26	DS 420S	Turn Table 2 m diameter	HD GmbH	420/573/99		
2.27	4HC1600/12750-1.5-KK	High Pass Filter	Trilithic	9942011		
2.28	foUSB-M Converter 2	Fibre optic link USB 2.0	PONTIS Messtechnik GmbH	4471520061		
2.29	WRCD1879.8-0.2/40-10EE	Notch Filter Ultra Stable	Wainwright Instruments GmbH	16		
2.30	Chroma 6404	AC Source	Chroma ATE INC.	64040001304		

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
2.31	JS4-00102600-42-5A	Broadband Amplifier 30 MHz - 26 GHz	Miteq	619368		
2.32	TT 1.5 WI	Turn Table	Maturo GmbH	-		
2.33	HL 562 ULTRALOG	Biconical-log-per Antenna (30 MHz - 3 GHz)	Rohde & Schwarz GmbH & Co. KG	100609	2019-05	2022-05
2.34	HF 906	Double-ridged horn	Rohde & Schwarz	357357/001	2018-03	2021-03
2.35	foCAN (v 4.0)	Fibre optic link CAN	Audivo GmbH (PONTIS EMC)	492 1607 014		
2.36	FS-Z325	Harmonic Mixer 220 - 325 GHz	Rohde & Schwarz Messgerätebau GmbH	101006	2017-03	2020-03
2.37	MA4985-XP-ET	Bore Sight Antenna Mast	innco systems GmbH	none		
2.38	A8455-4	4 Way Power Divider (SMA)		-		
2.39	JUN-AIR Mod. 6-15	Air Compressor	JUN-AIR Deutschland GmbH	612582		
2.40	foEthernet_M	Fibre optic link Ethernet / Gb-LAN	PONTIS Messtechnik GmbH	4841516023		
2.41	5HC3500/18000-1.2-KK	High Pass Filter	Trilithic	200035008		
2.42	OLS-1 M	Fibre optic link USB 1.1	Ingenieurbüro Scheiba	018		
2.43	HFH2-Z2	Loop Antenna	Rohde & Schwarz	829324/006	2018-01	2021-01
2.44	Voltcraft M-3860M	Digital Multimeter 01 (Multimeter)	Conrad	IJ096055		
2.45	Opus10 THI (8152.00)	ThermoHygro Datalogger 12	Lufft Mess- und Regeltechnik GmbH	ID 12482	2019-06	2021-06
2.46	ESR 7	EMI Receiver / Spectrum Analyzer	Rohde & Schwarz	101424	2019-01	2020-01
2.47	foEthernet_M	Fibre optic link Ethernet / Gb-LAN	PONTIS Messtechnik GmbH	4841516022		
2.48	JS4-00101800-35-5P	Broadband Amplifier 30 MHz - 18 GHz	Miteq	896037		
2.49	AS 620 P	Antenna Mast (pneumatic polarisation)	HD GmbH	620/37		
2.50	6005D (30 V / 5 A)	Laboratory Power Supply 120 V 60 Hz	Peaktech	81062045		
2.51	TD1.5-10kg	EUT Tilt Device (Rohacell)	Maturo GmbH	TD1.5-10kg/024/3790709		
2.52	ESIB 26	Spectrum Analyzer	Rohde & Schwarz	830482/004	2018-01	2020-01
2.53	Innco Systems CO3000	Controller for bore sight mast SAC	innco systems GmbH	CO3000/967/39371016/L		

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
2.54	NRV-Z1	Sensor Head B	Rohde & Schwarz GmbH & Co. KG	827753/006	2019-08	2020-08
2.55	foCAN (v 4.0)	Fibre optic link CAN	Audivo GmbH (PONTIS EMC)	492 1607 013		
2.56	PAS 2.5 - 10 kg	Antenna Mast	Maturo GmbH	-		
2.57	AFS42-00101800-25-S-42	Broadband Amplifier 25 MHz - 18 GHz	Miteq	2035324		
2.58	WRCA800/960-0.2/40-6EEK	Tunable Notch Filter	Wainwright Instruments GmbH	20		
2.59	AM 4.0	Antenna Mast 4 m	Maturo GmbH	AM4.0/180/1192 0513		
2.60	HF 907	Double-ridged horn	Rohde & Schwarz	102444	2018-07	2021-07
2.61	E4408B	Spectrum Analyser (9 kHz to 26.5 GHz)	Agilent Technologies Deutschland GmbH	MY45103714		

3 Radio Lab
Conducted Radio Test Lab

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
3.1	1575	Broadband Resistive Power Divider DC to 40 GHz	API Weinschel, Inc.	4070		
3.2	FSV30	Signal Analyzer 10 Hz - 30 GHz	Rohde & Schwarz	103005	2018-04	2020-04
3.3	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2018-04	2020-04
3.4	FSIQ26	Signal Analyser 20 Hz to 26.5 GHz	Rohde & Schwarz GmbH & Co. KG	840061/005	2019-06	2021-06
3.5	Chroma 6404	AC Source	Chroma ATE INC.	64040001304		
3.6	Temperature Chamber VT 4002	Temperature Chamber Vötsch 03	Vötsch	58566002150010	2018-04	2020-04
3.7	A8455-4	4 Way Power Divider (SMA)		-		
3.8	Opus10 THI (8152.00)	ThermoHygro Datalogger 03	Lufft Mess- und Regeltechnik GmbH	ID 7482	2019-06	2021-06
3.9	SMBV100A	Vector Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz	259291	2016-10	2019-10
3.10	WRCA800/960-0.2/40-6EEK	Tunable Notch Filter	Wainwright Instruments GmbH	20		

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.

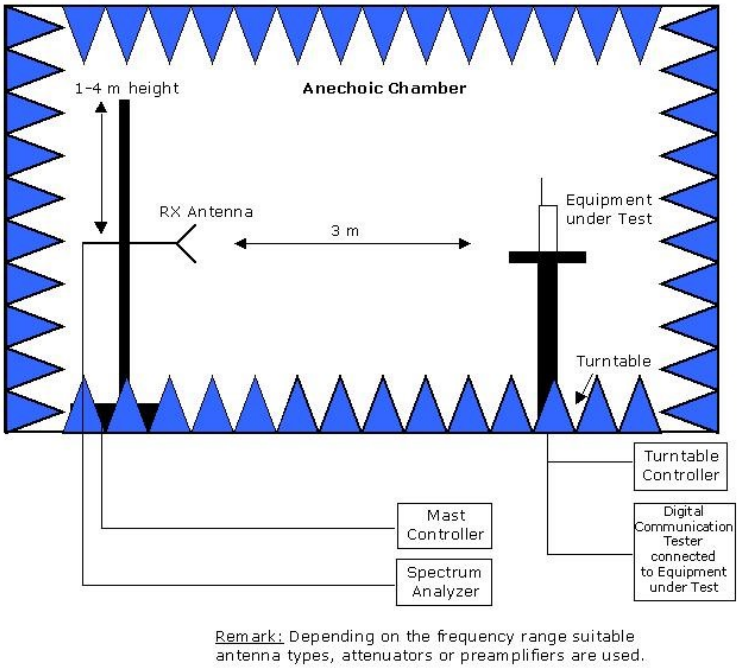
7.6 ANTENNA EMCO 3160-10 (26.5 GHZ – 40 GHZ)

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

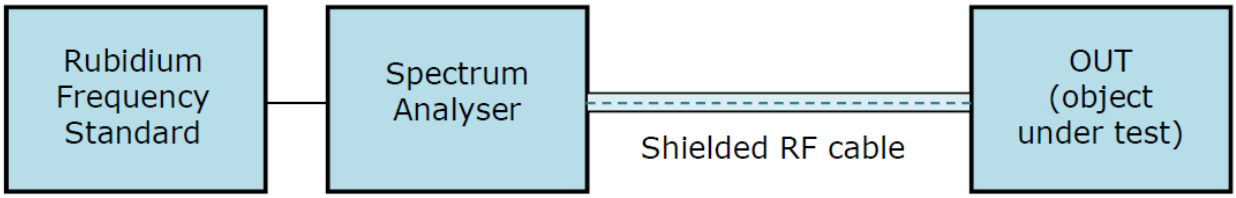
Sample calculation

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.

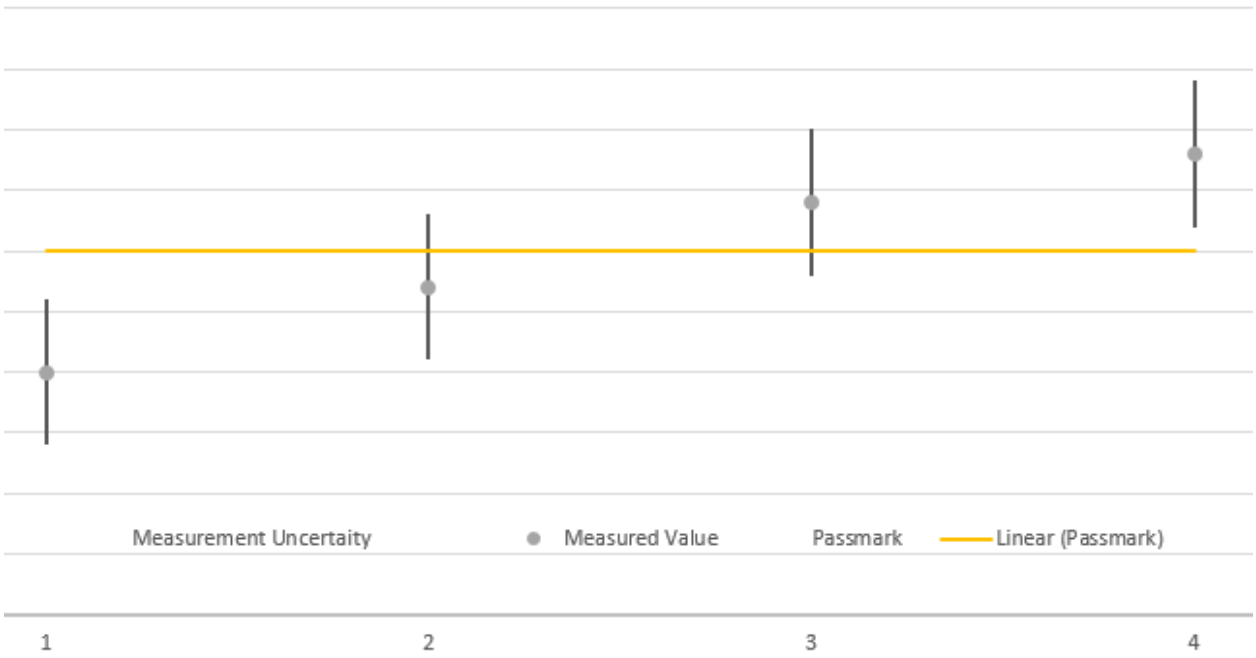


Drawing 2: Setup for conducted radio tests.

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

The measurement uncertainties for all parameters are calculated with an expansion factor (coverage factor) k = 1.96. This means, that the true value is in the corresponding interval with a probability of 95 %.



The verdicts in this test report are given according the above diagram:

Case	Measured Value	Uncertainty Range	Verdict
1	below pass mark	below pass mark	Passed
2	below pass mark	within pass mark	Passed
3	above pass mark	within pass mark	Failed
4	above pass mark	above pass mark	Failed

That means, the laboratory applies, as decision rule (see ISO/IEC 17025:2017), the so called shared risk principle.

10 PHOTO REPORT

Please see separate photo report.